Ada County Sheriff's Office

Forensic Lab

Track Mark Analytical Method

Version 1.0

1.0 **Scope**

1.1 This analytical method specifies procedures to follow during laboratory development, collection, and preservation of track mark impressions. Forensic track mark impressions include, but is not limited to, footwear impressions, tire impressions, and fabric impressions.

1.2 This analytical method specifies procedures to follow during analysis, comparison, evaluation, and verification of track mark impressions.

1.3 This analytical method is intended to be followed to ensure the highest level of quality and safety for track mark processing and comparison.

2.0 References

ACSO Policy Manual

Ada County Forensic Crime Lab Quality Assurance Manual

Ada County Forensic Crime Lab Health and Safety Manual

SWGTREAD

SWGIT Sections 6, 8, and 11

3.0 Terms and Definitions

3.1 Adhesive lifter
Any of a variety of adhesive coated materials or tapes used for lifting track evidence.

3.2 Attenuated light
Supplemental light that is added when photographing luminol enhancements. The light is sufficient to allow for the exposure on the film of the object being photographed but not to significantly interfere with the photography of luminol.

3.3 Casting
The filling of a three - dimensional impression with material that takes on and retains the characteristics which were left in that impression.

3.4 Class characteristics
An intentional or unavoidable characteristic that repeats during the manufacturing process and is shared by one or more other products.

3.5 Combined class characteristics
The combination of two or more independent class characteristics.

3.6 Deformable impression
An impression that causes the surface to deform, either permanently or temporarily. Permanent deformable impression would include those impressions in sand, soil, and snow whereas a temporarily deformed impression would include those on skin or carpet.

3.7 Dental stone
A gypsum product. Similar to Plaster of Paris, but with different properties due to the manufacturing process.

3.8 Distortion
An unclear or inaccurate representation of a mark due to interference with the impression marking process or the retrieval.

3.9 Documentary Images
Images taken to represent visual observations only, and at the time of acquisition, not intended to be used for comparative analysis. Examples may include: recording observations regarding evidence packaging, labels, overall images of an item of evidence, etc.

3.10 Dry origin
An impression that contained no moisture, either from the object or the substrate, and which has remained free of moisture.

3.11 Electrostatic lifting device
A device consisting of a high-voltage supply used with a special conductive film to electrostatically transfer a dry impression from the substrate to the film.

3.12 Enhancement
Rendering an impression more clear or more visible through physical, electronic, photographic, or chemical means.

3.13 Examination quality Image

Examination Quality (EQ) Images are intended at the time of acquisition to capture the maximum amount of detail with a minimum amount of distortion for use in comparisons and/or to preserve transient impressions that may be damaged or unintentionally altered through evidence handling, transport, or time. Examination quality images may be either unaltered original images or images that have been enhanced with photo editing software such as Photoshop.

3.14 Fixative

A spray or powder applied cautiously to a three-dimensional footwear impression prior to casting. It assists in the release of the substrate material from the cast.

3.15 Gelatin lifter

A gelatin material laid on a pliable backing that can be applied to a surface to lift an impression. The lifters can be white, black, or clear.

3.16 Identifying characteristics

A particular characteristic resulting from something randomly added or removed from a surface (shoe sole or other) and which causes or contributes to making that surface unique. (examples: cuts, burns, scratches) Also referred to as Accidental, Randomly Acquired, or Individual Characteristics.

3.17 Known (standard)

An object of known origin that is compared to a questioned mark.

3.18 Lift

To transfer an impression from its original surface to a surface having better contrast.

3.19 Oblique light

Light that is positioned at a low angle of incidence relative to the surface being photographed. Also referred to as side lighting.

3.20 SEARCH (MAKE/MODEL or CASE-to-CASE)

An individual attempt to find a similar make/model or similar case record. (Examples: visual search of one volume of the Tread Design Guide, a single search of the SICAR database using a particular combination of codes)

3.21 SEARCH PROCESSES (MAKE/MODEL or CASE-to-CASE)

The combination of all searches performed in reaching the final conclusion regarding a make/model or case-to-case search.

3.22 Test impression

An impression made utilizing a known object for the purpose of comparing it to a questioned impression.

3.23 Three-dimensional impression

An impression with the dimension of length, width, and depth.

3.24 Two-dimensional impression

An impression which for all practical purposes has only length and width and not depth.

3.25 Wear

The erosion of the outsole due to frictional and abrasive forces that occur between the outsole and the ground.

3.26 Wear characteristics

Changes in the surface of the outsole that are observable in the impression and/or the known shoe and that reflect the erosion of the surface of the outsole.

3.27 Wear pattern

The position of wear on a shoe(s).

3.28 Wet origin

An impression containing moisture, contributed by either the object and/or surface. Although a wet impression will dry, it is still an impression of wet origin.

4.0 Management Requirements

4.1 to 4.12 **See Ada County Sheriff's Office Forensic Crime Lab Quality Assurance Manual**

4.13 **Technical Records**: Track mark documentation is extremely important to provide a detailed record of tests performed, conclusions, and allow for independent review by other experts.

4.13.1 **General**

4.13.1.1 Track mark documentation includes a combination of notetaking, photographing, and diagramming.

4.13.1.2 If multiple forensic scientists conduct casework, each analyst shall document the tests they performed, reagent lot numbers used, controls, specific areas or items tested, and the equipment they utilized. Each analyst shall produce a separate report for the work that they performed.

4.13.1.3 Photographs of examination quality shall be maintained as a digital record. Digital records shall be contained within the Laboratory Management System (LIMS).

4.13.2 **Technical records**

4.13.2.1 All original documentation shall be retained. Original documentation can be retained through scanning in a digital file and maintaining this file in the LIMS.

4.13.2.2 Impression processing documentation shall include:

the test performed
the outcome of any control performed
the conclusion of each test.
the location of a developed impression that is suitable for analysis
the identifier of a developed impression that is suitable for analysis

4.13.2.3 Impression examination documentation shall include if known:

the identifier of the examined impression
the comparison conclusion

4.13.2.4 Verifications of impression examinations shall be documented in the technical records to allow determination of the impression verified, the verifier, and the date verified.

4.13.3 **Photography and Imaging**

4.13.3.1 General Photography

4.13.3.1.1 Impressions developed in the lab can be captured by photographing or scanning.

4.13.3.1.2 Examination quality impressions shall be captured in a loss less digital format or a high quality JPEG at a resolution of at least 1000 ppi. If an image is captured as a JPEG it should be saved as a TIFF before processing further.

4.13.3.1.3 All impressions of examination quality that are not developed in the lab shall be saved in a loss less format as soon as practicable.

4.13.3.1.4 A scale shall appear in the photograph or scan and an attempt to fill the frame should be made.

4.13.3.2 Digital image enhancement

4.13.3.2.1 Image processing shall only be conducted on a working copy of the original image.

4.13.3.2.2 A history of the image processing shall be maintained.

4.13.3.2.3 Images, both processed and original, shall be stored in a secure format. This is usually done through the LIMS.

5 Technical Requirements

5.1 General:

Track Mark processing and comparison are a combination of both laboratory procedures and analytical examination. Processing may require a sequencing of techniques to develop impressions that are then analyzed for value to compare.

5.2 Personnel

5.2.1 A forensic scientist may perform track mark processing and a separate forensic scientist may perform analytical examination.

5.3 Accommodation and Environmental Conditions

5.3.1 Safety

Refer to the Health and Safety Manual.

5.4 Testing Methods

5.4.1 Track Mark Detection and Preservation

5.4.1.1 General

Track mark impressions can be developed and preserved through a variety of methods depending on the matrix of the deposited impression and the substrate. The following lists provide guidelines on the sequencing of methods based on the matrix and substrate:

General Evidence:

Porous

1. **Visual**
2. **Alternate light source (ALS)**
3. **Electrostatic Dust Lift (EDL)**
4. Iodine Fuming
5. **7,8 Benzoflavone**
6. **8 - hydroxyquinoline**
7. **Potassium Thiocyanate**
8. Physical Developer or Silver Nitrate

Non-Porous

1. **Visual**
2. **ALS**
3. **EDL**
4. **Cyanoacrylate Fuming (CAE)**

5. **Powder**

Blood Evidence:

Porous

1. **Visual**
2. **ALS**
3. **Ninhydrin, Leucocrystal Violet (LCV), Leucomalachite Green, or Amido Black**

Non Porous

1. **Visual**
2. **ALS**
3. **Amido Black, Leucomalachite Green, or LCV**
4. **Powder**

Human Skin

1. Visual
2. EDL (if deceased)

5.4.1.1.1 **Alternate Light Source (ALS)**

See section 5.5.1

5.4.1.1.2 **Amido Black (methanol based)**

Amido black is used on bloody impressions and is a dark blue-black colored reagent. It reacts with the proteins present in blood, staining blood a blue-black color. The background reagent can be rinsed away which may increase the contrast of the impression on the substrate.

Amido black is especially useful for bloody or protein-based impressions deposited on lighter colored, non-porous surfaces such as glass, plastic, vinyl, etc. but may work on concrete or some papers. Results may be best on faint impressions.

Reagents

Developer Solution

Naphthol blue black	2 g
Glacial acetic acid	100 mL
Methanol	900 mL

Dissolve the Naphthol blue black in the above ingredients.

Rinse Solution

Glacial acetic acid	100 mL
Methanol	900 mL

Final Rinse – Rinse with distilled water.

The Reagent and Rinse solutions are stored in bottles at room temperature or refrigeration.

The Reagent and Rinse solutions do not expire and may be used until the entire volume is consumed.

Method

- Stain and rinse a small area of substrate that is not part of the impression, to check for background staining. Do not use this reagent if significant background staining occurs.
- Apply the Reagent to the impression via spraying, pouring, or submersion. To ensure complete staining, the solution should remain in contact with the impression for at least 1-2 minutes to obtain maximum development.

- Apply the Rinse solution to remove Reagent stain from background areas. An optional water rinse may follow.
- Allow the impression to air dry.
- The impression may be re-stained to make darker, if desired.

Interpretation

Positive: A blue-black staining will appear within 1-2 minutes.

Negative: No change or less intense blue-black staining results.

Cautions/Safety

- Use in a very well-ventilated area. Methanol and glacial acetic acid in the quantity and concentration of this formulation are inhalation hazards.
- Wear eye protection and masks when spraying any reagent.
- Amido black works only with bloody or other protein-based impressions. Consider a presumptive test for blood prior to application, when possible.
- Porous substrates may absorb the blue-black reagent causing background staining that cannot be rinsed away. This might result in little contrast with the treated bloody impression.
- This chemical enhancement does not include a chemical fixative. Fresh blood impressions may be damaged or destroyed if not fixed prior to treating.

Controls

Positive: A known blood stain on a substrate.

Negative: An unstained area of the substrate.

Controls are checked at the time of use.

5.4.1.1.3 **Amido Black (water based)**

Amido black is used on bloody impressions and is a dark blue-black colored reagent. It reacts with the proteins present in blood, staining blood a blue-black color. The background reagent is rinsed away which may increase the contrast of the impression on the substrate.

Amido black is especially useful for bloody or protein-based impressions deposited on lighter colored, non-porous surfaces such as glass, plastic, vinyl, etc. but may work on concrete or some papers. Results may be best on faint impressions.

The water based formula may be considered for use when the substrate is sensitive to methanol or in any situation where a less vaporous solution is desired.

Reagent

Deionized water	500 mL
5-sulfosalicylic acid dihydrate, ≥99.0	20g
Naphthol blue black	3g
Sodium carbonate	3g
Formic acid	50 mL
Glacial acetic acid	50 mL
Kodak Photo Flo solution	37.5 mL

Combine all reagent components in a ≥1L capacity bottle. Dilute mixture to 1L with deionized water. Although the mixture will be ready to use immediately, allow the mixture to stand for several days prior to use for best results.

The solution is stored in a bottle at room temperature or refrigeration. This reagent does not expire and may be used until the entire volume is consumed.

Rinse – water

Method

- Stain and rinse a small area of substrate that is not part of the impression, to check for background staining. Do not use this reagent if significant background staining occurs.

- Apply the Reagent to the impression via spraying, pouring, or submersion. To ensure complete staining, the solution should remain in contact with the impression for at least 3-5 minutes to obtain maximum development.
- Rinse with water to remove Reagent stain from background areas.
- Allow the impression to air dry.
- The impression may be re-stained to make darker, if desired.

Interpretation

Positive: A blue-black staining will appear within 3-5 minutes.

Negative: No change or less intense blue-black staining results

Cautions/Safety

- Amido black works only with bloody or other protein-based impressions. Consider a presumptive test for blood prior to application, when possible.
- Porous substrates may absorb the blue-black reagent causing background staining that cannot be rinsed away. This might result in little contrast with the treated bloody impression.
- Use in a ventilated area when possible.
- Wear eye protection and masks when spraying any reagent.

Controls

Positive: A known blood stain on a substrate.

Negative: An unstained area of the substrate.

Controls are checked at the time of use.

5.4.1.1.4 **Cyanoacrylate ester (CAE, superglue)**

Cyanoacrylate (CA, i.e., superglue) fuming has been shown to be an effective means of impression development on non-porous and some semi-porous surfaces (e.g., plastic, carbon paper, metals, glass, tapes, wood, rubber and rock). Cyanoacrylate ester fumes are monomers that polymerize on impression residue and create a more stable impression.

Method

Liquid CA with heat source

Liquid glue is placed in a disposable container (aluminum foil works well), which is then placed over a heat source in the vehicle, processing area, or fuming chamber resulting in the production of fumes. Heating may be accomplished with a coffee cup warmer or a light fixture assembly (60 watt bulb). DO NOT USE A HOT PLATE OR DIRECT FLAME. Once the test print shows sufficient development, ventilate area to evacuate all fumes.

Cautions/Safety

- Cyanoacrylate ester fumes are strongly irritating to the eyes and respiratory system. Fuming should only be conducted in a well-ventilated area and non-porous gloves should be worn to prevent skin contact.
- It should be noted, that the cyanoacrylate esters can cause a glaze-like coating to cover the entire evidentiary surface resulting in considerable loss of contrast when over-fuming occurs.
- Do not store cyanoacrylate in areas that can become hot (e.g., the trunk of a car); the cartridges may start to fume and the pads/packs or liquid may dry out.
- Cyanoacrylate should be allowed to come to room temperature prior to use.

Controls

Positive: A deposited print on a non-porous substrate. The test card is placed within the confines of the area to be fumed (for example, a vehicle interior). The test card must be visible so that impression development may be monitored to avoid over-fuming.

Negative: Area surrounding the intentionally deposited impressions.

Controls are checked at the time of use.

5.4.1.1.5 **Iodine**

Iodine fumes adhere to grease or oils on porous surfaces and appear as a yellow stain. Iodine reacts to recently deposited prints because specified residue tends to become less receptive to this process with time. Iodine is not suitable for metals or dark surfaces.

Reagent

Iodine crystals

Method

- Place iodine crystals in an airtight fuming chamber.
- Apply heat to the crystals and observe development.
- Remove the object from the chamber when sufficient development has occurred.
- Evaluate item for comparable ridge detail.
- Prints deemed to be of value are marked and photographed.

Cautions/Safety

- Use in a ventilated area. Iodine is toxic in any form. Always avoid inhaling iodine fumes.
- Iodine fumes may irritate the skin and damage the respiratory tract.
- Developed prints can vanish and must be persevered immediately.
- Prints that have faded or are completely gone, can sometimes be redeveloped by reprocessing. Reprocessing cannot be done if other methods have been used or if too long of a time span has elapsed.

Controls

Positive: A deposited print on a similar substrate being examined.

Negative: Area surrounding the intentionally deposited impressions.

Controls are checked at the time of use.

5.4.1.1.6 **Leucomalachite Green (LMG)**

Leucomalachite Green is a biological stain used to dye the blood hemoglobin components an intense green color.

Reagent

Leucomalachite Green	0.06g
Sodium perborate	0.2g
Methanol	20mL
Glacial acetic acid	10mL

Combine all ingredients. Stopper the flask and shake vigorously for 1 minute. Transfer to a spray bottle.

Method

- Spray the surface lightly 2 or 3 times, holding the sprayer approximately 14" or more from the surface.
- Photograph impressions.

Interpretation

Positive: A dark green color should appear fairly rapidly.
Negative: No color change.

Cautions/Safety

- LMG should not be used in large amounts. It can be harmful if inhaled, and is irritating to the eyes and skin.
- The LMG reagent is light sensitive and may discolor over time due to exposure. LMG reagent should be colorless or near colorless. Should it appear blue or violet, consider making up fresh reagent. Store in dark bottles.
- Use in a ventilated area or while wearing a respirator.
- Wear appropriate eye protection when using.

Controls

Positive: A known blood stain on a substrate.

Negative: An unstained area of the substrate.

Controls are checked at the time of use.

5.4.1.1.7 **Leucocrystal violet (LCV)**

LCV is for use on bloody impressions. LCV is the reduced form of crystal violet and is a clear, colorless reagent. When LCV and hydrogen peroxide come into contact with the hemoglobin in blood, an oxidation reaction catalyzed by the peroxidase-like activity of the hemoglobin will occur. The result is a dark violet dye which has an affinity for proteinaceous substrates. The resulting violet color may increase the contrast of an impression on a substrate.

LCV is especially useful for bloody impressions deposited on lighter colored, porous and non-porous surfaces such as vinyl flooring, carpeting, fabric, etc. Results may be best on faint impressions.

Reagent

5-sulfosalicylic acid dihydrate, ≥99.0	10g
Hydrogen peroxide (3% Concentration)	500 mL
Sodium acetate anhydrous	3.7g
Leucocrystal violet	1g

Combine the 5-sulfosalicylic acid, sodium acetate, and leucocrystal violet with the 500mL 3% hydrogen peroxide in a dark bottle. A 473mL volume of 3% hydrogen peroxide (the volume commonly sold at pharmacies) is an acceptable substitute for the 500mL 3% hydrogen peroxide volume.

The solution should be stored in a dark bottle and refrigerated. It expires 30 days after mixing.

Optional rinse – water

Method

- Apply LCV to the impression via spraying, pouring, or submersion and allow it to remain in contact with the impression for at least 30 seconds.
- Rinse non-porous substrates with water to remove excess LCV when necessary.

- Allow the impression to air dry.
- Enhanced impressions that aren't rinsed should be photographed as soon as possible. This is to document the impression prior to any background color development that may occur.

  An indirect sampling method may be used prior to LCV application, if desired. Define the area to be sampled and tested. Moisten filter paper with deionized water and press it onto the defined area. Mark the filter paper before removing it so the orientation is documented. Remove the filter paper and spray with LCV then proceed with the method described above. This technique may be less sensitive than directly spraying, pouring, or submersion because it relies on the efficacy of the stain to transfer to the filter paper.

Interpretation

Positive: A violet color within 30 seconds to 3 minutes.
Negative: No color change. Unreacted areas will also turn violet over time if not rinsed. See Cautions.

Because impressions that are not visible may be enhanced or detected with the application of LCV, a violet color reaction may be interpreted and reported as a positive result with a presumptive test for blood.

Cautions/Safety

- LCV crystals that have turned yellow should not be used.
- The LCV reagent is light sensitive and may discolor over time due to exposure. LCV reagent should be colorless or near colorless. Should it appear blue or violet, consider making up fresh reagent. Store in dark bottles.
- Treated areas will change from colorless to violet over time, unless rinsed. The timing varies with environmental conditions and may occur within hours to several days after application.
- Use in a ventilated area when possible.
- Wear appropriate eye protection when using.

Controls

Positive: A known blood stain on a substrate.

Negative: An unstained area of the substrate.

Controls are checked at the time of use.

5.4.1.1.8 **Ninhydrin**

Ninhydrin is used to develop impressions on porous surfaces. Ninhydrin reacts with the amino acids and proteins present in perspiration to produce a characteristic purple color. The combination of heat and humidity accelerates the reaction of the amino acids and ninhydrin.

Excessive background discoloration may occur in substrates composed of a high plant or animal protein content. It is not effective on items that have been wet.

Reagent

Ninhydrin	5 grams
Methanol	30 mL
Isopropanol	40 mL
Petroluem Ether	930 mL

Dissolve ninhydrin crystals in methanol. Then add the isopropanol followed by the petroleum ether. The solution should be stored in a dark bottle.

Method

- Apply ninhydrin via spraying, dipping or painting.
- Allow to dry.
- Accelerate development by using a humidified environment (humidified chamber or steam iron).
- Evaluate item for comparable track mark.
- Prints deemed to be of value are marked and photographed. Developed impression may fade with time and may not be retrievable with reprocessing.
- It is recommended that the item be re-examined after approximately 24 hours to ensure no additional impressions have developed.

Cautions/Safety

- Use in a ventilated area when possible.
- Wear appropriate eye protection when using.

Controls

Positive: A deposited impression on a substrate similar to the evidence being examined.

Negative: Area surrounding the intentionally deposited impressions.

Controls are checked at the time of use.

5.4.1.1.9 **Potassium Thiocyanate**

Potassium thiocyanate is for use on impressions created from wet soil or mud. Thiocyanate ions react with iron in an acidic solution and a positive reaction is a brick red color.

Potassium thiocyanate is especially useful for wet soil impressions deposited on surfaces (porous and non-porous) having a lighter color. Success of the enhancement depends on the mineral (iron) content in the particular impression deposit.

Reagent

Acetone	120 mL
Deionized water	15 mL
Potassium thiocyanate	15 g
30% v/v dilute sulfuric acid	8.5 mL

Prepare dilute sulfuric acid by adding 2.5mL of concentrated sulfuric acid to 6mL deionized water. Set aside.

Dissolve 15g potassium thiocyanate to the 120mL acetone and 15mL water. Use stir plate if necessary. Carefully add 8.5mL of the diluted sulfuric acid. A milky mixture will result indicating precipitation. Turn off stir plate and allow the mixture to settle into two layers. This may take several minutes to a half hour. Carefully decant the supernatant into a clean, dark glass bottle. Discard the precipitate layer.

Method

- Lightly spray the potassium thiocyanate solution on the impression.

Interpretation

A positive result is brick red, rust, or red-brown color almost immediately upon application.

Cautions/Safety

- Use in a ventilated area when possible. Sulfuric acid and acetone are inhalation hazards.
- Wear appropriate eye protection when using.
- All glassware used for mixing must be clean of mineral or metal ion contaminants.

Controls

Positive: A known ferric salt solution on a substrate

Negative: Area surrounding the intentionally deposited impression.

Controls are checked at the time of use.

5.4.1.1.10 **Physical Developer (PD)**

Physical developer is a silver-based aqueous reagent that reacts with lipids, fats, oils, and waxes present in the fingerprint residue to form a silver-gray deposit. Physical Developer is used to develop impressions on porous surfaces and on certain nonporous surfaces. PD has also been found to be highly effective in developing impressions on paper currency. Physical Developer is normally applied after DFO and/or ninhydrin.

This process cannot be used in conjunction with the silver nitrate method. If the PD process is used, it will negate the silver nitrate process.

Reagent

Physical Developer Kit (parts A & B)

Add 5 ml of solution A (20% silver nitrate solution) to 90 ml of solution B (reductant solution) in a beaker. Stir the working solution for approximately one minute with a clean glass/plastic stirring rod. Do not mix the working solution until you are ready to use it as it does not have a very long shelf life once mixed. Any contamination may ruin the physical developer working solution. To avoid contamination use clean glassware rinsed with tap water, then with distilled water prior to beginning.

Method

- Apply reagent via dipping. Allow to sit for 5-15 minutes until impression development is complete of adequate time has elapsed.
- Rinse with water until the water runs clear
- Allow to dry completely.
- Evaluate item for comparable ridge detail.
- Prints deemed to be of value are marked and photographed. Developed print may fade with time and may not be retrievable with reprocessing.

Cautions/Safety

- Use in a ventilated area when possible.
- Wear appropriate eye protection when using.
- Cleanliness is important in the physical developer method. Some contaminants, especially salts, will cause the silver nitrate in the solution to come out of suspension thus spoiling the physical developer solution and perhaps ruining the item being examined. It is important to keep the glassware spotless and rinsed with distilled water prior to use. When washing glassware, use detergent, not abrasive cleaners.
- Physical developer will cause dark stains on many surfaces. Care must be taken to avoid spills in the laboratory. Full strength chlorine bleach will usually remove any stains from counter tops and floors, but the bleach may cause damage to fabrics stained with physical developer.

Controls

Positive: A deposited print on a substrate similar to the evidence being examined.

Negative: Area surrounding the intentionally deposited impressions.

Controls are checked at the time of use.

5.4.1.1.11 **Powder**

Powders come in a variety of colors and combinations that can be used based on the substrate. This includes fluorescent and magnetic powders. The powder and tool for applying powder should be chosen based on the substrate and/or matrix of track mark residue.

Equipment

Fingerprint powder

Fingerprint brush

Fingerprint tape

Fingerprint cards

Method

- Use brush to lightly apply fingerprint powder
- Photograph or tape lift any prints that appear to be comparison quality

5.4.1.1.12 **Silver Nitrate**

Silver nitrate is used to develop impressions on porous objects. It reacts with the salt content in perspiration. Silver nitrate can be prepared with two different carriers-water or alcohol. An alcohol-based solution can be prepared for processing objects (waxed paper, cardboard with a wax finish, Styrofoam) that may repel a water-based mixture

Impressions developed by silver nitrate on certain types of glossy paper will often disappear within hours. These marks should be photographed as soon as possible.

Reagent

Water base

Silver nitrate	30 grams
Distilled water	1000 mL

Combine and stir for approximately 10 minutes or until all the crystals are dissolved.

Alcohol base

Silver nitrate	30 grams
Distilled water	100 mL
Ethanol	1000 mL

Combine the silver nitrate and distilled water and stir until all the crystals are dissolved. Add ethanol. The solution should be stored in a dark bottle.

Method

- Apply the Reagent to the impression via dipping or painting.
- Allow the impression to air dry.
- Subject to high-intensity light or sunlight to develop prints.
- Prints deemed to be of value are marked and photographed.

Cautions/Safety

- Use in a ventilated area when possible.
- Wear eye protection and masks when spraying any reagent.

Controls

Positive: A deposited mark on a substrate similar to the evidence being examined.

Negative: Area surrounding the intentionally deposited impressions.

Controls are checked at the time of use.

5.4.2 Exemplars

The exemplar provides a record of the characteristics present on an item of evidence at a given time.

Many common methods for collection of exemplars are listed below. Other published or accepted techniques may be used if two conditions are satisfied: 1) the reference for the technique must be cited in the notes 2) the technique yields high quality exemplars that represent the original item without permanent detrimental effects to the evidence.

Step-by-step procedures are listed only as a guide to assist the examiner and are not intended to be absolute. Slight modifications or additions to the steps may be made at the examiner's discretion provided that the quality of the resulting exemplar is maintained

Exemplars are not considered evidence as long as the original item is collected and the exemplars may be recreated. Therefore, they do not generally need to be assigned an exhibit number or entered into LIMS, and are not subject to the policies and procedures that apply to items of evidence. If the original item is not collected and only the exemplar will be retained, it must be made an item of evidence.

5.4.2.1 **Footwear Exemplars**

The impression a shoe leaves will be slightly different depending on the conditions under which it is created. An image of the shoe tread is sufficient for elimination when obvious exclusions based on tread design differences are present. A scale is recommended.

5.4.2.1.1 **TWO-DIMENSIONAL EXEMPLARS**

It is not possible or necessary to create an exact duplication of the materials and conditions that occurred in the creation of the questioned footwear impression. However, an analyst should attempt to make an exemplar that best depicts the detail required for a comparison. Obtaining adequate exemplars may take repeated attempts.

In addition to the methods listed below, photography, scanning, or photocopy of the sole may be acceptable methods of creating exemplars in some

instances. All images are subject to the requirements of the Imaging section of this manual.

Generally, each method of exemplar collection listed below can be accomplished either by stepping while wearing the footwear or by rolling/pressing the outsole by hand.

5.4.2.1.1.1 **"Inkless" Method**

The Identicator™ system or equivalent "inkless" system may be used. The Identicator™ system consists of a pad saturated with a chemical solution and chemically treated paper (some non-proprietary thermal papers will work with the pad). The chemical solution will develop into a black color when it contacts the treated paper. This method provides excellent detail and is quick and clean. For these reasons, along with its portable nature, it is also useful for recording elimination footwear exemplars at a scene.

1. Place a piece of treated paper on the floor with the treated side up.
2. Wearing the item(s) of footwear, step on the pad to evenly distribute the solution over the outsole.
3. Step onto a piece of the treated paper.
4. Label the impression with pertinent case information.

5.4.2.1.1.2 **Black Ink**

Black oil-based inks, such as printing inks or fingerprint inks, create impressions with excellent detail. Use an ink that will dry within 1 and 4 hours.

1. Spread a very thin layer of the ink onto a clean flat surface larger than the outsole with a fingerprint roller.
2. Wearing the item of footwear, step on the layer of ink to evenly deposit the ink over the entire outsole.
3. Step onto a piece of high quality white paper, clear film, or clear adhesive sheet. The choice of substrate may vary depending on the needs of the analyst and the nature of the questioned footwear impression.
4. Allow the exemplar to dry.
5. Label the impression with pertinent case information.

5.4.2.1.1.3 Fingerprint Powder and Roller Transport Film

This method leaves an impression of excellent quality and instant transparency using a photographic product known as roller transport film. Roller transport film has a gelatin coating on each side which becomes soft when wet.

1. Dust the footwear outsole with a medium to heavy coating of fingerprint powder. Tap the item of footwear firmly on its side to dislodge loose fingerprint powder. Set the item of footwear aside.
2. Obtain a sheet of roller transport film of appropriate size and place on a clean, dry surface.
3. Completely cover the film with water. The gelatin layer will remain soft for 1-2 minutes. Use a squeegee to remove excess water.
4. Place the wet film on a clean, smooth, firm surface that will not adhere to the film.
5. Wearing the powdered item of footwear, step onto the film, step off, and allow the film to dry for several minutes.
6. Label the impression with pertinent case information.
7. Spray a fixative, such as a clear lacquer, to preserve the exemplar. The impression will be damaged if the film gets wet without a fixative.

5.4.2.1.1.4 Water-Based Ink and Roller Transport Film

This method leaves an impression of excellent quality and instant transparency using a photographic product known as roller transport film. Roller transport film has a gelatin coating on each side which becomes soft when wet. Water-based inks may provide less detail than is achieved with other methods. The water of the ink is sufficient to soften the gel and embed the ink. There is no need to thoroughly wet the film.

1. Obtain an inkpad of suitable size impregnated with a water-based ink.
2. Obtain a sheet of roller transport film of appropriate size and place on a clean, dry surface.
3. Wearing the item of footwear, step on the inkpad to distribute the ink evenly over the pad and outsole.

4. Wearing the inked footwear, step onto the film, step off, and allow to dry for several minutes.
5. Label the impression with pertinent case information.
6. Spray a fixative, such as a clear lacquer, to preserve the exemplar. The impression will be damaged if the film gets wet without a fixative.

5.4.2.1.1.5 **Fingerprint Powder and Adhesive Sheet**

This method can provide a full representation of a known outsole including some recessed areas. The examiner should be aware that, when the sheet is pressed into recessed areas, this method could alter the size representation of the outsole typically making it appear longer.

1. Lightly dust a thoroughly dry outsole with fine, black fingerprint powder. Tap the item of footwear firmly on its side to dislodge loose fingerprint powder.
2. Obtain an adhesive sheet that has a cover sheet.
3. Prop the item of footwear up to expose its outsole.
4. Using a roller or hand, press the adhesive sheet onto all areas of the sole to obtain a full impression. If information from the recessed areas is desired, press the adhesive sheet onto the footwear beginning at one end and press the sheet into the recessed areas as they are encountered.
5. Carefully peel away the adhesive and cover with the cover sheet, avoiding air bubbles. Use of a fingerprint roller may help.
6. Label the impression with pertinent case information.

5.4.2.1.1.6 **Powder with Gelatin Lifters**

This method uses talcum or fingerprint powder deposited on a gelatin lifter to create the exemplar. Black powder used with white lifters and silver or white powders used with black lifters results in a high contrast exemplar. The examiner should be aware that, when the lifter is pressed into recessed areas, this method could alter the size representation of the outsole typically making it appear longer.

1. Lightly dust a thoroughly dry outsole sole with the talcum or fingerprint powder. Tap the footwear firmly on its side to dislodge loose fingerprint powder.
2. Obtain a gelatin lifter of contrasting color and a size larger than the outsole.
3. Label the impression with pertinent case information.
4. Remove the cover sheet and place the gelatin lifter on the floor, gelatin side up. The cover sheet may be discarded if it will not be re-applied after the impression is lifted.
5. Wearing the item of footwear, step onto the gelatin lifter. If information from the recessed areas is desired, press the lifter onto the footwear beginning at one end and press the lifter into the recessed areas as they are encountered.
6. Optional Step - Press the gelatin lifter onto all of the remaining areas of the sole to obtain a full impression if areas were missed.
7. Carefully peel away the gelatin lifter and, as soon as possible, photograph the exemplar to preserve it. Then, either cover with the cover sheet, avoiding air bubbles, or tape by the edges or corners in the bottom of a flat cardboard box to protect the exposed gelatin layer.

5.4.2.1.1.7 **Oil Residue Impressions Dusted with Fingerprint Powder**

This method leaves a positive impression and is created by thinly coating the outsole with petroleum jelly or oil. After stepping onto a substrate, the exemplar is dusted with fingerprint powder to develop the impression. The impression may smear if touched.

1. If using petroleum jelly, spread a very small amount between the hands and then evenly apply to the outsole. If using oil, spray a lint-free cloth with the oil or silicone spray and rub the outsole with the cloth to apply the oil to the outsole.
2. Wearing the coated item of footwear, step onto a piece of high quality white paper, white chart board, or other surface to deposit the impression. The choice of substrate may vary depending on the needs of the analyst and the nature of the questioned footwear impression.
3. Use a magna brush and magnetic fingerprint powder and lightly dust over the impression to develop it.
4. Spray a fixative, such as a clear lacquer to preserve the exemplar. The impression will be damaged if it is touched.
5. Label the impression with pertinent case information.

5.4.2.1.2 **THREE-DIMENSIONAL EXEMPLARS**

Because a cast is a positive likeness of the footwear outsole, it may be compared directly to the outsole and the footwear itself may be the best standard. When creating a three-dimensional exemplar is necessary or desired, there are several methods to choose from and these are described below. For three-dimensional questioned impressions that are imaged, a three-dimensional exemplar may be imaged with similar lighting condition for use in comparison. A cast may also be collected from the exemplar to permanently represent the footwear outsole.

5.4.2.1.2.1 **MikroTrack**

This material is a one-part system that does not require mixing. It is a white, reusable material that shows superior detail.

1. Remove approximately 1 liter of material from the container and knead.
2. Flatten to an appropriate size and thickness and place on a smooth hard surface.
3. Press the outsole into or walk across the product while wearing the footwear.
4. Label the impression with pertinent case information.
5. Image and/or cast to create the exemplar.

5.4.2.1.2.2 **Zetalabor or Polyvinylsiloxane**

These materials are used in the dental industry. They are products with a consistency of soft putty.

1. Mix the product per manufacturer's instructions.
2. Flatten to an appropriate size and thickness and place on a smooth hard surface.
3. Spray the outsole with a silicone spray.
4. Press the outsole into the product and leave the outsole in place until the material hardens.

5. Remove the outsole and label the impression with pertinent case information.
6. Image and/or cast to create the exemplar.

5.4.2.1.2.3 **Biofoam**

This is a deformable fragile foam product that can be used to create three-dimensional exemplars. Though Biofoam deforms with minimal pressure, it may not capture minute individual characteristics.

1. Press the outsole into the foam to the desired depth and remove.
2. Label the impression with pertinent case information.
3. Image and/or cast to create the exemplar.

5.4.2.1.2.4 **Mikrosil**

Mikrosil is a silicone-based product. Mikrosil is purchased in a tube with an accompanying tube of catalyst and various colors are available. After hardening, it forms a pliable mold of the surface.

1. Optional Step: Apply a very light application of fingerprint powder to the outsole prior to casting. This may improve contrast when imaging the cast.
2. Mix the product per manufacturer's instructions.
3. Immediately apply over the outsole with a spatula, forcing the Mikrosil into the tread.
4. Allow to harden and remove.
5. Label the impression with pertinent case information.
6. Image and/or cast to preserve the exemplar.

5.4.2.2 **Tire Exemplars**

The impression a tire leaves will be slightly different depending on whether or not it is under load. If exemplars are being made for purposes other than elimination, they must include the full circumference of the tire when under load. Typically this is between six and eight feet in length. When the actual vehicle is unavailable, the tire(s) may be mounted on a similar vehicle. The tread elements will not change significantly with slight air pressure or load variations.

5.4.2.2.1 **Partial Tire Exemplars**

Partial exemplars may be collected for purposes of elimination of non-suspect vehicle tires or for documentation of an obvious exclusion based on tread design differences.

5.4.2.2.1.1 **Imaging** An image of the tire tread is sufficient. A scale is recommended. Information about the tire and vehicle should be recorded.

5.4.2.2.1.2 **White Adhesive Lift** Using a large adhesive lift, the residual material on a tire can be lifted off, providing a good representation of a section of the tread design. Information about the tire and vehicle should be recorded.

5.4.2.2.1.3 **"Inkless" Method** Similar to the method described above for footwear exemplars, this system can be used to create an exemplar of a small area of the tire tread. Information about the tire and vehicle should be recorded.

5.4.2.2.2 **Full Tire Exemplars**

MATERIALS

Broom

Kraft Paper

Duct Tape

Work Gloves

Scissors/Utility Knife

Tire Markers

Chart Board

Printer's Ink, Petroleum Jelly, or Silicone Oil

Roller

Spatula

Wet Media Film

Colored Tape (for marking tire sidewalls)

Sharpie or other markers

Measuring Tape

Magnetic Fingerprint Powder

Magnetic Fingerprint Powder Brush

Clear Lacquer Spray

5.4.2.2.2.1 VEHICLE/TIRE PREPARATION

Before using any of the techniques listed below, the following steps must be performed.

1. Find an adequate surface to collect the tire exemplars. A smooth area of asphalt or concrete is sufficient and should be swept clean.
2. Roll out enough paper to keep the tires from collecting debris while moving. Secure the paper with tape.
3. Clean the tires by rubbing lightly while wearing work gloves. Cleaning should be to remove surface debris only. Rock-holds, etc. should be left in place.
4. Measure the circumference of the tire(s) of interest using a cloth measuring tape.
5. Measure the wheel base of the vehicle.
6. Mark the tire with tape at approximately 6 points equidistant around the tire and label A-F. The number of points may vary at the examiner's discretion depending on the size and design of the tire. Document the location of the labels on the tire with enough detail (e.g. close-up photography) that the labels can be re-created and/or replaced at a later date.
7. Record the information from the tire side wall.
   a) The make/model/year of the vehicle
   b) Make/model of the tire
   c) DOT number of the tire
   d) P-metric tire size designation
   e) Mold numbers when possible

5.4.2.2.2.2 Printer's Ink on Wet Media Film

This method provides a high level of detail while also providing a transparent background that facilitates the comparison process. It is important to use black printer's ink rather than fingerprint ink. Fingerprint ink is not recommended because it dries too quickly.

1. Tape sections of chart board together to achieve 2 lengths that are slightly longer than the tire circumference, typically 4-6 extra inches. Secure a length of clear wet media film on top of one of the lengths of chart board.

2. Create a "resting" section of chart board. This will serve as an area for the tire to sit after the tire has completed its turn on the wet media film. The resting section should be comprised of a piece of chart board and wet media film. The resting section should be slightly larger than the area of the tire that contacts the surface. It may be helpful to create two resting sections of chart board.
3. Use a spatula (or other device) and a fingerprint roller to thinly spread a layer of ink over one of the two sections of chart board.
4. Place the inked chart board in front of the tire of interest and push the vehicle in a continuous motion over the chart board to ink the entire circumference of the tire.
5. When the entire circumference has been inked, place the second piece of chart board with the wet media film attached in front of the tire and continue to push the vehicle to now deposit an inked impression of the tire onto the wet media film. As the tire rolls, mark the locations on the exemplar where the A-F labels on the tire correspond.
6. Mark the exemplar with pertinent case information that includes the location and orientation of the tire, along with the direction to the front of the vehicle.
7. Remove the wet media film from the chart board and allow to dry. This may take 4-6 hours or more depending on environmental conditions.
8. Two exemplars from each tire are recommended. The exemplars should be off-set so that they do not end in the same location.

5.4.2.2.2.3 **Printer's Ink on White Chartboard**

1. Follow the steps outlined for Printer's Ink on Wet Media Film method, using chart board alone.
2. Mark the exemplar with pertinent case information that includes the location and orientation of the tire.
3. Allow the exemplar to dry.
4. Two exemplars from each tire are recommended. The exemplars should be off-set so that they do not end in the same location.

5.4.2.2.2.4 **Petroleum Jelly/Silicone Oil, Fingerprint Powder on Chartboard or Wet Media Film**

It is important to use only a small amount of petroleum jelly or detail will be lost or obscured.

1. Choose a method: wet media film or chart board.
2. Tape sections of chart board together to achieve a length slightly longer than the tire circumference, typically 4-6 extra inches. If using wet media film, secure a length of film on top of one of the length of chart board.
3. Using your bare hands, rub a very small amount of petroleum jelly or silicone oil to coat your hands.

4. Then thoroughly rub the tread surface of the tire so an even, thin coating is applied to the full circumference.
5. Place an end of chart board (with or without film) just in front of the tire.
6. Push the vehicle in a continuous motion over the chart board, depositing an impression on the chart board/film. As the tire rolls, mark the locations on the exemplar where the A-F labels on the tire correspond.
7. Develop the impression by powdering it with magnetic fingerprint powder.
8. Spray 3-4 coats of a fixative, such as a clear lacquer to preserve the exemplar and allow to dry as per manufacturer's instructions prior to handling or packaging. The impression will be damaged if it is touched.
9. Mark the exemplar with pertinent case information that includes the location and orientation of the tire.
10. Two exemplars from each tire are recommended. The exemplars should be off-set so that they do not end in the same location.

5.4.2.3 **Other Exemplars**

Patterned impressions made by objects other than shoes or tires are sometimes encountered in casework. If exemplars are needed for comparison of these types of impressions, the method selected for exemplar collection is at the discretion of the analyst. The methods listed for the collection of footwear and tire exemplars will generally be applicable to making of exemplars from other objects.

Other published or accepted techniques may be used if two conditions are satisfied: 1) the reference for the technique must be cited in the notes 2) the technique yields high quality exemplars that represent the tire without permanent detrimental effects to the evidence.

5.4.3 Impression Examination – ACE-V

5.4.3.1 **General**

Impression examination follows application and documentation of Analysis, Comparison, Evaluation, and Verification (ACE-V).

5.4.3.2 **Analysis**

Analysis is the methodical examination of an impression to determine suitability for comparison. Analysis occurs independently of and prior to the Comparison, Evaluation and Verification steps of ACE-V. The goal of impression analysis is to determine suitability for comparison. Suitability may include detail sufficient to identify or exclude.

5.4.3.3 **Comparison**

A comparison is performed after analysis of an impression. This can be performed by comparing a known exemplar or an impression from another case.

5.4.3.3.1 **Comparison process – if similar move to next step**

- Design – if design is different this is an exclusion
- Size and shape – if physical size and shape are different this is an exclusion
- Wear pattern – if position or degree of wear are different this is an exclusion. It shall be taken into consideration when exemplars were collected since wear can change over time.
- Randomly acquired characteristics

5.4.3.3.2 **Evaluation**

5.4.3.3.2.1 Lacks sufficient detail
Insufficient detail was present in the questioned impression for a meaningful comparison with a known exemplar.

5.4.3.3.2.2 Identification
Identification is supported by randomly acquired characteristics.

5.4.3.3.2.3 High degree of association
Class characteristics of design, physical size, and general wear are all in correspondence.

5.4.3.3.2.4 Association of class characteristics
Class characteristics of both design and physical size correspond. This conclusion does not exclude other items that exhibit similar design and size.

5.4.3.3.2.5 Limited association

Some similar class characteristics are present; however, there are significant limiting factors in the questioned impression that do not permit a stronger association.

5.4.3.3.2.6 Indications of non-association

The questioned impression exhibits dissimilarities when compared to the known; however, certain details or features are not sufficiently clear to permit an exclusion.

5.4.3.3.2.7 Exclusion

This is the highest degree of non-association where sufficient differences were notes in the comparison between the questioned and known impressions. This indicates the known was not the source of the questioned impression.

5.4.3.3.2.8 No value

A determination of no value is given after analysis. This determination means that the impression is not suitable for comparison.

5.4.3.4 **Verification**

5.4.3.4.1 **Standard verification** – analysis and comparison is checked by an independent examiner.

5.4.3.4.2 **Blind verification –** at the discretion of the reporting examiner, the lab manager, or the technical leader a blind verification can be performed. A blind verification is the creation of a new duplicate case number with the impression. The duplicated case number is then given to a competent examiner to perform a repeat of the ACE process with no prior information.

5.5 Equipment

5.5.1 Alternate Light Source (ALS)

The ALS can be used to detect a wide variety of forensic evidence using the principles of fluorescence, reflection, and absorption.

5.5.1.1 **Method**

Various items of forensic interest (i.e. trace evidence, biological stains, etc) can be enhanced with the use of ALS with appropriate filters. Refer to the operations manual of the ALS model prior to use.

5.5.1.1.1 High intensity white light with blue filter and no goggles may be used to visualize blood.

5.5.1.1.2 Violet (400-430nm) and blue (430-470nm) colors with yellow/orange goggles are used to visualize biological substances.

5.5.1.1.3 The blue, blue-green (460-510nm) and green (500-550nm) colors with orange and red goggles are used to visualize fiber and general trace evidence or fluorescent latent print powders and dyes.

5.5.1.2 **Safety**

Precautions should be used when operating any ALS. Proper eye protection shall be worn by anyone operating an intense light source. Permanent eye damage can occur from direct illumination to the eye or reflected or refractive light hitting the eye. Exposing the skin to the beam of light can cause burns and other skin damage. All persons in proximity of usage shall adhere to the above safety guidelines.

5.6 Traceability

There are no measurements taken in track mark processing or comparison that require traceability.

5.7 Sampling

Sampling is not used for track mark processing or comparison.

5.8 Handling of test items

See Ada County Sheriff's Office Forensic Forensic Lab Quality Assurance Manual

5.9 Assuring the quality

See Ada County Sheriff's Office Forensic Forensic Lab Quality Assurance Manual

5.10 Reporting

See Ada County Sheriff's Office Forensic Forensic Lab Quality Assurance Manual

Track Mark Analytical Method History

Issuing Authority: Quality Assurance Manger

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