Idaho State Police
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Approval for Quality System Controlled Documents

Discipline/Name of Document: Footwear and Tire Impression Analytical Method

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IDAHO STATE POLICE FORENSIC SERVICES
FOOTWEAR AND TIRE IMPRESSION
ANALYTICAL METHOD

HISTORY PAGE

Revision #	Issue Date	History
1	3/29/02	Current methodology used by ISPFS
2	3/04	Listed ESDA (6.3) as a technique. Modified 6.3 and 6.4 regarding handling of lifts/results.
3	12/04	Modified wording of conclusions. Added digital imaging guidelines.
4	11/4/05	Modified 6.5.3.1, image history; 6.3.1 regarding low resolution digital imaging; 7.0 regarding overlays.
5	1/18/07	Modified 3.1.1.1, use of digital cameras; changed "SOP" to "Analytical Method"; added 10.0, case file contents; merged separate tire and footwear AMs into one; merged reagent formula appendix with the AM.
6	6/26/07	Modified analytical method to include expanded instructions for procedures, field processing, tire impression measurements and digital imaging. Added leucomalachite green back into chemical enhancements section after previous omission.
7	6/27/08	Remove presumptive blood test work step from the following procedures; Amido Black 10.1.5.1, Leucocrystal Violet 10.6.5.1, and Leucomalachite Green 10.7.5.1. Numbering change to accommodate removal.

IDAHO STATE POLICE FORENSIC SERVICES
FOOTWEAR AND TIRE IMPRESSION ANALYTICAL METHOD

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1 BACKGROUND/SCOPE

1.1 Footwear identification can be dated back to a homicide investigation in 1786. The initial interest in tire marks began with traffic investigation in the late 1920s. One of the earliest uses of tire impression evidence was in England in the early 1940s.

1.2 The discipline of Footwear and Tire Impression analysis is the process of determining whether a shoe or tire was the source of an impression.

1.3 It is a discipline based on the comparison of outsole or tread design, size, wear patterns and individual characteristics between an unknown or questioned impression and a known shoe or tire.

1.4 Footwear evidence may provide the type, make, description and approximate size of a shoe, as well as the number of suspects, sequence of events, and points of entry and exit. Tire track evidence may provide type, make, and approximate size of a tire. It may also indicate the type of vehicle used.

1.5 Footwear and tires may have individual characteristics produced as part of the manufacturing process. They also become worn and develop individual characteristics with use.

1.6 This Analytical Method defines both technical procedures for processing the majority of evidence encountered by the footwear and tire track impression analysts and comparison methodology.

1.6.1 These methods will describe procedures and techniques that are routinely used in the examination of evidence.

1.6.2 These methods cannot be expected to address each and every situation or type of evidence encountered.

1.6.3 The individual analyst must exercise sound judgment in selecting the methods which will best suit the requirements of the evidence submitted in a specific case; therefore, the procedures are designed to accommodate the majority of evidence encountered.

2 GENERAL REFERENCES

ASCLD/LAB - International, March 2006, *Supplemental Requirements for the Accreditation of Forensic Science Testing and Calibration Laboratories.*

International Laboratory Accreditation Cooperation (ILAC), Guide 2 - Traceability of Measurements of Measurement Results, 2002.

International Organization of Standardization (ISO)/International Electrochemical Commission (IEC), ISO/IEC17025 - *General requirements for the competence of testing and calibration laboratories*, 2005 (ISO/IEC 17025:2005(E).

The Scientific Working Group on Shoeprint and Tire Tread Evidence Technology (SWGTREAD) - *SWGTREAD documents are officially published in the Journal of Forensic Identification*, 766/55(6), 2005.

Idaho State Police Forensic Services – Quality Manual ISO/IEC 17025:2005 Compliant.

3 DEFINITIONS

Abrasion
The progressive wearing away of a tire in service.

Adhesive Lifter
Any adhesive coated material or tape used to lift impressions.

Aging
Deterioration (physical and chemical) of rubber through oxidation over a period of time.

Alternate Light Source
Ultraviolet light source which may have variable wavelengths, used to visualize footwear or tire track impressions.

Ambient Light
The available or existing light that surrounds the object being photographed.

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

Analysis
The methodical examination of footwear and tire track impressions, separation into parts so as to determine the nature of the whole.

Aspect Ratio
A numerical term that expresses the relationship between the cross-section height and the cross-section width of a tire. An aspect ratio of 75 means that the tire is approximately 75% as high as it is wide.

Balance
Equal weight distribution around the tire.

Band Ply
The first ply inside the tire.

Beads
Layers of cords are turned around a coil or "bead" of wire at the inner edge of the sidewall, allows the casing to be fitted to the wheel rim and provides an air-tight seal in tubeless tires.

Blemish
Surface irregularity or imperfection.

Blister
A separation within the sidewall or liner stock, or between the sidewall carcass or liner and the carcass.

Body
The tire structure except the tread and sidewall rubber. Also known as carcass.

Brand Name
The company name, which appears on the sidewall, not necessarily the name of the company that manufactured it.

Buffing Rib
Raised rib at the junction of black and white rubber on a white sidewall tire. Also called a scuffing rib.

Buttress
Portion of tread running around the shoulder and blending into the sidewall.

Camber
Tilt of front wheel; inward tilt at the top of the wheels is negative camber (excessive wear on outer tire tread shoulder edge) and inward tilt at the bottom of the wheels is positive camber (excessive wear on inner tire tread shoulder edge).

Casing
The whole tire.

Cast
The result of the filling of a three-dimensional impression with an appropriate material.

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

Casting Material
Dental stone, sulfur, or other suitable materials specifically used for and generally accepted to accurately reproduce impressions.

Checking
Minute cracking in the surface of the rubber caused by aging and oxidation.

Circumferential Cracks
Cracks in the tire running parallel to the beads, usually consists of cracks in the circumferential tread grooves.

Class Characteristics
Manufactured features that are shared by two or more shoes or tires.

Combined Class Characteristics
The combination of two or more independent class characteristics.

Coaxial Light
Illumination from the precise direction of the imaging lens, either through the lens or with a beam-splitter in front of the lens.

Comparison
The observation of two areas of footwear or tire track impressions for finding similarities and/or differences.

Cords
The tire casing or carcass is composed of flexible filaments of natural textile, synthetic polymer, glass fiber or steel embedded in or bonded to a matrix of natural or synthetic rubber.

Cracking Tread or Groove
Splitting in grooves caused by excessive strain.

Cross-Section Size
External sidewall-to-sidewall measurement of inflated tire exclusive of elevations due to raised lettering or protector bands.

Crown
Section between shoulders of the tire.

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

Dental Stone
A gypsum product, similar to plaster of paris, but with different properties due to the manufacturing process.

Design
The manufactured pattern of a shoe outsole or tire tread.

Discrepancy/Dissimilarity
A difference in two impressions due to different sources of the impressions (exclusion).

Distortion
Variances in the reproduction of impressions caused by pressure, movement, force, contact surface, etc. Distortion is not a discrepancy and is not a basis for exclusion.

DOT Number
Department of Transportation serial number assigned to every tire sold in the United States which gives information regarding the manufacturer of the tire, tire size, and date of manufacture of the tire.

Dry Origin Impression
Formed under dry conditions such as dry dust and dry residue impressions.

Elasticity
The ability of skin to recover from stretching, compression, or distortion.

Electrostatic Detection Device (EDD) or Analyzer (ESDA)
An instrument used primarily to detect indented writing on documents, which can also be used to detect footwear impressions on paper items.

Electrostatic Dust Lifting Device (EDL)

An instrument that utilizes electrostatic charges as a means of transferring dry origin impressions from a surface to a film.

Element
Unique and separate tire tread design areas distinguished by grooves, slots and sipes, that are the actual surface contact portion of the tread design. Also known as tread blocks. May also refer to design characteristics on footwear outsoles.

Elimination Prints
Exemplars of footwear or tires belonging to persons known to have had access to the item or area examined for impressions.

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

Erroneous Identification
The incorrect determination that two footwear or tire track impressions originated from the same source.

Evaluation
The determination of the significance, value, or clarity of an impression by careful observation and study.

Examination Quality Photographs
High quality photographs taken with a scale for use in the physical comparison of footwear and tire impressions with known footwear and tires.

Exclusion
The determination that two impressions did not originate from the same source (non-identification).

Feather Edge
Sharp knife-like feathering along one edge of tire tread rib or blocks, due to scrubbing action of misaligned wheels.

Feathering or Schallamach Pattern
A wear pattern that is the result of frictional abrasive forces which have crossed the shoe sole perpendicular to the direction of travel. This results in a unique pattern that bears some resemblance to ridge characteristics and bifurcations of a fingerprint pattern and which continuously evolves and changes.

Fixative
A spray or powder applied to a three-dimensional impression prior to casting. It assists with the release of the substrate material from the cast. It may also refer to the application of a reagent to an impression that assists with the adherence of the impression to the substrate prior to chemical enhancement.

Gelatin Lifter
Gelatin laid on a pliable backing that can be used to lift impressions.

Gouging
Chisel-like action of rocks or stubble on tires.

Grooves
Furrows that separate ribs and run around the tire circumference, enhancing tread performance.

Heat Breaks
Failure of fabric due to excessive heat generation in tires.

Identification
The positive association of an impression as having been made by a single shoe or tire to the exclusion of all others. The determination that the corresponding areas of the impressions originated from the same source to the exclusion of all others.

Identifying Characteristic or Individual Characteristic
A particular characteristic resulting from something randomly added or removed from a surface (shoe sole or tire tread) that contributes to making that surface unique. A particular feature individual to a specific shoe or tire that resulted from a random occurrence. Examples would include cuts, burns and scratches.

Impression
The product of direct physical contact of an item resulting in a transfer and retention of characteristics of that item.

Inconclusive
The inability to either individualize or exclude an area of impression detail.

Individual Characteristic
A particular feature individual to a specific shoe or tire that resulted from a random occurrence.

Intermediate Rib
A rib located between the center and outer ribs.

Knock-off
A copy of a popular brand of footwear.

Known Print (Footwear or Tire)/Exemplar/Test Impression
A recording of the outsole or tread pattern with black ink, electronic imaging, photography, or other medium on a contrasting background. An object of known origin that is compared to a questioned impression.

Lift
An adhesive or other medium on which recovered impression detail is preserved.

Lug
Lateral blocks or discontinuous rows of tread rubber usually located on the outer edges of the tread design.

Manufacturer
The company that made the shoe or tire.

Matrix
The substance that is deposited by the footwear or tire.

Misalignment
Maladjustment of one or more parts of steering mechanism of vehicle causing unsatisfactory operation and tire wear.

Missed Identification
The failure to make an identification (individualization) when, in fact, both impressions are from the same source.

Mold
The cavity in which shoes or tires are made that contains the design for the outsole or tread.

Mold Characteristics
Variations in the design pattern of an individual mold that is transferred to all shoes outsoles or tires made in that mold.

Non-Porous
Non-absorbent.

Non-Skid Depth
Depth of the tire tread design providing skid protection that is measured from the top of the ribs to the base of the grooves.

Oblique Light
Illumination from a light source that is at a low angle of incidence, or even parallel, to the surface of the item. (also known as side lighting)

Patterns
The designation of footwear and tire track impression designs as well as outsoles and tire treads into basic categories of general shapes.

Photo Log
A written record of photographs taken at the crime scene.

Pitch Sequence
The elements on the tire tread that are varied to reduce the noise of the tire and improve tire performance under the rated conditions. (Also known as **noise treatment**)

Plies
Cords are fabricated in a parallel fashion into several multifilament layers or plies.

Polarized Lighting
Lighting consisting of light rays with a single propagation direction and a single vibration direction. Polarized light is produced by the use of a polarizing filter.

Porous
Absorbent, a material or surface having pores.

Physical Size and Shape
The size, shape, spacing, and relative positions of the outsole design and tread elements (not the same as the manufacturer's shoe or tire size).

Preserved
Casting, photography, lifting, or other method used to capture latent impressions for further examination.

Profile
Shoulder to shoulder arc of tire tread cross-section.

Qualified Analyst
An individual who has completed the internal training program, passed competency testing, and been approved to perform case work.

Questioned Impression
An impression made by a shoe or tire whose origin is unknown. (Also known as an unknown impression).

Random Characteristic
A characteristic in which the size, shape, and/or position of the characteristic depends, to some degree, on chance.

Reagent
Substance used in a chemical reaction to detect, examine, measure, or produce other substances.

Recapping
A process known as "top capping" in which rubber is only applied to the tire tread surface.

Relative Position
Proximity of characteristics to each other.

Retreading
Renewing the tread on a tire by buffing the old surface and applying a new tread. It differs from recapping in that new rubber is applied to both the tread surface and shoulder area of the tire.

Ribs
Sections of tread rubber that run in rows circumferentially around the tire. The number of ribs across the width of the tread is often used when describing the tread design.

Rim
The metal support for the tire or tire and tube assembly on the wheel.

Sequential Processing
Use of a series of development methods in a specific order to maximize development of impression detail.

Shoulder
The outer edges of the tire connecting with the sidewall, may be molded round or square.

Sidewalls
The side of the tire between the rim and the tread. Sidewalls may be white or black and have information molded on them in the form of raised letters and numbers and other markings.

Sipes
Narrow slits incorporated into the tread design to provide improved traction and channel water off the surface of the ribs and into the grooves. Sipes that do not extend to the edge of a rib or element are called "contained sipes". Sipes that extend to the edge of a rib or element are known as "open sipes". Sipes are also known as blades or kerfs.

Slots
Narrow grooves (lateral slots or cross-grooves) that run in a lateral or diagonal direction across the tread, usually from one circumferential groove to another.

Spot Repair
A repair made by vulcanizing rubber to a tire without replacing cord.

Stock Solution
Concentrated solution diluted to prepare a working solution.

Stone Drilling
A condition in which a stone has penetrated the tread rubber or fabric of a tire, caused by failure of tires to eject stones picked up by the grooves.

Stud
A hard metal or plastic rivet inserted into a pinned tire for the purpose of improving winter traction.

Stud Pattern
Pattern of holes in the tread design which are strategically placed to hold small metal studs added to the tread area to improve traction.

Substrate
Surface upon which an impression is deposited.

Textured Sidewall
A tire sidewall which has been cured into a web-like pattern to decrease weather cracking.

Three-Dimensional Impression
An impression with the dimensions of length, width and depth.

Tie-Bars
Small connecting bars of rubber recessed in the grooves and sipes to add support to the elements, lugs and ribs which comprise the tread design.

Tire Balancing
Adding external weights to compensate for unequal distribution of tire weight.

Tire Growth
Slight increase in tire size over time due to inflation pressure and operating circumstances.

Tire Name
Name given to a particular design which distinguishes it from other tires of the same brand, appears in large letters on the sidewall of the tire.

Toe-in
Adjustment of front wheels so they are closer together at the front than at the back. Most wheels are set this way when the vehicle leaves the plant. Too much toe-in creates heavy wear on the outer shoulder of the tire, showing as heavy wear from one direction and sharp feathered edges from the other direction across the tread.

Traction
The grip or friction, pull or bite between the tire and the ground.

Tread
The portion of the tire that covers the plies and belts from shoulder to shoulder and makes contact with the surface.

Tread Wear Indicator
Raised rubber ridges in the grooves that run laterally across the tread which are used to signal when the useful life of the non-skid depth has expired. (Also known as **wear bars**).

Two-Dimensional Impression
An impression which for all practical purposes has only the dimensions of length and width.

Vehicle Track Width
Distance between the center points of the tires from one vehicle side to the other (i.e. from the center point of the passenger side front tire to the center point of the driver side front tire). On a dual axle vehicle, this is the distance from the center points between the dual tires on one vehicle side to the other.

Vehicle Turning Diameter
The diameter of the smallest circle that is made by the outer edge of the outer most front tire in a turn.

Vehicle Wheel Base
Distance between the front and rear axles of a vehicle.

Verification
Confirmation of an analyst's conclusion by another qualified analyst.

Wear
Erosion of the shoe outsole or tire tread due to friction and abrasive forces with the ground.

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

Wear Pattern
The position of wear on the shoe or tire.

Weather Checking
Fine hair-like cracks in the surface of the tire rubber, caused by oxidation and other atmospheric effects.

Wet Origin Impression
Formed under wet conditions, including impressions deposited by residues of blood, grease, mud, and other wet substances.

Wheel Alignment
Adjustment of wheels for proper vehicle operation.

Working Solution
Solution at the proper dilution for processing.

4 RESPONSIBILITIES

4.1 The Latent/Impression Evidence Section Supervisor is responsible for ensuring that personnel adhere to established analytical methods, safety practices, and laboratory policies and procedures.

4.2 The Latent/Impression Evidence Section Supervisor shall ensure that analyst's training records are on file in the latent section.

4.3 Individual analysts are responsible for adherence to established analytical methods, safety guidelines, and laboratory polices and procedures.

4.4 Footwear and Tire Impression analyst duties include, but are not limited to:

- 4.4.1 Development of impressions;
- 4.4.2 Documentation of visible or developed impressions;
- 4.4.3 Obtaining known test impressions from footwear and tires;
- 4.4.4 Analysis and comparison of impressions;
- 4.4.5 Verification of compared impressions;
- 4.4.6 Issuing reports of examination activities;
- 4.4.7 Performing technical and administrative casework reviews;
- 4.4.8 Responding to crime scenes to the extent to which they are trained;
- 4.4.9 Satisfactorily completing annual proficiency tests;
- 4.4.10 Presenting expert testimony in court.

5 EVIDENCE HANDLING PROCEDURES

5.1 Evidence handling will be in accordance to ISPFS Quality/Procedure Manual Section 5.8 HANDLING ITEMS OF EVIDENCE.

5.2 Analysts will place unique case identifiers and initials on items where possible.

5.3 Wet or damp evidence will be dried in a secure area.

5.4 Footwear and tire impression evidence will be stored at room temperature before and after the examination process unless there are special circumstances.

5.4 Casts and other items should be photographed for file documentation, unless a better method of documentation can be utilized.

5.5 Footwear and tire impression processing has the potential to irreparably damage items of evidence.

5.5.1 If an item is suspected to have great value (monetary or sentimental), the analyst should contact the submitting agency to explain potential damage and gain verbal approval prior to processing.

5.6 RETAINED EVIDENCE

5.6.1 Impression evidence generated by the analysts in the laboratory such as EDL lifts, EDD images, physical or chemical enhancements, and tire test impressions shall be documented for the case records by photography or other method, given a unique identifier related to the original evidence item, and returned to the submitting agency with the original item.

5.6.2 Lab generated footwear and tire photographs/digital images which cannot be reproduced will be sealed in an envelope, logged in as retained evidence (ST – Shoe/Tire Retained Evidence), and stored in the vault.

5.6.2.1 Retained impression evidence is considered both evidence and examination documentation.

5.6.2.2 Retained evidence shall not be released, but will be copied at the request of the submitting agency's, prosecutor's representative, or court order.

6 GENERAL FOOTWEAR AND TIRE IMPRESSION PROCESSING

6.1 Impression print evidence is processed according to the nature of the substrate (surface) to be processed.

6.1.1 Substrate types include porous and non-porous.

6.1.2 Processing is generally carried out in a sequential manner employing methods appropriate to the substrate type.

6.2 Impression evidence is also processed with regards to what the impression matrix may consist of.

6.3 For the purpose of this manual, footwear and tire impression methods are divided into three categories; light based methods, physical methods, and chemical methods.

6.3.1 LIGHT BASED METHODS

6.3.1.1 Impressions may be visualized through the use of various angles and wavelengths of light.

6.3.1.2 Visualization of impressions through the use of forensic lighting methods is non-destructive and should be attempted prior to other processing methods.

6.3.2 PHYSICAL METHODS

6.3.2.1 The development of impressions through the use of physical methods does not involve a chemical reaction between the impression and the method used.

6.3.2.2 Physical methods encompass dusting and other discoloration methods often relying on the adhesive quality of certain impressions.

6.3.2.3 The taking of known test impressions from shoes or tires shall be considered a physical method for the purposes of this manual.

6.3.3 CHEMICAL METHODS

6.3.3.1 The development of footwear and tire track impressions through the use of chemical methods occurs because of a chemical reaction between the impression residue components and the reagent.

6.3.3.2 Reagents shall be tested after they are prepared and prior to use. If the same lot of working solution is used multiple times in the same day, only the initial control tests must be noted on the Reagent Preparation Log sheet. Subsequent use of the reagent on the same day shall revert to the prior tests. Control test results shall also be recorded in the case documentation. Reagents made up for one-time use may be documented in the case notes only.

6.3.3.3 Traditional film development shall be considered a chemical method for the purposes of this manual.

7 QUICK REFERENCE SEQUENTIAL PROCESSING GUIDE

7.1 GENERAL EVIDENCE:

7.1.1 POROUS:

1. Visual: White light/Alternate Light Source (ALS)
2. Iodine Fuming
3. Visual: White light
4. 7,8 Benzoflavone
5. Visual: White light
6. 8-Hydroxyquinoline
7. Visual: Ultraviolet light 254nm-365nm
8. Ammonium Thiocyanate
9. Visual: White light
10. Physical Developer
11. Visual: White light

7.1.2 NON-POROUS:

1. Visual: White light
2. Cyanoacrylate Fuming
3. Visual: White light/ALS
4. Powders: Non-luminescent
5. Visual: White light/ALS

7.2 BLOOD EVIDENCE:

7.2.1 POROUS:

1. Visual: White light/UV
2. Amido Black, Leucocrystal Violet, or Leucomalachite Green
3. Visual: White light

7.2.2 NON-POROUS:

1. Visual: White light
2. Amido Black, Leucocrystal Violet or Leucomalachite Green
3. Visual: White light

7.3 GLASS:

1. Visual: White light
2. Electrostatic Dust Lift (EDL)
3. Cyanoacrylate Fuming
4. Visual: White light
5. Powders: Non-luminescent
6. Visual: White light

7.4 PAPER/ CARDBOARD:

1. Visual: White light
2. EDL
3. Iodine fuming

4. Visual: White light
5. 7,8-Benzoflavone
6. Visual: White light
7. 8-Hydroxyquinoline
8. Visual: Ultraviolet 254nm-365nm
9. Ammonium Thiocyanate
10. Visual: White light
11. Physical Develop
12. Visual: White light

7.5 HUMAN SKIN:

7.5.1 Living

1. Visual with white light, ultraviolet and infrared light

7.5.2 Deceased

1. Visual with white light, ultraviolet and infrared light
2. Electrostatic dust lift (EDL)

7.6 METAL:

1. Visual: White light
2. EDL
3. Visual: White light
4. Cyanoacrylate fuming
5. Visual: White light
6. Powders: Non-luminescent
7. Visual: White light

7.7 WET SURFACES:

7.7.1 POROUS:

1. Visual: White light
2. Dry to room temperature
3. Visual: White light
4. Physical developer

7.7.2 NON-POROUS:

1. Visual: White light
2. Small Particle Reagent (SPR)
3. Visual: White light

8 LIGHT BASED METHODS

8.1 ALTERNATE LIGHT SOURCE

8.1.1 BACKGROUND:

Alternate light sources (ALS) are portable, multi-waveband, and tunable light sources that are used to enhance or visualize potential items of evidence. Impressions may be composed of various substances such as blood, soil, chemicals or other organic substances that react differently to different wavelengths of light. When a luminescent deposit is excited with a particular wavelength of light, the deposit absorbs the light and re-emits it at a different wavelength. The short-lived light being re-emitted is termed fluorescence. The ALS can also be used to detect the presence of certain body fluids such as semen and saliva. There are several alternate light sources available to analysts that adequately meet the needs described in this manual.

8.1.2 SCOPE:

8.1.2.1 The ALS is used to attempt to create contrast between an impression and the substrate it is on.

8.1.2.2 Fluorescence may occur due to a naturally occurring substance within the impression residue itself (inherent luminescence), may be transferred to the shoe or tire via contamination and re-deposited, or may be chemically induced in impression residue with certain reagents known to exhibit fluorescent properties. Fluorescence of the substrate may also occur.

8.1.3 EQUIPMENT AND MATERIALS:

Alternate light source
Filtered goggles

8.1.4 REAGENTS:

Not applicable

8.1.5 PROCEDURE:

8.1.5.1 Turn the power switch on. The fan will begin to operate. Make sure the fan comes to full operating speed. You should be able to hear the fan come up to speed in a few seconds.

8.1.5.2 Turn on the lamp switch. The lamp should turn on in a few seconds. On some models, a ticking sound prior to the lamp engaging is normal.

8.1.5.3 Choose the band-width you wish to use. Some models have a variable power dial that may need to be adjusted.

8.1.5.4 Observe evidence with the appropriate wavelength/goggle combination:

< 400nm yellow or clear UV safe

400-450nm yellow
450-540nm orange
540->700nm red

8.1.5.5 Push the lamp switch to off.

8.1.5.6 Wait for the unit to cool down. After feeling the body of the unit and the exhaust to determine that the unit is cool, the power switch may be turned off.

8.1.6 ADDITIONAL INFORMATION:

8.1.6.1 The Omniprint 1000(A) is a monochromatic light source that has a range of 450-570 nm with one port of white light. When using the fiber optic cable, do not use the white light selection at full power for more than thirty seconds, as this will damage the cable. The operator may unscrew the lens from the cable and attach the lens directly to the unit, allowing hands-free operation.

8.1.6.2 Allow the unit to run for longer periods of time instead of turning the unit off and on for short periods. Repeatedly turning the unit off and on will shorten the life of the lamp. The lamp should be left on for a minimum of ten-fifteen minutes.

8.1.6.3 Maintenance shall consist of cleaning the exterior of the ALS with a soft cloth dampened with a mild detergent solution and using a cotton swab moistened with glass cleaner to clean the optical filters. Bulbs should be replaced as needed.

8.1.6.4 If an ALS malfunctions, it will be taken out of service until it can be repaired. The ALS shall be tagged indicating that it is out of service. Maintenance, service, etc. will be recorded in the maintenance log.

8.1.6.5 No calibration is required of these units.

8.1.6.6 The manufacturer's operator manuals for this equipment shall be read prior to using the equipment.

8.1.7 CONTROLS:

Not applicable

8.1.8 SAFETY:

8.1.8.1 As with other electrical appliances, guard against electrical shock. This can be accomplished by ensuring that all connections are proper and that no loose, damaged, or frayed wires exist. Make sure the ALS is unplugged before attempting any maintenance and do not use outdoors if wet conditions exist.

8.1.8.2 The eyes are generally more vulnerable than the skin, and appropriate eye protection must be used to protect them. Permanent eye damage can occur from reflected, refracted, or direct illumination to the eye. Most of the light emitted by an ALS is not absorbed, but is reflected and scattered off the surface being examined. Extreme care should be taken around highly reflective

surfaces. Never look directly into the light or allow beams to bounce off the surface into your eyes or the eyes of another person in the vicinity. Filtered goggles or shields shall be utilized when using this equipment as they provide protection from potentially harmful rays and provide additional enhancement for viewing impressions.

8.1.8.3 The nature and extent of all potential hazards are not yet known because in-depth assessments have not been made on most of the high intensity light sources used in forensic work.

8.1.9 REFERENCES:

Omnichrome Evidence Detection with Forensic Laser Technology, (1989).

Omniprint 1000A Operating Instructions, Omnichrome.

Mini-CrimeScope Tunable Forensic Light Source Model MCS-400W Operation and Maintenance Instructions (2003).

UltraLite ALS Operator's Manual, Lynn Peavey Co., (2004).

9 PHYSICAL METHODS

9.1 IODINE FUMING

9.1.1 BACKGROUND:

Iodine fuming is one of the oldest impression methods currently employed in the examination processes for the visualization of impressions. Iodine vapors react with some residues in footwear or tire track impression deposits and turn the impression a yellow/brown color. Iodine fuming has an advantage over powders and chemical treatment because it does not cause the destruction of minute details in the impressions.

9.1.2 SCOPE:

9.1.2.1 Iodine is non-destructive and can be used on porous and non-porous surfaces.

9.1.2.2 Use when attempting to develop impressions that are thought to be recently deposited and/or composed of fatty, oily, or organic residues. Iodine reacts to recently deposited impressions better than old ones because the residues tend to become less receptive to this process with time.

9.1.2.3 Other methods may cause interference. Therefore, if iodine fuming is to be used, it must be used prior to other development processes.

9.1.2.4 Iodine is not suitable for metals or dark surfaces.

9.1.3 EQUIPMENT AND MATERIALS:

Fume hood
Chamber or a heavy-duty sealable plastic bag
Iodine fuming "gun"
Glass container such as beaker or petri dish

9.1.4 REAGENT:

Iodine crystals

9.1.5 PROCEDURE 1 - CHAMBER METHOD:

9.1.5.1 In a fume hood, break open a glass ampoule of iodine crystals to reveal the iodine crystals.

9.1.5.2 Place the crystals in an airtight chamber (ex. sealable heavy plastic bag, commercial fuming chamber, etc.).

9.1.5.3 Apply heat if necessary. The application of heat may be accomplished in various ways including transfer of body heat, contained hot water, or an electric heater. Iodine crystals will start to sublimate, go from a solid to a gas, resulting in purplish fumes with the application of heat (approximately 100° F).

9.1.5.4 Place the control test and the questioned surface in the chamber and proceed with fuming.

9.1.5.5 The control test and evidence are monitored by viewing through the chamber to determine when processing is complete.
9.1.5.5.1 Impressions, if developed, will turn a yellow-brown color.
9.1.5.5.2 The process should be carefully monitored so that over-development does not occur.
9.1.5.6 Developed impressions are evaluated to determine their suitability for comparison.
9.1.5.7 Visible impressions are photographed or documented as soon as possible, and notes are taken.

9.1.6 PROCEDURE 2 - GUN METHOD:
9.1.6.1 Alternatively, the surface may be processed by using a commercially available fuming gun. The fuming "gun" consists of a length of rubber tubing (that acts as a mouthpiece) with a length of plastic tubing (about 6") attached. The plastic tubing contains an ampoule of iodine crystals, glass wool, and calcium chloride crystals to absorb the moisture that is introduced into the tube when the apparatus is blown into.
9.1.6.2 This method shall be performed in a fume hood or an area with generous ventilation (ex. outdoors).
9.1.6.3 The "gun" is used by breaking the ampoule open to reveal the iodine crystals and wrapping one's hand around the tube. The warmth from the hand is sufficient to cause the iodine to sublimate. The formation of purple fumes is indicative of iodine vapors.
9.1.6.4 When fumes are noticed, the mouthpiece is blown into, and the fumes are directed onto the substrate.
9.1.6.4.1 A control test is conducted prior to the evidence item.
9.1.6.4.2 Impressions, if developed, will turn a yellow-brown color.
9.1.6.4.3 The process needs to be carefully monitored so that over-development does not occur.
9.1.6.5 Developed impressions are evaluated to determine their suitability for comparison.
9.1.6.6 Visible impressions are photographed or documented as soon as possible, and notes are taken.

9.1.7 ADDITIONAL INFORMATION:
9.1.7.1 The resulting yellow-brown impressions can vanish and must be preserved.
9.1.7.2 It is suggested that the camera be set up prior to iodine processing.
9.1.7.3 Iodine enhanced impressions that have faded, or are completely gone, can sometimes be redeveloped by processing with iodine fuming again. Iodine reprocessing cannot be done if other methods have been used or if too long of a time span has elapsed.
9.1.7.4 Shelf life of sealed iodine is indefinite.

9.1.7.5 Iodine crystals originating from glass ampoules shall be disposed of in the hazardous waste containers located in the fume hoods. Excess tubing shall be removed from the fuming guns (thrown away) and the remainder (portion containing iodine) shall be placed in the hazardous wastes containers located in the fume hood.

9.1.7.6 A method of fixing iodine impressions is to apply soluble starch spray or powder (shaking off the excess powder), and pass the exhibit through steam. This method should not be used if further processing is going to be done.

9.1.7.7 The iodine-enhanced impression may be further visualized by the application of 7,8-benzoflavone dip or spray.

9.1.8 CONTROLS:

9.1.8.1 Testing of iodine crystals is performed prior to each use.

9.1.8.2 This test involves the making of an oil-based mark on a test surface similar to the evidence being examined.

9.1.8.3 The test is exposed to the fumes in the same manner as the questioned surface would be.

9.1.8.4 When using the chamber method, testing of the iodine crystals and processing may be conducted at the same time. When using the fuming gun, an analyst shall not proceed with the processing of the evidence until a control test bearing positive results (development of a yellow-brown color on the test mark) has been carried out on the control tests work sheet.

9.1.8.5 The area surrounding the intentionally deposited mark shall serve as a negative control.

9.1.9 SAFETY:

9.1.9.1 Safety is a serious concern when using the iodine fuming method. *Iodine is toxic in any form. ALWAYS AVOID INHALING IODINE FUMES AND NEVER BREATHE IN WHEN USING THE FUMING "GUN" APPARATUS!!*

9.1.9.2 Iodine fumes may irritate the skin and damage the respiratory tract. Headaches that can last for several days may result from exposure to iodine. Long-term effects to the thyroid gland may result from exposure.

9.1.9.3 Adequate ventilation when using the method is mandatory as the fumes are corrosive to metals and may discolor other surfaces that they come in contact with.

9.1.9.4 Iodine shall be purchased in disposable fuming guns or glass ampoules. The ampoules shall stay sealed until use.

9.1.10 REFERENCES:

Cassidy, M.J., *Footwear Identification*, Lightening Powder Co., Inc., Salem, Oregon, 1980, page 53.

Keedwell, E., et al, "Chemical Methods for Enhancement of Footwear Marks", Metropolitan Police Forensic Services Lab, Report No. 73 (1988), page 18.

9.2 LIFTING METHODS

9.2.1 BACKGROUND:

Lifting methods are effective for the preservation of some impressions because the adhesive on the lifting medium is stickier than the surface on which the impression deposit resides. It is a good idea to have a variety of lifting mediums as they vary in clarity, adhesion, and flexibility. The electrostatic dust lifting device (EDL) is effective on dry deposit impressions because an electrical charge induced in the particles of the deposit causes the impression to be attracted to and lifted onto an appropriate material. The electrostatic detection analyzer (ESDA) may be useful for dusty impressions on cardboard or paper because of a similar principle as the EDL. Indented impressions may be lifted from paper and cardboard by the ESDA because the cascade toner will adhere to slight indentations in the surface of the item causing visible black impression detail.

9.2.2 SCOPE:

9.2.2.1 Lifting methods are applicable to impressions that have first been developed utilizing other methods such as powders, SPR, and prints deposited in or composed of dust.

9.2.2.2 Some lifting methods may be effective on impressions made with blood, mud or other residues.

9.2.2.3 Lifts are inexpensive, easy, and a quick method of preserving developed impressions for future comparison.

9.2.2.5 Impression lifting is one method of preserving impressions at a crime scene.

9.2.2.5 Lifting may not be the most effective method of preserving a particular impression.

9.2.3 EQUIPMENT AND MATERIALS:

Exhaust vent or fume hood
Electrostatic Dust Lifting Device (EDL)
Electrostatic Detection Analyzer (ESDA)
Lifting film such as Mylar
Various sizes and types of standard lifting tapes
Adhesive lifters such as Handiprint
Gel lifters
Casting compounds

9.2.4 HANDIPRINT, TAPES, AND GEL LIFTERS:

9.2.4.1 Ensure that the surface has been prepared for lifting by removing excess powder, if powder was used first.

9.2.4.2 Lifting mediums should be removed from their backing in a smooth, continuous motion without hesitation to avoid lines in the adhesive.

9.2.4.3 The lifting medium is then applied to the impression bearing surface in a smooth continuous motion taking care to avoid air pockets and creases. It may be necessary to firmly rub the lifting medium onto the surface using a fair amount of pressure. If the gel lifter is applied to a residue impression, allow the lifter to remain on the impression for approximately 10 minutes to let the impression completely transfer.

9.2.4.4 Removal of the lifting medium from the impression bearing surface should also be performed in a smooth continuous motion and reapplied to a suitable backing material in the same manner as noted above.

9.2.4.5 Impression lifts shall be labeled with the following information:
Unique case identifier;
Date and initials.
Other useful information may include the impression source (description or source identifier) and significant information about the orientation and/or position of the impression on the object through description and/or diagram(s). One should be able to pinpoint the area and orientation of an impression on the object.

9.2.4.6 Lifts from multiple areas (different impressions) shall be placed on individual backing or paper.

9.2.5 CASTING COMPOUNDS (non-dental stone such as Mikrosil):

9.2.5.1 Ensure that the surface has been prepared for lifting by removing excess powder, if powder was used first.

9.2.5.2 Casting material is mixed either by hand or though the use of an extruder gun.

9.2.5.3 Casting material is applied to the impression-bearing surface in a manner that precludes air pockets. It may be necessary to place the casting material to the side of the impression and then smooth it across the surface.

9.2.5.4 The casting material is left in place until solidified.

9.2.5.5 The cast is then is removed from the surface and attached to a suitable backing. The appropriate documentation is noted as detailed in 9.2.4.5.

9.2.6 CASTING – DENTAL STONE:

9.2.6.1 Dental stone is mixed by following the manufacturer's powder/water ratio supplied with the dental stone powder (usually 8 to 9 ounces of water for 2 pounds of dental stone). Sufficient material is mixed to pour one three-dimensional impression at a time.

9.2.6.2 The cast is allowed to completely harden before it is loosened and lifted.

9.2.6.3 The back of the cast is marked with the unique case identifier (if known), impression identifier (if applicable), initials and date.

9.2.6.4 The cast is loosely wrapped in paper to protect it and allowed to dry 24 to 48 hours before cleaning.

9.2.6.5 The cast may be cleaned in a cleaning solution of saturated potassium sulfate (K2SO4) for approximately 1 hour, rinsed and dried. Only dental stone casts should be cleaned in this manner.

9.2.6.6 Casts are positives and represent the footwear outsole or tire tread that made the impression.

9.2.6.7 Casts may be made at crime scenes or utilized as a test impression method for lab comparisons.

9.2.7 ELECTROSTATIC DUST LIFTS:

9.2.7.1 Place the item (dust print up) to be tested on the ground plate with the ground clip connected or set the antenna ground next to the area with the dust impression.

9.2.7.2 Cover the evidence area with a piece of lifting film (metal-coated side away from the possible impression).

9.2.7.3 With the Voltage Adjust Knob set at "LOW", touch the high voltage probe to the surface of the lifting film, turn on the power for 5 to 15 seconds or until the lifting film has been "pulled down" to the surface, and roll out any air bubbles with the roller. The voltage may have to be increased.

9.2.7.4 Turn off the power and let the charge dissipate for several seconds. Remove the lifting film from the surface and turn over away from the evidence area. View the lifted impression with oblique light.

9.2.7.5 To preserve the lifted impression, tape the piece of lifting film into a manila file folder or fine cardboard box, impression side up, and cover to protect it.

9.2.7.6 Because the dust lift is not permanently attached to the lifting film, it can be easily damaged or destroyed. The dust lift should be photographed and any analysis should be done using the photograph.

9.2.7.7 Dust lifts are positives (see section 9.2.6.6 above) and are the reverse of the impression as viewed on the original item or area. Photographic negatives should be reversed to produce a photograph that is the same as the original impression or tests impressions. An electrostatic dust lift can be compared directly to the shoe or tire, if extreme caution is taken to prevent damage to the lift.

9.2.7.8 For metal surfaces, the lifting film should be attached to a piece of heavy duty plastic film and the impression should be lifted onto the plastic film. The black mylar can be left attached to the back of the plastic film to make the impression easier to see.

9.2.8 ELECTROSTATIC DETECTION APPARATUS:

9.2.8.1 For dusty impressions, place the item to be tested on the ESDA with the area with the suspected impression facing up.

9.2.8.2 Pull the plastic film over the item and switch on the vacuum.
9.2.8.3 Turn on the Corona switch and sweep the corona wand over the item. Remove the film and view. A successful lift should be stored as in 9.2.7.5.
9.2.8.4 For indented impressions, place the item to be tested on the ESDA and pull the plastic film over the item. Turn on the vacuum.
9.2.8.5 Turn on the Corona switch and sweep the corona over the item.
9.2.8.6 Tilt the box and pour the Cascade developer over the item to develop the impression. Continue until a suitable image is obtained.
9.2.8.7 Turn off the vacuum and cut the piece of film over the item. Remove the film and place on a white paper background to examine.
9.2.8.8 A successful lift may be preserved in a page protector.
9.2.8.9 If an impression is not developed on the first attempt, further lifting attempts may not work.

9.2.9 ADDITIONAL INFORMATION:
9.2.9.1 Caution should be exercised in using general-purpose tapes (those not developed for lifting impressions) as they may cause migration of some detail or may have striations or other imperfections making it hard to do comparisons.
9.2.9.2 Lifting should be performed after any necessary photography. The analyst's training and experience will determine the use and/or sequence of the lifting and photographic processes.
9.2.9.3 Store lifting mediums and casting compounds in a cool dry place.
9.2.9.4 Dispose of lifting mediums and casting compounds in the trash.

9.2.10 CONTROLS/SAFETY:
Controls are not applicable. There are no known health hazards associated with the use of lifting mediums, casting compounds or ESDA toner or Cascade Developer.

9.2.10.1 Persons using toner powders or Cascade Developer should monitor for allergic reactions (if any) to the powders.

9.2.10.2 Because the EDL uses high voltages, this device should not be used by persons who have pace makers and it should not be operated in wet conditions.
9.2.10.3 The corona unit on the ESDA must not be operated without the earth connection between the instrument body and the corona housing.
9.2.10.4 The EDL should not be used to lift dust impressions off living persons.

9.2.10.5 The lifting film or mylar should be isolated from metal conducting surfaces to prevent extreme sparking. Use of plastic barriers work well on metal surfaces.

9.2.11 REFERENCES:

Abbott, John R., *Footwear Evidence*, Charles C. Thomas, Springfield, 1964

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990.

Cassidy, M.J., *Footwear Identification*, Lightening Powder Co., Inc., Salem, Oregon, 1995 (revised).

Electrostatic Dust Print Lifter Directions for Use, Kinderprint Co., Inc

ESDA a new instrument for the detection of indented writing in documents, Foster & Freeman Ltd., (no date).

ESDA – Applications of the Instrument for the Detection of Indented Writing In Documents, Foster & Freeman Ltd., April 1986.

ESDA Operating Instructions, Foster & Freeman, (no date).

Hamm, Ernest D., "Footprints in the Dust of Time", Journal of Forensic Identification, Vol. 43, No. 4, Jul/Aug 1993, pp357-361.

Hildebrand, Dwayne S., *Footwear – The Missed Evidence*, Staggs Publishing, Temecula, California, 1999.

Keedwell, E., Birkett, J., and Davis, R.J., "Chemical Methods for the Enhancement of Footwear Marks", MPFSL Report No. 73, Metropolitan Police Forensic Science Laboratory, January, 1988.

Majamaa, Heikki and Hamm, Ernest D., "Using the ESDA to Detect Dust Shoeprints on Paper", Journal of Forensic Identification, Vol. 41, No. 6, Nov/Dec 1991, pp 421-425.

9.3 POWDER DETECTION METHODS

9.3.1 BACKGROUND:

Many commercially produced fingerprint powders are available and no powder is universally applicable to all types of non-porous surfaces. Most analysts stock a variety of different types and colors of powders as well as a variety of brushes for specialized applications. Powder particles physically adhere to impression residue allowing the impression to be visualized. This coloring of the residue occurs because the residue has greater adhesion properties than the substrate.

9.3.2 SCOPE:

9.3.2.1 Fingerprint powders are used to develop invisible detail, improve contrast of visible detail, and to facilitate lifting and preservation of impression evidence from non-porous surfaces.

9.3.2.2 The type of powder that is selected is dependent upon:

9.3.2.2.1 Whether resulting impression will be photographed. If so, a powder color that contrasts with the surface is often desirable.

9.3.2.2.2 The nature of the surface to be processed. Traditional powders are often most effective on non-textured surfaces while magnetic powders are often most effective on plastics and textured surfaces. The use of magnetic powders and wands should generally be avoided on substrates that contain iron. Fluorescent powders tend to have limited use. They are useful on multicolored surfaces or surfaces with a light texture that doesn't accept magnetic powder well.

9.3.2.3 The type of applicator selected is dependent upon:

9.3.2.3.1 The size of area to be dusted. Larger brushes are ordinarily used for large areas and smaller brushes on concentrated work or small partial impressions. Fiberglass brushes are often used for both instances.

9.3.2.3.2 The type of powder to be used. Magnetic wands are used in conjunction with magnetic powders while traditional powders are used with a variety of brushes. Traditional fluorescent powders are applied with a feather brush and their application requires the use of an ALS.

9.3.2.4 The prior use of cyanoacrylate esters often increases the adhesion of powders to impression residue.

9.3.2.5 Powder processing is not suitable for surfaces that are wet, tacky, or exceptionally rough and is generally the last step in the impression processing sequence.

9.3.3 EQUIPMENT AND MATERIALS:

Hood/exhaust vents/particulate filters
Traditional, magnetic, and fluorescent powders
Magnetic wand, feather brush, fiberglass brush, animal hair, etc.
Alternate light source
Filtered goggles

9.3.4 PROCEDURE 1 - TRADITIONAL POWDERS:

9.3.4.1 A variety of brushes or applicators may be utilized with the exception of magnetic wands.

9.3.4.2 Apply a small amount of powder to the brush and remove excess powder.

9.3.4.3 Powder should generally be applied to the surface in a smooth circular motion with only the tips of the brush touching the surface until optimal development is achieved

9.3.4.4 If too much powder has been applied, it may be possible to remove excess powder by tapping the object, blowing air over the surface, or by brushing it out.

9.3.4.5 Developed impressions are evaluated to determine their suitability for comparison.

9.3.5.6 Impressions deemed to be of value are marked and may be photographed or lifted.

9.3.5 PROCEDURE 2 - MAGNETIC POWDERS:

9.3.5.1 Magnetic powders generally utilize a magnetic wand in their application.

9.3.5.2 The wand is dipped into the magnetic powder where the powder is picked up by the tip of the wand. The powder actually forms a bristle-less brush that is then applied directly to the surface. The actual wand should not come in contact with the surface.

9.3.5.3 The application of magnetic powders is similar to the dusting method described in 9.3.4.3 & 9.3.4.4.

9.3.5.4 The plunger located at the end of the brush is pulled to its fully extended position to release the powder from the tip of the brush.

9.3.5.5 Excess powder may be removed by passing a wand over the surface without making contact.

9.3.5.6 Developed impressions are evaluated to determine their suitability for comparison.

9.3.5.7 Impressions deemed to be of value are marked and may be photographed or lifted.

9.3.6 PROCEDURE 3 - FLUORESCENT POWDERS:

9.3.6.1 A variety of brushes or applicators may be utilized.

9.3.6.2 Lightly dip the brush into the powder. Remove excess powder. A very small amount of fluorescent powder goes a long way.

9.3.6.3 If possible, it is best to use an ALS while applying the powder. This will prevent over powdering and loss of detail. The

application of fluorescent powders is similar to the dusting methods described in 9.3.4.3 & 9.3.4.4.

9.3.6.4 Developed impressions are evaluated to determine their suitability for comparison.

9.3.6.5 Impressions deemed to be of value are marked and may be photographed or lifted. When photographing impressions developed with fluorescent powders, it is necessary to use an ALS and a camera filter that corresponds to the color of viewing goggle utilized with the ALS. It is necessary to use black backing material with fluorescent powders.

9.3.7 ADDITIONAL INFORMATION:

9.3.7.1 Occasionally, impression quality may be enhanced by repeated powdering and lifting of the same area.

9.3.7.2 An ample number of appropriate brushes will help preclude cross-contamination of powders and brushes.

9.3.7.3 When powder-processing evidence that may be biologically contaminated, every effort shall be made to avoid cross contamination by utilizing previously unused brushes and powder. Brushes and powder will be discarded after use on contaminated items. Magnetic wands will be disinfected.

9.3.7.4 Powders stored in a cool dry place have an indefinite shelf life.

9.3.7.5 Dispose of powders in the trash.

9.3.8 CONTROLS:

Control impressions are not needed for powder processing. However, when there is doubt as to the suitability of a powder for processing a particular surface, the powder should be tested on a similar surface if available. If a similar surface is not available, then the powder may be tested on an edge of the suspected surface, carefully avoiding the area that may contain impressions.

9.3.9 SAFETY:

9.3.9.1 Safety concerns when using commercial fingerprint powders are minimal.

9.3.9.2 Analysts should use the hoods or exhaust vents when performing powdering and lifting in the laboratory.

9.3.9.3 When fingerprint powders are to be used for an extended period of time, a dust mask or half face respirator with dust filters should be worn to minimize the inhalation of the powder particles.

9.3.9.4 Persons using fingerprint powders should monitor for allergic reactions (if any) to the fingerprint powders.

9.3.10 REFERENCES:

Abbott, John R., *Footwear Evidence*, Charles C. Thomas, Springfield, 1964

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990.

Cassidy, M.J., *Footwear Identification*, Lightening Powder Co., Inc., Salem, Oregon, 1995 (revised)

Hildebrand, Dwayne S., *Footwear – The Missed Evidence*, Staggs Publishing, Temecula, California, 1999.

Keedwell, E., Birkett, J., and Davis, R.J., "Chemical Methods for the Enhancement of Footwear Marks", MPFSL Report No. 73, Metropolitan Police Forensic Science Laboratory, January, 1988.

9.4 SMALL PARTICLE REAGENT

9.4.1 BACKGROUND:

Two types of small particle reagents (SPR) are available for use, traditional SPR that consists of a suspension of fine molybdenum disulfide (MoS_2) particles in a detergent solution and commercially available white SPR. These solutions works like a liquid fingerprint powder by adhering to the fatty or oily portion of the impression residue resulting in a gray or white colored impression.

Comment [PC1]:

9.4.2 SCOPE:

9.4.2.1 Small particle reagent is used to develop impressions from a variety of surfaces including adhesives and non-porous items that are or have been wet.

9.4.2.2 The color of SPR should be chosen to contrast with the background.

9.4.2.3 SPR may be used by dipping or spraying. Dipping is the preferred method as spraying is less sensitive. It is, however, difficult to prevent damage to impressions located on the lower side of an article in a dish and spraying is a valid alternative when processing large items, vehicles, or responding to crime scenes.

9.4.2.4 Surfaces that need other forensic examinations such as biology, questioned document, or trace examinations should be carefully evaluated prior to processing to determine if the SPR procedure will have an impact on subsequent examinations.

9.4.3 EQUIPMENT AND MATERIALS:

Beaker
Balance
Magnetic stirrer/stirring bar
Spray bottles
Processing tray

9.4.4 REAGENTS:
Commercially available white SPR
Molybdenum Disulfide (MoS_2)
Photo Flo 200
Distilled water

Small Particle Reagent Working Solution:
1. Place a 1500 ml beaker on magnetic stirrer base.
2. Add 1000 ml of distilled water to the beaker.
3. Place a magnetic stirring bar in the beaker.
4. Dissolve 30g of MoS_2 in the water (MoS_2 comes in 30g bottles).
5. Add three to four drops of Photo Flo 200 to the solution.

9.4.5 PROCEDURE 1 - DIPPING METHOD:
9.4.5.1 Shake or stir the SPR thoroughly and pour the solution into a tray.
9.4.5.2 Add the item to be processed to the solution. The item should be submerged.
9.4.5.3 Agitate the solution in the tray for 2-3 minutes, remove the item from the SPR and gently rinse with tap water.
9.4.5.4 Allow the surface to dry (if feasible).
9.4.5.5 Developed impressions are evaluated to determine their suitability for comparison.
9.4.5.6 Impressions deemed to be of value are marked and may be photographed or lifted. Depending on the circumstances, the item may or may not be dried prior to lifting.

9.4.6 PROCEDURE 2 - SPRAY METHOD:
9.4.6.1 Place the SPR into a spray bottle and shake thoroughly. The bottle should be shaken often to keep the MoS_2 in suspension.
9.4.6.2 Spray the SPR onto the item being examined. If the location of the impressions are known, spray the area above the impressions and allow the SPR to flow over them. Otherwise, spray the area to be examined starting at the top and working downwards.
9.4.6.3 Gently rinse the processed area with tap water and allow it to dry (if feasible).
9.4.6.4 Developed impressions are evaluated to determine their suitability for comparison.
9.4.6.5 Impressions deemed to be of value are marked and may be photographed or lifted. Depending on the circumstances, the item may or may not be dried prior to lifting.

9.4.7 ADDITIONAL INFORMATION:
9.4.7.1 Pre-mixed molybdenum has an indefinite shelf life. The shelf life the SPR working solutions is at least six months, but shall be tested prior to each use.

9.4.7.2 Excess reagent shall be collected and placed in the hazardous waste container located in the fume hood.

9.4.8 CONTROLS:

9.4.8.1 Testing of SPR is performed each day prior to use.

9.4.8.2 This test involves the making of oily mark on a test surface similar to the one being examined.

9.4.8.3 The test mark is exposed to the SPR in the same manner as the questioned surface.

9.4.8.4 An analyst shall not proceed with the processing of the evidence until a control test bearing positive results (development of a gray colored mark with traditional SPR or a white colored mark with white SPR) has been carried out and documented on the control tests work sheet.

9.4.8.5 The area surrounding the intentionally deposited mark shall serve as a negative control.

9.4.9 SAFETY:

There does not appear to be any health hazards associated with small particle reagent, but the process should be monitored to see if there are any allergies. Lab coats, gloves, and safety glasses should be worn.

9.4.10 REFERENCES:

Keedwell, E., Birkett, J., and Davis, R.J., "Chemical Methods for the Enhancement of Footwear Marks", MPFSL Report No. 73, Metropolitan Police Forensic Science Laboratory, January, 1988.

Lee, H.C. and Gaensslen, R.E., *Advances in Fingerprint Technology*, Elsevier, 1991, p 82.

Navarro, R.L., "Chemical Enhancement of Questioned Footwear Impressions", N.C. Bureau of Investigation, 1992, p 53.

9.5 CREATING TEST IMPRESSIONS

9.5.1 BACKGROUND:

Test impressions (reference or known exemplars) is a term used to describe impressions that are purposely made. These impressions may be made using a number of techniques, including, but not limited to, ink, photocopies, photography, three-dimensional impressions in sand or other material, casting, and powder/adhesive lift methods. The goal of the process is to produce legible impressions that are suitable for comparison.

9.5.2 SCOPE:

9.5.2.1 The footwear methods can be used on all footwear. If a shoe is heavily damaged, Biofoam or a casting method may be used to demonstrate what type of impression the shoe would leave.

9.5.2.2 Tires should remain mounted on the vehicle. Test impressions are made by pushing or driving the vehicle over the test impression medium.

9.5.2.3 The spare tire should not be overlooked when doing tire test impressions if there is an indication that it could have been on the vehicle at the time of the incident.

9.5.2.4 Additional test impressions may be necessary when the unknown impression shows distortion in the design elements from the way it was made.

9.5.3 EQUIPMENT AND MATERIALS:

Black printer's ink
Ink pad and roller
Kodak roller transport film
Black fingerprint powder
Inkless Shoeprint Kit
Vaseline or other grease such as WD40
Sand box
Dental stone
Fiberglass brush
Adhesive lifters
Butcher paper
Poster board (44"x28", may be cut in half lengthwise)
Biofoam
Silicone spray
Camera, 35mm or digital

9.5.4 REAGENTS:

None required

9.5.5 PROCEDURE - FOOTWEAR

9.5.5.1 Conduct a visual examination of the shoe for the presence of trace and biological evidence. If any probative evidence is present, documentation and collection must be completed before proceeding. Do test impressions of the shoes as received, then clean them (saving debris from each in separate packages) and repeat the test impression process.

9.5.5.2 Inkless Method

- 9.5.5.2.1 Press shoe to inkless pad.
- 9.5.5.2.2 Press shoe to piece of inkless paper.
- 9.5.5.2.3 Label test impression with "test impression", unique identifier, initials or signature, date, and which shoe is represented.
- 9.5.5.2.4 Repeat the method with the other shoe.
- 9.5.5.2.5 These inkless impressions can fade with exposure to light and a photocopy may be taken as well.
- 9.5.5.2.6 Transparent overlays can be made by using overhead projection transparency material and a photocopier.

9.5.5.3 Ink Method

- 9.5.5.3.1 Press shoe to inkpad.
- 9.5.5.3.2 Press inked shoe sole to plain white paper or damp roller transport film.
- 9.5.5.3.3 Label as in 9.5.5.2.3 above.
- 9.5.5.3.4 Repeat the method with the other shoe.

9.5.5.4 Powdered Test Impression Method

- 9.5.5.4.1 Cover the sole of the shoe with a heavy coating of black fingerprint powder and tap off the excess.
- 9.5.5.4.2 Press the shoe sole onto an adhesive lifter such as Handiprint.
- 9.5.5.4.3 Carefully position the transparent cover onto the test impression avoiding air bubbles.
- 9.5.5.4.4 Label as in 9.5.5.2.3 above.
- 9.5.5.4.5 Repeat the method with the other shoe.
- 9.5.5.4.6 By using transparent lifters, overlays can be made using this method. Otherwise, use overhead transparency material and photocopy as in 9.5.5.2.6.

9.5.5.5 Biofoam 3-D Method

- 9.5.5.5.1 Press the shoe into the Biofoam material.
- 9.5.5.5.2 Add a scale properly positioned next to the impression.
- 9.5.5.5.3 Photograph the impression using oblique lighting.

9.5.5.6 Sand 3-D Method

- 9.5.5.6.1 Press the shoe into an area of smoothed sand.
- 9.5.5.6.2 Add a scale properly positioned next to the impression.
- 9.5.5.6.3 Photograph the impression using oblique lighting.

9.5.5.6.4 The photograph may serve as documentation for the case file or a 1:1 enlargement of this photograph may be used for comparison.

9.5.5.6.5 For additional comparison to an unknown cast, the 3-D test impression may be cast with dental stone.

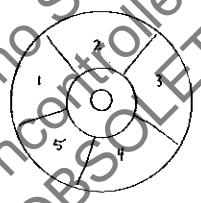
9.5.5.7 Other methods may be used such as potters clay or direct photography of outsole.

9.5.6 PROCEDURE - TIRES:

9.5.6.1 Ideally, tires are left in position on the vehicle. If mounted tires are received, they should be placed on a vehicle in the same position. Test impressions may be made of an unmounted tire by rolling the tire along the test media. Conduct a visual examination of the tire for the presence of trace and biological evidence. If any probative evidence is present, documentation and collection must be completed before proceeding. Tire treads should be brushed clean of dirt, but all embedded stones should be left in place.

9.5.6.2 Inked Method

9.5.6.2.1 Outer sidewall of tire is divided into segments (usually four to seven) with tire crayon or chalk and each segment is numbered (1 up to 7 depending on number of segments).



9.5.6.2.2 An inkpad is prepared by taping pieces of poster board together end to end until there is enough length for a complete tire rotation. Printer's ink is placed onto the inkpad and rolled into a thin, smooth layer from edge to edge. Position the completed inkpad in front of the selected tire.

9.5.6.2.3 The test impression board is prepared by taping pieces of poster board together end to end until there is enough length for a complete tire rotation plus 6" to 12" extra. The test impression made be made directly on the board or on plastic film taped to the board.

9.5.6.2.4 Position the test impression board in front of the inkpad. Roll the vehicle (push or drive) so the tire rotates over the

inkpad . When the tire is coated with ink, continue the rotation of the tire along the test impression board.

9.5.6.2.5 As the tire moves along the test impression board, mark the segment bars and segment numbers on the test impression board beside the test impression.

9.5.6.2.6 Once the test impression is complete, the following information should be placed on the test impression:

- Unique identifier
- Initials or signature
- Date
- Which tire is represented
- Direction of rotation
- Inside and outside of impression

Other information that must be documented in notes:

- Complete vehicle information including, make, model, color, VIN, and license plate number.
- Complete tire information from sidewall of tire, including make, model, size, type of tire, etc.
- DOT number.
- Mold number, if possible.

9.5.6.2.7 Repeat the method for the other tires.

9.5.6.2.8 Allow the inked impressions to completely dry in a secure location. Package using appropriate evidence packaging and sealing techniques.

9.5.6.3 Grease Method

9.5.6.3.1 Follow the same instructions for marking the sidewalls as in 9.5.6.2.1.

9.5.6.3.2 Using proper safety precautions, jack up the tire until it "spins free". Coated the tire tread lightly with grease.

9.5.6.3.3 The test impression board is prepared by taping pieces of poster board together end to end until there is enough length for a complete tire rotation plus 6" to 12" extra. The test impression may be made directly on the board or on butcher paper (paper side up) taped to the board.

9.5.6.3.4 The board is placed in front of the tire, and the vehicle is rolled along the length of the board.

9.5.6.3.5 As the tire moves along the test impression board, mark the segment bars and segment numbers on the test impression board beside the test impression.

9.5.6.3.5 On the completed impression, add/collect the information as directed in 9.5.6.2.6.

9.5.6.3.6 Repeat the method for the other tires.

9.5.6.3.7 The "greased" impressions may be developed using black magnetic fingerprint powder.

9.5.6.3.8 Package using appropriate evidence packaging and sealing techniques.

9.5.6.4 The vehicle should be kept impounded in a secure area so that additional test impressions can be made and/or the tires can be directly compared to the impressions, if needed.

9.5.7 CONTROLS:
Not applicable

9.5.8 SAFETY:
All human biological material shall be treated as if infectious.

9.5.8.1 Gloves, eye protection, lab coat, and/or a protective disposable apron shall be worn at all times when working with footwear or tires contaminated with biological evidence.

9.5.8.2 Utensils shall be disposed of or cleaned and disinfected after use and surfaces will be disinfected.

9.5.8.3 Although there aren't any health effects associated with the black printer's ink used for tire test impressions, this ink is very viscous and difficult to remove from clothing and skin. The analyst should wear protective clothing and disposable gloves when working with this material.

9.5.8.4 Precautions should be taken when jacking up the vehicle.

9.5.9 REFERENCES:

Abbott, John R., *Footwear Evidence*, Charles C. Thomas, Springfield, 1964

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990.

Bodziak, William J., "Some Methods for Taking Two-Dimensional Comparison Standards of Tires", Journal of Forensic Identification, Vol. 46, No. 6, 1996, pp 689-701.

Cassidy, M.J., *Footwear Identification*, Lightening Powder Co., Inc., Salem, Oregon, 1995 (revised)

10 CHEMICAL METHODS

10.1 AMIDO BLACK BLOOD IMPRESSION PROCESSING

10.1.1 BACKGROUND:

Amido Black is also known as Amido Black 10B, Amido Black 12B, Naphthol Blue Black, or Naphthalene Black. Amido black is a dye that stains the protein portion of blood a blue-black color.

10.1.2 SCOPE:

10.1.2.1 Blood contaminated impressions may be processed with amido black to detect faint deposits of impression detail. It is generally used on dried blood stains on non-porous surfaces, but has been successful in developing impressions on some semi-porous and porous surfaces as well.

10.1.2.2 Amido black will not detect the normal constituents of impressions and therefore must be used in the proper sequence with other impression processing methods.

10.1.2.3 The amido black process utilizes a working solution, a rinse solution, and a wash solution (distilled water). Blood must be fixed prior to the application of amido black (unless using methanol in the amido black working solution as a fixative) to prevent the liquid solutions used in the process from washing away some or all of the blood deposits.

10.1.2.4 Bloodstains must be carefully examined and evaluated to preclude destruction of potentially valuable evidence. Any samples to be used for the biological examination of blood deposits or trace analysis should be collected prior to enhancement. It is often necessary to coordinate with investigators and/or other laboratory sections (biology for example) to determine which procedures may provide the most valuable findings.

10.1.3 EQUIPMENT AND MATERIALS:

Balance, magnetic stirrer/stirring bar
Pipettes
Beakers
Graduated cylinder
Storage bottles
Spray bottles

10.1.4 REAGENTS:

Amido Black
Glacial acetic acid
Methanol
Distilled water

5-sulfosalicylic acid

Amido Black Working Solution:
1. Weigh out 0.2g of amido black and place in a beaker.
2. Measure out 10mL of glacial acetic acid and add to the amido black.
3. Measure out 90mL of methanol and add to the beaker containing the amido black and glacial acetic acid.
4. Stir the solution with a magnetic stirrer for thirty minutes and transfer the solution to a clean spray bottle.

Rinse Solution 1 (de-stain):
1. Measure out 10mL of glacial acetic acid and pour into beaker.
2. Measure 90mL of methanol and add to the beaker.
3. Stir the solution for two to three minutes and transfer the solution to a clean, dry spray bottle.

Rinse Solution 2 (de-stain)
1. Measure out 5mL of glacial acetic acid and pour into a beaker.
2. Measure 98mL of methanol and add to the beaker.
3. Stir the solution for two to three minutes and pour into a spray bottle.

Fixative
1. Measure 20g of 5-sulfosalicylic acid and place into a 1500mL or larger beaker.
2. Add 1 liter of distilled water, mix well and pour into a storage bottle.

10.1.5 PROCEDURE:

10.1.5.1 Determine if samples for biology should be taken prior to processing.

10.1.5.2 Conduct control tests.

10.1.5.3 "Fix" impressions using heat, methanol, 5-sulfosalicylic acid, or super-glue.

Blood can be fixed to an object by heating in a 100° centigrade oven for thirty minutes (restricted to non-heat sensitive objects). Methanol may be sprayed or pipetted over the item. The item can be immersed in the sulfosalicylic acid solution for 10 minutes, then in distilled water for 5 minutes. Large areas such as floors may be sprayed with the sulfosalicylic acid solution. The first amido black rinse that contains methanol may suffice for this "fixing" rinse. Super-glue is an effective method for non-porous evidence as it will fix all possible impressions not just those contaminated with blood.

10.1.5.4 Immerse the item in the amido black working solution for two to three minutes. Alternatively, the item may be sprayed or irrigated with the amido black working solution.

10.1.5.5 Immerse or irrigate the item with the de-stain rinse solution(s) to remove the excess dye.

10.1.5.6 Resulting impressions are a dark blue-black. The above process may be repeated to improve contrast.

10.1.5.7 Immerse or irrigate the surface with a distilled water wash (optional).

10.1.5.8 Allow the item to dry thoroughly.

10.1.5.9 Developed impressions are evaluated to determine their suitability for comparison.

10.1.5.10 Impressions deemed to be of value are marked and photographed.

10.1.6 ADDITIONAL INFORMATION:

10.1.6.1 Shelf life of the pre-mixed amido black working solution, de-stains and fixative is indefinite.

10.1.6.2 Excess reagent shall be collected, when possible, and placed in the hazardous waste container located in the fume hood.

10.1.7 CONTROLS:

10.1.7.1 Testing of amido black is performed each day prior to use.

10.1.7.2 Control tests are performed by the application of the reagent to a slide prepared with known blood. For safety reasons, analysts *will not* prepare impressions made with blood. A smear will be applied to the slide instead.

10.1.7.3 An analyst shall not proceed with the processing of the evidence until a control test bearing positive results (known blood staining a blue-black color) has been carried out and documented on the Reagent Preparation Log sheet or control tests work sheet.

10.1.7.4 The area surrounding the intentionally deposited blood smear shall serve as a negative control.

10.1.8 SAFETY:

10.1.8.1 Gloves, lab coats, goggles, and respirators, (if there is a chance of the reagents becoming airborne) are worn when mixing or using Amido Black.

10.1.8.2 Glacial acetic acid is corrosive and extremely irritating to the eyes and respiratory system. Avoid breathing the vapors and use in a fume hood, with a respirator, or with adequate ventilation. Glacial Acetic Acid will cause burns if it comes in contact with skin.

10.1.8.3 Methanol is *flammable*. It needs to be handled carefully and non-permeable gloves worn during the mixing and use of Amido Black. Methanol is toxic in quantities as small as 30 ml and should not be allowed to come in contact with the skin, eyes, or mouth. It is possible for methanol to be absorbed through the skin. If methanol comes into contact with the eyes or mouth, the

area should be flushed with generous amounts of water and a doctor may be consulted. Inhalation of methanol vapors should be kept at a minimum and the solution should be used in a well-ventilated area.

10.1.8.4 In addition, analysts must be aware of the biological hazards associated with blood and other body fluids and take extra precautions to protect themselves.

10.1.9 REFERENCES:

Bodziak, William J., *Footwear Impression Evidence*, CRC Press, 1999.

Journal of Forensic Identification, Vol. 45, No. 5 Sept/Oct 1995, "Superglue of Latent Shoe Prints in Blood Prior to Processing", pages 498-50.

Lee, H.C. and Gaensslen, R.E., *Advances in Fingerprint Technology*, Elsevier, 1991, p 85.

Navarro, R.L., "Chemical Enhancement of Questioned Footwear Impressions", North Carolina State Bureau of Investigations, 1992.

10.2 AMMONIUM THIOCYANATE

10.2.1 BACKGROUND:
Iron is found in many residues, particularly in soil or mud. Ammonium thiocyanate reacts with ferric iron in impression residues to form a red-brown color.

10.2.2 SCOPE:
- 10.2.2.1 This procedure works well for wet residues and muddy impressions on all surfaces.
- 10.2.2.2 Further enhancement with Physical Developer may be used after ammonium thiocyanate because nitric acid is used (other acids may interfere with Physical Developer).
- 10.2.2.3 Faint impressions sprayed with this reagent may be enhanced to show highly visible detail.
- 10.2.2.4 This reagent has better solubility than potassium thiocyanate so there isn't a need to filter after preparation of the reagent.

10.2.3 EQUIPMENT AND MATERIALS:
Balance, magnetic stirrer/stirring bar
Pipettes
Beakers
Graduated cylinder
Spray bottles

10.2.4 REAGENTS:
Ammonium thiocyanate
Acetone
2N nitric acid (1.2mL nitric acid/8.8mL distilled water)

Ammonium Thiocyanate Working Solution
1. Dissolve 2g of ammonium thiocyanate in 90mL of acetone.
2. Slowly add 10 mL of 2N nitric acid.
3. Transfer to fine mist spray bottle and loosely cap so gases can escape.

10.2.5 PROCEDURE:
- 10.2.5.1 Conduct control tests.
- 10.2.5.2 Apply two light spray applications of approximately 3 seconds each.
- 10.2.5.3 Resulting impressions are a red-brown or rust-brown color.
- 10.2.5.4 Developed impressions are evaluated to determine their suitability for comparison.
- 10.2.5.5 Impressions deemed to be of value are marked and photographed.

10.2.6 ADDITIONAL INFORMATION:
- 10.2.6.1 This reagent should be freshly prepared for each application.

10.2.6.2 The reaction product is water soluble so caution is required with non-absorbent surfaces.

10.2.6.3 For faint impressions on paper or cloth, a pre-wash treatment with 0.2% ferrous sulfate should be considered. The item is immersed in the pre-wash for 1 minute followed by 2 immersions in distilled water. The item is then placed on blotter paper and allowed to dry.

10.2.6.4 A source of contamination is excess soil from the surface.

10.2.6.5 If the substrate is red-brown or rust colored, gel lifting of the impression first and treatment of the gel lift with this reagent may be indicated.

10.2.6.6 Avoid over-spraying of the item so that the soil residue doesn't wash off the item.

10.2.7 CONTROLS:

10.2.7.1 Testing of ammonium thiocyanate is performed when the reagent is prepared.

10.2.7.2 Control tests are performed by the application of the reagent to a mark made with a ferric salt solution.

10.2.7.3 An analyst shall not proceed with the processing of the evidence until a control test bearing positive results (known mark staining a red-brown color) has been carried out and documented on the Impression Evidence Reagent Prep Log or control tests work sheet.

10.2.7.4 The area surrounding the intentionally deposited mark shall serve as a negative control.

10.2.8 SAFETY:

10.2.8.1 Ammonium thiocyanate is an eye, skin and respiratory irritant and safety glasses should be worn when measuring it.

10.2.8.2 Acetone is highly flammable and the reagent should be prepared in the fume hood.

10.2.8.3 If the spray bottle cap is tightened, a build-up of gases will cause the bottle to blow the top and release the contents in a violent manner.

10.2.9 REFERENCES:

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990.

Davis, R.J., "Notes on the use of Chemical Methods for the Enhancement of Footwear Marks", Metropolitan Police Forensic Science Lab, January, 1988.

Davis, R.J., "A Systematic Approach to the Enhancement of Footwear Marks", Canadian Society of Forensic Science Journal, Vol. 21, No. 3, 1988, pp 98-105.

10.3 7,8-BENZOFLAVONE

10.3.1 BACKGROUND:
Benzoflavone is absorbed by a range of fatty, oily and organic materials to give a blue colored impression after enhancement by iodine fuming.

10.3.2 SCOPE:
10.3.2.1 The blue color isn't permanent and will weaken with time. Photography should closely follow the treatment.
10.3.2.2 Post-treatment of an iodine-enhanced impression with benzoflavone will often visualize additional detail because of the darker blue color.
10.3.2.3 The item may be sprayed or dipped into the reagent.
10.3.2.4 Further chemical enhancement may be utilized after this treatment.

10.3.3 EQUIPMENT AND MATERIALS:
Balance, magnetic stirrer/stirring bar
Pipettes
Beakers
Graduated cylinder
Storage bottle
Spray bottle

10.3.4 REAGENTS:
7,8-benzoflavone
Chloroform
Petroleum ether

Benzoflavone Working Solution
1. Dissolve 0.2g of benzoflavone in 2 to 3mL of chloroform.
2. Make up to 100mL with petroleum ether.
3. Place in storage bottle or spray bottle.

10.3.5 PROCEDURE:
10.3.5.1 Conduct control tests.
10.3.5.2 Dip the item in the reagent for 10 seconds or spray.
10.3.5.4 Developed impressions are evaluated to determine their suitability for comparison.
10.3.5.5 Impressions deemed to be of value are marked and photographed.

10.3.6 ADDITIONAL INFORMATION:
10.3.6.1 Benzoflavone working solution has a shelf life of up to one year, but is generally made just before using.

10.3.6.2 This reagent is used as an additional enhancement step following iodine fuming.

10.3.7 CONTROLS:

10.3.7.1 Testing of benzoflavone is performed when the reagent is prepared and before each use if reagent has been stored.

10.3.7.2 Control tests are performed by the application of the reagent to a known mark in starch.

10.3.7.3 An analyst shall not proceed with the processing of the evidence until a control test bearing positive results (known mark staining a blue color) has been carried out and documented on the Impression Evidence Reagent Prep Log or control tests work sheet.

10.3.7.4 The area surrounding the intentionally deposited mark shall serve as a negative control.

10.3.8 SAFETY:

10.3.8.1 Benzoflavone is an irritant and caution should be taken when weighing the powder.

10.3.8.2 Chloroform is a know mutagen and carcinogen. The reagent should only be used in a fume hood or with proper respiratory protection.

10.3.9 REFERENCES:

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990.

Davis, R.J., "Notes on the use of Chemical Methods for the Enhancement of Footwear Marks", Metropolitan Police Forensic Science Lab, January, 1988.

Davis, R.J., "A Systematic Approach to the Enhancement of Footwear Marks", Canadian Society of Forensic Science Journal, Vol. 21, No. 3, 1988, pp 98-105.

Keedwell, E., Birkett, J., and Davis, R.J., "Chemical Methods for the Enhancement of Footwear Marks", MPFSL Report No. 73, Metropolitan Police Forensic Science Laboratory, January, 1988.

10.4 CYANOACRYLATE ESTER

10.4.1 BACKGROUND:

Cyanoacrylate ester (CAE) also referred to as "superglue," is sold as a number of brands and in a number of viscosities. Items that are to be processed with CAE need to be exposed to an atmosphere rich in CAE fumes. This may be accomplished through the use of a traditional fuming chamber, superglue-fuming wand, or vacuum chamber.

10.4.2 SCOPE:

10.4.2.1 Fuming with cyanoacrylate esters (super-glue) is a process that is used to visualize impression deposits on non-porous and some semi-porous objects. CAE processing also prepares the surface for the acceptance of powders and dye-stains that may enable further visualization of the impressions.

10.4.2.2 CAE is most effective on wet-origin impressions and least effective on dry-origin impressions.

10.4.2.3 When superglue vapors contact moisture and other components of impression residue the cyanoacrylate ester polymerizes fixing the impressions to the surface. This makes them more stable and less easily damaged.

10.4.2.4 The process is temperature, humidity, and pressure sensitive.

10.4.2.5 Objects that need additional forensic examinations such as trace or questioned document examinations should be carefully evaluated prior to processing to determine if this procedure will have an impact on subsequent examinations.

10.4.3 EQUIPMENT AND MATERIALS:

Relatively airtight container such as a tank or sealed plastic bag
Vacuum chamber
Superglue fuming wand
Cups/warm water (optional)
Low temperature heating element (optional)

10.4.4 REAGENTS:

Cyanoacrylate gel or liquid
One shot fuming kit or equivalent
Superglue cartridges

10.4.5 PROCEDURE 1 - TRADITIONAL FUMING CHAMBER:

10.4.5.1 Select the appropriately sized fuming chamber.

10.4.5.2 Place the surface to be processed in the chamber (suspend if possible).

10.4.5.3 Add control test.

10.4.5.4 Add humidity to the chamber via cups of hot water (larger chambers will require more cups, smaller chambers fewer cups).

10.4.5.5 Allow the chamber to warm (if necessary) and humidity to build (80 degrees Fahrenheit and 80 % humidity is optimal but satisfactory results may be obtained at varying temperatures and humidity levels).

10.4.5.6 Add the CAE source.

10.4.5.6.1 Hot Plate Method - plug in the hot plate and place in the chamber. Add an approximately 2-3 cm in diameter pool of liquid superglue to a disposable aluminum dish and place on the hot plate.

10.4.5.6.2 Gel Packet Method - open and add one or more foil CAE gel packets (dependent on size of chamber, fuming rate, and analyst's preference) to the chamber. Once the gel is exposed to the air, the CAE will begin to vaporize at a controlled rate.

10.4.5.6.3 "ONE-SHOT" fuming kits - place the "activator solution" in the jar provided. Add the "activator canister" to the solution. Empty the CAE on to the top of the "activator canister." This method is generally reserved for crime scene response.

10.4.5.7 Secure the door to the chamber.

10.4.5.8 Fuming times will vary by the size of the chamber, the properties of the cyanoacrylate being used, the amount of heat and humidity, and the properties of the evidence being fumed. A control test should be carefully monitored by the analyst to prevent over or under fuming. Proper development is achieved when impression details on the control turn slightly white in color and begin to show good contrast. In the event of under fuming, the item may be re-fumed.

10.4.5.9 When development is complete evacuate the CAE fumes and remove the CAE source from the chamber.

10.4.5.10 Remove the item from the chamber and examine for comparable impression detail.

10.4.5.11 Impressions may be marked and photographed at this point, but are more commonly further enhanced with powders or dyes prior to preservation.

10.4.6 PROCEDURE 2 – SUPER GLUE FUMING WAND METHOD:

10.4.6.1 In a fume hood or other well ventilated area, place a superglue cartridge over the end of the fuming wand. Select cartridge size dependent upon amount and size of evidence.

10.4.6.2 Set control level to high and ignite the fuming wand. Fumes should be visible once the wand is hot, approximately 1-2 minutes.

10.4.6.3 Lower the heat level if desired.

10.4.6.4 Conduct a control test.

10.4.6.5 Fume the item by holding the fuming wand approximately 4-8 inches away. Fumes from the wand will rise so it is best to direct the fumes below your item if possible or deflect the fumes toward your item. Do not hold the wand too close or in the same area too long as damage and/or over development may occur.

10.4.6.6 Turn the fuming wand off and allow the unit to cool completely prior to removing cartridges or repackaging.

10.4.6.7 Examine item for impression detail.

10.4.6.8 Impressions may be marked and photographed at this point, but are more commonly further enhanced with powders or dyes prior to preservation.

10.4.7 PROCEDURE 3 - VACUUM CHAMBER METHOD:

10.4.7.1 Place items of evidence and controls into the vacuum chamber. It is not necessary to unfold garbage bags or leave large amounts of space between the items. *Do not place pressurize items such as sealed cans, bottles etc. in the chamber as they may explode.*

10.4.7.2 Add the CAE source. Foil CAE gel packs are recommended (number is dependent on chamber size and space), but a small dish with liquid CAE may also be used.

10.4.7.3 Place the lid on the vacuum chamber and close the release valve.

10.4.7.4 Turn on the vacuum pump.

10.4.7.5 Open the Gas Ballast Valve about one half turn.

10.4.7.6 Open the Isolation Valve (up position). If necessary, press on the lid until the chamber begins to evacuate.

10.4.7.7 Close the Gas Ballast Valve.

10.4.7.8 Evacuate the chamber to approximately 25 inches of mercury as shown on the chamber gauge.

10.4.7.9 Close the Isolation Valve.

10.4.7.10 Open the Gas Ballast Valve, wait 2-3 seconds and turn off the pump.

10.4.7.11 Close the Gas Ballast Valve.

10.4.7.12 Leave the items under vacuum for at least 20 minutes. There is no danger of over fuming.

10.4.7.13 Evacuate the chamber by slowly opening the release valve.

10.4.7.14 Remove glue and evidence. Examine item for impression detail.

10.3.7.15 Impressions may be marked and photographed at this point, but are more commonly further enhanced with powders or dyes prior to preservation.

10.4.8 ADDITIONAL INFORMATION:

10.4.8.1 In the event of over-fuming, it may be possible to use an adhesive lifting technique (tape, gel lifter etc.) to lift away heavy upper deposits, revealing underlying detail.

10.4.8.2 The "foil packets" may be stored at room temperature and have a shelf life of six months to a year. Liquid CAE and cartridges may be stored at room temperature with an indefinite shelf life.

10.4.8.3 CAE may be disposed of in the trash.

10.4.8.4 Analysts shall read the manufactures operating instructions for the super glue fuming wand and vacuum chambers prior to operating this equipment.

10.4.9 CONTROLS:

10.4.9.1 Testing of CAE and processing are performed at the same time.

10.4.9.2 A test impression is applied to a non-porous surface and put into the tank in an easily-monitored position with the questioned surface.

10.4.9.3 When the development of the control test is complete, the questioned surface is also finished. Positive results are indicated by development of a white impression.

10.4.9.4 The area surrounding the intentionally deposited impression shall serve as a negative control.

10.4.9.5 Results of control tests shall be documented on control tests work sheet.

10.4.10 SAFETY:

10.4.10.1 Super glue fuming should only be conducted in well-ventilated areas. Precautions should be taken to avoid inhaling or allowing the vapors to contact the eyes, as the vapors can be irritating to the eyes, nose, and throat. Persons wearing contact lenses should not open CAE chambers without taking proper precautions. Non-vented goggles should be worn.

10.4.10.2 Precautions include using relatively sealed CAE chambers and evacuating the fumes from the chambers prior to removal of the questioned and test surfaces.

10.4.10.3 Gloves should be worn to prevent the cyanoacrylate from contacting the skin. If liquid glue is allowed to contact the skin, adhesion may result. If the skin sticks together, immerse affected areas in warm water. This will loosen the skin so that it can be gently pulled apart.

10.4.11 REFERENCES:

Coleman Vacu-Print Instructions and Notes, Lightning Powder, (1995).

Cushman, B. Q. and Simmons, N.J., "A Cyanoacrylate Fuming Method for the Development of Footwear Impressions", Journal of Forensic Identification, Vol. 46, No. 4, Jul/Aug, 1996, p 412.

Lee, Henry C. and Gaensslen, R. E., *Advances in Fingerprint Technology*, Elsevier, 1991, p 67.

Llewellyn, P.E. and Scott-Dinkins, L., "A New Use for an Old Friend", Journal of Forensic Identification, Vol. 45, No. 5 July/August, 1996; Vol. 46, No. 1 Sep/Oct, 1995, p 498.

Paine, N., "Use of Cyanoacrylate Fuming and Related Enhancement Techniques to Develop Shoe Impressions on Various Surfaces", Journal of Forensic Identification, Vol. 48, No. 5, Sep/Oct, 1998, p 585.

10.5 8-HYDROXYQUINOLINE

10.5.1 BACKGROUND:

8- hydroxyquinoline reacts with calcium, magnesium, iron, aluminum and other metal cations (positive ions) that may be present in small amounts in impression residues. The reaction causes fluorescence that is visible under ultra-violet (UV) light.

10.5.2 SCOPE:

10.5.2.1 The fluorescence is not permanent and will fade within a day or so. Photography with color or black and white film, an appropriate filter, UV light and long exposure times should follow within a short time.

10.5.2.2 This procedure works well on impressions made with either wet or dry residues.

10.5.2.3 This reagent is very useful on raw wood surfaces.

10.5.2.4 If the substrate fluoresces with this reagent but the residue doesn't contain any metal cations and the impression prevents fluorescing where it lies, a dark impression on a fluorescing background will be produced.

10.5.2.5 If the fluorescence fades, repeat spraying will not work.

10.5.2.6 Other chemical enhancement methods may be used after this treatment.

10.5.3 EQUIPMENT AND MATERIALS:

Balance, magnetic stirrer/stirring bar
Pipettes
Beakers
Graduated cylinder
Storage bottle
Spray bottle

10.5.4 REAGENTS

8-Hydroxyquinoline
Acetone
Distilled water

8-Hydroxyquinoline Working Solution

1. Mix 90mL of acetone with 10mL of distilled water.
2. Dissolve 0.5g of 8-hydroxyquinoline into the above mixture.
3. Stir well and pour into a storage bottle or spray bottle.

10.5.5 PROCEDURE

10.5.5.1 Conduct control tests.

10.5.5.2 Lightly spray the area of interest.

10.5.5.3 View with short wave and long wave UV light.

10.5.5.6 Developed impressions are evaluated to determine their suitability for comparison.

10.5.5.7 Impressions deemed to be of value are marked and may be photographed or lifted.

10.5.6 ADDITIONAL INFORMATION

10.5.6.1 8-Hydroxyquinoline working reagent has a shelf life of 6 months.

10.5.6.2 If both the substrate and residue have cations that fluoresce, this reagent will not work. Lifting the impression from the substrate by gel lifter first and spraying the gel lift may work.

10.5.7 CONTROLS

10.5.7.1 Testing of 8-hyroxyquinoline is performed each day prior to use.

10.5.7.2 This test involves the making of a mark in chalk on a test surface and following the processing procedure.

10.5.7.3 An analyst cannot proceed with the processing of the evidence until a control test bearing positive results (development of a purple fluorescing mark with UV light) has been carried out and documented on the Impression Evidence Reagent Prep Log or control tests work sheet.

10.5.7.4 The area surrounding the intentionally deposited latent print shall serve as a negative control.

10.5.8 SAFETY

10.5.8.1 This reagent is both a skin and respiratory irritant and should only be used in a fume hood or with proper respirator protective equipment. Disposable gloves should also be worn.

10.5.8.2 Acetone is very flammable and this reagent should not be used near an open flame or ignition source.

10.5.8.2 The reagent should be stored in an amber bottle in the fume hood.

10.5.9 REFERENCES

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990.

Davis, R.J., "Notes on the use of Chemical Methods for the Enhancement of Footwear Marks", Metropolitan Police Forensic Science Lab, January, 1988.

Davis, R.J., "A Systematic Approach to the Enhancement of Footwear Marks", Canadian Society of Forensic Science Journal, Vol. 21, No. 3, 1988, pp 98-105.

Keedwell, E., Birkett, J., and Davis, R.J., "Chemical Methods for the Enhancement of Footwear Marks", MPFSL Report No. 73, Metropolitan Police Forensic Science Laboratory, January, 1988.

10.6 LEUCOCRYSTAL VIOLET

10.6.1 BACKGROUND:
Leucocrystal Violet is a biological stain used to dye the blood hemoglobin components of impression residues an intense purple color. Due to the toxic nature of this reagent, it should only be used in small quantities with the appropriate safety precautions observed.

10.6.2 SCOPE:
- 10.6.2.1 Leucocrystal violet is a dye stain used to visualize impression deposits on many types of adhesive surfaces.
- 10.6.2.2 Leucocrystal violet may also be used on small non-porous surfaces contaminated with grease and oils. It is not suitable for water-soluble adhesives or porous surfaces.
- 10.6.2.3 Surfaces that need other forensic examinations such as biology or trace should be carefully evaluated prior to processing to determine if this procedure will have an impact on subsequent examinations.

10.6.3 EQUIPMENT AND MATERIALS:
Balance
Magnetic stirrer/stirring bar
Graduated cylinder
Glass beaker
Glass tray
Storage bottles

10.6.4 REAGENTS:
Leucocrystal Violet
5-sulfosalicylic acid
3% hydrogen peroxide
Distilled water

10.6.4.1 Formula "A"
- 10.6.4.1.1 Dissolve 10g of 5-sulfosalicylic acid in 100ml distilled water.
- 10.6.4.1.2 Add 400ml 3% hydrogen peroxide to sulfasalicylic acid solution.
- 10.6.4.1.3 **Immediately prior to use, add 0.75g leucocrystal violet to above. Stir the mixture vigorously.**

10.6.4.2 Formula "B"
- 10.6.4.2.1 10g 5-sulfosalicylic acid dissolved in 500ml 3% hydrogen peroxide.
- 10.6.4.2.2 Add 3.7g sodium acetate and 1.0g leucocrystal violet. Sir the mixture vigorously.

10.6.5 PROCEDURE:

10.6.5.1 Determine if samples for biology should be taken prior to processing.

10.6.5.2 Conduct control tests.

10.6.5.3 Spray the impression using a fine mist sprayer. Items may also be soaked or the surface flooded with the solution.

10.6.5.4 Development of dark purple impressions should occur in 30 seconds.

10.6.5.5 Developed impressions are evaluated to determine their suitability for comparison.

10.6.5.6 Impressions deemed to be of value are marked and may be photographed or lifted.

10.6.6 ADDITIONAL INFORMATION:

10.6.6.1 Shelf life of the working solution is approximately 3 months.

10.6.6.2 Excess reagent shall be collected and placed in the hazardous waste container located in the fume hood.

10.6.7 CONTROLS:

10.6.7.1 Testing of leucocrystal violet is performed each day prior to use.

10.6.7.2 This test involves the making of a mark in blood on a slide and following the processing procedure.

10.6.7.3 An analyst cannot proceed with the processing of the evidence until a control test bearing positive results (development of a purple mark) has been carried out and documented on the Reagent Preparation Log sheet or control tests work sheet.

10.6.7.4 The area surrounding the intentionally deposited latent print shall serve as a negative control.

10.6.8 SAFETY:

10.6.8.1 Leucocrystal violet is a suspected human carcinogen. It is known to effect the kidney, ureter, bladder, and thyroid of animals. It can be harmful if inhaled, and is irritating to the eyes and skin.

10.6.8.2 Leucocrystal violet should not be used in large amounts.

10.6.8.3 A respirator should be used when working with the dry form. Leucocrystal violet should be prepared and used in a fume hood or well-ventilated area. The analyst should wear a lab coat, heavy-duty (non-disposable) gloves, and safety glasses.

10.6.8.4 In addition, analysts must be aware of the biological hazards associated with blood and other body fluids and take extra precautions to protect themselves.

10.6.9 REFERENCES:

Bodziak, William J., "Use of Leucocrystal Violet to Enhance Shoe Prints in Blood", Forensic Science International, Vol. 82, No. 1, September 1996.

Chemical Formulas and Processing Guide for Developing Latent Prints, US Department of Justice, 1994, pp 47-48.

Fisher, John F., "An Aqueous Leucocrystal Violet Enhancing Reagent for Blood Impressions", Symposium on the Forensic Aspects of Footwear and Tire Impression Evidence, FBI Academy, 1994.

10.7 LEUCOMALACHITE GREEN (LCG)

10.7.1 BACKGROUND:

Leucomalachite green, is a biological stain used to dye the blood hemoglobin components of impression residues an intense green color. Due to the toxic nature of this reagent, it should only be used in small quantities with the appropriate safety precautions observed.

10.7.2 SCOPE:

10.7.2.1 Leucomalachite green is a dye stain used to visualize impression deposits on many types of surfaces without coloring the background. There is no need for destaining.

10.7.2.2 Leucomalachite green may also be used on small non-porous surfaces contaminated with grease and oils.

10.7.2.3 Surfaces that need other forensic examinations such as biology or trace should be carefully evaluated prior to processing to determine if this procedure will have an impact on subsequent examinations.

10.7.3 EQUIPMENT AND MATERIALS:

Balance
Magnetic stirrer/stirring bar
Graduated cylinder
Glass beaker
Glass tray
Spray bottle

10.7.4 REAGENTS:

Leucomalachite green
Sodium perborate
Methanol
Glacial acetic acid
Freon-113 (trichlorotrifluoroethane or 1,1,1-trichloroethane)

Leucomalachite Green Working Solution

1. Mix together 0.06g of leucomalachite green, 0.2g sodium perborate, and 20mL methanol and 10mL glacial acetic acid.
2. Stopper the flask tightly and wrap the stopper with Parafilm.
3. Shake the flask vigorously for 1 minute.
4. Transfer to a spray bottle.

10.7.5 PROCEDURE:

10.7.5.1 Determine if samples for biology should be taken prior to processing.

10.7.5.2 Conduct control tests.

10.7.5.3 Spray the surface lightly 2 or 3 times, holding the sprayer approximately 14" or more from the surface.
10.7.5.4 Development of dark green impressions should occur rapidly.
10.7.5.5 Developed impressions are evaluated to determine their suitability for comparison.
10.7.5.6 Impressions deemed to be of value are marked and may be photographed or lifted.

10.7.6 ADDITIONAL INFORMATION:
10.7.6.1 Leucomalachite green reagent should be freshly prepared with each application.
10.7.6.2 This reagent does not color the substrate and is very good for absorbent paper, cloth, carpet or other porous substrates.

10.7.7 CONTROLS
10.7.7.1 Testing of leucomalachite green is performed prior to use.
10.7.7.2 This test involves the making of a mark in blood on a slide and following the processing procedure.
10.7.7.3 An analyst cannot proceed with the processing of the evidence until a control test bearing positive results (development of a dark green mark) has been carried out and documented on the Reagent Preparation Log sheet or control tests work sheet.
10.7.7.4 The area surrounding the intentionally deposited latent print shall serve as a negative control.

10.7.8 SAFETY:
10.7.8.1 Leucomalachite green is a suspected human carcinogen. It may affect the kidney, ureter, bladder, and thyroid of animals. It can be harmful if inhaled, and is irritating to the eyes and skin.
10.7.8.2 Leucomalachite green should not be used in large amounts.
10.7.8.3 A respirator should be used when working with the dry form outside of the fume hood. Leucomalachite green should be prepared and used in a fume hood or well-ventilated area. The analyst should wear a lab coat, heavy-duty (non-disposable) gloves, and safety glasses.
10.7.8.4 In addition, analysts must be aware of the biological hazards associated with blood and other body fluids and take extra precautions to protect themselves.

10.7.9 REFERENCES:

Moses, Kenneth R., "Special Techniques for Latent print Development", San Francisco Police Department instructions.

Patty, John R. and Giberson, Michael W., "Bloody Fingerprint Spray Reagent", CAC Newsletter, 1984.

Stow, K.M., "Direct lift-enhancement of blood-contaminated shoe marks by leuco malachite green-impregnated membranes", Journal of the Forensic Science Society, 34(4), 1994, pp 241-244.

10.8 PHYSICAL DEVELOPER (PD)

10.8.1 BACKGROUND:

Physical developer is a silver-based aqueous reagent that reacts with lipids, fats, oils, and waxes present in the impression residue to form a silver-gray deposit.

10.8.2 SCOPE:

10.8.2.1 Physical developer is a method used for the development of impressions on porous substrates. It is not suitable for non-porous surfaces.

10.8.2.2 This method is the final step in the sequential processing of porous items.

10.8.2.3 Physical developer is the only method to show adequate results on paper that has been wet.

10.8.2.4 Surfaces that need other forensic examinations such as body fluid, trace, or questioned document examinations should be carefully evaluated prior to processing to determine if this procedure will have an impact on subsequent examinations.

10.8.3 EQUIPMENT AND MATERIALS:

Graduated cylinder
Glass trays
Plastic tongs

10.8.4 REAGENTS:

Physical Developer Kit (parts A & B)

1. 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.
2. Add 5 ml of solution A (20% silver nitrate solution) to 90 ml of solution B (reductant solution) in a beaker.
3. Stir the working solution for approximately one minute with a clean glass/plastic stirring rod.
4. 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.

10.8.5 PROCEDURE:

10.8.5.1 Arrange the glass trays in the stainless steel sink in the Latents Processing Lab so that the evidence can be moved easily from one tray to another in the proper sequence.

10.8.5.2 Add the physical developer working solution to its dedicated glass tray.

10.8.5.3 Use plastic photographic tongs or plastic forceps without serrated edges to add or remove articles from PD solutions. Do not use metal tools.

10.8.5.4 Conduct control tests.
10.8.5.5 Immerse the item and gently rock the tray for approximately 5-15 minutes until impression development is complete or adequate time has elapsed (analyst's discretion).
10.8.5.6 Remove the item from the physical developer working solution and place into a tray with running tap water. Rinse until the water runs clear.
10.8.5.7 Dry completely.
10.8.5.8 Developed impressions are evaluated to determine their suitability for comparison.
10.8.5.9 Impressions deemed to be of value are marked and photographed.

10.8.6 ADDITIONAL INFORMATION:
10.8.6.1 Cleanliness is important in the physical developer method. A good deal of the instability in the earlier solutions was a result of laboratory equipment that was not spotless. 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 or de-ionized water prior to use. When washing glassware, use detergent, not abrasive cleaners.
10.8.6.2 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.
10.8.6.3 Shelf life for ready to use kit (un-mixed) is six months from date of purchase. The reagent shall be mixed upon each use.
10.8.6.4 Excess reagent shall be collected and placed in the hazardous waste container located in the fume hood.

10.8.7 CONTROLS:
10.8.7.1 Testing of physical developer is performed prior to each use.
10.8.7.2 This test involves the making of a quality (oil based) mark on a test surface similar to the evidence being examined and following the processing procedure.
10.8.7.3 An analyst shall not proceed with the processing of the evidence until a control test bearing positive results (development of a silver-gray mark) has been carried out and documented on the control tests work sheet.
10.8.7.4 The area surrounding the intentionally deposited mark shall serve as a negative control.

10.8.8 SAFETY:

10.8.8.1 Physical developer should only be used in well-ventilated areas, as it is irritating to the respiratory tract. Standard laboratory protocol is followed for chemical handling.

10.8.9 REFERENCES:

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990, pp 144-148.

"Chemical formulas and Processing Guide for Developing Latent Prints", U.S. Department of Justice, FBI Laboratory, 1994, p 35.

Keedwell, E., Birkett, J., and Davis, R.J., "Chemical Methods for the Enhancement of Footwear Marks", MPFSL Report No. 73, Metropolitan Police Forensic Science Laboratory, January, 1988.

Navarro, R.L., "Chemical Enhancement of Questioned Footwear Impressions", North Carolina State Bureau of Investigation, 1992.

"Physical Developer", Manual of Fingerprint Development Techniques, British Home Office Scientific Research & Development Branch, 1986.

Technical Note #1-2730, Lightning Powder Co., (1993).

10.9 TRADITIONAL FILM DEVELOPMENT (BLACK AND WHITE)

10.9.1 BACKGROUND:
The primary function of film is to record the image that is focused upon it by the lens of a camera. The recorded image is called a latent image because it is not visible on the film; exposed film cannot be visually distinguished from unexposed film. However, the film has changed physically during exposure and that change can be made visible if the film is treated chemically. The chemical treatment that causes the latent image to become a visible image is called development.

10.9.2 SCOPE:
Develop latent images on traditional black and white film.

10.9.3 EQUIPMENT AND MATERIALS:
Film reel
Development tank

10.9.4 REAGENTS:
Kodak D-76 Developer
Kodak Fixer
Perma Wash
Photo Flo

10.9.5 PROCEDURE (in the Latents Processing Lab):

10.9.5.1 Wind film onto reels, place in the developing tank, and secure the lid. Handle undeveloped film in total darkness (no safe light).

10.9.5.2 Fill tank with tap water (approximately 70° F). Firmly tap tank to dislodge air bubbles. Soak film one (1) minute. Empty tank.

10.9.5.3 Fill tank with pre-mixed Kodak D-76 Developer. Firmly tap tank to dislodge air bubbles. Provide initial agitation of the development tank for 15-20 seconds. Agitate film frequently during development period. Develop film for fifteen to twenty (15-20) minutes. Return used D-76 developer to the developer storage container, using designated funnel.

10.9.5.4 Rinse film with tap water (approximately 70° F) for two (2) minutes. Empty tank.

10.9.5.5 Fill tank with pre-mixed Kodak Fixer. Firmly tap tank to dislodge air bubbles. Agitate film frequently during fixing. Fix film for fifteen to twenty (15-20) minutes. Return fixer to the fixer storage container, using designated funnel.

10.9.5.6 Rinse film with running tap water (approximately 70° F) for a minimum of two (2) minutes, twenty to thirty (20-30) minutes if time allows. Empty tank. Film may be removed from tank at this point and examined.

10.9.5.7 Fill tank with Perma Wash, agitate and let stand for two (2) minutes. Perma Wash may be washed down the drain.

10.9.5.8 Rinse film with tap water (approximately 70° F) for two (2) minutes. Empty tank.

10.9.5.9 Fill tank with tap water (approximately 70° F), add two or three drops of Photo Flo and agitate. Photo Flo minimizes water/drying marks.

10.9.5.10 Remove film from reel, remove excess water from film, and hang till dry in a dust-free place.

10.9.6 ADDITIONAL INFORMATION:

10.9.6.1 Pre-mixed chemicals should be room temperature when used.

10.9.6.2 If negatives show a pink stain after fixing, the fixer may be near exhaustion or the fixing time was too short. If the stain is slight, it will not affect image stability or negative contrast. If the stain is pronounced and irregular over the film surface, re-fix the film in fresh fixer.

10.9.7 CONTROLS:

Not applicable

10.9.8 SAFETY:

Film development reagents may cause eye or skin irritation. If exposure occurs, rinse with generous amounts of water.

10.9.9 REFERENCES:

Police Photography, Larry S. Miller, pagers 27, 81-98.

Eastman Kodak Company, Kodak Professional D-76 Developer packaging. www.kodak.com/go/professional

Eastman Kodak Company, Kodak Professional Fixer packaging. www.kodak.com/go/professional

11 DIGITAL IMAGING PROCEDURE

11.1 BACKGROUND:
Footwear and tire track impression images are frequently captured, enhanced, and stored using digital devices. The intent of image enhancement is to make details of an image that are less visible more visible. Enhancement may be used to increase the contrast between the impression and the substrate, reverse the color of the impression, etc.

11.2 SCOPE:
This sets forth the Footwear and Tire Track Impression Evidence procedures for the capture, storage, enhancement, and output of impression digital images.

Note: Sections 11.3, 11.4, 11.5, 11.6, 11.7 and 11.8 only apply to Latents Section Digital Workplace. If Digital Workplace isn't used, these do not apply. Go directly to Section 11.9 for enhancement with Adobe Photoshop.

11.3 RESPONSIBILITIES:

11.3.1 Latent/Impression Evidence Section Supervisor

11.3.1.1 The Latent/Impression Evidence Section Supervisor shall act as the Digital Imaging System Administrator or appoint a Digital Imaging System Administrator.

11.3.1.2 The Latent/Impression Evidence Section Supervisor shall oversee and document the training of each new digital imaging system operator. This includes documenting competency testing.

11.3.1.2 The Latents/Impression Evidence Section Supervisor shall ensure access is limited to authorized users.

11.3.1.4 The Latent/Impression Evidence Section Supervisor or designee shall act as a liaison with CJIS and Digital Imaging system technical staff on system maintenance, upgrades, and when technical difficulties arise.

11.3.1.5 The Latent/Impression Evidence Section Supervisor or designee shall be the only personnel authorized to delete images or cases entered into Digital Workplace or equivalent software.

11.3.2 Digital Imaging System Administrator

11.3.2.1 The Digital Imaging System Administrator shall update the Latent Print Section Digital Imaging System User's Manual.

11.3.2.2 The Digital Imaging System Administrator shall be responsible for system maintenance to include: tape backups, deletion of images/cases, archiving, etc.

11.3.2.3 The Digital Imaging System Administrator shall communicate system status to the supervisor and other system users.

11.3.3 Analysts

11.3.3.1 Analysts shall only use enhancement techniques that are supported by their training and/or experience.

11.3.3.2 Analysts shall maintain system security.

11.3.3.2.1 Network and program passwords are not to be distributed to unauthorized users. Operators may change their passwords as needed.

11.3.3.2.2 The external modem shall remain off unless technical support is being contacted.

11.3.3.3 Analysts shall fill out the Latent Section CD/DVD Log when filing or retrieving archived images from the vault.

11.4 DIGITAL IMAGE CAPTURE

11.4.1 All digital evidentiary impression images may be acquired through the Digital Workplace or equivalent software. **Once the Digital Workplace or equivalent software is upgraded to a server-based system with multiple work stations, all digital impression images will be acquired through the new system.**

11.4.2 Digital Workplace or equivalent software shall establish a chain of custody from the time of acquisition into the program.

11.4.3 Images shall be designated using a file name structure generated by Digital Workplace or equivalent software (e.g. Digital Workplace designates images "Set#-ICD#.tif" where ICD equals the name given to an image at the time of capture by a particular device – scanner, camera, film scanner). The first image acquisition for a case may consist of one or more images, and shall be designated as Set0001. Subsequent acquisitions within the same case shall increase the "set" number by 1 (e.g. Set0002, Set0003). The digital image capture device will assign a file name at the time of acquisition (e.g. 'umax1.tif' for the scanner). Once theimages are acquired by Digital Workplace or equivalent, their file names will be preceded by the designated "set" number (e.g. scanner image umax1.tif will become Set0001 – umax1.tif if it is in the first group of images acquired for a case, Set0002 – umax1.tif if it is in the second group of images acquired for a case, and so on).

11.4.4 Analysts shall use one of the following digital image capture devices to acquire images of the impression(s) in question.

11.4.4.1 Flat Bed Scanner

11.4.4.2 Digital Camera

11.4.4.3 Camera Card

11.4.4.4 Film Scanner

11.4.4.5 Outside agencies may submit processed film for digital capture or digitally submit impression images.

11.4.4.5.1 Images of impressions should contain a scale.

11.4.4.5.2 It is preferred that existing images from outside agencies be submitted in a loss-less format such as '.tif' and at as high a resolution as possible.

11.4.5 All original close up images captured by impression analysts shall contain a scale in centimeters.

11.4.6 Images shall be captured at the highest resolution practical for their intended use.

11.5 DIGITAL IMAGE ENHANCEMENT

11.5.1 All digital evidentiary images requiring enhancement may be enhanced through Digital Workplace or equivalent software via Adobe PhotoShop using a copy of the original image. **Once the Digital Workplace or equivalent software is upgraded to a server-based system with multiple work stations, all digital impression images will be enhanced through the new system.** If using Digital Workplace or equivalent software for enhancement, sections 11.5.2-11.5.4 apply.

11.5.2 Enhanced images will be designated using the file name structure generated by Digital Workplace or equivalent software. Digital Workplace designates enhanced images by the addition of 'FAXXXX.tif' where XXXX represents the order in which the enhancement was created. E.g. The first enhancement of image 'Set0001 – unmax1.tif' would be named 'Set0001 – unmax1.tif – **FA0001.tif**', the next enhancement would be 'Set0001 – unmax1.tif – **FA0002.tif**', and so on. Enhancements of enhancements default to the next sequential FAXXXX number (e.g. The enhancement of image 'Set0001 – unmax1.tif – **FA0001.tif**' would be named 'Set0001 – unmax1.tif – **FA0002.tif**', the next enhancement whether on 'Set0001 – unmax1.tif – **FA0001.tif**' or 'Set0001 – unmax1.tif – **FA0002.tif**', would be 'Set0001 – unmax1.tif – **FA0003.tif**', and so on).

11.5.3 All enhancement history shall be recorded via Digital Workplace or equivalent software. Digital Workplace utilizes meta data and may be viewed under the 'History' tab.

11.5.4 At the conclusion of the examination, the analyst shall print a hard copy of the Digital Workplace or equivalent report and place it in the case file. Due to document size, the enhancement history for each image does not need to be included in the case file.

11.6 DIGITAL IMAGE STORAGE, ARCHIVAL, AND RETRIEVAL

11.6.1 All images, both original and enhanced, will be temporarily stored on the digital imaging system hard drive until the examination is completed.

11.6.2 Once completed, the case's originating analyst shall make an entry in the Digital Imaging Notebook (located in the Latents Section Digital Imaging Lab) on the "Cases to be Archived" form. The entry shall contain the date entered, analyst's initials, and complete case number to be archived.

11.6.3 A tape backup will be completed by the Latent/Impression Evidence Supervisor or Digital Imaging System Administrator no less than once a week, more often if needed.

11.6.4 Archiving of images will be completed by the Latent/Impression Evidence Section Supervisor or Digital Imaging System Administrator on an as needed basis.

11.6.4.1 It is recommended that images be recorded on Write-once Compact Disk Recordable (CD-R) or DVD-R.

11.6.4.2 The CD/DVD along with a printed copy of listed contents will be stored in the evidence vault. A printed copy of listed contents will also be placed in the Archived Cases Log Book.

11.6.5 All CDs/DVDs will be logged in and out of the vault using the "Latent Section CD/DVD Log" sheet. The log shall detail the CD/DVD title, date out/date returned, requesting analyst, and the person checking it in or out.

11.7 QUALITY CONTROL:

11.7.1 Performance checks will be conducted on equipment as needed.

11.7.2 When a problem is noted with a particular piece of equipment, software program, etc., the Digital Imaging System Administrator and/or Latent/Impression Evidence Section Supervisor will be notified.

11.7.3 If it is determined that the situation is persistent or cannot be easily rectified, an entry will be made on the "Instrument Maintenance Log".

11.7.3.1 The log will detail the date, the person making the entry, the piece of equipment/software involved, and relevant details of the situation.

11.7.4 Affected equipment/software will be taken off line and all users notified.

11.7.5 If necessary, technical support shall be sought and/or the equipment repaired before being put back into operation.

11.7.6 Actions taken to repair or correct the problem will be documented on the "Instrument Maintenance Log."

11.7.7 Image calibration shall be checked, as needed by comparing the scale in the printed image with a standard metric scale.

11.8 TRAINING:

11.8.1 All analysts utilizing imaging technologies shall be trained and tested for competency in the standard operating procedures and the operation of the relevant imaging technologies.

11.8.2 Formal training may be modified at the discretion of the Latent/Impression Evidence Section Supervisor dependent upon previous training and/or experience.

11.8.3 Recommended formal training consists of:

11.8.3.1 Reviewing the ISP-FS Footwear and Tire Impression Digital Imaging Procedure.

11.8.3.2 Reviewing the Digital Workplace Quick Reference Guide or equivalent.

11.8.3.3 Reviewing the ISP Latent Print Section Digital Imaging User's Manual.

11.8.3.4 Review of relevant chapters of the Adobe Photoshop Users Manual and/or completion of a digital imaging course that utilizes Adobe Photoshop.

11.8.3.5 Satisfactory creation and digital processing of a mock-case using ADAMS (or equivalent) and Adobe Photoshop software or equivalent software.

11.8.3.6 Satisfactory completion of a written test.

11.8.4 Continuing education shall be provided as courses become available through outside sources such as Foray, the FBI, etc.

11.8.5 Competency testing shall be repeated when significant changes in hardware or software are made.

11.9 DIGITAL IMAGE ENHANCEMENT USING ADOBE PHOTOSHOP

11.9.1 The analyst will use Adobe Photoshop CS or newer. The history tracker is turned on and set to its maximum level.

11.9.2 The analyst will only work on a duplicate copy of the original image.

11.9.3 Basic image enhancement techniques are those used to improve the overall appearance of the image.

11.9.4 Image enhancing techniques can be applied over the whole image or in localized areas of an image.

11.9.5 Image enhancing techniques include:

11.9.5.1 Brightness and contrast adjustment, including dodging and burning.

11.9.5.2 Resizing (file interpolation), including calibration.

11.9.5.3 Cropping.

11.9.5.4 Positive to negative inversion.

11.9.5.5 Image rotation/inversion.

11.9.5.6 Conversion to grayscale.

11.9.5.7 White balance.

11.9.5.8 Color balancing and/or color correction.

11.9.5.9 Basic image sharpening and blurring (pixel averaging).

11.9.5.10 De-interlacing.

11.9.5.11 File format conversion.

11.9.6 Advanced image enhancement techniques are applied to images to extract information and may/may not improve the overall appearance of the image.

11.9.7 Advanced enhancement techniques include, but are not limited to:

11.9.7.1 Frame Averaging.

11.9.7.2 Fourier Analysis (including the use of FFT).

11.9.7.3 Deblur.

11.9.7.4 Noise reduction.

11.9.7.5 Image restoration.

11.9.7.6 Color channel selection and subtraction.

11.9.7.7 Perspective control and/or geometric correction.

11.9.7.8 Advanced sharpening tool, such as unsharp mask.

11.9.8 Enhancement steps must be documented in sufficient detail that a comparably trained analyst could understand the steps taken, the techniques used, repeat the steps and produce a comparable image.

11.9.8.1 All enhancement steps will be recorded in the order they are performed via use of the Adobe Photoshop history tracker.

11.9.8.2 Exploratory enhancement operations not incorporated into the final image do not need to be documented. Test prints and/or intermediate images resulting from a variety of techniques not incorporated into the final image should be discarded.

11.9.8.3 Minimum requirements for documentation include identifying the software application (Adobe Photoshop/version) and/or techniques as well as setting and the parameters used.

11.9.8.4 Documentation can be recorded in a variety of ways including hand-written notes, electronic recording, or through the use of automated logging tools.

11.9.9 Final enhanced images are saved as "TIFF" at as high a resolution as possible and appropriate to the image.

11.9.10 Once the case is ready to be closed, all images are burned onto a CD or DVD and saved in the vault in the Latent Print Section storage area.

11.9.11 Safety: None

11.9.12 Limitations: Based on existing equipment and technology.

11.10 REFERENCES:

International Association for Identification "Resolution 97-9."

Digital Workplace Quick Reference Guide.

Scientific Working Group on Imaging Technologies (SWIGIT), "Best Practices for Documenting Image Enhancement", Version 1.2, March 04, 2004.

Scientific Working Group on Imaging Technologies (SWIGIT), "Definitions and Guidelines for the use of Digital Image Technologies in the Criminal Justice System," Version 2.3-June 6, 2002.

Scientific Working Group on Imaging Technologies (SWIGIT), "Recommendations and Guidelines for the Use of Digital Image Processing in the Criminal Justice System," Version 1.2-February 2001.

Scientific Working Group on Imaging Technologies (SWIGIT), "Guidelines and Recommendations for Training in Imaging Technologies in the Criminal Justice System," Version 1.2-December 6, 2001. *Forensic Science Communications,* April 2002-Volume 4-Number 2.

Scientific Working Group on Imaging Technologies (SWIGIT), "Guidelines for Field Applications of Imaging Technologies in the Criminal Justice System,"

Version 2.3, December 6, 2001. *Forensic Science Communications,* April 2002-Volume 4-Number 2.

12 FOOTWEAR AND TIRE IMPRESSION EXAMINATION AND COMPARISON PROCESS

12.1 BACKGROUND:

12.1.1 When shoes and tires impact with a surface, a record of that impact remains on the surface.

12.1.2 The amount of detail in the impression depends on many factors (not all-inclusive):

- Type of substrate or surface.
- Color, pattern and texture of the surface.
- Type of residue in the impression.
- Type of footwear or vehicle tire.
- Resolution of impression photographs.
- Type of casting material used.
- Tire pressure, vehicle load, wheel alignment, wheel balance, ambient temperature, and other factors.
- How the footwear impression was made, such as shoe impact on door or step on flooring.
- Physical characteristics of shoe wearer such as weight, type of stride or infirmities.

12.1.3 Footwear and tires may leave unique impressions depending on the level of detail and the presence of one or more individual characteristics.

12.1.4 An impression contains class characteristics.

12.1.5 An impression containing a sufficient quantity and quality of detail may be individualized to or excluded from a particular source.

12.1.6 No scientific basis exists for requiring a pre-determined minimum number of individual characteristics to be present in two impressions in order to establish a positive identification.

12.1.7 Identification/Exclusion is supported by the theories of the random nature of individual characteristics, probability modeling, and empirical data gained through more than one hundred years of operational experience.

12.2 SCOPE:

After footwear and tire impressions are documented and collected in the field, analysts will use a combination of visual inspection, documentation, photography, test impression preparation, and other procedures to compare the known exemplar to the questioned impression to reach a decision about the source of the questioned impression. Impressions from one crime scene or area of a crime scene may be compared to impressions in another crime scene or area of the same crime scene to determine if they have a common origin.

12.3 EQUIPMENT AND MATERIALS

Magnifiers
Dividers
Finely divided rulers and scales
Stereomicroscope

Digital and/or 35mm cameras
Digital imaging system

12.4 PROCEDURE:

12.4.1 The case report is examined to determine if other testing is required on any items of evidence prior to the impression comparison process. This determination may also be made by discussion with other analysts and/or the investigating officer.

12.4.2 The impression evidence is documented in the notes and is properly labeled with the unique case identifier and initials of the analyst if possible. Photographic documentation may also be done.

12.4.3 If casts are included, they are cleaned, either by hand or in the cleaning tank if necessary.

12.4.4 The footwear or tire impression is assessed to determine suitability for comparison.

12.4.4.1 The analyst should determine if the impression contains sufficient detail to proceed with the comparison.

12.4.4.2 If "no", the notes should reflect that the impression was not suitable for comparison.

12.4.4.3 If "yes", the analysis continues.

12.4.4.4 At any stage of the process, **exclusion** is reached when the impressions being compared are in disagreement or contain an unexplainable discrepancy.

12.4.4.5 Inconclusive findings result from the absence of sufficient details (individual characteristics) to effect a conclusion of individualization or exclusion, although class characteristics may be comparable.

12.4.5 Comparison Process For Footwear and Tires

12.4.5.1 **General design:** The analyst does a visual comparison of the impression general design with the known footwear or tires.

12.4.5.1.1 If the design is different, document, discontinue this process and report accordingly. This is an **exclusion.**

12.4.5.1.2 If the design is similar and there is sufficient detail, prepare test impressions as in Section 9.5 and continue with the process.

12.4.5.2 **Specific Design:** The analyst compares the specific outsole or tread design, including mold characteristics, in the impression with the test impressions and/or shoes and tires.

12.4.5.2.1 If the design is different, document, discontinue this process and report accordingly. This is an **exclusion.**

12.4.5.2.2 If the design is similar and there is sufficient detail, continue with the process.

12.4.5.3 **Size and Shape:** The analyst compares the physical size and shape of the impression design with the test impressions and/or shoes and tires.

12.4.5.3.1 **Tire Noise Treatment Analysis**

12.4.5.3.1.1 Noise treatment analysis can help determine if the suspect tire is consistent in size and design with the crime scene impression, if the impression has sufficient size and detail for this process.

12.4.5.3.1.2 Noise treatment analysis can define the location(s) on the circumference of the suspect tire that could have made the crime scene impression and once the location(s) is determined, the examination for general wear and individual characteristics can proceed.

12.4.5.3.1.3 The process utilizes a high quality crime scene impression photograph (or cast) and a full circumference transparent tire test impression, or a crime scene impression transparency and a full circumference tire test impression on poster board or paper. In circumstances where a transparency can't be made, noise treatment can be determined by comparing the test impression to the manufacturer's mold drawings.

12.4.5.3.1.4 Any wear bars that are visible in the impression are marked. Wear bars are marked on the tire test impression, bases on the markings on the sidewall and the segment mark and segment number on the test.

12.4.5.3.1.5 The transparency is moved along the item until the noise treatments coincide. This area is marked.

12.4.5.3.1.5 Once the location(s) has been found, the comparison can proceed. If noise treatment doesn't coincide and a cast is available, repeat using the cast. If only a photograph is available, consider scaling, perspective and other issues that may account for the differences.

12.4.5.3.2 If the physical size and shape are different, document, and consider scaling, perspective and other issues that may account for differences. If the differences can't be explained, discontinue this process and report accordingly. This is an **exclusion.**

12.4.5.3.3 If the physical size and shape, to include noise treatment of tires, are similar and there is sufficient detail, continue with the process.

12.4.5.5 **Wear Pattern:** The analyst compares the wear pattern in the impression with the test impressions and/or shoes and tires.

12.4.5.5.1 If the position and degree of general wear are different, document, and evaluate possible wear changes between the date of the crime (when impression was made) and the date that the shoes or tires were recovered. If the differences can't be explained, discontinue this process and report accordingly. This is an **exclusion**.

12.4.5.5.2 If the position and degree of general wear are similar and there is sufficient detail, continue with the process.

12.4.5.6 **Individual Characteristics:** The analyst examines the impression for the presence of individual characteristics.

12.4.5.6.1 Individual characteristics can include bubbles, tears and other flaws imparted during the manufacturing process.

12.4.5.6.2 Individual characteristics can include cuts, nicks, tears, burns, feathering and chunk outs occurring during use of the shoe or tire.

12.4.5.6.3 Individual characteristics can include additions to the outsole or tire tread such as rocks, glass, wads of gum and thorns.

12.4.5.6.4 These characteristics should be evaluated according to their position, size, shape, orientation, and clarity.

12.4.5.6.5 Tire impression casts (or photos, if that is all that's available) are compared directly to the known unmounted tires. The impression/tire are compared for individual characteristics.

12.4.5.6.6 When sufficient individual characteristics are present in the questioned impression and correspond with respective features in the known shoe or tire, an identification or match can be effected. Evaluate, document and report accordingly.

12.4.5.6.7 Due to varying circumstances, not all individual characteristics will reproduce in every impression. Therefore, the absence of an individual characteristic is not a basis for elimination and does not preclude identification.

12.4.6 **Verification**

12.4.6.1 Verification is the confirmation of an analyst's conclusion by another qualified analyst.

12.4.6.2 A qualified analyst shall verify all footwear and tire impression comparisons and/or identifications.

12.4.6.3 The verifier will complete the Footwear and Tire Impression Verification Worksheet and place it in the case file.

12.4.6.3 Analysts shall not verify any conclusions with which they are not comfortable. Comfort level is a function of training and experience.

12.4.6.4 Analysts are encouraged to work out differing conclusions through collaboration. If the conflict cannot be resolved within the Forensic Services system, an analyst from an external ASCLD/LAB certified laboratory or an IAI certified examiner shall review the impression(s) in question. If a conclusion is reached, it shall be verified by another analyst.

12.5 DISTRIBUTION OF FOOTWEAR AND TIRES:

12.5.1 Background: Footwear and tires are produced, marketed, distributed and sold in stores for the purpose of generating profits at various levels. This information is tracked by various manufacturers, intermediaries and retail stores and can be obtained by forensic laboratories to assist with criminal cases.

12.5.1.1 Tire manufacturers can be contacted through *Who Makes it and Where Tire Directory* printed yearly, *Who Retreads Tires* and contact links on the C.A.S.T. website http://members.aol.com/varfee/mastssite/index.html.

12.5.1.2 Footwear manufacturers can be contacted by using the links on the C.A.S.T. website http://members.aol.com/varfee/mastssite/index.html.

12.5.1.3 When contacting the manufacturer, the request should be addressed to the public relations branch, sales department or engineering department. They may be able to supply a considerable amount of information regarding the shoe or tire in question:

- If the manufacturer has an exclusive contract for the molds producing the outsole or tire tread which is only sold with one brand name on it (may be several models with same outsole under the brand name) or if the mold produces an outsole or tire tread which may be distributed under several brand names.
- Number of shoe or tires produced from that mold in the year in question (production runs).
- Retail stores handling that design in the area of interest.
- Number of shoes or tires sold during the year in question.
- Samples of outsoles from the mold.
- Mold drawings of a particular tire.

12.5.1.4 Requests usually have to be followed up with a formal letter on letterhead stationary listing the request and general reasons for the request. The companies will not require specific case information, but may require information about the severity of the crime for an "expedite" request.

12.6 CONTROLS/SAFETY

12.6.1 Controls do not apply.

12.6.2 Contamination of footwear and tires by biological material is a possibility. Proper precautions should be taken such as gloves, lab coats and eye protection.

12.6.3 Shoe and tires may contain inclusions such as sharp rocks and glass, which cannot be removed prior to the comparison process. The analyst should exercise caution to prevent cuts.

12.6.4 Mounted tires may present a lifting hazard. The analyst should seek assistance with moving these, if necessary.

12.7 REFERENCES:

Bodziak, William J., *Footwear Impression Evidence*, Elsevier, New York, 1990, pp 144-148.

Chesapeake Area Shoeprint and Tire track (C.A.S.T.) examiners website http://members.aol.com/varfee/mastssite/index.html.

Nause, S/Sgt. Lawren, *Forensic Tire Impression Identification*, Canadian Police Research Centre, 2001.

The Scientific Working Group on Shoeprint and Tire Tread Evidence Technology (SWGTREAD) - *SWGTREAD documents are officially published in the Journal of Forensic Identification*, 766/55(6), 2005.

13 FOOTWEAR AND TIRE SEARCH

13.1 The footwear and tire impression analysts may be asked to provide information about the type of shoe or tire that left the impression at a crime scene in cases where a suspect hasn't been identified yet. Generally, the analyst will work with a high quality photograph and/or cast of an impression that shows the finer design details. A complete shoe impression from heel to toe and a complete tire impression at least 12" long showing the design from inner to outer edge will make this task easier.

13.2 Shoe searches may be accomplished by:

- Using a commercially available shoe database software program,
- Hand searching in stores,
- Contacting manufacturers,
- Utilizing some of the search features on the C.A.S.T. website, http://members.aol.com/varfee/mastssite/index.html.
- Internet searches of producer's collections of outsoles and manufacturer's and producer's images of outsoles.
- Sending a copy of the impression to another lab such as the FBI Lab.
- Posting a copy of the impression on the WANTED PAGE, a link located on the C.A.S.T. website http://members.aol.com/varfee/mastssite/index.html.

13.3 Tire searches may be accomplished by:

- Using a commercially available tire database software program such as **Tread Assistant**.
- Hand searching the *Tread Design Guide*, available in the reference library.
- Contacting local tire stores.
- Contacting manufacturers.
- Utilizing some of the search features on the C.A.S.T. website, http://members.aol.com/varfee/mastssite/index.html.
- Sending a copy of the impression to another lab such as the FBI Lab.

13.4 SEARCH PROCEDURE:

13.4.1 The analyst may work from a photograph or a sketch of the impression showing design details.

13.4.2 The actual evidence must not be taken from the lab to conduct the search.

13.4.3 Unless the impression is in the form of a cast, the analyst will have to do a negative to positive conversion to find the outsole or tread design.

13.4.4 Based on the footwear impression design elements, the analyst may be able to determine a category of shoe, such as hiking, work boot, cowboy boot, or athletic shoe to narrow the search.

13.4.5 Examination of a tire impression can give the analyst the number of ribs and grooves, whether there's a center rib and its appearance, and appearance of grooves, slots and sipes. This information will assist in the search for a possible tire(s).

13.4.6 When the analyst finds potential candidates, they should be printed for re-examination later.

13.4.7 The search candidates should account for all the design elements in the impression. If a design element cannot be accounted for, a knock-off shoe or manufacturer's design change may be possible. The analyst should consider contacting the manufacturer of the "close" candidate for assistance.

13.4.8 The analyst should be aware that new shoe or tire brands and models may be produced with the same design after the search is finalized.

13.5 **TIRE TRACK MEASUREMENT VEHICLE COMPUTER SEARCH:**

13.5.1 When measurements of wheel base and/or vehicle track width have been collected at the scene, a candidate list can be obtained by submitting the information to the Michigan Department of State Police or Florida Department of Law Enforcement.

13.5.2 Contact information:

Michigan Department of State Police
East Lansing Laboratory
714 South Harrison Road
East Lansing, Michigan 48823
Tel: 517-336-6130 Lee Brin-Conti (check C.A.S.T. website)

Florida Department of Law Enforcement
Jacksonville Regional Laboratory
Latent Print Section
711-A Liberty Street
Jacksonville, Florida 32202
Tel: 904-359-6390 Dawn A. Walters (check C.A.S.T. website)

13.6 DOCUMENTATION AND REPORTING:

13.6.1 The search results should be documented in the notes and copies of any pictures of the shoes or tires should also be kept with the notes.

13.6.2 When a report is generated with the search result(s), a disclaimer should always be added that the list is not all-inclusive, unless the manufacturer has indicated that the list is complete.

13.6.3 Because of 13.4.8, a recommended start to the search report would be a general disclaimer "As of _____date".

14 CASE WORK DOCUMENTATION AND REPORT WRITING

14.1 Case work documentation and report writing will be according to ISPFS Quality Manual, Section 5.10 Reporting The Results.

14.2 Documentation shall be to the extent that another qualified analyst would be able to determine each examination activity conducted, their sequence, results of the activities, and any conclusions reached.

14.2.1 As each development method is completed it is noted in sequence on the EXAMINATION WORKSHEET and the evidence is visually examined for the presence of comparable impression detail.

14.2.2 When comparable impression detail is observed, it should be preserved prior to additional processing.

14.2.2.1 Comparable impression detail may be photographed upon initial examination, as additional detail develops, after a specific method, and/or prior to a subsequent method.

14.2.2.1.1 Impression photographs/images and/or case documentation shall include a scale, unique case identifier, date, analyst's initials.

14.2.2.2 Impressions developed via powder processing may be lifted in lieu of photography.

14.2.2.2.1 Impression lifts shall contain the unique case identifier, date, and analyst's initials.

14.2.3 Impression examination documentation shall include which impressions were analyzed, compared, evaluated, and the conclusions reached.

14.2.3.1 Each impression analyzed shall have an individualizing alpha and/or numeric designation.

14.2.3.2 The analyst will note any impressions deemed to not be of comparison quality.

14.2.3.3 Impression documentation may also include, at the analyst's discretion, the source of the impression and pattern if discernable.

14.2.3.4 Analysts shall document what the impressions were compared to and the results of those comparisons.

14.2.3.4.2 The verifying analyst shall complete the Footwear and Tire Impression Verification Worksheet.

14.2.3.4.3 Documentation of exclusions shall include, at a minimum, which impression(s) was excluded and the known shoes or tires the impression was excluded to.

14.2.3.4.4 Documentation of inconclusive findings shall include the reason(s) for the inconclusive finding. If the quality of the test impression(s) is at fault, additional test impressions should be made to improve the quality. If quality test impressions cannot be produced because the shoes or tires are severely damaged (for example, in a

fire), this problem would be listed as a reason for the inconclusive finding.

14.2.4 A reproduction suitable for comparison of both the compared impressions and the known test impressions must be retained as part of the case record.

14.2.4.1 When the laboratory cannot ensure that the original impression or test impressions used and relied upon in the examination, will be maintained by the contributing agencies, the laboratory must maintain an image of the actual data.

14.2.4.1.1 The analyst will produce shoe test impressions (except elimination prints/photographs) from footwear submitted by the agency. Footwear that can be eliminated based on outsole design differences does not require test impressions.

14.2.4.1.2 Case documentation shall contain copies of all impressions submitted by the customer. All impressions deemed of value for comparison shall be preserved in photographic or digital form.

14.2.4.1.3 Impression lifts produced and retained in the laboratory do not need to be copied for the case file.

14.2.4.1.4 Case documentation shall contain originals or machine copies of all known test impressions used in the comparison. Known test impressions submitted by the customer agency shall be copied prior to being returned. Copies must be suitable for comparison.

14.3 The report shall be as clear and concise as possible, convey the analytical findings and conclusions, and will be supported by scientific procedures.

14.3.1 The report is generally divided into three sections: EVIDENCE DESCRIPTION, EXAMINATION, and CONCLUSION. The following are some basic report wording guidelines categorized according to where they would appear in the report. There may be situations that do not fit the examples given. Unique wording for these situations will be developed as the need arises.

14.3.1.1 EVIDENCE DESCRIPTION:
Forensic Services Exhibit#, (Agency Exhibit #), a brief description of the evidence with an explanation if any unique identifiers were used to differentiate more than one item in the exhibit.

14.3.1.2 EXAMINATION:
14.3.1.2.1 Use for enhancement and development of impressions: Describe what steps were taken to make the impressions sufficiently visible for the comparison process, including visual examination.

14.3.1.2.2 Use for retained evidence: Describe any impression lifts or photographic evidence that was marked and sealed for preservation and is being retained by ISP Forensic Services.

14.3.1.2.3 Use for footwear or tire search and vehicle track computer program: Describe what resources were used to do the search for make and model information.

14.3.1.2.4 Use for comparison: Describe which shoes and/or tires were compared to which impressions.

14.3.1.3 LEVELS OF CONCLUSION (this exact wording need not be used):

14.3.1.3.1 Identification (definite conclusion of identity) – this is the highest degree of association expressed in footwear and tire impression examination. This opinion means that the particular shoe or tire made the impression to the exclusion of all other shoes or tires.

14.3.1.3.2 Probably made (very high degree of association) – this opinion means that the evidence is very persuasive that the shoe or tire made the impression, yet some critical feature or quality is lacking and/or missing so that an identification is not in order.

14.3.1.3.3 Could have made (significant association of multiple class characteristics) – this opinion means that the design and physical size correspond and there may also be some correspondence of the general condition of wear.

14.3.1.3.4 Inconclusive (limited association of some characteristics) – this opinion means some similarities are noted; however, there are significant limiting factors in the questioned impression that do not permit a specific association between the questioned impression and the known shoe or tire.

14.3.1.3.5 Probably did not make (very high degree of non-association) – this opinion means that the evidence is very persuasive that the shoe or tire did not make the impression, but the impression lacks sufficient quality or clarity for an elimination. Some possible dissimilarities may exist.

14.3.1.3.6 Elimination (definite exclusion) – this is the highest degree of non association expressed in footwear and tire impression examinations. This opinion means that the shoe or tire did not make the impression.

14.3.1.3.7 Unsuitable (lacks sufficient detail for a meaningful comparison) – this opinion means that insufficient detail was present in the questioned impression to enable any meaningful comparison with any known shoe or tire.

14.3.1.3.8 Footwear and tire search results, if done by ISP Forensic Services.

14.3.1.3.9 Discouraged expressions – the following expressions should not be used because they may cause misinterpretation of the conclusion:

- Consistent with
- Match/no match
- Responsible for/ Not responsible for
- Done by/ Not done by
- Caused with/ Not caused with

14.4 The case file shall be organized in the folder from front to back as follows:
Report;
Examination documentation packet (notes, exam worksheets, copies/forms, digital imaging reports, photographs, test impressions);
Administrative documentation (copies of submission forms, communication logs, agency reports, etc.).

14.5 The verifying analyst shall perform the technical and administrative review on the case. In the event that the verifying analyst is unavailable, another approved analyst may perform the reviews.

14.6 REFERENCES

The Scientific Working Group on Shoeprint and Tire Tread Evidence Technology (SWGTREAD) - *SWGTREAD documents are officially published in the Journal of Forensic Identification*, 766/55(6), 2005.

15 FIELD PROCESSING

15.1 BACKGROUND

Proper collection of footwear and tire impression evidence by photography, casting and lifting can preserve the fragile evidence for laboratory examination. There may be some differences in the methods chosen for use in the field because of ambient conditions and other factors. There is often other information available in the area of the impressions that may provide valuable assistance to the investigation.

15.2 SCOPE

15.2.1 Impression evidence may be easily destroyed by other people driving or walking in the scene.

15.2.2 Lack of success in finding impression evidence at a scene may be due to:

- Not believing that impressions will be found at the scene and not aggressively looking for them.
- Incomplete searches of the scene, possibly due to lack of knowledge about where they can occur and how they can be found.
- Arrival at scene after other people have driven or trampled over the impression evidence and failure to looks for impressions in those areas. Allowing unauthorized persons to walk or drive through the scene area.
- The combination of shoe/tire and surface characteristics not being conducive to the production of impressions.
- The impression has been intentionally destroyed.
- Weather destroyed exterior impressions.

15.2.3 Impressions may be found in the following areas:

- At the actual point of occurrence of the crime. "Where was the crime committed?"
- At the point of entry. "How did the suspect get to the scene and how did the suspect enter the scene?"
- On the path through the scene. "What did the suspect do in the scene?"
- On the victim. "How did the victim get injured or die?"
- On the point of exit and other exterior areas. "How did the suspect leave the scene and what did the suspect do outside the scene?"

15.2.4 Although the basic methods for processing footwear and tire impressions are similar, tire impressions require some additional processing because of the large tread area that impacts the surface and other factors associated with tires.

15.2.5 The four basic methods of recording impressions in the field are:

15.2.5.1 Photography.

15.2.5.2 Documentation/sketching.

15.2.5.3 Casting.

15.2.5.4 Lifting.

15.2.6 Photography is always done before casting or lifting.

15.2.7 Casting is advisable after photography when:

- Impressions are over ¼ inch deep into the substrate.
- Impressions are so deep that interfering shadows appear with oblique lighting.
- Impressions having different orientations are closely aligned with one another.

15.3 EQUIPMENT AND MATERIALS

Digital and/or 35mm camera (in manual setting)
35mm color or black & white film ISO 100
Large memory card (1 gigabyte or more is best)
Tripod
Flash and sync cord
Shutter release cable
Photo logs
Scales (FBI-type scale preferred)
Measuring tapes
Flashlight
Measuring cup or beaker
Mixing bucket
Heavy-duty stir stick
Deflecting sticks (tongue depressors)
Cardboard
Sun blocking method (either a dark cloth, blanket, or other large item)
Newspaper or wrapping paper
Electrostatic dust lifter
Mylar
File folders
Tape to fix the EDL lifts into file folders
Gel lifters
Adhesive lifters
3" fingerprint tape
Portable stove
Pot
Thermometer
Large evidence bags
Numbered or lettered markers
Sketch pad
Pens/pencils

15.4 REAGENTS

Pre-weighed dental stone in heavy-duty zipper closure plastic bags

- 2 pounds of dental stone/bag for shoe casts and small tire casts
- 5 pounds of dental stone/bag for tire impression casts, 10 lb for 3' cast

Supply of tap water (large water carboy for tire tracks)
Snowprint Wax

Black spray paint (or other color)
Hair spray
Sulfur granules (prill sulfur)
5% potassium sulfate solution (approximate)

15.5 FOOTWEAR AND TIRE IMPRESSION PHOTOGRAPHY

15.5.1 The impressions are numbered by the scene markers. The scene is photographed showing the markers at every impression. General scene photography is done taking overall, medium and close up shots prior to examination quality photographs.

15.5.2 In order for an analyst to perform a quality examination, high-quality close-up photographs are required.

15.5.3 If using a digital camera, the camera is set on the maximum resolution setting, preferably in tiff or raw.

15.5.4 The 35mm camera has a "normal" lens.

15.5.5 The camera is mounted on a tripod in such a manner that the plane of the film is parallel to the plane of the impression.

15.5.6 The scale is placed adjacent to and on the same plane as the impression. The scale may have to be depressed into the soil or snow adjacent to the impression. The scale should run the length of the impression. An additional scale may be placed along the width of, but not actually in, the impression. An additional tape measure(s) is laid down along the side of the tire impression as a reference.

15.5.7 The shutter release cable and flash on a long sync cord are attached to the camera. The camera self-timer may be used in lieu of the shutter release cable.

15.5.8 The frame of the camera's view finder is filled with the impression, scale and label. Focus on the impression, not the scale.

15.5.9 Oblique lighting is used to enhance the impression. When necessary, ambient light is blocked out. The flash is positioned at least three feet from the impression.

15.5.10 A photo log is established and all photographs are entered on the photo log. Information to be entered on the photo log should include:

- Case number.
- Film information.
- Photograph number with description and maker number of item photographed.
- F-stop and exposure time.

15.5.11 Impressions in snow may be highlighted with a light misting of colored aerosol sprays:

- Grey auto primer
- Rust auto primer
- Snowprint Wax
- Other colored spray paints

When using any type of spray on an impression, caution should be used. The spray should be directed into the air over the impression and allowed

to drift down into the impression. Use of sprays may damage the impression even though precautions are taken.

15.5.12 A minimum of four photographs are taken of each impression (or section of tire impression), one without a scale and three with a scale.

15.5.13 Photographs should be taken of impressions made by each foot, whenever possible.

15.5.14 A tire impression should be divided up into sections, labeled and overlapping photographs taken in sequence. Enough length should be photographed to include one tire rotation, if the impression is long enough.

15.5.15 Markers (and section labels) are left in place for casting.

15.5.16 Do not delete any digital photographs.

15.5.17 Avoid "playing back" digital photographs because this may cause loss of resolution.

15.5.18 Digital photographs should be saved directly to a computer file or burned directly to a CD or DVD.

15.6 DOCUMENTING AND SKETCHING

15.6.1 Note case number (if available), date, time, location of scene, conditions at scene (such as soil, weather, moisture, and substrate), scene responders from lab, agency(s) involved, lead investigator and contact information.

15.6.2 Once markers have been placed next to impressions, diagram impressions to record relationship to one another and direction of travel.

15.6.3 Record measurements of impressions in scene using baseline, triangulation or other measurement system.

15.6.4 Document which impressions had examination quality photographs taken.

15.6.5 A photo log should be kept of all photos.

15.6.6 Document which impressions were cast.

15.6.7 Measure and document vehicle track width, turning diameter, wheel base, and direction of travel of tire impressions, if possible.

15.6.8 Determine need for elimination impressions. Collect elimination impressions and/or photographs of footwear and tires of non-suspect persons and vehicles.

15.6.8.1 Document brand name, manufacturer, model, size and DOT information of tires.

15.6.8.2 Document brand, style and size of footwear.

15.6.9 Sketches should have the following information on them:

- "Not to Scale", unless drawn to scale.
- If drawn to scale, should have the scale indicated.
- North indicated.
- Initials or signature of preparer.
- Date of preparation.
- Case number.
- Measurements or measurement table with units indicated.

15.6.10 Sketches can be rough representations of the item or area.

15.6.9 A report of crime scene activities should be entered into the Forensic Services electronic evidence tracking system, a written report generated, and placed in the file. This report may be given to the agency.

15.7 CASTING FOOTWEAR IMPRESSIONS IN SOIL

15.7.1 Casting is done after the general and examination quality photography is completed.

15.7.2 Hair spray may be applied to loose sandy soil as a means to "bind" the loose particles prior to casting.

15.7.3 Lightweight debris which has fallen into the impression obviously after the impression was made may be carefully removed. Extraneous matter which is part of the impression itself must not be removed.

15.7.4 The required amount of water is added to the 2 lb bag of dental stone, following the manufacturer's powder/water ratio supplied with the dental stone powder (usually around 8 to 9 ounces of water).

15.7.5 The bag is squeezed and massaged to completely mix the water and dental stone for 2 to 3 minutes. The viscosity of the mixture should be that of pancake batter.

15.7.6 While pouring, the bag should be held at a height of just a few inches above the impression.

15.7.7 Casting material is poured on the ground surface just off to the side of the impression. Continue to add casting material until the mixture overflows the impression. Never pour the material directly onto any design-bearing or pattern-bearing part of the impression. An alternative method is to pour the material onto a deflecting stick and then onto the impression area (not as good a method).

15.7.8 As the cast begins to harden, information may be written on the back surface of the cast:

- Initials
- Case number
- Date
- Impression number
- Orientation marks

15.7.9 The cast should be allowed to completely harden, at least 20 minutes (time is very temperature and humidity dependent). If the ground is very wet and the cast will not harden, add more dry dental stone powder to the top of the cast or pour another bag of mixture on top of the cast.

15.7.10 When the cast has hardened, loosen all around the edges of the cast and lift. Pad with paper and pack loosely into a bag or box. Allow the cast to dry at room temperature for at least 24 hours before packaging or attempting to clean.

15.7.11 Casts are packaged in paper or cardboard boxes that can "breath". Avoid the use of any bubble wrap, Styrofoam packing or Styrofoam lined boxes.

15.7.12 **Cast Cleaning Process:** Casts may be hand-cleaned, brush-cleaned or cleaned in the cleaning tank which contains a saturated solution of potassium sulfate in tap water. The cast should be fully submerged in the

solution for 1 hour. The cast is removed, brushed lightly to removed addition debris, rinsed with water, and dried.

15.8 CASTING TIRE IMPRESSIONS IN SOIL

15.8.1 Casting is done after the general and examination quality photography is completed.

15.8.2 The tire impression is carefully examined to determine the area that will be cast. One section (or more) approximately 3' long is chosen and blocked off with cardboard or other dams on each end. If more than one section is chosen, each is cast separately using the following instructions.

15.8.3 Two 5-pound bags of dental stone are emptied into the mixing bucket and sufficient tap water (approximately four 12oz cups) is added. The mixture is thoroughly blended with a mixing stick for 2 to 3 minutes. The resulting mixture should have the consistency of pancake batter.

15.8.4 The mixture is poured onto a piece of cardboard deflector held a couple of inches above the surface and the casting compound is allowed to flow into the chosen section of impression.

15.8.5 As the cast begins to harden, information may be written on the back surface of the cast:

- Initials
- Case number
- Date
- Impression number
- Orientation marks

15.8.6 The cast should be allowed to completely harden, at least 20 minutes (time is very temperature and humidity dependent). If the ground is very wet and the cast will not harden, add more dry dental stone powder to the top of the cast or pour another bag of mixture on top of the cast. Tire impression casts are very large and additional time to completely harden is necessary.

15.8.7 When the cast has hardened, loosen all around the edges of the cast and gently lift. Pad loosely with paper and transport to the lab or agency facility. Allow the cast to dry at room temperature for at least 24 hours before packaging or attempting to clean.

15.8.8 Casts are packaged in paper or cardboard boxes that can "breath". Avoid the use of any bubble wrap, styrofoam packing or styrofoam lined boxes.

15.8.9 **Cast Cleaning Process:** Casts may be hand-cleaned, brush-cleaned or cleaned in the cleaning tank which contains a saturated solution of potassium sulfate in tap water. Because of the size of these casts, they cannot be submerged completely in the cleaning tank. Each end should be submerged in the solution for 1 hour. The cast is removed, rinsed with water, brushed lightly to removed addition debris, and dried.

15.8.10 The cast is examined carefully for the presence of wear bars and, if found, these are marked on the cast.

15.9 CASTING IMPRESSIONS IN SNOW

15.9.1 Casting is done after the general and examination quality photography is completed.

15.9.2 There are several difficulties associated with casting snow impressions:

- As the casting material sets, heat is generated which can partially melt the impression.
- Viscous casting material has a tendency to penetrate the base of the snow impression and flow through the impression.
- The "walls" of the impression may fall into the impression causing trapped air to create voids in the cast.
- The casting compound may freeze before the cast has set.

15.9.3 The dental stone-water mixture may be super-cooled by adding snow to the mixture (with corresponding less water) or by using very cold water.

15.9.4 The addition of 5% potassium sulfate solution to the dental stone will prevent the formation of ice crystals on the cast. This lowers the freezing point of the water. It also decreases the setting time, so that the cast will set before the water freezes. This technique should be considered when casting in temperatures close to or below zero.

15.9.5 To allow the cast to retain heat during setting in cold weather, cover the cast with sheets of newspaper, cardboard box or a cement blanket.

15.9.6 If using Snowprint Wax:

15.9.6.1 The instructions on the can should be followed.

15.9.6.2 The can of wax should be at room temperature before use. If the can is too cold, the pressure of the propellant will be too low.

15.9.6.3 Completely seal the impression, including the walls of the impression and surrounding area with a least three generous applications of the wax spray.

15.9.6.4 Let the wax set for 10 minutes.

15.9.6.5 Prepare, then pour, a slightly thickened mixture of dental stone and water.

15.9.6.6 Minimum setting time is 60 minutes.

15.9.6.7 When completely hardened, lift the cast without damaging the wax shell. The wax is a permanent part of the cast.

15.9.6.8 Let cast sit at room temperature for 48 hours to allow any frozen dental stone material to thaw without surface damage.

15.9.7 Casts may be poured following steps from 15.9.6.5 after application of primer spray paints or without any addition to impression.

15.9.8 **Sulfur casting**. Sulfur casting works best under extremely cold snow conditions. It does not give very good impression detail with warmer snow conditions or with granular snow.

15.9.8.1 Construct a pour channel by building up the snow to a level that is higher than and sloping down to the impression.

15.9.8.2 Approximately 5 pounds of crystalline or prill sulfur is needed for one shoe impression. Fill a 1-quart aluminum pot (with a handle) with sulfur and set onto a heating plate with stirring capability. Add a stir bar.

15.9.8.3 Turn the heat to a low to medium setting and heat the sulfur slowly to the melting point around 115°C, stirring constantly. The temperature may be checked with a thermometer. As the sulfur melts, add more sulfur until the amount for one cast, approximately 5 pounds, has been reached.

15.9.8.4 When all the sulfur has been melted, the heat source can be removed or turned off. Continue stirring until the sulfur begins to crystallize around the edges and the crystals do not redissolve with stirring.

15.9.8.5 Pour the entire amount of sulfur into the prepared channel so that it is directed down the channel into the impression.

15.9.8.6 Let the cast sit undisturbed for at least 30 minutes until it is thoroughly cooled. Sulfur casts are very fragile and brittle, so extreme care must be exercised when lifting and handling the cast.

15.9.8.7 **Note:** If a portable gas stove is used, use extreme caution during the melting process over an open flame.

15.10 CASTING IMPRESSIONS UNDER WATER

15.10.1 Impressions that are only partially under water, or that have standing water in them can be cast using the methods in sections 15.7 and 15.8 because the casting compound displaces the water from the impression.

15.10.2 Impressions that are totally under water can also be cast.

15.10.3 Do not attempt to drain the water away as this may disturb the impression.

15.10.4 Casting is done after the general and examination quality photography is completed.

15.10.5 Carefully place a casting frame around the impression that is large enough to allow 2" of extra space on all sides of the impression. Suggestions for a casting frame include:

- Chart board
- Cardboard
- File folder
- Bucket with bottom removed

15.10.6 Lightly sift the dental stone powder over the areas of the impression that are under water until about 1" of the casting powder covers the area.

15.10.7 Prepare a mixture of dental stone as in 15.7 or 15.8, making enough to fill the frame to a depth of 2". Add the mixture to the frame by carefully pouring it into that area and allowing it to settle through the water onto the impression.

15.10.8 Allow the cast to set for at least 60 minutes.

15.10.9 Lift the cast and allow it to dry. Mark the cast when it is dry with the information included in 15.7.8 and 15.8.5.

15.11 LIFTING

15.11.1 **Electrostatic Dust Lifting**

15.11.1.1 The EDL device has been successfully used to lift dry deposit impressions from the following substrates:

- Paper and cardboard
- Linoleum or tile
- Metal
- Laminate, plastic or stone countertops
- Seat covers
- Wood
- Carpet
- Asphalt
- Concrete

15.11.1.2 The impression is photographed first using proper comparison photographic techniques.

15.11.1.3 The mylar lifting film is not reused. A new piece of mylar of sufficient size for the impression is used for the lift.

15.11.1.4 The general instructions in Section 9.2.7 and the manufacturer's instruction manual are followed.

15.11.2 **Gel Lifting**

15.11.2.1 Gel lifters contain a low adhesive gelatin layer that permits the lifting of traces of residue from almost every surface, including porous material such as cardboard or paper.

15.11.2.2 The lifters can be cut to size using scissors and can be marked with appropriate information.

15.11.2.3 The gel lifters come in several types:

- Black
- White
- Transparent

15.11.2.4 The area of interest is photographed using proper techniques first.

15.11.2.5 Impressions can be lifted using gel lifters both before and after applying fingerprint powder.

15.11.2.6 Even if the impressions did not show upon the lighting of the surface and were not visible when lifted, they may show up under oblique lighting of the lifter surface in a dark room (after removing the cover sheet). Lifters with no apparent impressions in normal light, may show highly detailed images with oblique lighting in a dark room.

15.11.2.7 Follow the general lifting technique as described in Section 9.2.4.

15.11.2.8 The gel lifter should be left on the impression for about 10 minutes prior to lifting/recovery. This allows sufficient time for the impression to completely transfer to the lifter.

15.11.2.9 When impressions contain very coarse material (sand), problems can be expected in replacing the cover sheet. It is recommended to photograph the impression before attempting to

replace the cover. The lifter can be secured in the bottom of a cardboard box without the cover sheet on the lifter.

15.11.3 **Powdering and Handiprint/Tape Lifting**

15.11.3.1 This technique is often useful on freshly waxed tile or linoleum floors.

15.11.3.2 The area of interest is photographed using proper techniques first.

15.11.3.3 The powder is applied as described in Sections 9.3.5 to 9.3.7 and lifted with 3" fingerprint tape or Handiprint using the methods described in Section 9.2.4.

15.11.3.3 If 3" tape is used, the tape should be placed on the impression in overlapping strips until the impression is completely covered. All the pieces should be lifted together in a smooth action.

15.11.3.4 Opaque Handiprint lifts are the reverse of the impressions and should be treated as positives. After covering, transparent Handiprint lifts should be turned over before labeling on the back of the lift. Transparent lifts handled in this manner are negatives and represent the impressions as seen on the substrate..

15.12 TIRE TRACK IMPRESSION MEASUREMENTS

15.12.1 The dimensions of vehicle tire impressions can be used to determine possible manufacturer's brand and model.

15.12.1.1 The high degree of design, engineering and refinements to a vehicle prior to mass-production, results in an individualizing of the dimensions (including track width) of vehicles.

15.12.1.2 Use of this information can produce a list of candidate vehicles that corresponds to the dimensions of the track width(s) recorded at the scene.

15.12.1.3 This can eliminate models of vehicles, as well as reduce the number of vehicle models to be considered in the investigation.

15.12.1.4 This information makes use of a program called the *Forensic Tire & Vehicle Track Identification* program jointly developed by the Royal Canadian Mounted Police and the Michigan State Police.

15.12.2 There are several factors that affect track width measurements:

15.12.2.1 Measurement of the track width(s) must be precise. Known track width measurements are entered into the computer in tenths of an inch increments. Measurements at a scene must also be converted into tenths of an inch prior to computer entry.

15.12.2.2 Measurements should be taken by two people. Care must be taken to measure the track width perpendicularly across the tracks with the tape measure pulled tight. This reduces the chance for error in the measurement.

15.12.2.3 Track width measurements usually differ from front and rear axles on many vehicles.

15.12.2.4 Vehicle conditions such as improper camber and toe-in or toe-out will distort track width measurements from manufacturers specifications.

15.12.2.5 If the original rims on a vehicle have been replaced with over-size rims, the center point of the track measurement will shift.

15.12.3 **Wheelbase Measurement**

15.12.3.1 This is the distance between the front and rear axles of a vehicle.

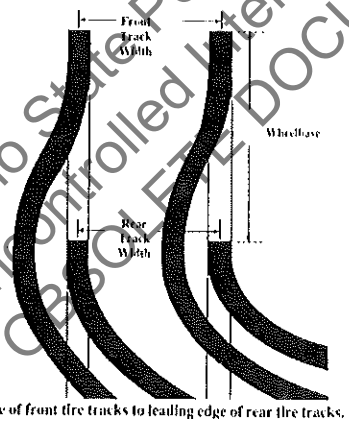
15.12.3.2 Ascertain a break in the flow of the tire tracks so that a reference point can be located for both front and rear "leading" edges.

15.12.3.3 When a vehicle stops and reverses direction, the wheelbase can be obtained by measuring from the leading edge of the rear to the leading edge of the front tire tracks.

15.12.3.4 Whenever possible, wheelbase measurements should be taken from both sides to ensure accuracy.

15.12.3.5 One person should hold the zero end of the tape measure at the reference point. The tape is pulled tight and a reading taken over the second reference point.

15.12.3.6 As long as the tire tracks are made by a vehicle which had its front tire straight at the time it reversed, accurate measurements can be taken.



Leading edge of front tire tracks to leading edge of rear tire tracks.

15.12.4 **Vehicle Track Width (Stance) Measurement**

15.12.4.1 The distance between the center points of the tires from one vehicle side to the other. The measurements provided by the manufacturers for the vehicle database represent center to center dimensions.

15.12.4.2 Track width dimensions for both front and rear axles vary on most vehicles. Rear track width is usually narrower for most North American vehicles.

15.12.4.3 Whenever possible, record track width measurements, locating the center point of the scene tire impression on one side and measure at right angles to the center point on the other side.

15.12.4.4 Use the center rib, center groove or visual examination to locate the center point of the tread pattern and mark the location.

15.12.4.5 If the center points have been obliterated and can not be calculated, other methods may have to be used:

- Outside edge to inside edge.
- Inside edge to outside edge.
- Inside edge to inside edge plus tire width.
- Outside edge to outside edge minus tire width.

15.12.4.6 Do not rely on front track width measurements recorded from tire tracks that were made when the vehicle was turning.

15.12.4.7 Except for vehicle with 4-wheel steering, rear track width can be obtained from tracks left by vehicles turning at the scene.

15.12.4.8 When dealing with tire tracks left by vehicles with dual tires, take the measurement from the center point between the two tires.

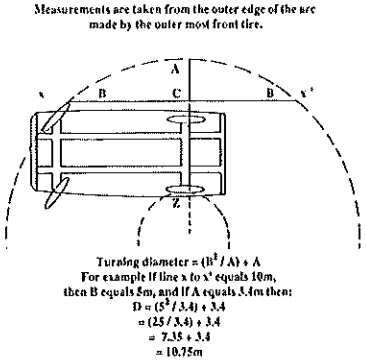
15.12.4.9 **Measuring track width on suspect vehicles:** Record the center to center distances low on the tires as close to the road surface as possible. The vehicle must not be raised on a hoist for this measurement as this may cause errors.

15.12.5 **Turning Diameter Measurement**

15.12.5.1 If the vehicle has made a sharp turn at the scene, this measurement may be possible.

15.12.5.2 Problem: The driver may/may not have applied the "full lock" to the steering mechanism when turning (turned the steering wheel tight into position as far as it will go in the turning direction).

15.12.5.3 Calculating a turning diameter in some cases may be useful in eliminating suspect vehicles that cannot make as tight a turn as that found at the scene.



15.12.5.4 Select a segment of a front tire track which reflects the sharpest portion of the turn.

15.12.5.5 Referring to the diagram, lay a measuring tape along an imaginary cord connecting two points of the outer margin of the track arc. The position of this line is not critical but its measurement is. The measurement should be taken from outer margin to outer margin as illustrated in the diagram.

15.12.5.6 Bisect arc x-x' at mid-point C and at this point erect a line at right angle, extending from line y outward to the outer margin of arc x-x', as shown in the diagram. This line will be referred to as line A, and its measurement is also critical. This makes Cx and Cx' equal, allowing either to be defined as B.

15.12.5.7 The line defined as Z in the diagram is an imaginary line extending from point C to the other side of the circle, whose diameter is to be calculated. The diameter is now calculated by the following short formula: diameter = $(B^2/A) + A$.

15.12.5.8 Vehicles with 4-wheel steering can produce a smaller turning diameter and tighter space maneuverability at low vehicle speeds.

15.12.6 **Tread Design Width (Tread Width) Measurement**

15.12.6.1 The measurement across the tread from one edge of the design to the other is referred to as the tread width.

15.12.6.2 Do not rely solely on a scale in a photograph for this dimension. It should also be recorded at the scene.

15.12.6.3 Factors that can affect this measurement:

- Tire inflation pressure.
- Load on tire.

15.12.6.4 The edge of the tread design in a scene impression may be difficult to discern because of:

- Tire design (round shoulders, offset lugs).
- Wear to edge of tire.

- Nature of substrate in which impression was made.

15.12.6.5 If a full tread width is not available, this information may still be possible to determine. By locating the center of the pattern and measuring to one edge, the manufacturer may be able to calculate the full width of the impression and suggest a possible tire size.

15.12.6.6 As the tread design wears down, the measurable width increases slightly for designs with rounded and sloping shoulders.

15.12.6.7 Over-inflated tires or those with badly worn shoulders may not flatten out completely to leave a full width "footprint". This is important knowledge to have when explaining slight discrepancies that can occur in measurements between scene and known impressions.

15.12.7 **Direction of Travel Determination**

15.12.7.1 Observations can be made at the scene regarding the direction of vehicle travel and vehicle position/orientation.

15.12.7.2 Vegetation is bent into the direction of travel by vehicle passing over and/or through the vegetation.

15.12.7.3 Soil and snow "droppings" are displaced into the direction of travel by a vehicle traveling at moderate speeds, as opposed to a vehicle just starting out. "Droppings" are cause by debris adhering into the grooves and slots of the tire, and falling out back into the track.

15.12.7.4 Splashes from puddles and stains are displaced into the direction of travel by a vehicle traveling at moderate speeds across accumulations of liquid substances such as blood, muddy water, paint and oil.

15.12.7.5 A vehicle traveling from an area of soil will transfer traces onto a hard-covered surface such as asphalt or concrete. The transfer will become lighter as the vehicle gets further from the source of the contamination.

15.12.7.6 A vehicle at rest may leak oil and other liquids from the engine or hood region that may provide an orientation of the vehicle.

15.13 REFERENCES

Abbott, John R., *Footwear Evidence*, Charles C. Thomas, Springfield, 1964.

Bodziak, William J., *Footwear Impression Evidence*, CRC Press, 1999.

Bodziak, William J., *Footwear Impression Evidence*, Elsevier , 1990.

Chesapeake Area Shoeprint and Tire track (C.A.S.T.) examiners website http://members.aol.com/varfce/mastssite/index.html.

Hilderbrand, Dwayne S., "Footwear, The Missed Evidence", *Minutiae, Lightning Powder Co. Newsletter*, Nov-Dec 1995, pp 2-5.

Nause, S/Sgt Lawren, *Forensic Tire Impression Identification*, National Research Council of Canada, 2001.

The Scientific Working Group on Shoeprint and Tire Tread Evidence Technology (SWGTREAD) - *SWGTREAD documents are officially published in the Journal of Forensic Identification*, 766/55(6), 2005.

Appendix A
Footwear and Tire Impression Instrument Maintenance

Manufacturer's instrument manuals designated with * are on file in the Latent Section (*1), Drug Lab (*2) or the Criminalistics/Alcohol Lab (*3).

ALS*1
For ALS maintenance see method 8.1.

Balances (located in Drug Lab)
Footwear and tire impression analysts will use the balances located in the drug lab following the Controlled Substances Discipline "Balance Calibration Verification Analytical Method".

CAE Fuming Chambers
Maintenance shall consist of cleaning the tanks as needed.

Cameras (*3 and Latents Lab)
General maintenance consists of wiping camera bodies with a soft cloth, blowing off lenses and mirrors to remove dust or dirt, and then cleaning with a soft cloth or eyeglass cleaner.
If a camera malfunctions, it will be taken out of service until it can be repaired. The camera shall be tagged indicating that it is out of service. Maintenance, service, etc. will be recorded in the maintenance log.

ESDA (*3)
The bronze plate may become contaminated by fingerprints or small quantities of toner during use. The best method of cleaning this plate is to brush vigorously with tissue paper. If the plate becomes seriously contaminated or damaged such that the vacuum is impaired, the plate should be replaced. Additional maintenance shall be conducted as needed and all maintenance will be recorded in the maintenance log.

Electrostatic Dust Print Lifter (*3)
Recharge the battery overnight approximately every two months or as needed. Maintenance shall be conducted as needed and all maintenance will be recorded in the maintenance log.

Eyewashes and showers
Eyewash function shall be checked monthly and documented on the Chemistry Section QC worksheet. The showers are also checked annually by building maintenance.

Fume Hoods (in Drug Lab*2, in Latents Chemical Processing Lab*1)
All hoods are equipped with continuous flow monitoring devices. Capture velocity at the open face of the commercially purchased hoods is at least 100 feet/minute. Capture velocity at the open face of the sink hoods ranges between 75-100 feet/minute.
If a hood fails a monthly check, the check will be repeated. If the hood still fails, it will be taken out of service until it can be repaired. The hood shall be tagged indicating that it is out of service.

General maintenance consists of cleaning. Filters are changed regularly by building maintenance staff. Additional maintenance shall be conducted as needed and will be recorded in the maintenance log.
Fume hoods are certified yearly by an outside source.

Magnifying Glasses
Magnifying glasses should be cleaned regularly with a high quality lens cleaner and soft cloth. No caustic chemicals should be applied to the lens.

Microscopes (Drug Lab*2, *3)
All microscopes have year servicing performed by an outside source.

Powder Station Exhaust Vents (Latents Powder Lab)
Filters are washed periodically and replaced annually by the building maintenance staff. Additional maintenance is performed as needed. Maintenance, service calls, etc. will be recorded in the maintenance log.