Laboratory Services Impression Evidence

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1. Scope

1.1. There are a variety of processes, physical and chemical, used to detect and enhance Footwear and Tire Track impressions. The following is an overview of physical means; photography, and chemicals and reagents used. *Appendix A* contains more detailed information on specific chemical processes that may be used. If an examiner uses another formulation, commercially available kit, or another technique not mentioned in *Appendix A*, the formulation and a reference for that formulation shall be cited in the case record. These processes are intended to be used by personnel who have received the training necessary to employ these methods. Examiners can determine what processing procedures are appropriate or acceptable in casework.

2. Procedures

2.1. There are many ways to collect questioned and known footwear and tire tracks. The chosen procedure will depend on the nature and quality of the evidence.

2.1.1. *Best Practices for the Preparation of Test Impressions from Footwear and Tires. ANSI/ASB Best Practice Recommendation 021, First Edition, 2019.*

2.1.2. *Best Practice Recommendation for Lifting of Footwear and Tire Impressions, ANSI/ASB Best Practice Recommendation 049, First Edition, 2020.*

2.1.3. *Best Practice Recommendation for Casting Footwear and Tire Impression Evidence at the Crime Scene, ANSI/ASB Best Practice Recommendation 126, First Edition, 2020.*

2.1.4. *Best Practice Recommendation for Photographic Documentation of Footwear and Tire Impression Evidence, ANSI/ASB Best Practice Recommendation 050, First Edition, 2021.*

3. Instrumentation/Reagents

3.1. The following equipment is generally used in the mixing, applying, and storing of chemical reagents: beakers, glass trays, graduated cylinders, magnetic stirrer and stirring bar, scales, squirt bottles, and storage bottles. Processes should be applied in a fume hood, and appropriate protective equipment should be worn. Development may require the use of a low level oven or humidity chamber. An alternate light source or LASER may be necessary to visualize present/developed/enhanced impressions. Refer to a specific process for the reagents needed to mix stock and working solutions.

3.2. Fingerprint powders, brushes, casting material, ink and ink roller, and lifting equipment and materials.

3. Safety Considerations

3.1. The procedures may involve the use of hazardous materials. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution should be exercised and the use of personal protective equipment should be utilized to avoid exposure to dangerous chemicals. Consult the appropriate SDS for each chemical prior to use.

4. Quality Assurance and Controls

4.1. A control sample demonstrates the effectiveness of a reagent. The control sample will be a substance on an appropriate surface for testing the reagent. Control samples can be generated at the time of testing a reagent, or they can be produced *en masse* for routine testing. When impressions are developed on the control sample, it will be noted in the appropriate logbook, and for casework, in the case record. A positive reagent check is required for the working solution to be used in casework. If the reagent check is negative (no impression developed), a second control sample will be processed. If the second check is positive, record the results in the logbook and case notes. The working solution will not be used in casework if there is a second negative reagent check.

4.2. Working solutions are tested after preparation and prior to use – if it has been more than one day since the solution was prepared.

4.3. A control sample will be included in the cyanoacrylate fuming chamber every time evidence is processed.

4.4. The use of reagents may interfere with other forensic examinations such as: inks, paper, handwriting, indented impressions, body fluids, fibers, and paint. Examiners will be aware of how chemical/physical processing may affect another discipline's examinations.

4.5. Follow all federal, state, and local disposal regulations.

Amido Black

Amido black, or naphthalene black 10B, is a protein indicator particularly sensitive to those proteins present in blood. While other techniques for the enhancement of blood impressions are available, they may pose serious health hazards or display a reaction for short durations. Amido black is a safer, permanent procedure which can be used on porous or non-porous surfaces. Amido black does prevent subsequent serological examination and therefore may only be used after serological examination of the evidence. However, Amido black can be applied after cyanoacrylate fuming in many cases (see McCarthy and Grieve, 1989).

Successful staining of the impression will result in a blue-black colored impression.

Ways to Fix Blood Prior to Processing

1. Bake the item at 100° C for 30 minutes. Heat-sensitive items may be baked at a lower temperature for a longer time.
2. Submerge the item in the following solution: 20 g 5-Sulfosalicylic acid dissolved in 1000 ml distilled water for 3-5 minutes.
3. For dried blood, soak the item in methanol for at least 10 minutes.

Working Solutions

Amido Black (Methanol Base) Working Solution

Dissolve 2.0 g of amido black 10B in 100 ml of glacial acetic acid.
Add 900 ml of methanol and thoroughly mix.

1st Rinse

Mix 100 ml of glacial acetic acid with 900 ml of methanol.

2nd Rinse

Distilled (or tap) water.

Shelf life

Working Solution: indefinite 1st Rinse: mix as needed

Storage

Working Solution: dark glass bottle

Procedure

1. Place the amido black 10B working solution into a tray large enough to accommodate the item being processed.
2. Completely immerse the item being processed for 30 seconds to 1 minute. The solution should be agitated before as well as during the evidence application.

3. 1st Rinse.
4. 2nd Rinse.

Ammonium Thiocyanate

Two dimensional impressions in dust or soil can be enhanced to make the impression more visible. Successful staining of the impression(s) will produce a reddish-brown colored impression (a reaction of iron with the dust or soil).

Working Solution

Combine 2.0 g ammonium thiocyanate with 90 ml acetone.
Slowly add 10 ml dilute nitric acid.

Shelf Life

Working Solution: 6 months

Storage

Working Solution: dark glass bottle

Procedure

1. Using a spray bottle, spray a fine mist onto the surface.
    a. If the surface is non-porous, be sure not to over spray the substrate to prevent the solution from running.

Cyanoacrylate Ester (Superglue) Fuming
Cyanoacrylate vapor, ethyl or methyl cyanoacrylate, polymerizes with some latent impressions to produce a white residue. The contrast of developed impressions may sometime be improved by the application of fluorescent dyes and/or powders.

Working Solution
Liquid cyanoacrylate ester (superglue).

Shelf life
Working Solution: indefinite

Storage
Working Solution: original container

Procedure
1. Place evidence in the superglue chamber. When appropriate, hang items or place loose items in processing baskets.
    a. If the chamber has UV capability, remove and secure the UV tubes.
2. Place enough superglue to cover the bottom surface of an aluminum dish then place it on the heating element in the superglue chamber.
3. Close and secure the chamber door.
4. Start the automatic cycle.
5. Remove evidence once the chamber door unlocks.
    a. If the chamber has UV capability, replace the UV tubes and run a UV cycle in the chamber.

LASER and Alternate Light Source Examination

Scientific instrumentation for the visualization of natural and chemical luminescence of latent impressions on physical evidence.

Procedure

1. Check instrument connection to electrical source.
2. Activate power and light source.
3. Select light source filter frequency (ALS).
4. Direct light wand towards evidence.
5. While wearing filter goggles, open the shutter and examine evidence for latent print luminescence. Close shutter when finished.

Leucocrystal Violet (LCV)

LCV is a reagent used to enhance and develop impressions deposited in blood. Successful staining of the impression will result in a violet colored impression. This reagent is sensitive to ultraviolet light and, within several days, the entire application area will turn violet – particularly if the background could not be rinsed. Developed impressions should be photographed as soon as possible.

Working Solution

Combine the following ingredients in the order listed and place on a stirring device for approximately 30 minutes.

1. 1000 ml hydrogen peroxide, 3%
2. 20 g 5-Sulfosalicylic acid
3. 7.4 g sodium acetate
4. 2.0 g LCV*

**If the LCV crystals are yellow instead of white, do not use them. This is an indication that the reagent is old and the resulting solution will not be effective.*

Shelf life

Working Solution: up to 30 days

Storage

Working Solution: dark glass bottle

Procedure

Spraying (most effective method of application)

1. Use the finest mist possible to spray LCV over the item.
2. Wait 30 seconds for development to occur.
3. Blot the area with a tissue or paper towel.
4. Repeat to improve contrast.
5. Do not leave processed item exposed to direct sunlight as photoionization may occur and result in unwanted background development.

Alternate application methods:

Dipping, or use of a squirt bottle.

Luminol

This reagent is best used on multi-colored or dark surfaces where other reagents will not produce an impression with sufficient contrast. A positive reaction will produce a blue white chemi-luminescence which appears almost immediately and fades rapidly. Spraying can be repeated during photography if necessary to maintain luminescence although this may result in degradation or washing away of the impression so care should be taken not to over spray the impression.

Working Solution

Dissolve 0.1 gram Luminol and 5.0 g sodium carbonate in 100 ml distilled water. Immediately before using the mixture, add 0.7 g sodium perborate and mix completely.

Shelf life

Working Solution: use immediately

Storage

Working Solution: dark glass bottle

Procedure

1. Apply the working solution with a non-metallic aerosol sprayer.
2. The working solution must be applied in total darkness to be visualized.

NOTE: This chemical does not have a fixative in it and the blood may run with continuous spraying.

Ninhydrin

Ninhydrin, or tri-keto-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 with older deposits with even minute amounts of amino acids. While ninhydrin can be used on any surface, normally processing is confined to porous items which have not subsequently become water-soaked or do not contain inherent animal proteins.

Working Solutions

Alternate Petroleum Ether Formula

1. Dissolve 5.0 g of ninhydrin in 30 ml of methanol
2. Add 40 ml of isopropanol
3. Add 930 ml of petroleum ether

Acetone formula

Dissolve 6.0 g of ninhydrin in 1.0 L of acetone

Shelf life

Working Solution: up to 1 year

Storage

Working Solution: dark glass bottle

Procedure

Dipping (preferred method of application)

1. In a tray large enough to accommodate the evidence, pour enough working solution to cover all of the items.
2. Completely immerse each item to be processed in the working solution until the item is completely saturated, usually five seconds or less. The item can be manipulated using tongs or forceps.
3. Remove and allow the item to dry completely.
4. Place the item in the heat/humidity chamber at no greater than 80 degrees centigrade and between 60% and 80% relative humidity.
5. Check the item periodically to monitor the impression development. Care should be taken not to saturate the item with water vapor.

Alternate application methods

Brushing, spraying, or use of a squirt bottle.

Larger items that will not fit conveniently into processing trays should be painted with

the ninhydrin solution using a soft bristle brush. Two inch to four-inch nylon paintbrushes are adequate. Care must be taken to apply an even and thorough amount to all surfaces. Applying ninhydrin via aerosolized spray cans or squirt bottles to items of evidence is also permissible.

Additional formulas are available for use (commercial and manual preparation) and are widely accepted.

Physical Developer

Physical developer is a product devised specifically for the examination of wetted or water soaked porous items. This technique is a method which utilizes silver nitrate in an unstable ferrous/ferric redox solution in combination with a detergent solution. Although this technique was developed for water soaked items, it can be used on any porous item – water soaked or not.

Water soaked or wetted papers rarely contain sufficient amounts of amino acids or salts for effective examination with normal porous surface processes.

Physical developer requires special care and exact adherence to procedures. Some glassware and utensils must be dedicated to the technique and reagent contamination must be avoided.

Stock and Working Solutions

Solution 1 – Maleic Acid Prewash

1. Pour 1000 ml of distilled water into a 1500 ml beaker.
2. Add 25 g of maleic acid and a large magnetic stir bar rinsed with distilled water.
3. Stir with a magnetic stirrer until all solids are dissolved.

Solution 2 – Buffered Ferrous/Ferric Redox Solutions

1. Pour 1000 ml of distilled water into a 1500 ml beaker
2. Rinse a large magnetic stir bar with distilled water and place in the beaker.
3. Add the following chemicals in the order given making sure each chemical is fully dissolved before adding the next:
   30 g of ferric nitrate
   80 g of ferrous ammonium sulfate
   20 g of citric acid

Stir until all chemicals are dissolved and then stir an additional five minutes.

Solution 3 – Stock Detergent Solution

1. Pour 1000 ml of distilled water into a 1500 ml beaker containing a large magnetic stir bar previously rinsed with distilled water.
2. Add 3.0 g of n-Dodecylamine Acetate and stir with a magnetic stirrer.
3. Add 4.0 g of Synperonic N.
4. Stir for thirty minutes.
5. Pour the solution into a 1000 ml glass bottle, transferring any material not yet dissolved.

Solution 4 – Silver Nitrate

1. Pour 50 ml of distilled water into a 100 ml beaker.
2. Add 10 g of silver nitrate and stir for one minute.

If using a magnetic stir bar, rinse with distilled water. The chlorine in tap water would combine with the silver nitrate and form a milky colored solution (silver chloride), rendering the solution unusable. Never use tap water for any of the working solutions.

Redox Working Solution
(must be combined in the order listed; mix in a beaker on a stirring device)

1. 1000 ml of Solution 2 (ferric redox)
2. 40 ml of Solution 3 (detergent)
3. 50 ml of Solution 4 (silver nitrate)
4. Mix for 3 – 5 minutes then place solution in a tray for processing.

Bleach Solution

1. The bleach solution is made by diluting household bleach at a ratio of 1:1 with tap water.

Shelf life

Solution 1: indefinite
Solution 2: indefinite
Solution 3: indefinite
Solution 4: indefinite
Redox working solution: mix as needed
Bleach solution: mix as needed

Storage

Solution 1: clear or dark glass bottles
Solution 2: clear or dark glass bottles
Solution 3: clear or dark glass bottles
Solution 4: dark bottles

Procedure

Step 1 – Maleic Acid Prewash:

1. Pour enough maleic acid prewash to cover the item that is being processed into a glass tray.
2. Immerse the item in the solution for at least five minutes, or until bubbles are no longer given off.

Step 2 – Redox Working Solution:

1. Pour enough Redox Working Solution to cover the items being processed into a glass tray.
2. Drain the items of excess prewash.
3. Immerse the items in the working solution and gently rock the tray.
4. Keep the items separated and be careful not to crease or handle the items extensively.
5. The processing time will vary from 5 to 15 minutes. It is important to monitor the development very closely to avoid over processing and obliteration of weaker impressions. Remove the item when optimum contrast is observed.

Step 3 – Water Rinse:

1. Fill a glass tray with enough tap water to cover the processed items.
2. Place processed items into the water rinse and agitate to remove the Redox Working Solution.
3. Continue until items are not releasing Redox Working Solution into the water.

Step 4 – Bleach Solution (optional – should be used when trying to improve the contrast of darker impressions):

1. Place the item in bleach solution for approximately 15 seconds.
2. Rinse the item under running tap water for at least one minute.

Step 5 – Drying:

1. Allow the items to air dry on a flat surface. The items may be blotted carefully to speed the drying process taking care with fragile evidence.

Potassium Thiocyanate

Two dimensional impressions in dust or soil can be enhanced to make the impression more visible. Successful staining of the impression(s) will produce a reddish-brown colored impression (a reaction of iron with the dust or soil).

Working Solution

Combine 15 g potassium thiocyanate with 120 ml acetone and 15 ml water.
Slowly add 8.5 ml dilute sulfuric acid.
Let the milky solution stand until it separates into two layers.
Decant the top layer off (and dispose of the bottom layer).

Shelf Life

Working Solution: 6 months

Storage

Working Solution: dark glass bottle

Procedure

1. Using a spray bottle, spray a fine mist onto the surface.
    a. If the surface is non-porous, be sure not to over spray the substrate to prevent the solution from running.

Powders

Fingerprint powders and particulate developers are very fine particles with an affinity for moisture. Palmar sweat, grease, oil, and most contaminants that coat the surface of friction ridge skin possess sufficient moister and viscosity to attract and bind the fine particles together. Contact between friction ridge skin and a non-porous surface will sometimes result in a transfer of the skin coating to that surface. The non-absorbency of the surface prevents penetration by the deposited moisture. All fingerprint powders and particulate developers are indiscriminate in adhesion to moisture. Surfaces coated with residue in addition to suspected latent prints will attract powders and particulate developers throughout the surface.

The most effective agent in terms of adherence to moisture, non-adherence to dry surfaces, particle size, shape, uniformity, and intensity of color is carbon. Black powders generally produce the best results. Other colored powders may be required due to the substrate encountered, but should be restricted to absolute necessity.

Magnetic powders are powder-coated, fine iron filings subject to magnetic attraction. These adhere to moisture to a lesser degree than carbon powders, but can be applied with less destructive force to the surface.

Particulate developers are substances which produce extremely fine particle residue upon burning. Materials with a high hydrocarbon content such as camphor, pine knots, or crumbled masking tape burn slowly and release soot in large quantities. Fine particulate carbon soot adheres extremely well to more viscous moisture while heat from the flame softens the residue. White or light colored soot may be produced by burning magnesium ribbon.

Most commercial black fingerprint powders have a high carbon base. According to the manufacturer's particular formula and production methods, the carbon base may be from a variety of sources, including lamp black, bone, or wood charcoal. Ground carbon alone cannot match the adhesion ability of fine particle carbon soot, but commercial powders contain milled carbon of highly uniform size and shape along with additional ingredients to preserve the milled condition and retard air moisture absorption.

No specific preparations are needed as the powders and materials being used are available commercially prepared.

DNA collection should always be a consideration when using powder. It is recommended to remove a small amount of powder from the container for use, and then throwing it away when finished. Single-use powders and brushes are commercially available, and should be used as needed in casework.

Shelf life
indefinite

Storage
original containers

Procedure

Nonmagnetic Powders

1. Remove the needed amount of powder from the storage container.
2. Dip the tip of the brush bristles into the powder.
3. Tap the excess powder onto the surface of the item being processed, and begin to brush.
4. Brush in the direction of developing ridges.
5. Slowly build powder onto ridges and stop when there is sufficient development.

Magnetic Powders

1. Remove the needed amount of powder from the storage container.
2. Place magna wand, with magnet engaged, into the powder.
3. Move the wand in a circular motion over the surface of the item being processed. The powder should touch the surface, never the wand.
4. Once development has occurred, release the attached powder back into the pile removed from the storage container.

Rhodamine 6G

Rhodamine 6G is a supplemental processing procedure designed to enhance faint or indistinct impressions developed by superglue fuming. Rhodamine 6G has an affinity for adhesion to polymerized latent impressions even at levels below visual observation. Excitation of Rhodamine 6G with the 488 nm, 510 nm, 514.5 nm, or 532 nm lines of the laser produces extremely bright fluorescence at about 550 nm.

Stock and Working Solutions

Petroleum Ether Carrier Formula

Stock Solution: dissolve 1.0 g Rhodamine 6G in 1000 ml of methanol.

Working Solution:

Mix in order:

3.0 ml stock solution
15 ml acetone
10 ml acetonitrile
15 ml methanol
32 ml isopropanol
925 ml petroleum ether

Methanol/Isopropanol Formula

Dissolve 0.1 g of Rhodamine 6G in 1000 ml of methanol or isopropanol.

Aqueous Formula

Dissolve 0.1 g of Rhodamine 6G in 1000 ml of distilled water.

Shelf life

Stock Solution: indefinite

Working Solutions: up to 6 months

Storage

Stock Solution: dark glass bottle

Working Solution: dark glass bottle

Procedure

1. Apply the solution to the item of evidence by using a squirt bottle or immersion.
2. Allow to dry completely.
3. Examine the item using a laser or other alternate light source.

Small Particle Reagent (SPR)

Small particle reagent was devised and refined by the British Home Office as an effective procedure for processing wet surfaces. Both porous and non-porous, which are wet at the time of the latent deposit and those that become wet after deposit, seldom retain sufficient water soluble material for conventional processing methods. Non-porous items which have been allowed to dry offer some potential if the deposit contains non-water soluble oily matter. However, the drying process lessens the possibility of adequate adhesion for powders or particulate.

SPR is very effective in the secondary treatment of cyanoacrylate ester developed impressions by adhering to faint impressions generally better that powders and particulate. Molybdenum disulfide is produced in various particle sizes. Smaller particle size is the most effective.

Stock and Working Solutions

Surfactant Stock Solution

1. Dissolve 8.0 ml of Tergitol 7 in 500 ml of distilled water.

This will make approximately 10 L of working solution.

SPR Suspension Working Solution

1. Add 10 g of molybdenum disulfide to 5.0 ml of the Surfactant Stock Solution stirring slowly.
2. Continue to stir until the mixture is of a creamy consistency and free of any dry powder.
3. Stir in 900 ml of distilled water.

Shelf life

Stock Solution: indefinite

Working Solution: up to 6 months

Storage

Stock Solution: dark bottle

Working Solution: bottle

Procedure

Immersion Technique

1. Shake the working solution well and place in a shallow tray. Pour in enough solution to cover the item being processed.
2. Stir again before placing the item into the solution.
3. Place the item being processed into the solution.
4. Allow the item to remain in the suspension long enough for the molybdenum particles to settle on the item (approximately 30 seconds).
5. Turn the item and leave for an additional 30 seconds.
6. Continue, repeating stems 4 and 5 above until all surfaces of the item have been exposed to the solution.

7. Place the item into a tray of tap water and rock until the excess SPR is removed.
8. Allow the item to dry.

Spray Bottle Application

1. Using a spray bottle, disperse enough SPR to cover the item.
2. Wash off excess SPR by running the item under a slow flow of tap water.
3. Allow the item to dry.

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1. Scope

1.1. These guidelines will ensure that Laboratory Services case records contain examination documentation that support the reported findings in a way that in the absence of the primary examiner, another qualified examiner in the discipline or supervisor could evaluate what was done and interpret the data.

1.2. These guidelines establish the methodology used in the examination of footwear and tire track impressions.

1.3. These guidelines establish the acceptable conclusions that can be reached from the comparison of footwear and tire track impressions.

1.4. The following are applicable to all case records generated by Laboratory Services examiners who examine footwear and tire track impression evidence.

1.4.1. *United States Department of Justice Uniform Language for Testimony and Reports for the Forensic Footwear Discipline.*

1.4.2. *United States Department of Justice Uniform Language for Testimony and Reports for the Forensic Tire Discipline.*

2. Procedure for Documentation

2.1. Inventory

2.1.1. The inventory of a questioned footwear or tire impression should be conducted prior to the inventory of a known footwear or tire.

2.1.2. Note collection information, if available (e.g., date of recovery, location, recovery methods).

2.2. Analysis

2.2.1. The analysis of a questioned footwear or tire impression shall be conducted prior to the analysis of a known footwear or tire in each step of the method when possible (e.g., general tread, size, wear, randomly acquired characteristics (RACs)).

2.2.2. Documentation of the analysis of footwear or tire impressions includes:
sample preparation;
date of collection;

examination quality photographs of questioned impression(s) and photographs of known(s);
processing techniques of questioned impression(s);
questioned impression(s):
- § quality;
- § class characteristics (e.g., manufacturing information, observed features);
- § interferences/limitations;
- § potential randomly acquired characteristics (RACs);

known footwear or tire(s):
- § condition of outsole or tread;
- § class characteristics (e.g., manufacturing information, observed features);
- § interferences/limitations;
- § RACs of use;
- § test impressions;
- § manner in which they were prepared;
- § matrix;
- § substrate.

2.2.3. Documentation shall correspond to the complexity of the examination and include markings of class characteristics and RACs of use where applicable.

2.3. Comparison

2.3.1. Documentation of comparison shall correspond to the complexity of the examination and should include markings of correspondence and non-correspondence, where applicable.

2.3.2. Documentation includes:
method of comparison (e.g., side-by-side, overlay);
class characteristics and RACs (if reproduced).

2.4. Evaluation

2.4.1. Documentation of evaluation includes:
identifier of examiner;
date;
identification of items used;
conclusion/interpretation reached, including justification.

2.5. Verification

2.5.1. Documentation of the verification corresponds to the complexity of the examination and includes:

signature and date of verifying examiner;
method of verification;
items examined;
conclusion/interpretation reached including justification.

3. Methodology

3.1. Analysis

3.1.1. Examination of questioned impression conducted to determine suitability for comparison. The quantity (how much of the impression is present) and the quality (clarity) of the detail are assessed and are dependent on a number of factors, including, but not limited to, the substrate, interferences, and the presence or absence of scales.

3.2. Comparison

3.2.1. The direct, side-by-side, and/or superimposed examination of a questioned impression to a known item to determine whether there is correspondence in class characteristics (e.g., outsole design, physical size, and wear) and/or randomly acquired characteristics.

3.3. Evaluation

3.3.1. Formulation of a conclusion based on the analysis and comparison of the questioned impression and known item.

3.4. Verification

3.4.1. Independent application of the ACE methodology by another qualified examiner.

4. Conclusions

4.1. Source identification (i.e., Identified)

4.1.1. ‘Source Identification’ is an examiner’s conclusion that the known footwear/tire item made the questioned impression. This conclusion is an examiner’s opinion that the known footwear/tire item and the questioned impression have corresponding

class characteristics (i.e., outsole design, physical size, and wear) and one or more randomly acquired characteristics with no meaningful differences, and the observed corresponding characteristic are sufficient such that an examiner would not expect to see the same combination of characteristics repeated in a different footwear/tire item.

4.1.2. The basis for a *source identification* conclusion is an examiner's opinion is that the observed corresponding characteristics provide extremely strong support for the proposition that the known footwear/tire item made the questioned impression and extremely weak support for the proposition that a different footwear/tire item made the questioned impression.

4.1.3. A *source identification* is the statement of an examiner's opinion (an inductive inference) that the probability that a different footwear/tire item made the questioned impression is so small that it is negligible.

4.2. Inclusion based on class and randomly acquired characteristics (i.e., Included)

4.2.1. 'Inclusion based on class and randomly acquired characteristics' is an examiner's conclusion that the known footwear/tire item probably made the questioned impression. This conclusion is an examiner's opinion that the known footwear/tire item and the questioned impression have corresponding class characteristics and one or more randomly acquired characteristics with no meaningful differences; however, there are limitations associated with the evidence that prevent a *source identification* opinion. For another footwear/tire item to have made the questioned impression, it would have to exhibit the same observed corresponding characteristics.

4.2.2. The basis for an *inclusion based on class and randomly acquired characteristics* conclusion is an examiner's opinion that the observed corresponding characteristics provide strong support for the proposition that the known footwear/tire item made the questioned impression and weak support for the proposition that a different footwear/tire item made the questioned impression.

4.3. Inclusion based on class characteristics (i.e., Included)

4.3.1. 'Inclusion based on class characteristics' is an examiner's conclusion that the known footwear/tire item could have made the questioned impression.

4.3.2. The basis for an *inclusion based on class characteristics* conclusion is an examiner's opinion that the known footwear/tire item and questioned impression have observed corresponding class characteristics with no meaningful differences.

There may be other footwear/tire items with characteristics that are indistinguishable from the known footwear/tire item that could have also made the questioned impression.

4.4. Inconclusive

4.4.1. 'Inconclusive' is an examiner's conclusion that no determination can be reached as to whether the known footwear/tire item could or could not have made the questioned impression.

4.4.2. The basis for an *inconclusive* conclusion is an examiner's opinion that there are limitations associated with the evidence that prevent an examiner from either including or excluding the known footwear/tire as a possible source of the questioned impression.

4.5. Support for exclusion

4.5.1. 'Support for exclusion' is an examiner's conclusion that the known footwear/tire item probably did not make the questioned impression. This conclusion is an examiner's opinion that the known footwear/tire item and questioned impression have different class characteristics and/or randomly acquired characteristics; however, there are limitations associated with the evidence that prevent an examiner from reaching *source exclusion* conclusion.

4.5.2. The basis for a *support for exclusion* conclusion is an examiner's opinion that the observed characteristics provide strong support for the proposition that a different footwear/tire item made the questioned impression and weak support for the proposition that the known footwear/tire item made the questioned impression.

4.6. Source exclusion (i.e., Excluded)

4.6.1. 'Source exclusion' is an examiner's conclusion that the known footwear/tire item did not make the questioned impression. This conclusion is an examiner's opinion that the known footwear/tire item and questioned impression have different class characteristics and/or randomly acquired characteristics.

4.6.2. The basis for a *source exclusion* conclusion is an examiner's opinion that the observed characteristics provide extremely strong support for the proposition that a different footwear/tire item made the questioned impression and extremely weak or no support for the proposition that the known footwear/tire item made the questioned impression.

5. References

5.1. Bodziak, W., *Footwear Impression Evidence: Detection, Recovery and Examination*, 2nd ed., CRC Press, Inc., 2000.

5.2. Bodziak, W., *Tire Tread and Tire Track Evidence*, CRC Press, Inc., 2008.

5.3. Cassidy, M., *Footwear Identification*, Canadian Gov. Pub., 1980.

5.4. McDonald, P., *Tire Imprint Evidence*, CRC Press, Inc., 1992.

5.5. Nause, L., *Forensic Tire Impression Identification*, RCMP.

1. Scope

1.1. This document establishes the acceptable reporting of conclusions for the comparison of footwear and tire track impressions. It is applicable to all Laboratory Services Forensic Science Laboratories.

2. Comparison conclusions

2.1. The following interpretation scale, in italics below, will be included as an appendix to comparative reports.

The following descriptions are meant to provide context to the opinions reached in this report. Not every type of conclusion may be applicable in every report.

Source Identification *(i.e., Identified) is an examiner's conclusion that the known footwear/tire item made the questioned impression. This conclusion is an examiner's opinion that the known footwear/tire item and the questioned impression have corresponding class characteristics (i.e., outsole design, physical size, and wear) and one or more randomly acquired characteristics with no meaningful differences, and the observed corresponding characteristic are sufficient such that an examiner would not expect to see the same combination of characteristics repeated in a different footwear/tire item.*

The basis for a source identification conclusion is an examiner's opinion is that the observed corresponding characteristics provide extremely strong support for the proposition that the known footwear/tire item made the questioned impression and extremely weak support for the proposition that a different footwear/tire item made the questioned impression.

A source identification is the statement of an examiner's opinion (an inductive inference) that the probability that a different footwear/tire item made the questioned impression is so small that it is negligible.

Inclusion based on class and randomly acquired characteristics *(i.e., Included) is an examiner's conclusion that the known footwear/tire item probably made the questioned impression. This conclusion is an examiner's opinion that the known footwear/tire item and the questioned impression have corresponding class characteristics and one or more randomly acquired characteristics with no meaningful differences; however, there are limitations associated with the evidence that prevent a source identification opinion. For another footwear/tire item to have made the questioned impression, it would have to exhibit the same observed corresponding characteristics.*

The basis for an inclusion based on class and randomly acquired characteristics conclusion is an examiner's opinion that the observed corresponding characteristics provide strong support for the proposition that the known footwear/tire item made the questioned impression and weak support for the proposition that a different footwear/tire item made the questioned impression.

Inclusion based on class characteristics *(i.e., Included) is an examiner's conclusion that the known footwear/tire item could have made the questioned impression.*

The basis for an inclusion based on class characteristics conclusion is an examiner's opinion that the known footwear/tire item and questioned impression have observed corresponding class characteristics with no meaningful differences. There may be other footwear/tire items with characteristics that are indistinguishable from the known footwear/tire item that could have also made the questioned impression.

Inconclusive *is an examiner's conclusion that no determination can be reached as to whether the known footwear/tire item could or could not have made the questioned impression.*

The basis for an inconclusive conclusion is an examiner's opinion that there are limitations associated with the evidence that prevent an examiner from either including or excluding the known footwear/tire item as a possible source of the questioned impression.

Support for exclusion *is an examiner's conclusion that the known footwear/tire item probably did not make the questioned impression. This conclusion is an examiner's opinion that the known footwear/tire item and questioned impression have different class characteristics and/or randomly acquired characteristics; however, there are limitations associated with the evidence that prevent an examiner from reaching source exclusion conclusion.*

The basis for a support for exclusion conclusion is an examiner's opinion that the observed characteristics provide strong support for the proposition that a different footwear/tire item made the questioned impression and weak support for the proposition that the known footwear/tire item made the questioned impression.

Source exclusion *(i.e., Excluded) is an examiner's conclusion that the known footwear/tire item did not make the questioned impression. This conclusion is an examiner's opinion that the known footwear/tire item and questioned impression have different class characteristics and/or randomly acquired characteristics.*

The basis for a source exclusion conclusion is an examiner's opinion that the observed characteristics provide extremely strong support for the proposition that a different footwear/tire item made the questioned impression and extremely weak or no support for the proposition that the known footwear/tire item made the questioned impression.

3. References

3.1. *United States Department of Justice Uniform Language for Testimony and Reports for the Forensic Footwear Discipline.*

3.2. *United States Department of Justice Uniform Language for Testimony and Reports for the Forensic Tire Discipline.*

1. Scope

   1.1. These guidelines will ensure that Laboratory Services case records contain examination documentation that support the reported findings in a way that in the absence of the primary examiner, another qualified examiner in the discipline could evaluate what was done and interpret the data.

   1.2. These guidelines establish the methodology used in the examination of fabric impressions.

   1.3. Fabric Impressions: Fabric impressions occur from the transfer of a fabric's construction pattern (i.e., weave, twill, stitching, seams) to the surface of another object. Impressions can be produced when the fabric leaves behind some material (i.e., blood, grease, dirt) on the receiving object, or when a fabric removes a material from the receiving object. A three-dimensional impression is produced when a fabric is pressed into the receiving object to the extent that it embeds into the material (e.g., impression in mud). The process of analyzing impressions is a step-by-step methodical approach that uses class and randomly acquired characteristics found in known and unknown impressions.

2. Instrumentation/Reagents

   2.1. Camera or other imaging equipment

   2.2. Casting material

   2.3. Fingerprint powders and brushes

   2.4. Ink and ink roller

   2.5. Lifting equipment and materials

   2.6. Stereomicroscope (*ATF-LS-TE02)*

   2.7. UV Light or alternative light source

3. Safety Considerations

   3.1. The examiner shall follow biohazard procedures and use universal precautions.

4. Procedure or Analysis

4.1. For general processing guidelines for any possible trace evidence within a fabric impression or known fabric, see *ATF-LS-TE00 Standard Approach for Examinations of Trace Evidence*.

4.2. Fabric Impressions

4.2.1. All examinations, relevant observations, and results shall be documented in the examination records and support conclusions reached. If at any time during the comparative scheme of analysis an exclusionary difference is observed between the Q and the K samples, no further examinations need to be conducted, and the samples can be reported as being dissimilar to one another.

4.2.2. Detection/Collection/Processing: Impressions can be submitted to the laboratory in various forms (e.g., digital images, impressions on objects, lifts, casts). These impressions will be observed using oblique light, alternative light source, and/or digital, chemical, or physical enhancement. They may be captured using photography, scanning, lifting, and/or casting. They may also be processed digitally, physically, and/or chemically, to prepare for examination and/or optimize visibility. See also *ATF-LS-I1 Detection and Collection of Footwear and Tire Tracks* and *ATF-LS-I1 Appendix A - Processing*.

4.2.3. Suitability: The unknown impression needs to be assessed to determine whether it is suitable for comparison. Unsuitable impressions lack sufficient detail and will prevent meaningful comparisons with a known source. The quantity (how much of the impression is present) and quality (clarity) of detail are assessed. This assessment is dependent on several factors such as the substrate, interferences, and the presence or absence of scales. These factors may limit or qualify an examiner's conclusions.

4.2.4. Comparison: To compare a questioned impression to a known fabric, clear and detailed test impressions should be made with the known. The purpose of creating known test impressions is to record the characteristics of the fabric. Prior to making known impressions, the examiner should recognize and preserve other relevant physical evidence as well as document and photograph the original condition of the fabric. The case specifics will determine the number and types of impressions to be made.

4.2.4.1. The comparison can be a side-by-side comparison and/or a superimposed observation of the unknown impression with the known fabric impression.

4.2.4.1.1. Class characteristics such as specific design, weave, spacing, manufacturing characteristics and shape of the design, are evaluated and compared.

4.2.4.1.2. Randomly acquired characteristics (RACS) are evaluated according to their position, size, shape, orientation, and clarity. RACS shall be confirmed on the fabric itself when possible.

4.2.4.1.3. When sufficient RACS are present in the unknown impression and correspond with features on the known object, a Type I Inclusion can be made.

4.2.4.1.4. See *ATF-LS-TE16 Report Writing* for the interpretations and report wording for fabric impressions.

4.2.4.2. All comparisons are evaluated by a second qualified examiner (verifier). Verifications shall be documented in the technical record in accordance with *ATF LS 7.7 Section 2.6 Casework Verification*.

4.9 Fabric Impression Comparison Interpretations

The following are examples of how the interpretation scale is applied to fabric impressions.

Type I Inclusion: Source Identification

Items share a combination of class characteristics and randomly acquired characteristics that demonstrates the questioned impression(s) were made by the known item

Type II Inclusion: Inclusion with highly discriminating characteristics

Some distinctive characteristics
- Small hole

Type III Inclusion: Inclusion with discriminating characteristics

Items correspond in all class characteristics.
Common construction (twill pattern) with seams, unusual construction patterns, airbag singe patterns designating driver or passenger side airbag

Type IV Inclusion: Inclusion with limitations

Limiting factors in the impression or photograph

- Scale is not present or 1:1

Common construction (twill pattern in blue jeans)

Inconclusive

Interference from substrate
Limited sample size
Lack of characteristics

Exclusion with Limitations

The questioned impression exhibits some dissimilarities to the known exhibit but lacks sufficient quality or detail.

Exclusion

Differences in pattern or spacing

5. Quality Assurance and Controls

5.1. Quality is assured through the proper training and testing of examiners, the laboratory's technical review process, and the use of appropriate equipment that is maintained and performance checked.

5.2. The techniques described above for textile examinations are well known and scientifically accepted in the forensic community and private industry. Relevant examples of related literature can be found in Section 7 (References).

6. Report Wording

If fabric impressions are not on the laboratory's ANAB scope, then the ANAB logo will be removed from the final report.

Additional information regarding listing of techniques used in reports as well as statements regarding activity level can be found in *ATF-LS-TE16-Report Writing for Trace (Materials).* The following examples are meant to give guidance with regards to report wording for textile examinations.

6.1. COMPARISON of fabric impressions

The following examples are meant to give guidance with regards to report wording; however, exact wording should be left to the discretion of the examiner.

Type I Inclusion: Source Identification

*The fabric impression from Exhibit 2 corresponded in construction, weave, and the presence of multiple holes to the known fabric from the Exhibit 1 jeans. Therefore, the Exhibit 1 jeans are the source of the fabric impression in Exhibit 2 (**Type I Inclusion**). This conclusion was reached because these distinct characteristics would not be expected to be repeated in another source.*

Type II Inclusion: Inclusion with highly discriminating characteristics

*The impression from Exhibit 1 corresponded in construction and weave to the known shirt in Exhibit 2. In addition, there was an outline of a small hole found in both the Exhibit 1 impression and the known shirt/badge in Exhibit 2. Therefore, the Exhibit 1 impression could have been made by the Exhibit 2 known shirt or another source having the same highly discriminating characteristics (**Type II Inclusion**).*

Type III Inclusion: Inclusion with discriminating characteristics

*The Exhibit 1 impression corresponded in construction and weave pattern as well as seam lines to the known pair of pants in Exhibit 2. Therefore, the known pants in Exhibit 2 could be the source of the impression in Exhibit 1 (**Type III Inclusion**). This type of conclusion was reached because other items (can list item type) may have been manufactured to the same specifications that would be indistinguishable from the submitted evidence.*

Type IV Inclusion: Inclusion with limitations

*The known shirt in Exhibit 2 corresponded in construction and weave pattern to the partial fabric impression in Exhibit 1. Therefore Exhibit 2 could be the source of the Exhibit 1 impression, however this association is limited due to the commonality of the fabric construction [or other limitation] in the Exhibit 1 impression (**Type IV Inclusion**). This type of conclusion was reached because other items (can list item type) may have been manufactured to the same specifications that would be indistinguishable from the submitted evidence.*

Inconclusive

*The photographs on the Exhibit 1 CD contained images of a fabric impression, however the substrate that the impression was on interfered with the pattern. Therefore, no conclusion can be reached as to the source of the questioned impression (**Inconclusive**).*

Exclusion with Limitations

*Exhibit 1 has a similar pattern to the questioned impression from Exhibit 2, but there were minor differences [list differences] in the pattern and therefore, Exhibit 1 may not be the source (**Exclusion with Limitations**).*

*The pattern seen in the questioned impression shows some similarity to the known item, however, test impressions made with the known could not replicate the exact pattern. Therefore, it is unlikely that the known pants made the questioned impression (**Exclusion with Limitations**).*

Exclusion

*The pattern seen in the Exhibit 1 questioned impression was different from the known fabric from Exhibit 2 and therefore, can be excluded as being a possible source for the Exhibit 1 impression (**Exclusion**).*

7. References

7.1. OSAC Registry Standards

ASTM E2225 Standard Guide for Forensic Examination of Fabrics and Cordage

7.2. ANSI/ASB Standards

Best Practice Recommendation 021, Best Practices for the Preparation of Test Impressions from Footwear and Tires

Best Practice Recommendation 049, Best Practices for Lifting of Footwear and Tire Impressions

7.3. ASTM International Standards

ASTM E1459 Standard Guide for Physical Evidence Labeling and Related Documentation

ASTM E1492 Standard Practice for Receiving, Documenting, Storing and Retrieving Evidence in a Forensic Science Laboratory

7.4. Scientific Working Group for Materials Analysis (SWGMAT) Documents found at htpp://www.asteetrace.org

Forensic Fiber Examination Guidelines

"Introduction to Fibers Chapter" (2011 Update)

"Microscopy Chapter" (2011 Update)

"UV-VIS Spectroscopy of Textile Fibers Chapter" (2011 Update)

7.5. Others

Gaudette, B.D. In Forensic Science Handbook; Saferstein, R., Ed.; Prentice Hall: Englewood Cliffs, N.J., 1988; Vol. II, Chapter 5

Robertson J, Grieve M. Forensic Examination of Fibres 2nd Edition, Taylor & Francis, 1999.

Schubert, Glenn, "Fabric Impression Workshop" PowerPoint presentation from IPES located on Trace FSL Shared Folder.