Arizona Department of Public Safety

Scientific Analysis Bureau

Latent Print Analytical Protocol

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1 EVIDENCE PROCESSING 4
1.1 PROCESSING DOCUMENTATION 4
1.2 SEQUENTIAL PROCESSING GUIDE 4
1.2.1 POROUS EVIDENCE 4
1.2.2 NON-POROUS EVIDENCE 4
1.2.3 BLOOD EVIDENCE 5
1.2.4 TAPE 5
1.3 LATENT LIFTS 5
1.4 PHOTOGRAPHS 6
1.5 STORAGE OF LATENT LIFTS, PHOTOGRAPHS, AND EXEMPLARS 6
2 PHYSICAL PROCESSING TECHNIQUES 7
2.1 POWDER PROCESSING USED ON NON-POROUS ITEMS 7
2.1.1 BRUSHES 7
2.1.2 CONVENTIONAL POWDER (includes black, white, gray, fluorescent, etc.) 8
2.1.3 MAGNETIC POWDER 8
2.2 LIFTING LATENTS 9
2.2.1 TAPES AND LIFTS 9
2.2.2 LIFTING PROCEDURE 9
2.3 ACCUTRANS (POLYVINYLSILOXANE) LIFTING MATERIAL 9
2.3.1 ACCUTRANS PROCEDURE 10
2.4 SMALL PARTICLE REAGENT (SPR) 10
2.5 STICKY SIDE TAPE POWDER 10
2.6 WETWOP™ 11
2.7 IODINE FUMING 11
2.8 FLAME TECHNIQUE 12
2.9 OBTAINING EXEMPLAR PRINTS 12
3 CHEMICAL PROCESSING 13
3.1 NINHYDRIN (TRIKETOHYDRINDENE HYDRATE) 13
3.1.1 ZINC CHLORIDE 14
3.1.2 NINHYDRIN THERMAL MIX (THERMANIN) 14
3.2 DFO (1, 8-DIAZAFLUOREN-9-ONE) 15
3.3 PHYSICAL DEVELOPER (PD) 15
3.4 SILVER NITRATE 16
3.5 CYANOACRYLATE ESTER OR SUPERGLUE FUMING (CA) 16
3.5.1 SUPERGLUE FUMING PROCEDURE 17
3.5.2 SODIUM HYDROXIDE PROCEDURE 18
3.5.3 LUMICYANO 18
3.5.4 NOTES 18
3.6 DYE STAINS 19
3.6.1 RHODAMINE 6G 19
3.6.2 ARDROX P-133D (Ardrox) 19
3.6.3 RAM 20

3.6.4 BASIC YELLOW 40 (BY40) 20
3.7 AMIDO BLACK 20
3.8 GENTIAN VIOLET (CRYSTAL VIOLET) 21
3.9 GUN BLUING SOLUTION 22
3.10 DECEASED HAND PROCESSING 22
3.11 1,2-INDANEDIONE 23
4 FRICTION RIDGE EXAMINATION 23
4.1 ANALYSIS 23
4.2 COMPARISON 27
4.3 EVALUATION 28
4.4 VERIFICATION 29
4.5 CONSULTATION 30
4.6 CONFLICT RESOLUTION 30
4.7 COMPARISON DOCUMENTATION 31
5 LATENT PRINT EXAMINATION RECORDS/DOCUMENTATION 33
5.1 LATENT PRINT EXAMINATION RECORDS 33
5.2 LATENT PRINT REPORT WRITING 33
5.2.1 RESULTS 33
5.3 TECHNICAL REVIEWS 34
6 AUTOMATED FINGERPRINT IDENTIFICATION SYSTEMS 35
7 LATENT PRINT DIGITAL IMAGING 36
7.1 CAMERA 36
7.1.1 CAMERA EQUIPMENT REQUIREMENTS 36
7.1.2 IMAGE CAPTURE REQUIREMENTS – DIGITAL CAMERA 36
7.2 SCANNER 36
7.2.1 DIGITAL SCANNER REQUIREMENTS 36
7.2.2 IMAGE CAPTURE REQUIREMENTS – SCANNER 36
7.3 DIGITAL IMAGE ENHANCEMENT 37
7.3.1 PURPOSE 37
7.3.2 DOCUMENTATION 37
7.3.3 TRAINING 37
7.4 DIGITAL IMAGE PRINTING 37
7.4.1 PRINTERS 37
7.4.2 PAPER 38
7.4.3 PRINTING 38
7.4.4 RETENTION 38
8 DNA SWABBING 38
8.1 CLEAN TECHNIQUES 38
8.2 DNA SWABBING TECHNIQUES 38
8.3 DNA SWABBING DOCUMENTATION 39
8.4 REPORTING DNA SWABBING 39

9 REVISION HISTORY 40
Appendix A FORMULARY 43

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1 EVIDENCE PROCESSING

1.1 PROCESSING DOCUMENTATION

Examination records are written reflecting the examiner's observations, the processing techniques used, and conclusion/opinions reached. Latent print examination records include written laboratory examination documentation and information/notations on lifts, photographs, printouts, and electronic files. Documentation of the latent print examination must be sufficient to support conclusions such that another competent examiner could evaluate what was done and reach valid conclusions.

A visual examination for the presence of ridge detail is performed prior to processing and also, after each process. If comparable ridge detail is visible, the latent print must be photographed or lifted prior to any additional processing. The latent prints may be visualized using light sources (e.g. flashlight, floodlight, forensic light source, etc.). In some cases the contrast is poor and the comparable latent print cannot be photographed properly. If so, then a notation will be made as to why the photograph was not taken prior to processing.

The processing techniques used are at the discretion of each individual examiner.

Processing techniques are further explained in the Physical Processing and Chemical Processing sections 2 and 3 of these protocols.

Care should be taken to note whether additional processing by other units is requested. If DNA is requested see Section 8 DNA SWABBING.

1.2 SEQUENTIAL PROCESSING GUIDE

Below is a processing guide that may be used for general evidence.

1.2.1 POROUS EVIDENCE

Items with surfaces that tend to absorb latent prints (paper, cloth, wood, etc.)

- Visual: white light/inherent luminescence
- Iodine fuming*
- DFO
- Indanedione
- Ninhydrin (Zinc Chloride)
- Silver nitrate
- Physical developer

*Iodine fuming is only used in extreme circumstances due to the hazards of the process.

1.2.2 NON-POROUS EVIDENCE

Items with surfaces that do not tend to absorb latent prints (glass, plastic, etc.)

- Visual: white light/inherent luminescence
- Cyanoacrylate fuming (or Powder)
- Flame Technique

- Dye stain
- Powder*

*Powdering may be used before and/or after dye staining.

1.2.3 BLOOD EVIDENCE

Porous evidence with blood stains
- Visual: white light/inherent luminescence
- Amido black or ninhydrin

Non-porous evidence with blood stains
- Visual: white light/inherent luminescence
- Amido Black
- Cyanoacrylate fuming
- Dye stain
- Powder

1.2.4 TAPE

Adhesive side
- Visual: white light/inherent luminescence
- Sticky side tape powder or Wetwop™
- Gentian violet (crystal violet)
- Physical developer

or
- Visual: white light/inherent luminescence
- Cyanoacrylate fuming
- Dye stain

1.3 LATENT LIFTS

- The lift side of a lift card must be marked with the DPS DR #, date, examiner's initials, original item #, and a unique identifier. Lifts created by the examiner will include a description and/or diagram indicating its position on the item.
- The examiner's initials and the date must be placed across the edges of the lift tape whenever possible.
- Each lift must have a unique identifier (e.g. 1.1, 1.2, L1, L2, etc.) and must be documented in the examination notes in addition to being documented on the lift card.
- Each compared latent print and each latent print searched through Arizona Automated Fingerprint Identification System (AZAFIS) or Next Generation Identification (NGI) must be marked with a unique identifier.
- When a latent print is identified, the lift card will be marked with the subject's name, DOB (when available), finger number or anatomical area, examiner's initials, date, verifier's initials, and date verified. The information recorded in Mideo satisfies this requirement.

Arizona Department of Public Safety Crime Laboratory Justitia Per Scientiam Scientific Analysis Bureau

1.4 PHOTOGRAPHS

- A scale, the DPS DR #, Item #, date, and examiner's initials must be included in each photograph. The information can be recorded in Mideo to satisfy this requirement.
- Each photograph must have a unique identifier (e.g. P1, P2, ^001, ^002, etc.) and must be documented on the photograph or in the digital file.
- Each compared latent print and each latent print searched through AZAFIS or NGI must be marked in the digital image management system with a unique identifier.
- When a latent print is identified, the photograph will be marked with the subject's name, DOB (when available), finger number or anatomical area, examiner's initials, date, verifier's initials, and date verified. This information will be recorded in Mideo for digital photos.
- See additional information in Section 7 DIGITAL IMAGING.

1.5 STORAGE OF LATENT LIFTS, PHOTOGRAPHS, AND EXEMPLARS

- Submitted latent lifts and/or photographs may be returned to the requesting agency after examination. When the lifts and/or photographs are released, a comparison quality copy of any latent prints of value for comparison (NVID or LV) will be retained. Latent prints shall be scanned at 1000 ppi, or above, and exemplar cards shall be scanned at 500 ppi, or above. A scale should be used for scanned latent prints and exemplar cards.
- Latent prints determined to be of no value for comparison may be returned without retaining a comparison quality copy. The latent prints must be examined by another qualified examiner (preferably in technical review) before being returned.
- If used in case examination, exemplars (or a comparison quality copy) will be retained in the regional laboratory's Latent Print Unit file, in the examiner's notes, or in Mideo.
- Digital photographs will be maintained on DPS servers. Backup copies of all digital photographs will be maintained on digital image discs or on backup servers. When the discs are created, they will be write protected so that no changes can be made. The discs are stored in the Latent Print Unit files.
- Latent lifts and evidence photographs must be stored in sealed containers. The latent lifts and photographs will be sealed as soon as possible after the Scientific Examination Report and case files have been technically reviewed, UNLESS further examination of the latent prints is in progress for a separate case file/report. The envelope that a disc is stored in does not need to be sealed.
- A chain-of-custody must be maintained for latent lifts, evidence photographs, and discs.
- Multiple DR #'s may be stored in a single sealed container.
- Deceased exemplar prints may be retained in the Latent Print Unit files or, may be returned to the submitting agency. Photocopies or scanned copies of the exemplars must be retained in the examination records if the exemplars are returned.

2 PHYSICAL PROCESSING TECHNIQUES

The development of latent prints through the use of physical techniques does not involve a chemical reaction between the impression and the technique used; they encompass dusting and other discoloration methods often relying on the adhesive quality of certain latent prints. (See Appendix A Formulary) If processing is needed by another unit and the examiner is unsure of the result of the other unit's examination, then the examiner will contact a member of the unit for instruction.

2.1 POWDER PROCESSING USED ON NON-POROUS ITEMS

The use of controls with physical processing techniques is not required; however, the materials used to develop the print (powder, SPR) should be closely examined prior to each use. If the processing materials appear to be clumped or contaminated they should be discarded and new processing material obtained for use in casework.

If there is any question regarding the suitability of a technique for a purpose or surface, a test print (a latent print left on a similar surface) will be used to verify the technique works properly. All test prints will be documented in the examination records.

Safety Note: Powder application presents little known hazard when properly performed. Personnel should wear gloves and avoid eye contamination, ingestion, or inhalation of the powder. Dusting procedures should be performed in a suitable, contained, designated area (dusting hood) when possible. A mask may be worn to prevent inhalation in situations where processing in a hood is impractical.

2.1.1 BRUSHES

The four primary categories of brushes are feather, fiberglass (carbon filament), hair, and magnetic.

<u>Feather Brush</u>
Generally used for delicate processing purposes involving the removal of excess powder or soot and fluorescent powders. Feather brushes are not as durable as other types and must be handled with greater care.

<u>Fiberglass Brush</u>
Consists of fine fiberglass bristles and is commonly used as an all-purpose brush in lieu of several other sizes and types. The primary advantage is the ability to process a large area with considerably less "re-powdering" of the brush than other types.

<u>Carbon Filament</u>
Is similar to a fiberglass brush. It is used to remove excess powder.

<u>Hair Brush</u>
These brushes should be very soft and pliable. Commercially produced latent print hair brushes are most often made from camel hair or squirrel hair.

<u>Magnetic Brush (Wand)</u>
These wands are used only for the application of magnetic type powders (or mixtures of magnetic/conventional powders).

Mitts, Pads and Cotton Batting or Balls
The mitts or pads are used to cover large areas in a shorter amount of time. They are also useful when powdering items that have been previously processed with cyanoacrylate. Care must be taken when using these items to ovoid wiping and/or damaging ridge detail.

2.1.1.1 MAINTENANCE OF BRUSHES

Brushes may be cleaned with mild detergent and water. Blow drying will help (especially with hair brushes) to prevent matting after washing with the soapy solution. Dirty or contaminated brushes cannot always be cleaned to alleviate stiff bristles. Brushes that have been cleaned and still have stiff bristles should not be used for dusting latent prints. Brushes may also benefit from combing to remove matted bristles and clumps of powder.

2.1.2 CONVENTIONAL POWDER (includes black, white, gray, fluorescent, etc.)

- Select the appropriate brush depending on the surface to process.
- Use a small amount of powder with a delicate touch. Work with a portion of the powder in a work container or shallow dish.
- Touch only the ends of the brush bristles to the powder. The excess powder should be shaken or tapped off. A smooth twirling motion is used to apply the powder.
- Adherence of powder to a latent print can be enhanced by humidifying the print. This is easily accomplished by gently breathing hot air on the surface immediately prior to powdering. Caution must be exercised not to over-humidify as this can cause excessive "background" from the powder sticking to the entire surface.
- After lifting, a latent may be enhanced by reprocessing with a brush and powder.
- Excess powder should be blown off the evidence prior to lifting to prevent "fish-eye" artifacts in the latent print.

2.1.3 MAGNETIC POWDER

- When the magnetic wand is inserted into the magnetic powder, the powder will be picked up with the tip of the wand. The powder is released from the tip of the brush by pulling up on the end of the rod.
- Only the powder should touch the surface being processed and not the wand itself. A light, smooth stroking motion is used in guiding the magnetic wand over the area to be processed.
- Adherence of powder to a latent print can be enhanced by humidifying the print.
- Magnetic powder may not be appropriate on some ferrous or magnetic surfaces.

2.2 LIFTING LATENTS

2.2.1 TAPES AND LIFTS

Tape
Special latent print lifting tapes, including transparent and frosted, are available from several commercial sources. Lifting latent prints with tape enables direct comparison with inked impressions and can be used with a wide variety of black or white backing materials, including pre-printed backing cards, index cards, photographic papers, and vinyl backing tabs. Poly tape (polyethylene tape) can be used for curved or textured surfaces.

Hinge Lifters
These consist of a transparent lifting medium (tab) attached to a clear, black or white plastic backing tab.

Gel Lifters
Gel lifters are used to lift latent impressions from curved surfaces without the creases inherent to tape and hinge lifts. Gel lifts come in either black or white and are available in sizes appropriate for lifting different sizes of developed prints.

2.2.2 LIFTING PROCEDURE

Generally, lift tape is recommended for lifting powdered prints. If a latent is in a position or of a delicate nature that lifting could destroy or compromise its integrity, it should be photographed, prior to lifting.

- When lifting a latent print with lift tape, the tape should be unrolled in one smooth continuous action to prevent hesitation creases.
- When applying the lift tape to the latent, press the starting end of the tape down above the latent (or area of interest), then use one continuous sweeping motion over the print to prevent air bubbles in the tape.
- Lift the impression away from the surface in a smooth continuous motion. Apply the lift to the card in the same manner it was applied to the surface. Air bubbles may be removed by rubbing over the tape after the lift is placed on a lift card.
- The method of marking where a latent was lifted from is left to the discretion of the examiner; however, each examiner should attempt to mark their latent lifts and evidence in such a way as to prevent the possibility of latent print fabrication or tampering of the latent after lifting.

2.3 ACCUTRANS (POLYVINYLSILOXANE) LIFTING MATERIAL

AccuTrans lifting material is used to preserve latent prints developed with powder techniques on textured, curved, or wrinkled non-porous surfaces such as plastic, glass or metal. The advantages of this lifting material are that the liquid AccuTrans material fills all texture, flows around curved surfaces, and does not pull apart wrinkled plastic. After application, the AccuTrans material dries in a relatively short time depending on the air and surface temperature.

Acidic, alkaline, and sulfurous compounds (e.g. skin secretions, latex gloves and surfaces contaminated by latex gloves) can influence or prevent curing of the AccuTrans material.

2.3.1 ACCUTRANS PROCEDURE

- Apply powder as described in Section 2.1.
- Insert an AccuTrans cartridge into the dispenser gun.
- Attach a mixing tip.
- Squeeze the trigger.
- Keep the mixing tip in the transparent AccuTrans material as it comes out of the mixing tip to eliminate the chance of air bubbles.
- Lift the AccuTrans material off the surface after it has dried.
- The print can then be evaluated and may be photographed or scanned for comparison.
- The AccuTrans lift can be photographed or scanned and returned to Property and Evidence with the evidence it was lifted from or stored in the latent print files.

2.4 SMALL PARTICLE REAGENT (SPR)

Use on wet non-porous surfaces.

- Small particle reagent is purchased as a kit. The ingredients are mixed according to the supplier's directions.
- While the surface bearing latent prints is still wet, SPR is sprayed on the surface with a spray bottle.
- The latent prints can be photographed or lifted using normal lifting techniques. This can be done with the prints wet or dry.
- This technique is particularly useful when there are oily prints on a wet surface.
- Other processing techniques can be used following SPR processing; however, due to water immersion, it may be difficult to develop further prints.

2.5 STICKY SIDE TAPE POWDER

Use on the adhesive side of tape and labels.

- Sticky side tape powder can be purchased as a kit and mixed according to the supplier's directions, or can be made from common laboratory supplies.
- To mix sticky side tape powder from laboratory supplies, the following items will be needed: powder, water, surfactant, and dish or beaker.
- A powder is selected to contrast with the tape adhesive.
- A surfactant (dish detergent, liquid soap, or Photoflo all work well—the choice of surfactant is at the discretion of the examiner) is mixed with equal parts of water. The powder (usually the finer powders work better) is then mixed with the water and surfactant to form a thick liquid (approximately as thick as pancake batter).
- The sticky side tape powder is then brushed onto the sticky side of the tape with a soft brush (such as a "camel hair" brush), or the tape is drawn through a shallow dish with the sticky side tape powder in it.

- Rinse after approximately 10 seconds under gently running tap water. Care must be taken not to leave the reagent on the tape too long as it will cause a darker background and diminished contrast.
- Sticky side tape powder should be used only after the back side (non-adhesive) of the tape has been processed.

2.6 WETWOP™

Use on the adhesive side of tape and labels.

- Wetwop™ may be used as a primary processing technique, or may be used in conjunction with other sequential processing techniques such as Gentian violet and Cyanoacrylate.Shake the Wetwop™ container thoroughly.
- Pour a small amount of Wetwop™ into a container such as a plastic weigh boat, glass dish, or beaker.
- Using a soft brush (such as a "camel hair" brush), apply the Wetwop™ to the adhesive side of the evidence for approximately 15 to 30 seconds, covering the entire surface.
- Rinse the evidence with a gentle stream of water. Care should be taken to rinse the surface before the Wetwop dries completely as permanent staining may occur that could obscure ridge detail.
- Multiple applications of Wetwop may be applied to darken ridge detail and increase contrast.
- Allow evidence to dry.
- Examine the evidence visually once dry, then photograph or scan developed latent prints.

2.7 IODINE FUMING

Use on porous surfaces such as paper and unfinished wood, but may be considered for application to any surface.

- Many methods of application exist, but the best known are the iodine fuming "gun" and the iodine fuming chamber. Place a small amount of iodine crystals into the fuming gun or chamber. As the crystals are heated at low temperature, expose the item to the fumes.
- The discoloration brought about during iodine fuming is a result of the physical absorption or adherence of the purplish fumes to the latent print residue. This processing will cause the ridges to appear yellowish-brown in color.
- When spraying iodine spray reagent, the finest mist possible is the most effective method of application. If the spray is heavy, it will overdevelop the area being processed. An artist-type air brush has proven to be very effective in applying this process.
- One characteristic of the developed iodine impression is that it fades rapidly. There are several methods which will "fix" the print and cause the ridge detail to become semi-permanent.
    - Iodine prints may be fixed and simultaneously enhanced to a deep blue color with the application of a starch powder, followed by gentle exposure to steam (this method does not readily allow the subsequent processing with ninhydrin or silver nitrate). Excessive exposure to the steam may allow condensation to occur, with a resulting blur of the ridge details. Starch fixing of iodine fumed prints is not permanent, but generally lasts for several months.

- Silver-transfer lifting uses a polished silver plate that is pressed against the iodine developed ridge detail and then exposed to sunlight, an ultraviolet light, or flood lamp to develop dark ridge detail. Care must be taken to avoid further exposure to ultraviolet light once maximum contrast is achieved. Photography should be accomplished using yellow "bug" lights which do not emit ultraviolet light.
- When necessary, iodine fumed prints or stains may be quickly cleared by exposure to ammonia fumes.
- The fixing or clearing of iodine developed impressions is rarely performed due to the chemical techniques which are subsequently applied to porous surfaces (ninhydrin, silver nitrate, etc.).

2.8 FLAME TECHNIQUE

Use on non-porous surfaces

- Resinous pine, pine tar, camphor, masking tape, and other materials may be burned to produce black soot. Magnesium or titanium tetrachloride may be incinerated to produce white soot.
- The surface suspected of bearing latent prints should be passed over the burning substance until an even deposit of soot is accumulated. The deposit should not be allowed to become too heavy, nor should the flame touch the object. Excess soot should be removed with a soft brush or a gentle stream of cold water.
- These techniques are particularly valuable in developing old impressions on glass and metal, particularly galvanized metal such as air ducts or vending machine coin boxes.

2.9 OBTAINING EXEMPLAR PRINTS

- Use any of the available cards to record major case prints (e.g. Applicant, Personal Identification, Single Print File Card, Arrest Fingerprint Card, Palm Print Card, etc.).
- Have the subject sign each of the cards prior to inking their hands.
- Fill out any information (e.g. subject's name, date of birth, SID#, etc.) on the cards before or after inking.
- Have the subject wash their hands prior to inking. If the hands become too dry, it may be necessary to add lotion.
- Kits are available that include cardholders and inking plates.
- Use printer's ink, porelon or other fingerprint ink pads. Inkless pads are available but not generally used.
- Use a roller to apply printer's ink to the inking plate in a thin, even coating.
- Roll the fingers (either in printer's ink or on the pads) in a horizontal motion covering the pad of the finger from tip to below the first joint on the inked plate or pad, then use the same motion to roll on the card.
- For full fingerprints use the ink roller to cover the entire finger from tip to the third joint. Roll the finger in the same fashion to cover the card.
- For palm prints use the ink roller to cover the entire palm from wrist crease to the fingers and thumb to writer's palm. Lay palm flat on the palm print card, pressing down in the middle and between the fingers. It may be necessary to place a stack of paper towels beneath the center of the card or use a large roller to obtain the entire palm area.

- Record the outside edge of the hypothenar area by inking the palm, then placing it on the card and rolling towards the outside/back side of the palm.
- Prior to the subject cleaning their hands, visually review the completed major case prints to ensure complete recordings have been obtained.

3 CHEMICAL PROCESSING

The development of latent prints through the use of chemical techniques occurs because of the chemical reaction between the latent print residue components and the chemical technique components.

- Before applying chemicals to any items, the examiner should determine that no further analysis is needed by another unit. The application of chemicals to an item may interfere with processing by another unit. (Questioned Documents, DNA, etc.) Therefore, if processing is needed by another unit and the examiner is unsure of the result of the other unit's examination, then the examiner will contact a member of the unit for instruction.
- A control print must be processed for each chemical lot number each day it is used. A control latent print is made on any available item, preferably consistent with the item of evidence. Process the item with the chemical and observe the result. A positive result of developed ridge detail must be completed on a test print prior to the chemical being used on an evidence item (with the exception of Cyanoacrylate Ester or Superglue Fuming). All reagent tests will be documented in the examination records.
- Only one laboratory lot number of a chemical will be in use at one time. When a new laboratory lot number is mixed any remaining chemical from the previous lot will not be used for casework, but may be used for training purposes.
- A forensic light source may be used in conjunction with the chemical techniques.
- See Appendix A - Formulary

3.1 NINHYDRIN (TRIKETOHYDRINDENE HYDRATE)

Use on porous evidence.

- Ninhydrin reacts with alpha-amino acids, proteins, and polypeptides which are present in a variety of body fluids including blood, saliva, and sweat. The developed impression will usually appear to have a purplish coloration (Ruhemann's purple).
- Heptane is the most commonly used solvent for ninhydrin processing in the DPS laboratory. Acetone, methyl alcohol, ethyl alcohol, and petroleum ether may also be used, but may cause inks on the item to run. Water may not be used as a carrier for ninhydrin because amino acids are water soluble.
- The solution may be applied by spraying, brushing, or dipping.
- After applying the ninhydrin solution to a surface, allow the item to completely dry.
- Applying heat and humidity to the processed item can accelerate the chemical reaction. This can be accomplished with several passes of a steam iron above the surface of the item. Care should be taken if a steam iron or humidity chamber is used to process ninhydrin treated wood or very porous paper such as tissue or paper towels. The humidity may cause a migration or blurring of ridge detail.

- Although most prints will visibly develop with the application of heat and humidity, further prints may develop over several days. Items where no ridge detail of value for comparison was developed must be left to sit for at least 2 to 3 days to allow for potential development of additional latent print detail.
- Ninhydrin prints can fade over time (days or years). Therefore, it is important to photograph developed ridge detail the day of application and after 2-3 days or more if further prints develop.
- Techniques utilizing "dry" ninhydrin may also be employed in developing latent prints on paper.
    - Powdered ninhydrin can be sprinkled on the surface to be processed and then subjected to heat and moisture to develop the latent prints; or
    - A blotter can be dipped into a ninhydrin solution and then dried. The surface to be processed is placed between the dried blotter and another sheet of paper. The ninhydrin is absorbed into the processed surface. Heat and moisture can then be applied to the processed area.
- Because the ninhydrin/amino-acid reaction is very sensitive, very minute traces and very old prints (many years) can be recovered.
- Ninhydrin is sometimes not appropriate for use on paper with high animal glue (gelatin) content such as jewelry gift boxes or currency. The large concentration of amino acids in these surfaces causes a strong purplish discoloration and generally a total loss of latent print detail.
- Ninhydrin stains can be cleared from documents, but is not recommended as a general rule. Ninhydrin stains should not be cleared if any additional processing is planned. Documents and papers should be blotted and dried immediately after application of one of the following clearing solutions:
    - One part household bleach with two parts water.
    - One part concentrated ammonium hydroxide with two parts water.

3.1.1 ZINC CHLORIDE

- May cause latent prints, previously processed with ninhydrin, to fluoresce with forensic light source illumination. Zinc chloride reacts with the ninhydrin to cause an orange color shift.
- Neither the zinc chloride nor the alternate light source develops latent print detail. The zinc chloride may cause the prints to be visualized with better contrast.
- Application of zinc chloride solution by spraying or dipping will cause a color change almost immediately.
- A humidity chamber or steam iron can be used to introduce heat and moisture.
- View and photograph under a forensic light source at 450nm to 530nm using a dark orange or red filter.

3.1.2 NINHYDRIN THERMAL MIX (THERMANIN)

Use on porous evidence

- Ninhydrin Thermal Mix reduces the risk of thermal paper turning black during processing.
- Ninhydrin Thermal Mix reacts with alpha-amino acids, proteins, and polypeptides which are present in a variety of body fluids including blood, saliva, and sweat. The developed impression will usually appear to have a purplish coloration (Ruhemann's purple).
- The solution may be applied by spraying.
- After applying the ninhydrin thermal mix solution to a surface, allow the item to completely dry.
- Applying humidity to the processed item can accelerate the chemical reaction. Do not heat as it will cause the paper to turn black.

3.2 DFO (1, 8-DIAZAFLUOREN-9-ONE)

Use on porous surfaces.

- DFO develops latent prints containing amino acids present in a variety of body fluids including blood, saliva, and perspiration.
- The item is dipped or sprayed with the DFO, dried, and placed in a chemical processing oven at 100° C for 20 minutes. If an oven is not available, a dry household-type iron may be used.
- Any latent prints tend to develop immediately after application of heat. Humidity is not required for this reaction.
- The developed latent prints fluoresce under a 445 nm to 590 nm forensic light source and should be viewed and photographed with an orange, red, or yellow filter.

3.3 PHYSICAL DEVELOPER (PD)

Use to develop latent prints on porous evidence.

- Physical developer reacts with fats, oils, and waxes present in perspiration or found on the skin surface. The developed latent prints will appear gray or black.
- This technique -may be effective in developing latent prints on paper bags, currency, and items that have been subjected to water or moisture.
- Use clean glassware in preparing and processing the PD solution. Glassware should first be washed with detergent (do not use scouring materials which will scratch the surface of the glassware), rinsed with tap water, and then rinsed thoroughly with distilled or deionized water. If the glassware is dirty, silver will deposit in those areas and not on the evidence.
- Some papers which contain fillers may have to be dipped into a maleic acid solution prior to processing (heavy cardboard, construction paper, etc.).
- Immerse the item in the maleic acid solution for 10 minutes or until no more bubbles are seen coming from the paper, whichever is longer. Most writing paper, check paper, or corrugated cardboard do not need to be processed with maleic acid.
- Immerse the item in the physical developer working solution until prints develop (no more than 20 minutes).

- Physical developer (PD) contains silver nitrate. The silver will precipitate out of the solution unless it is continuously mixed; therefore, it is necessary to gently rock the PD container during the developing process.
- Use plastic photographic tongs or plastic forceps without serrated edges to remove articles from the PD solution; do not use metal tools. Handle items carefully, and do not poke or dent the paper items while they are submerged in PD. Dents made by metal forceps or tweezers and glove marks may cause deposits of silver which may obliterate usable prints.
- Immerse the item in a dish of distilled water, and rinse until the water runs clear. Wash in cold tap water for an additional 5-10 minutes. The item should then be thoroughly dried. This can be accomplished with the use of a photoflood lamp.
- To provide greater contrast between the developed latent and the background after the item is dried, the item can be rinsed in a 50% household bleach/water solution.

Note: Conduct this process only in a fume hood as irritating gases may be released when the item is placed in the bleach solution.

3.4 SILVER NITRATE

Use on porous surfaces such as paper, cardboard, and unfinished wood.

- Silver nitrate reacts with salts present in perspiration to form oxidized silver. The developed impressions will have a grayish-brown appearance.
- Water and ethyl alcohol are the most commonly used solvents used in silver nitrate processing.
- Alcohol based silver nitrate is generally used on waxed paper, cardboard, Styrofoam, or other surfaces which may repel water.
- Apply the solution by dipping or brushing.
- After applying the silver nitrate solution to the surface, the item must be allowed to dry.
- Subjecting the processed surface to ultraviolet light will allow the prints to develop.
- Prints developed with silver nitrate must be photographed immediately upon development. The prints can continue to develop (particularly with exposure to UV light) causing the background to obscure the developed prints.
- Evidence should be stored in a light proof package to inhibit further development of background.

3.5 CYANOACRYLATE ESTER OR SUPERGLUE FUMING (CA)

Use on non-porous surfaces.

- Fuming with cyanoacrylate ester (superglue) will cause latent print residue to appear white in color.

  Safety: Cyanoacrylate ester fumes are extremely irritating to the eyes and respiratory system. Fuming should only be conducted in a well ventilated area or superglue fuming chamber and non-porous gloves should be worn to prevent skin contact. Excessive heating of the cyanoacrylate may produce potentially harmful fumes and should be avoided.

- "Superglue" is a trade name of Super Glue Corporation. As used herein, "superglue" is a generic reference to any of a number of brands of cyanoacrylate ethyl esters or methyl esters, widely available in a variety of viscosities.
- Latent prints can be developed with superglue fumes in a fuming chamber (a commercially made chamber, cardboard box, aquarium, garbage can, etc.). A fuming chamber should include a heating element, one or more windows to allow observation of development, a way to humidify, non-exposed metal components, and a way to seal and safely vent the chamber. A commercially available fuming gun may also be used.
- Test prints on a similar surface should be exposed to the superglue fumes at the same time as the item fumed. This test print will help to determine how long fuming should last.

3.5.1 SUPERGLUE FUMING PROCEDURE

- The evidence items should be hanging, standing, or leaning on an edge to allow for maximum exposure to the superglue fumes.
- The liquid glue is poured in a disposable container (aluminum dish) and placed into the fuming chamber. The quantity of glue is primarily dependent upon the size of the particular fuming chamber and the surface area of the item to be fumed.
- A coffee cup warmer or hot plate with temperature control and a thermometer may be used to heat the superglue to accelerate fuming.
- The humidity of the chamber plays a major role in successful development of ridge detail. Some commercially made chambers come equipped with humidity control. A container of hot water can be placed in the chamber if a humidity control is not available. If the relative humidity in lab is low, it may be necessary to let the chamber humidify several minutes prior to heating the superglue.
- Seal the fuming chamber. Once the desired humidity is reached, begin heating the superglue. Check the items and the test print frequently until the latent prints become visible.
- As long as fuming continues, additional latent prints may develop on certain items (e.g. leather products) even after initial prints are visible.
- Sometimes over development will occur, usually in the form of a heavy white deposit, obscuring some latent prints. This is caused by fuming for too long. Lifting with adhesive tape is an effective way to remove the heavy deposits, revealing underlying ridge detail. All lifts taken will be retained with the evidence or if they contain latents of value for comparison, in the latent print files. Lifts with ridge detail of value for comparison may be scanned into Mideo in lieu of retaining them in the latent print files.
- Heating the chamber can cause a glaze-like coating to cover the entire evidence item, resulting in a loss of contrast in some extreme instances.
- Care must also be exercised to not "boil" the superglue, causing a spattering of residue on nearby evidence.

3.5.2 SODIUM HYDROXIDE PROCEDURE

- Cut cotton batting or gauze into patches (approximately 5 cm x 5 cm) and immerse them into a solution of household bleach or a 4.0% (w/v) aqueous solution of sodium hydroxide. Squeeze any excess liquid from the cotton and allow the patch to dry.

  Safety: When using sodium hypochlorite (bleach) or sodium hydroxide on a patch as a fuming accelerant, protect the skin from contact with these strong oxidizers by wearing personal protective equipment and ensure adequate ventilation is present.

- Elevate the patch above the floor of the fuming chamber (a "u"-shaped piece of wire mesh makes a good platform for the patch) and liberally apply superglue to the patch after the evidence has been positioned in the chamber.
- Visible fumes should appear almost immediately as the reaction beings.
- Development should be allowed to continue until optimal contrast is achieved. This may take less than 10 minutes.

3.5.3 LUMICYANO

Lumicyano is a commercially available product that is cyanoacrylate with a fluorescent dye as part of the formulation.

- When using Lumicyano, analysts must determine the cubic feet of the glue chamber they will be using for processing. The calculation is: length(inches) × width(inches) × height(inches) ÷ 1728 = cubic feet(f^3). Once the volume of the chamber (f^3) is determined the analyst should refer to the Lumicyano package insert to determine the amount of product to use and the development time.
- The humidity of the chamber should be set at 70%-80% when possible.
- The windows and chamber should be clean as old cyanoacrylate residues will attract the Lumicyano fluorescence.
- Examine Lumicyano processed items using a forensic light source at 475 nm to 515 nm using an orange filter.
- The fluorescence fades over time so latent prints should be photographed within one week of application.
- If the fluorescence is not strong enough, a second Lumicyano process may be performed or a dye stain such as BY40, RAM or Rhodamine 6G may be applied after any latent prints of value for comparison have been photographed.
- If an insufficient amount of cyanoacrylate is deposited on the item of evidence, a standard cyanoacrylate process may be performed.

3.5.4 NOTES

- Commercially available cyanoacrylate packets are slower than heat or chemically accelerated fuming development, and do not require handling chemicals.

- Cleaning tools for the removal of superglue deposits in fuming chambers include a scraper (box cutter, razor blade, or putty knife), soapy water, glass cleaner, acetone, or acetonitrile (cyanoacrylate ester deposit remover).
- The glass of the superglue chambers will be cleaned as needed to improve visibility within the chambers.

3.6 DYE STAINS

Use after superglue fuming on non-porous evidence.

- Latent prints fluoresce after staining and are visualized with a forensic light source.
- The cyanoacrylate/dye staining process should be used prior to powdering techniques. However, powder may be applied prior to, in place of, or after dye staining.
- Items should be examined for background fluorescence prior to application of a dye stain.
- Dye stains do not develop latent prints. Superglue fuming develops the prints and the dye stain with a forensic light source allows the prints to be visualized.
- The light bulb and fuses on the alternate light source will be changed as needed.

3.6.1 RHODAMINE 6G

- Rhodamine 6G can be applied after cyanoacrylate fuming or after powdering. The powder will not interfere with proper Rhodamine 6G application because the liquid rinses tend to remove heavy powder deposits.
- Rhodamine 6G is typically dissolved in methanol or ethanol. However, it can be dissolved in water to develop latent prints on fibrous tapes, items with lacquer coatings (i.e., rifle stocks), leathers, and porous plastics which would normally be damaged with a methanol solvent.
- Application of the “one-step” Rhodamine 6G dye involves rinsing items previously processed with superglue and/or powder with the dye stain.
- Application of the “two-step” Rhodamine 6G dye involves rinsing as above then rinsing the item with methanol/ethanol to remove excess dye.
- Heavy deposits of Rhodamine 6G can obscure any underlying ridge detail.
- Examine Rhodamine 6G processed items using a forensic light source at 495 nm to 540 nm using an orange or red filter.

3.6.2 ARDROX P-133D (Ardrox)

- Ardrox can be used in conjunction with Rhodamine 6G.
- Use Ardrox full strength from the container or diluted to various strengths with methanol. This will depend upon the nature of the item being stained. Ardrox staining generally requires a water rinse, but caution must be exercised when examining surfaces which may be damaged by water, such as gun metal. This does not prevent the use of Ardrox in undiluted or diluted form, but does eliminate the water rinse portion.
- Application of Ardrox may be by dipping or washing.
- Place the cyanoacrylate fumed item into Ardrox for about 10 minutes, or wash the surface area with Ardrox and allow it to sit for 10 minutes.

- Remove excess stain by rinsing with water until no yellow color remains.
- Examine the Ardrox processed items using a forensic light source at 280 nm to 470 nm using an orange filter.

3.6.3 RAM

- RAM is a mixture of three fluorescent dyes Rhodamine 6G, MBD, and Ardrox P-133D.
- After an item has been processed with superglue, RAM can be applied by dipping, washing, or spraying.
- After the item has dried, it can be examined under a forensic light source.
- Examine RAM processed items using a forensic light source at 415 nm to 530 nm using an orange filter.

3.6.4 BASIC YELLOW 40 (BY40)

- After an item has been processed with superglue, BY40 can be applied by dipping, washing, or spraying.
- Application of BY40 may be followed by a rinse with distilled water. The BY40 carrier may be used instead, but will tend to rinse the BY40 out of the cyanoacrylate.
- Examine BY40 processed items using a forensic light source at 365 nm to 515 nm using a yellow or orange filter.

3.7 AMIDO BLACK

Use for enhancing latent impressions in blood.

- Amido black is a dye which stains protein present in blood to give a blue-black product.
  Note: Blood marks must be carefully evaluated and coordinated with other forensic scientists to preclude destruction of potentially valuable evidence. Occasionally, it will be necessary to decide which of two (or more) procedures may produce the more valuable findings (i.e., the possibility of enhancing unidentifiable ridge detail to positively identify a suspect versus the potential value of serological findings).
- Amido black should be used when blood surrounds an area of faintly visible ridge detail or when an impression is caused by the "lifting away" (negative image) of blood from the surface of the item.
- All blood must be dried prior to application.
- Blood proteins must be fixed prior to amido black application. If the blood impression has been dried for more than 14 days, it is considered fixed.
- If the blood impression has not been dry for at least 14 days, then it must be fixed with one of the following methods:
  - When possible, the blood impression should be washed with a methanol rinse. The first amido black rinse, which contains methanol, will suffice for this fixing rinse.
  - If it is not possible to rinse with methanol due to the composition of the evidence, it should be baked. Bake the evidence at 100° C for 30 minutes, or bake heat-sensitive evidence at a lower temperature for a longer time.

- When using the methanol base formula, apply developer solution to the item by dipping or spraying, completely covering the target area for 30-90 seconds. Apply rinse solution to the entire target area. Repeat application of both solutions to improve contrast. Apply the final rinse.
- When using the water base formula, apply developer solution to the item by dipping or spraying, completely covering the target area for 2 minutes. Apply rinse solution to the entire target area. Repeat application to improve contrast. Apply the final rinse.
- When possible, all non-porous items of blood evidence should be fumed with superglue to protect other latent prints. Superglue fuming usually does not harm the blood impression for DNA/serology. Methanol may damage DNA and should be avoided whenever DNA analysis may follow latent print examination. Amido Black should be performed in the area of the blood impression prior to superglue fuming.
- Caution must be exercised when applying the methanol based formula to painted, varnished, or lacquered surfaces. This formula may destroy the surface beneath the latent print, as well as the latent.

3.8 GENTIAN VIOLET (CRYSTAL VIOLET)

Use on the adhesive side of tape. Can also be used to enhance latent impressions in blood.

- Gentian violet is a biological stain which reacts with epithelial cells and sebaceous matter deposits of latent print residue to develop violet ridge detail.
- Water soluble adhesive-type tapes should not be processed by this method.
- Caution must be used when processing tape that has been wrapped around itself. It is very possible to develop reversed prints that were transferred from one tape surface to another.
- Dip or brush the adhesive surface with gentian violet solution for one to two minutes, then rinse with cold tap water for 30 seconds.
- Gentian violet may fluoresce on dark colored tapes exposed to certain wavelengths of light. It may be necessary to examine items processed with gentian violet using a forensic light source at 505 nm to 570 nm using a red filter.
- When processing dark colored adhesive tape without a forensic light source, an alternate technique is suggested.
    - Immerse the tape in the working solution as described above, and then rinse with tap water.
    - Immerse the tape in a wetting agent (i.e., Kodak Photo-Flo).
    - Gently press the tape onto a sheet of white (unexposed) resin coated photographic paper that has previously been fixed, washed, and dried.
    - Place a pad of absorbent tissue over the tape and then place the paper and tape "sandwich" in an unheated, dry mounting press for 5-10 minutes.
    - Slowly peel the tape away to reveal the transferred ridge detail that now appears in reverse on the paper.
- Gentian violet usually produces less distinct ridge detail than most other latent print processing techniques. As the tape dries after processing, the stained impressions may fade too much for

effective photography. Immersing the tape in a tray of clear water while photographing may improve the impression.

- The gentian violet solution may be collected after use for reuse provided excessive contaminants are not present.
- Use appropriate protective gear as any skin stained with gentian violet will remain stained until the outer layers of skin slough off.

3.9 GUN BLUING SOLUTION

Use to develop latent prints on brass cartridges and cartridge cases. If this technique is used, it should be conducted before other techniques.

Safety: The primary components of this material are selenious and nitric acids with a dye in a water base. It is poisonous and corrosive to skin, eyes, and mucous membranes. Always wear a lab coat, rubber gloves (preferably butyl rubber or neoprene, but latex will work for short duration contacts), and eye protection. If allowed to get under the fingernails, this material will cause severe inflammation of the nail beds. Wash any exposures immediately with plenty of water. Seek medical attention if it gets into the eyes. Read the Material Safety Data Sheet and ensure that a label is attached with the following information:

Caution: Poisonous and corrosive; contains nitric and selenious acids.

- Add one drop of gun bluing reagent to one to two milliliters of distilled water.
- Immerse the cartridge or cartridge case for several seconds and examine.
- Discoloration of the brass surface will occur with any latent print residue revealed as shiny detail.
- Re-immerse the items as needed for better contrast.
- After achieving desired development, rinse the item with plain tap water to halt the discoloration process.
- The item may be coated with a thin clear lacquer to preserve the latent print.

3.10 DECEASED HAND PROCESSING

- When possible, photograph visible ridges on the fingers or palms prior to soaking. If hands are received dried, mummified, or frozen, place them in a solution of fabric softener, salt, and water to thaw and soften. The hands should be stored in the designated laboratory refrigerator for overnight safekeeping.
- After the initial soaking, the hands may also be placed in solutions of .1N sodium hydroxide or 3.0% potassium hydroxide. Monitor the soaking hands to prevent deterioration of the skin. When thawed or softened, allow hands to dry.
- Injection of sodium hydroxide or potassium hydroxide solutions and tissue massage may be required to reconstruct the hands to a useable condition. Extreme caution should be exercised when using syringes, needles, scalpels, and solutions in the reconstitution process.
- Visually examine the hands. Photograph visible ridge detail, including close ups of fingers and palms.

- If hands are still in rigor mortis, it may be necessary to break rigor. Gently do this by pulling each finger back.
- If the fingers are not wrinkled after soaking, apply ink and record ridge detail on paper or apply powder and lift ridge detail with tape. It is important to note that when lifting powdered prints from the fingers, the prints will appear reversed. Photography after powdering or inking can improve contrast.
- If the hands are wrinkled, additional processing may be needed. The fingers and palms can be submersed in warm (not boiling) water or injected with water, sodium hydroxide, or potassium hydroxide to plump up the skin.
- Ink or powder can also be applied after the tissue has been plumped up.
- The above processes may need to be repeated to obtain comparison quality prints.
- Photography at each step may be needed to record necessary ridge detail for comparison.
- In extreme cases, the epidermis or dermis may be cut away with a scalpel and mounted between glass plates for photography.

3.11 1,2-INDANEDIONE

Use on porous evidence

- 1,2-Indanedione reacts with alpha-amino acids, proteins, and polypeptides which are present in a variety of body fluids including blood, saliva, and sweat.
- The solution may be applied by spraying, brushing, or dipping.
- After applying the solution to a surface, allow the item to completely dry.
- Place in a chemical processing oven at 100 degrees C for 10 minutes. Humidity is not required for this reaction. If an oven is not available, a dry household-type iron may be used. Examine 1,2 Indanedione processed items using a forensic light source at 445 nm to 550 nm using an orange (light or dark) or red filter.

4 FRICTION RIDGE EXAMINATION

Analysis, Comparison, Evaluation, and Verification (ACE-V) is the method of friction ridge examination. It is not generally applied as a strictly linear process, but may include a return to any previous phase.

Equipment used in comparison may include a magnifier, digital imaging software, and ridge counters.

4.1 ANALYSIS

Analysis is the assessment of all observable detail in a friction ridge impression. Analysis determines suitability or value for comparison based on first, second, and third level detail. Suitability is the determination that there is potentially adequate quality, quantity, and specificity of friction ridge features for further examination.

<u>Levels of Detail</u>

- First level detail refers to the overall ridge flow including pattern, cores, and deltas.
- Second level detail refers to individual friction ridge paths, friction ridge events (e.g. bifurcations, ridge endings, and dots), and their relative arrangements.

- Third level detail refers to ridge structures (edge shapes and pores) and their relative arrangements.
- Creases, scars, warts, incipient ridges, and other features may be reflected in all three levels of detail.

Levels of Quality

The following table broadly describes how the overall quality of an impression can be defined by the clarity at different levels of detail.

Very High	First level detail is distinct; Second level details are distinct; There are abundant distinct third level details.
High	First level detail is distinct; Most second level details are distinct; There are minimal distinct third level details.
Medium	First level detail may be distinct; Some second level details are distinct; There are no distinct third level details.
Low	First level detail may not be distinct; Most second level details are indistinct; There are no distinct third level details.

Table 1: Levels of quality

Arizona Department of Public Safety Crime Laboratory Justitia Per Scientiam Scientific Analysis Bureau

Levels of Value

During the Analysis phase, the examiner must make a prediction as to whether sufficient information might be present between the latent print and any potential exemplar print to reach an identification or an exclusion decision. The following questions and the diagram below illustrate the examiner's thought process in determining suitability for latent print comparison.

- Is there observable friction ridge detail?
- Is the impression potentially suitable for identification?
- Is the impression potentially suitable for exclusion?

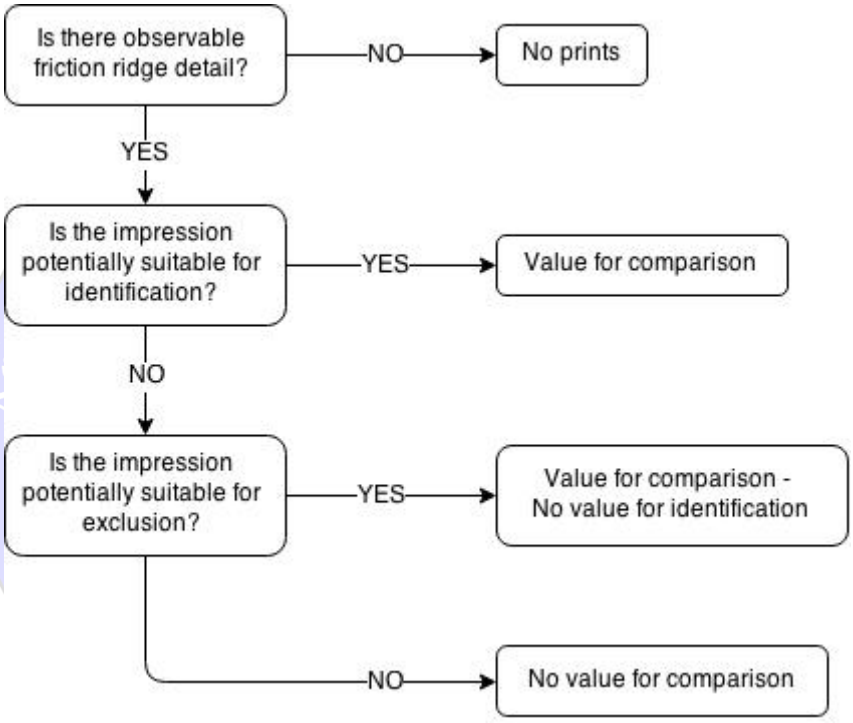

Diagram 1: Analysis decisions

- No prints: No observable friction ridge detail.
- No value for comparison: impression is not potentially suitable for identification and not potentially suitable for exclusion.
- Value for comparison: impression is potentially suitable for identification or exclusion
- No value for identification: impression is not potentially suitable for identification but is potentially suitable for exclusion. These latent prints are not usually compared, unless specifically requested.

Suitability for identification is typically based on the number of discernable minutiae, the presence of third level detail, the physical area of the latent print, and/or the quality/clarity of the latent print. The area above the blue curve in Figure 1 generally illustrates the amount of quality and quantity of detail in impressions that are potentially suitable for identification.

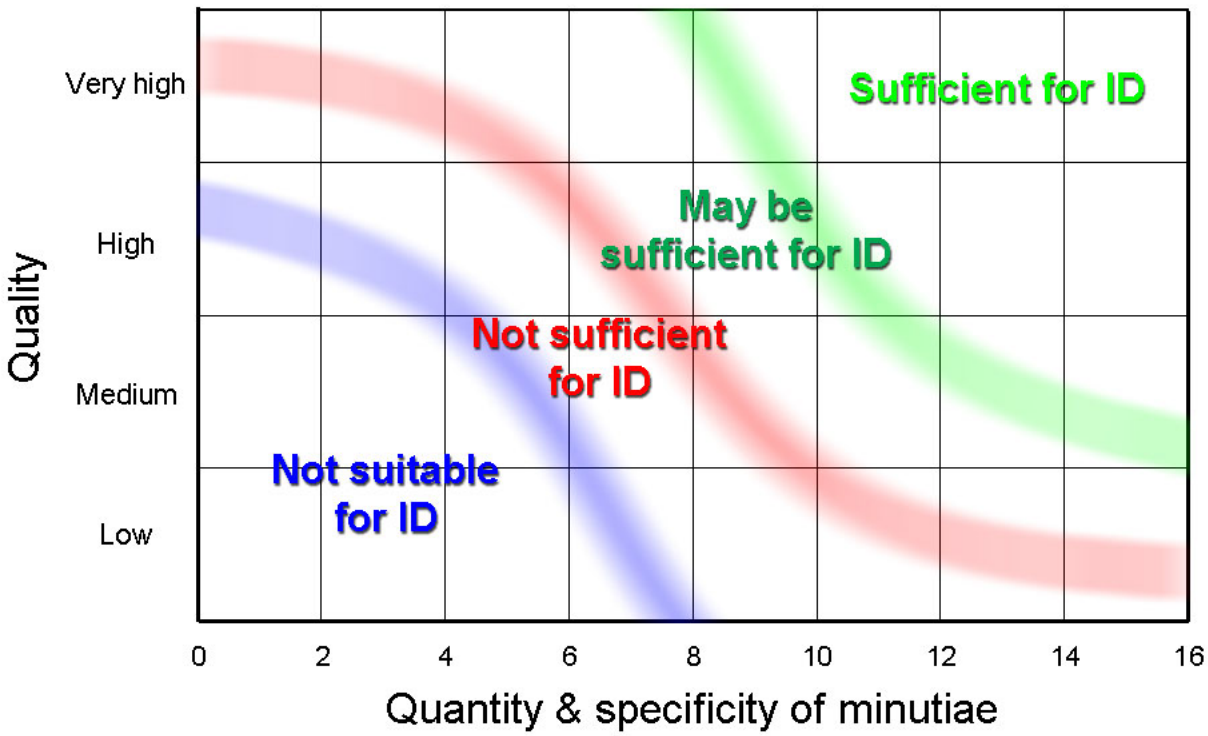

Figure 1: Sufficiency / Suitability for Identification

Suitability for exclusion is based on Section 4.1 ANALYSIS. As suitability for identification and exclusion are based on different types of information, latent prints may be suitable for only one, the other, or both. The area above the blue curve in Figure 2 generally illustrates the minutiae clarity and location confidence in impressions that are potentially suitable for exclusion.

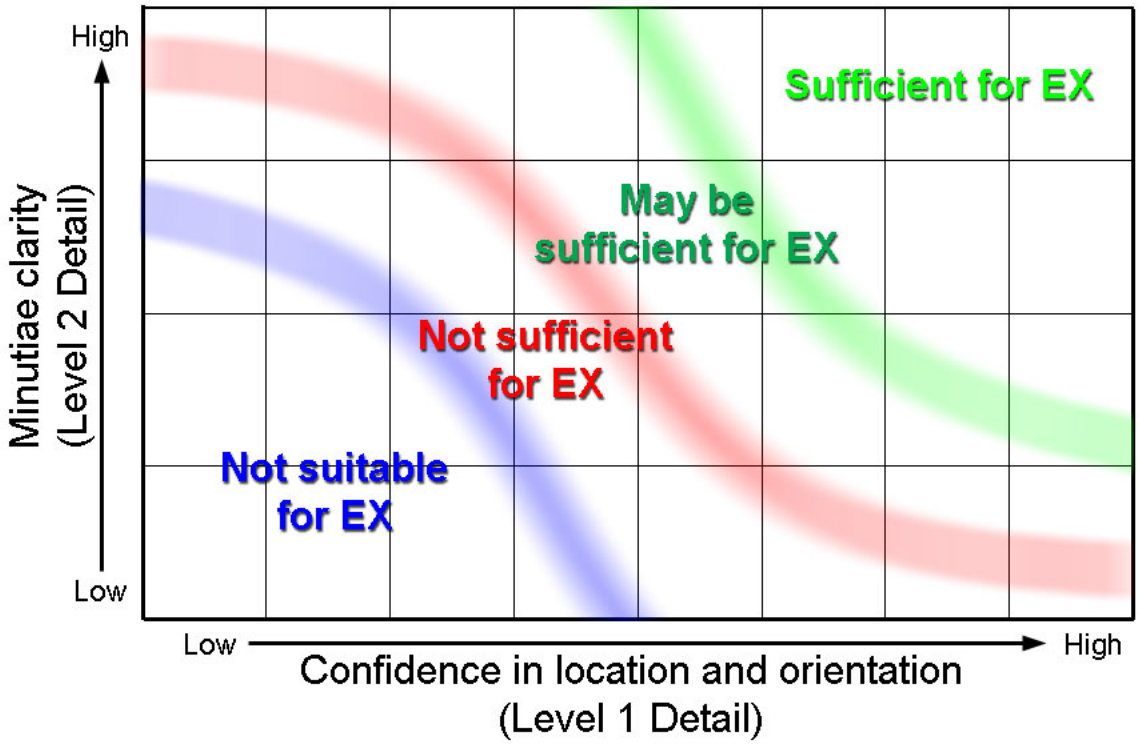

Figure 2: Sufficiency / Suitability for Exclusion

4.2 COMPARISON

Comparison is the direct or side-by-side observation of friction ridge detail searching for agreement or disagreement between two impressions based upon features, sequence, and spatial relationship.

Comparison begins by selecting a target group in the unknown impression comprised of second level features and an associated anchor point (if available). This target group is searched within all possible anatomical areas and orientations of the exemplar prints. If no significant agreement is found, a second target group is selected for search. This group should be associated with a different anchor point and in a different area of the unknown impression whenever possible.

The comparison phase shifts to evaluation after:

- significant agreement is found;
- significant disagreement is found using two or more target groups; or
- the examiner decides that additional target group searches will not reveal significant agreement or disagreement.

4.3 EVALUATION

Evaluation considers all features observed during the Analysis phase and all of the agreement and/or disagreement observed during the Comparison phase to reach a decision. There are three possible decisions after examination has begun and the examiner has reached the Evaluation phase.

Identification is the decision by an examiner that there are sufficient features in agreement to conclude that two areas of friction ridge impressions originated from the same source. Identification of an impression to one source is the decision that the likelihood the impression was made by another (different) source is so remote that it is considered a practical impossibility.

Exclusion is the decision by an examiner that there are sufficient features in disagreement to conclude that two areas of friction ridge impressions did not originate from the same source. This decision can only be reached if all relevant anatomical areas are represented and legible in the known exemplars. The examiner will only reach an exclusion decision if the following requirements are met.

- First level detail of an "anchor point" must be present to reliably determine the anatomical location of the unknown impression. Examples include delta, core, anatomical aspect allowing origin determination (e.g. outline of hand or finger, characteristic ridge flow or pattern, etc.), and/or a large field of ridge detail, which may not have the above (e.g. hypothenar of the palm).
- Second level detail must be used in conjunction with first level detail to reach an exclusion decision. Second level detail includes bifurcations, ridge endings, dots, and open fields. The examiner will use more than one target group of second level characteristics, and these features must be associated with the first level anchor point, before reaching the exclusion decision.

Inconclusive is the decision by an examiner that there are insufficient features in agreement to conclude that two areas of friction ridge impressions originated from the same source AND that there are insufficient features in disagreement to conclude that two areas of friction ridge impressions did not originate from the same source.

The reason(s) for each inconclusive conclusion must be documented and reported.

- Insufficient Detail in Latent: Insufficient quality and/or quantity of friction ridge detail exists in the latent print to effect a conclusion of identification or exclusion. This may be due to a lack of sufficient similarities to reach the identification decision or due to a failure to meet the requirements of the exclusion decision.
    - Inconclusive with Similarities: If similarities are observed between the unknown and known impressions, but insufficient detail is present for an identification, the examiner may choose to reflect this information in the notes and report. This reason must not be construed as a statement of probability.
- Insufficient Detail in Exemplar: Insufficient quality and/or quantity of friction ridge details exists in the known impressions to effect a conclusion of identification or exclusion. The known prints are incomplete or illegible in a relevant anatomical area. Comparisons were made to the extent possible, however, additional clear and completely recorded exemplars, to include the required relevant anatomical areas, are needed for re-examination which may result in an

exclusion, inconclusive, or identification decision. More complete or legible exemplars will be requested in the report.

- Insufficient Detail in Latent and Exemplar: Insufficient quality and/or quantity of friction ridge details exists in the latent print and the exemplars (see above sections).

The following diagram illustrates the process of how to reach these decisions.

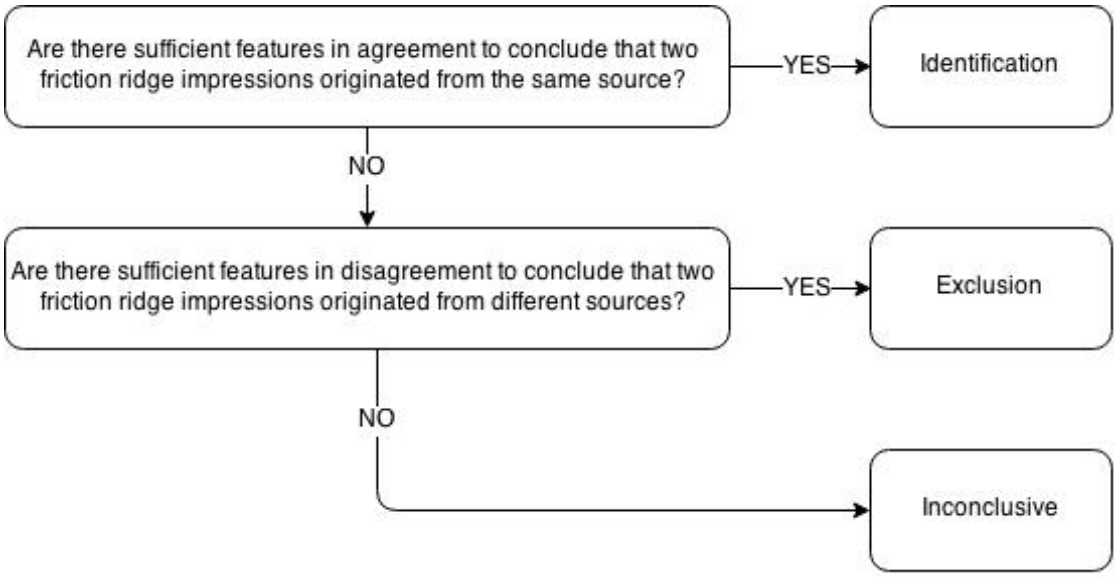

Diagram 2: Evaluation decisions

The areas labeled in Figure 1 illustrate the amount of corresponding quality and quantity of detail between two impressions that would be sufficient for an identification decision, may be sufficient for an identification decision, or would not be sufficient for an identification decision.

The areas labeled in Figure 2 illustrate the minutiae clarity and location confidence of non-corresponding detail between two impressions that would be sufficient for an exclusion decision, may be sufficient for an exclusion decision, or would not be sufficient for an exclusion decision.

4.4 VERIFICATION

Verification is the independent examination by another qualified examiner to ensure that the original examiner came to a valid conclusion. The independent examination is a separate application of the ACE process that also includes looking for details to disprove the original conclusion.

4.5 CONSULTATION

Examiners in the latent print unit are encouraged to foster a culture of openness and discussion regarding the comparison of latent prints. Most discussions about latent print comparisons do not need to be documented as part of the examination record.

A consultation is defined as, input from another examiner that is needed or influences the conclusion. The consulting examiner will be documented in the original examiners notes and will not be the verifier for that conclusion.

4.6 CONFLICT RESOLUTION

If the verifier discovers an erroneous identification or an erroneous exclusion, they will first notify the Latent Print Technical Lead of the error (or another qualified examiner if the error was made by the Technical Lead). After the Technical Lead verifies that an error has occurred, the original examiner's supervisor will be notified.

- For an erroneous exclusion caught in verification, a Quality Control Action Form (QCA) will be filled out by the Supervisor. The completed QCA form will be forwarded to the SAB Quality Assurance Unit for review.
- For an erroneous identification or erroneous exclusion (not caught in verification), the supervisor will initiate the SAB formal Corrective Action Process.

If the verifier feels that another conclusion would be more appropriate (e.g. an inconclusive result would be more appropriate than exclusion), they will discuss the comparison with the original examiner. Any decision change in the original examiner's notes must be documented. If the examiners reach a consensus, no additional consultation documentation is needed. If a conclusion cannot be agreed upon by the verifying and original examiner, the Latent Print Technical Lead (or another qualified examiner if the Technical Lead is either the verifier or original examiner) will be notified to consult with both examiners.

If the technical reviewer feels that another value statement would be more appropriate (e.g. latent of value versus no value for identification), they will discuss the decision with the original examiner. Any decision change in the original examiner's notes must be documented. If the examiners reach a consensus, no additional consultation documentation is needed. If an agreement cannot be reached by the technical reviewer and original examiner the Latent Print Technical Lead (or another qualified examiner if the Technical Lead is either the reviewer or original examiner) will be notified to consult with both examiners.

The following diagram illustrates the process of conflict resolution.

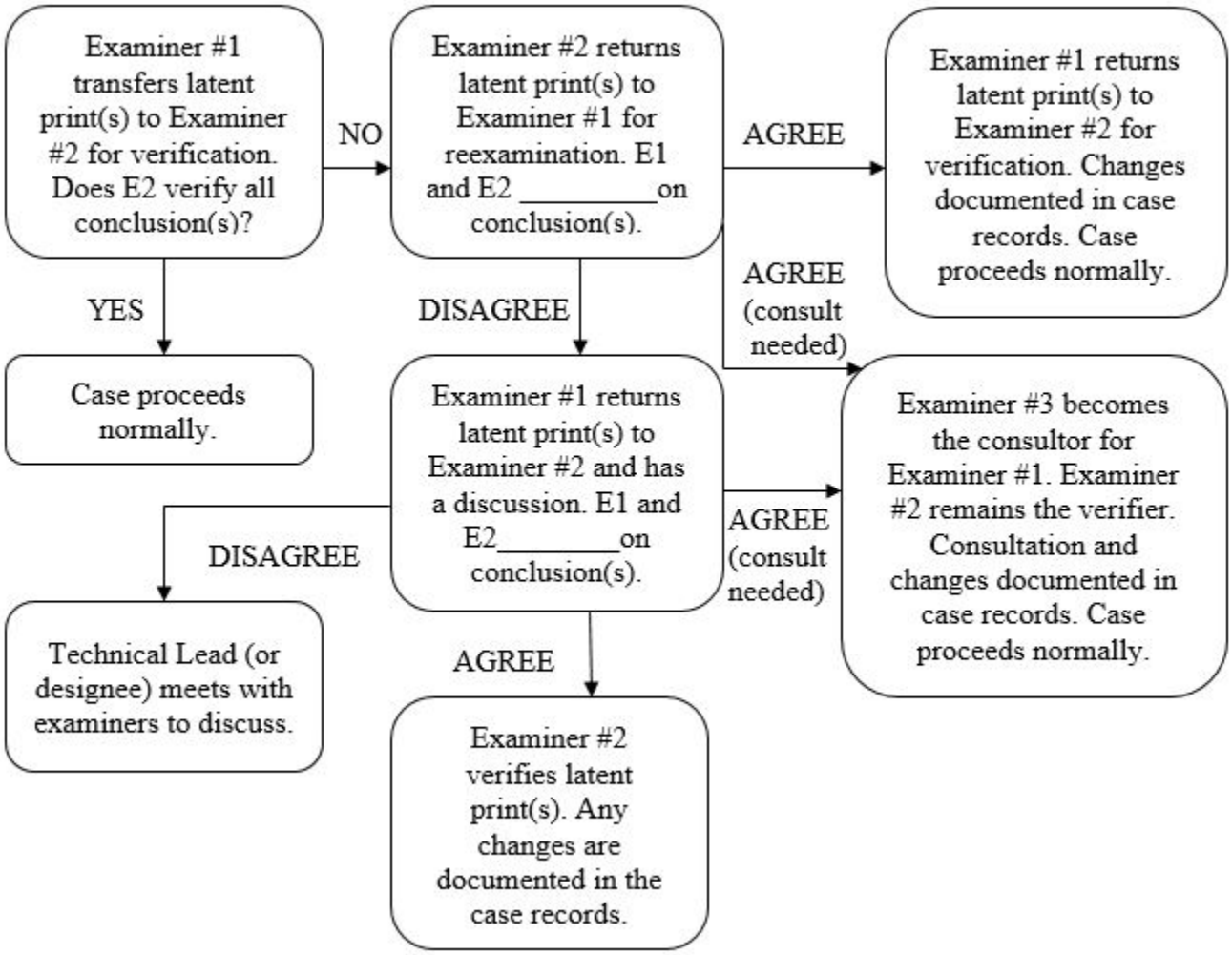

Diagram 3: Conflict Resolution

4.7 COMPARISON DOCUMENTATION

The following must be recorded in the examination record:

- The item number, a unique identifier for each latent print that was compared, the lift or photograph the latent came from, and which exemplar/individual it was compared to. The unique identifier for each latent print will be marked in close proximity to the latent print or added to the digital image being compared.

- The name and other identifying information (DOB, SID#, ARN, etc.) from the exemplars, and where the exemplars were obtained from. If obtained from the AZAFIS Record Archive Services (RAS) or from the FBI's NGI, they may be retained in the examination records. The exemplars must be marked with the DR#, date, and examiner's initials.
- It is the examiner's discretion whether to compare elimination exemplars or not. (Elimination exemplars are usually from victims or officers.) The examiner may skip these comparisons in favor of comparing suspects and/or entering the latent prints into the AFIS. When submitted elimination exemplars are not compared, the examiner will report that they were received but not analyzed.
- The conclusion of the comparison (identification, exclusion, or inconclusive).
    - If the result is identification, then the subject's name, DOB (when available), finger number or anatomical area, examiner's initials, date, verifier's initials, and date verified must be recorded in the examination record in Mideo, and may additionally be recorded on the lift card and/or exemplar.
        - It is acceptable to discontinue comparisons of latent prints from items of similar type with the appropriate documentation in the notes and report after identifications to all listed suspects.
        - It is acceptable to discontinue comparisons in an AFIS case if an ID is made. For an IDENT in AFIS, all entered latent prints that are/will be saved to the unsolved latent database must be compared to ensure that identified latent prints are not submitted to the unsolved latent database. All latent prints saved in the unsolved latent database must be compared when one of the latent prints from that case is subsequently identified. All searched latent prints, that are suitable for retention, will be saved in the unsolved latent database. Suitability is at the discretion of the examiner.
        - For property crimes, it is acceptable to discontinue comparisons in a case once an identification is made and the examiner has attempted to contact the officer for approval.
        - It is acceptable to perform an AFIS search prior to comparing any listed suspects. If the search results in no identifications, the listed suspect(s) must be compared.
    - If the result is exclusion, then the subject's name, DOB (when available), examiner's initials, date, verifier's initials, and date verified must be recorded in the examination record.
    - If the result is inconclusive, then the subject's name, DOB (when available), examiner's initials, date, verifier's initials, date verified, and the reason for the inconclusive result must be documented in the examination record.
    - All conclusions must be verified by a second examiner.
    - The compared prints (both the exemplars and latent prints) or a copy of sufficient quality for comparison purposes must be retained in the Crime Laboratory files (Latent Print Unit files or examination record).
    - Any ridge detail that was not compared or evaluated must be acknowledged and the reason given as to why it was not compared. The most common reasons for not comparing additional ridge detail are:

- Additional ridge detail is not of value for comparison.
- Additional ridge detail is not of value for identification.
- Additional ridge detail is of value for identification, but comparisons were discontinued due to identification(s).
- Additional ridge detail is of value for identification, but more complete exemplars are required for comparison.

5 LATENT PRINT EXAMINATION RECORDS/DOCUMENTATION

5.1 LATENT PRINT EXAMINATION RECORDS

The examination records will include:

- Each examination conducted and the result of each examination.
- The condition of packaging from evidence items will be documented in the examination notes. The packaging of retained items may be destroyed, as long as it is documented in the examination record.
- Visual examination with conclusion. The conclusion must be either: no latent prints, no latent prints of value for comparison, or documentation of the number of photographs and a collective value statement. (See Section 4.1 ANALYSIS)
- Each processing technique used with conclusion. The conclusion must be either: no latent prints, no latent prints of value for comparison, or documentation of the number of photographs or lifts and a collective value statement. (See Section 4.1 ANALYSIS) Occasionally, latent prints of value for comparison will not be photographed before continuing with the next process (usually due to low contrast). This must be noted in the examination record and include a reason that photographs were not taken.
- Number of AFIS or NGI searches conducted with the results (See Section 6 AUTOMATED FINGERPRINT IDENTIFICATION SYSTEMS).
- Any printouts or photocopies should be retained with the case records.
- Cases with AFIS searches must include the candidate list and the screen shot of each latent searched as part of the examination record (no screen shot needed for latent prints identified after auto coded, one candidate searches).
- NGI printouts should include the candidate list and a printout of each latent searched.
- Comparison documentation (See Section 4.7 COMPARISON DOCUMENTATION).

5.2 LATENT PRINT REPORT WRITING

- The use of undefined acronyms should be avoided. (e.g. AFIS should be written “Automated Fingerprint Identification System (AFIS)” the first time used in report).
- Multiple requests should, whenever possible, be combined and reported in a single report.
- Multiple requests for the same DR# should, when possible, be worked by the same examiner.

5.2.1 RESULTS

The results will document examinations conducted, the result of the examination, and the conclusions of the examiner.

- Value of latent prints (submitted and/or developed) will be reported.
- The report will state if processing was performed. It is not necessary to include the processing techniques that were used.
- The number of AFIS searches and results will be reported. Any latent print images retained in the unsolved latent database will be reported.
- When an AFIS search is requested, the report will state when no searches are conducted. This applies only when the latent prints are of value for identification.
- The number of latent prints compared and results of the comparisons (i.e. identification, exclusion, or inconclusive) will be reported.
- Inconclusive results will state the reason(s) that a conclusive result was not reached.
- The results will list from what item the latent prints were developed. Results on submitted lift cards will list where they were lifted from (e.g. from a lift card labeled "Front driver door", if available). Results on lift cards developed on larger items (e.g. vehicles) will also list where they were lifted from.
- Exemplars listed in reports will list demographic information. (e.g. bearing the name John Doe, DOB, when available). The SID, PCN, or ARN may also be included. If the person identified is a known employee of any law enforcement agency, the name will be listed on the report, but the DOB and ARN (or PCN) will not be included.
- Any ridge detail that was not compared or evaluated must be acknowledged and the reason given as to why it was not compared.
- The results may contain requests for additional information and/or exemplars.
- The report will state when submitted evidence is retained at DPS.

5.3 TECHNICAL REVIEWS

- All latent lifts, photographs (or CD/DVDs of images), and exemplars must be reviewed by the technical reviewer.
- The technical review will include a verification of every value statement and will verify that all latent prints of value for comparison were compared or the reason is given as to why they were not compared.
- If the technical reviewer determines additional comparisons/searches are necessary, the original examiner will be notified. Any additions/changes will be initialed and dated on the original notes.

6 AUTOMATED FINGERPRINT IDENTIFICATION SYSTEMS

The systems used for searching latent prints are the Arizona Automated Fingerprint Identification System (AZAFIS) and the FBI Next Generation Identification (NGI), which is integrated into AZAFIS or uses the Universal Latent Workstation (ULW) software.

- Latent fingerprints developed on evidence items, at crime scenes, and/or submitted into SAB Property and Evidence, may be searched through the AZAFIS and/or NGI.
- Inked or exemplar prints will not be searched through AZAFIS unless the DPS Fingerprint Unit have determined that they cannot search the prints according to AZAFIS policy. These prints may then be submitted to the Property and Evidence section for search.
- Fingerprints from deceased persons may be run through AZAFIS and/or NGI for identification purposes.
- All searches entered into the AZAFIS will be in accordance with AZAFIS policy and follow the procedures as outlined in the AZAFIS Policy and Procedures Manual and the MorphoBIS Latent Expert Workstation User Guide.
- When an AZAFIS search results in an identification, an INCONCLUSIVE result will initially be declared. An IDENT will be declared after the identification is verified.
- When an AZAFIS search does not result in an identification, a NON-IDENT result will be declared for each candidate. A NON- IDENT result does not require independent verification. All latent prints suitable for retention in the latent database will be retained in the unsolved latent database for ongoing search. Suitability is at the discretion of the examiner.
- Closed searching is an industry tool available to examiners that uses the AZAFIS algorithms/matchers for specific minutiae locations related to a specific individual's record(s). A closed search is not a search of the AZAFIS database. The latent print(s) will not be retained in the database for ongoing searches. When a closed search is performed it will be added to the examination record but is not reported.
- For AZAFIS and NGI purposes only, ongoing Tenprint (or Palm) vs. Latent Verification responses which result in NON-IDENT decisions will not routinely be reported. Ongoing Tenprint (or Palm) vs. Latent Verification candidate information is maintained within the AZAFIS system and can be made available as requested.
- Any latent print searched through the database that results in an inconclusive with similarities result will be verified, declared a NON-IDENT in the database, and reported.
- All FBI NGI searches will be in accordance with the AZAFIS Policy and Procedures Manual and the MorphoBIS Latent Expert Workstation User Guide.
- For examination records the following must be printed:
- The screen shot of the manually coded image. Auto coded searches that result in IDENT decisions do not require a screen shot.
- The candidate list must always be printed for NON-IDENT or IDENT.
- A printed screenshot of the search and candidate images (OR descriptor information) needs to be printed if there is an IDENT.

7 LATENT PRINT DIGITAL IMAGING

7.1 CAMERA

7.1.1 CAMERA EQUIPMENT REQUIREMENTS

- A minimum of 6 megapixel capture.
- Capable of capturing in a lossless compression format (e.g. tif or raw).
- Synchronized external flash capability.
- Interchangeable lenses.
- Capable of accurate exposure and white balance.
- Manual metering and focus override capabilities.
- Capable of storing images on removable media and/or directly on computer storage location.

7.1.2 IMAGE CAPTURE REQUIREMENTS – DIGITAL CAMERA

- If a flash card will be used for the initial capture, the card must be formatted prior to use (see camera manual for specific directions).
- The flash card containing images must remain in a secure location until time of transfer to the Mideo database.
- The camera capture format is set to a lossless compression format (e.g. tif or raw).
- When photographing a latent print image for comparison purposes the image shall be at least 1000 pixels per inch (ppi).
- Photographs should be captured in color.
- A tripod or camera stand should be used when possible.
- A scale, the DPS DR#, item #, date, and examiner's initials will be included in the digital file of each photograph.
- Images captured in formats other than those listed here or images captured at a resolution less than 1000 ppi may still be suitable for comparison purposes. Deviation from standard image formats or resolution standards will be documented in the examination record.
- Photographs for documentation purposes only may be captured at less than 1000 pixels per inch. This must be reflected in the examiner's notes.

7.2 SCANNER

7.2.1 DIGITAL SCANNER REQUIREMENTS

- Compatible with Adobe Photoshop, Mideo Digital Image Management Systems, or current enhancement software and hardware.
- Capable of capturing images in 24 bit color or 8 bit grayscale.
- Must be capable of capturing images at a minimum of 1000 ppi.

7.2.2 IMAGE CAPTURE REQUIREMENTS – SCANNER

- When capturing a latent print image for comparison purposes the image shall be captured at a minimum resolution of 1000 ppi.

- When capturing an exemplar print image for comparison purposes the image shall be captured at a minimum resolution of 500 ppi.
- The image may be scanned in color or grayscale.
- The DPS DR#, item #, date, and examiner's initials will be included in the digital file of each scanned image.

7.3 DIGITAL IMAGE ENHANCEMENT

- All images will be saved in the Mideo database prior to enhancements or changes according to the SAB General Procedures Manual Section EVIDENTIAL PHOTOGRAPHS/DIGITAL IMAGES.
- The final, enhanced version of each image used in a comparison will be saved in the Mideo database.

7.3.1 PURPOSE

- Digital image enhancement may only be used with the intention of producing clear and accurate representations of the images or in order to better reveal image detail that is present but obscured by background, poor lighting or exposure, or poor color contrast.
- Images may be enhanced utilizing the tools and filters available in Mideo and Adobe Photoshop.
- See the "Mideo Work Instructions" in the Latent Print Training Manual and/or "Mideo Users Guide" documents located on the SAB Intranet in the Mideo folder for specifics related to calibration of image and use of enhancement tools.

7.3.2 DOCUMENTATION

- For image enhancements utilizing Adobe Photoshop, the image must first be saved in the Mideo database and then opened in Adobe Photoshop. Once the image enhancements are complete the image will be returned to the Mideo database with changes. The Mideo software will record a history of enhancements made in Adobe Photoshop. The history tracking function must be enabled in Adobe Photoshop.
- A history log of all changes made to the image, utilizing Mideo tools and Adobe Photoshop tools, is available in the Mideo software.

7.3.3 TRAINING

All personnel using digital imaging enhancement software must be trained in the use of the software and also in courtroom testimony pertaining to digital imaging enhancements.

7.4 DIGITAL IMAGE PRINTING

Digital image photographs may be printed for documentation.

7.4.1 PRINTERS

Printers used to print friction ridge images must be capable of printing 300 dpi.

7.4.2 PAPER

Photographs printed for court purposes should be printed on photo quality paper. Many different brands and qualities of paper are available and may be suitable for printing; however, the best quality possible should be selected.

7.4.3 PRINTING

- Digital photographs which are printed for court purposes should be printed at the best quality possible.
- The resolution of the printer is significantly less that the resolution of the image, therefore, it may be necessary to print the image enlarged.
- See "Resolution of Digital Photos" documents located in Appendix B.

7.4.4 RETENTION

Digital photographs which are printed are not considered evidence and serve as documentation, therefore may be stored as part of the examination records or in the latent print unit files with latent lifts.

8 DNA SWABBING

Evidence submitted for both latent print examination and DNA may be swabbed by latent print personnel who have received training and have been approved to perform swabbing. The latent print unit personnel will only swab evidence submitted for non-violent crimes (e.g. burglary or auto theft). Violent crime evidence submitted for latent print processing and DNA analysis will not be examined by a Latent Print Examiner until a DNA analyst has been consulted. If suspected visible blood is present, the DNA section will be contacted prior to latent print processing (even if no DNA examination was requested).

8.1 CLEAN TECHNIQUES

- Clean techniques must be used when swabbing any DNA evidence to limit contamination.
- Each analyst is responsible for cleaning his or her own work area with 10% bleach, or any DNA removing cleaner, before and after each item to be swabbed for DNA.
- Instruments used for sample processing (forceps, scissors, scalpels, etc.) may be purchased sterile and opened individually just prior to use for each sample. Alternatively, instruments may be soaked in a 10% bleach solution between each sample. These instruments may be rinsed in sterile water or alcohol after the bleach and wiped dry with a new wipe.
- Evidence items must be placed on a clean surface for processing (i.e. butcher paper).
- Samples are processed individually. Put away the previous evidence item before opening the next item. Use clean instruments and paper for each item.
- Change gloves frequently during processing, especially after swabbing each item. If gloves become contaminated, discard them and replace with new ones.

8.2 DNA SWABBING TECHNIQUES

- Latent Print personnel will only swab property crimes, as designated by the DNA unit. If what appears to be blood is present, DNA and/or trained serology personnel must be contacted.
- Decontamination of work area must be noted in the examination record.

- Put down fresh paper.
- Open a package of sterile swabs and label one stick (or plastic bag the swab will be packaged in) with a unique identifier
- Slightly wet one swab with sterile water. Do not soak the swab, damp is sufficient (1-2 drops of water). Do not touch the swab with the dropper.
- With sufficient pressure, swab the area of interest with the wet swab.
- Allow the swab to dry for approximately 1 hour in designated drying rack/area. Do not dry the swab(s) from more than one case in the same drying rack or area.
- When dry, place the swab into a small zip-lock plastic bag labeled with the DR#, item #, sub-itemization (as determined by examiner), date, and examiner's initials.
- Place the zip-lock plastic bag into a small manila envelope with the DPS DR#, item #, submitting agency name and DR#, and label as "Swabs" from "Item Description".
- At the conclusion of the case, retain the swab in designated storage.

8.3 DNA SWABBING DOCUMENTATION

- The examination documents will include a notation that the processing surface was decontaminated.
- The examination records will include a clear depiction of what areas were swabbed using written description, photographs, and/or drawings.
- The transfer of the swabs will be noted in the chain of custody.

8.4 REPORTING DNA SWABBING

The latent print report will include a statement that "Item 1... was swabbed for possible future DNA analysis. The swabs have been forwarded to the DNA Casework Unit."

Arizona Department of Public Safety Crime Laboratory Justitia Per Scientiam Scientific Analysis Bureau

9 REVISION HISTORY

CHANGES MADE	DATE	ISSUING AUTHORITY
LP-SOP Issue 4 Update section numbering, Add Rev. History	11/12/02	Todd A. Griffith, Supt.
LP-SOP 2005 Review	06/30/05	Todd A. Griffith, Supt.
LPP2006.1 Review	2006	Todd A. Griffith, Supt.
LPP2006.2 Add 1.5.8.4.1, reformat header	12/18/06	Todd A. Griffith, Supt.
LPP2007.1 Major Revision	7/18/07	Todd A. Griffith, Supt.
LPP2008.1 Review, Add Wetwop, AccuTrans to 4.1, Add new section 1.8 – Notes, define latents as both evidence and documentation	6/10/08	Todd A. Griffith, Supt. (RDB Acting)
LPP2008.2 Add 1.7.3.5. retention of exemplars as exam documentation and 1.7.3.6. sealing of latent print packages change to 5-year limit.	9/24/08	Todd A. Griffith, Supt.
LPP2009.1 1.7.3.6 sealing of latent prints change to 1-year limit. 1.8.3 to increase awareness of existing QAM policy restated that inconclusive results must have reason(s) recorded in exam documentation.	1/21/09	Todd A. Griffith, Supt.
LPP2009.2 Expanded section 1.6.1.4.3 (pg. 7) in the Evaluation step of ACE-V to include three possible conclusions that can be reached (i.e. Identification, Exclusion, or Inconclusive). Added requirement in section 1.8.3 (pg. 11) to document the verification of identifications and exclusions in the examiner's notes with the verifier's initials and date.	10/21/09	Todd A. Griffith, Supt.
LPP2012.1 Major Revision	04/11/12	Vincent Figarelli, Acting Superintendent
LPP2013.1 Updated Modification to policy information and 7.2.2. Clarified 1.3, 1.4, and 5.1	10/02/2013	Vincent Figarelli, Superintendent
LPAP (LPP2015.1) Rev 1	May 2015	SAB Superintendent

1st version in Qualtrax Adding all the Modifications Adding in 1.3 and 1.4 “The information can be recorded in Mideo to satisfy this requirement.” Adding to Section 4 Adding Section 4.6 Conflict Resolution Changing bullet 2 under 5.1. "The packaging of retained items may be destroyed, as long as it is documented in the examination record. IAFIS is changed to NGI Changing 7.1.2 bullet 7 to "A scale, the DPS DR #, item #, date, and examiner’s initials will be included in the digital file of each photograph" Changing 7.1.2 bullet 9 to "Photographs for documentation purposes only may be captured at less than 1000 pixels per inch. This must be reflected in the examiner's notes" Changing 7.2.2 bullet 4 to "A scale, the DPS DR #, item #, date, and examiner’s initials will be included in the digital file of each scanned image" Adding to 8 "The DNA section will be contacted prior to latent print processing (even if no DNA examination was requested)" Also, one swab will be taken instead of two.		
LPAP Rev 2 3.11 Indanedione updated wavelength from 515 to 475nm and light or dark orange filter. 4.6 Conflict Resolution added Diagram 3 6 Automated Fingerprint Identification System updated with new information and printout requirements.	November 2016	SAB Superintendent
LPAP Rev 3 Significant Changes: Removed AutoOpen Macro Took out references to GPM and QAM 1.1 added opinions 3 added CA exception 3.1 changed recommended to required when waiting for NP items 3.5 updated CA info 3.11 Increased FLS range 4.3 Took out probability statement 4.7 updated for UL information	Aug 2018	SAB Superintendent

5.1 changed AFIS autocode 6 updated for UL and Inc with similarities 8.4 changed Criminalist to Forensic Scientist Formulary Amido Black to 200 Photo-Flo No additional changes		
LPAP Rev 4 1.5 Change for lifts/photos to be returned instead of retained 4 Format issue 4.6 Diagram 3 changed Cased to Case 5.2.1 Removed DOB and ARN for known employees 6 Added NGI and Closed Searching 8.1 Changed to bleach or any DNA removing cleaner Appendix A spacing issue and took out 5.1 Amido Black to 200 Photo-Flo BY40 updated Gentian violet to 200 Photo-Flo Appendix B Removed	May 2019	SAB Superintendent
LPAP Rev 5 1.3, 1.5 AND 3.2 Changes from modification document 2.1.1 Added mitts, pads and cotton balls as brush type 2.6 Undu removed as processing technique added multiple applications of WetWop 3.5.1 Added lifts must be retained 3.5.3 Lumicyano added 4.5 Removed initialing of notes by consulting examiner 4.7 Conclusions must be recorded in Mideo 6 Allow inked fingerprints from deceased person to be searched for identification purposes 7.4 Printed images no longer used for comparison 8.4 Report wording changed to current approved DNA wording	May 2020	SAB Superintendent

Arizona Department of Public Safety Crime Laboratory Justitia Per Scientiam Scientific Analysis Bureau

Appendix A FORMULARY

Many acceptable variations exist to the formulae listed in this section. It is the responsibility of each examiner to select the appropriate formula best suited to the evidence being analyzed in each case.

It should be noted that exact measurements and proportions when preparing chemical solutions are desirable for consistent quality; however, successful results in developing latent fingerprints are not dependent upon unequivocal accuracy (with the exception of Physical Developer). There is considerable latitude in preparing chemical solutions for latent fingerprint techniques without adversely affecting the successful development of latent prints.

Reagents prepared in the laboratory will be properly logged and labeled according to SAB Quality Manual. Solutions should be prepared using clean volumetric glassware. Whenever applicable, stock quantitative solutions which are retained for use over a period of time should have a scheduled replacement date. A reagent log will be maintained for reagents prepared in the laboratory. Documentation of the reagent reliability check will be included in the case notes.

AMIDO BLACK

CHEMICALS: Amido black 10B (naphthol blue black, acidal black 10B, acid black 1), glacial acetic acid (water-free acetic acid), methanol, citric acid, Kodak Photo-Flo 200 Solution

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Glacial acetic acid is flammable and is strongly irritating to eyes, nose, and throat and can cause skin burns upon contact. It may be mutagenic or toxic.

Methanol is flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. It may be mutagenic or toxic.

Citric acid is irritating to eyes, lungs, and skin and can cause burns and blindness.

Photo-Flo may cause eye irritation and is toxic if ingested.

STORAGE: Clear or dark bottles

MAINTENANCE OF EQUIPMENT: Wash all containers in mild detergent and rinse thoroughly.

FORMULA I: Amido black (methanol base formula)

Developer Solution (Solution A)
2 g amido black
100 mL glacial acetic acid
900 mL methanol
Combine and mix with a stirring device until dissolved; approximately 30 minutes.

Rinse Solution (Solution B)
100 mL glacial acetic acid
900 mL methanol

Final Rinse
Distilled water (tap water is also acceptable)

FORMULA II: Amido black (water base formula)

Citric Acid Stock Solution (Solution A)
38 g citric acid
2 L distilled water
Stir until dissolved.

Developer Solution (Solution B)
1 L citric acid stock solution
2 g amido black
2 mL Kodak Photo-Flo 200 Solution
Slowly add amido black to stock solution and stir for 30 minutes. Add the Photo-Flo 200 and stir lightly.

Rinse Solution
1 L citric acid stock solution

Final Rinse
Distilled water

BASIC YELLOW 40

CHEMICALS: Basic yellow 40 (maxilon flavine 10GFF, panacryl brilliant flavone10GFF), methanol, ethanol

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals. Basic Yellow 40 presents few safety hazards when properly used. Basic Yellow 40 is an eye irritant. Repeated or prolonged exposure may lead to cracked or dry skin.

Methanol and ethanol are flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. They may be mutagenic or toxic.

STORAGE: Store in original container or in clear or dark bottles.

MAINTENANCE OF EQUIPMENT: Wash all equipment in mild detergent.

PRE-MIXED SOLUTION: Pre-mixed Basic Yellow 40 may be used full strength from its container. Ethanol or methanol may also be used to dilute pre-mixed Basic Yellow 40 to the strength preferred.

FOR ALL FORMULAS OF BY40

FORMULA I: 3 g basic yellow 40
500 mL methanol
Combine and mix until dissolved.

FORMULA II: 1 g basic yellow 40
500 mL methanol
Combine and mix until dissolved.

FORMULA III: 1 g basic yellow 40
4 L methanol
Combine and mix until dissolved.

Aliquots of BY40 are not considered stock bottles or working containers and may be labeled with only "BY40 Wash Only" and a hazard label. Both stock bottle and aliquots must be empty prior to preparing a new stock bottle.

DFO (1,8-DIAZOFLUOREN-9-ONE)

CHEMICALS: DFO (1,8-diazafluoren-9-one), methanol, **absolute ethanol**, glacial acetic acid (water-free acetic acid), ethyl acetate (ethyl ester), petroleum ether, heptane

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

DFO is harmful if swallowed and may irritate eyes.

Methanol and ethanol are flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. They may be mutagenic or toxic.

Glacial acetic acid is flammable and is strongly irritating to eyes, nose, and throat and can cause skin burns upon contact. It may be mutagenic or toxic.

Ethyl acetate is flammable and is hazardous in case of ingestion or inhalation and may cause skin irritation. It may be toxic.

Petroleum ether is flammable and is irritating to the eyes. It is slightly irritating to the skin and may be absorbed through the skin. It may be toxic.

Heptane is flammable and is slightly irritating to the eyes skin. It may be toxic.

STORAGE: Store both stock and working solutions in dark bottles. The working solution should be stored in a refrigerator.

MAINTENANCE OF EQUIPMENT: Wash all containers in mild detergent.

PRE-MIXED SOLUTION: DFO can be purchased fully prepared and should be used according to manufacturer's instructions.

FORMULA I:

<u>Stock Solution</u>
0.5 g DFO
100 mL **absolute** ethanol (or methanol)
20 mL glacial acetic acid
100 mL ethyl acetate
Dissolve DFO in ethanol or methanol. Add acetic acid and ethyl acetate.

<u>Working Solution</u>
~220 mL Stock Solution
~780 mL petroleum ether
Add petroleum ether to Stock Solution until the total volume is 1 L.

FORMULA II:

<u>Stock Solution</u>
0.5 g DFO

60 mL ethanol
30 mL glacial acetic acid

Working Solution
~90 mL Stock Solution
~910 mL heptane
Add heptane to Stock Solution until the total volume is 1 L.

GENTIAN VIOLET

CHEMICALS: Gentian violet (crystal violet, basic violet 3)
Kodak Photo-Flo 200 Solution
Ammonia

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Gentian violet may cause irritation to the nose, lungs, or skin. It is toxic if ingested.

Photo-Flo may cause eye irritation and is toxic if ingested.

Ammonia is toxic, corrosive, and may cause burns to eyes or skin. It is harmful if swallowed, inhaled, or absorbed through the skin. Ammonia vapors may be flammable.

STORAGE: Clear or dark bottles

MAINTENANCE OF EQUIPMENT: All equipment should be washed thoroughly in a mild detergent.

FORMULA I: 1.0 g gentian violet
1 L distilled water
Mix by inversion.

FORMULA II: 1.0 g gentian violet
1 L distilled water
Ammonia
Mix by inversion. Add ammonia to adjust pH between 7-8.

1,2-INDANEDIONE

CHEMICALS: 1,2-Indanedione, zinc chloride, HFE 7100, **absolute ethanol**, glacial acetic acid (water-free acetic acid), ethyl acetate (ethyl ester)

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Indanedione is harmful if swallowed and may cause eye, skin, or respiratory irritation.

Zinc chloride is very hazardous if ingested, inhaled, or comes in contact with skin or eyes. It may be mutagenic or toxic. Repeated inhalation may result in lung damage.

Ethanol is flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. It may be mutagenic or toxic.

Glacial acetic acid is flammable and is strongly irritating to eyes, nose, and throat and can cause skin burns upon contact. It may be mutagenic or toxic.

Ethyl acetate is flammable and is hazardous in case of ingestion or inhalation and may cause skin irritation. It may be toxic.

HFE 7100 may be harmful if inhaled, swallowed, or absorbed through skin and causes irritation to skin, eyes, and respiratory tract.

STORAGE: Store both stock and working solutions in dark bottles.

MAINTENANCE OF EQUIPMENT: Wash all containers in mild detergent.

FORMULA I:

1 g 1,2-indanedione
35 mL ethyl acetate
465 mL HFE 7100
Dissolve indanedione in ethyl acetate. Add solution to HFE 7100.

FORMULA II:

Stock Solution
0.4 g zinc chloride
10 mL absolute ethanol
1 mL ethyl acetate
190 mL HFE 7100

Dissolve zinc chloride in ethanol, ethyl acetate, and HFE 7100.

Working Solution
0.4 g 1,2-indanedione
45 mL ethyl acetate
5 mL glacial acetic acid
40 mL zinc chloride stock solution
410 mL HFE 7100
Dissolve indanedione in ethyl acetate. Add glacial acetic acid and zinc chloride stock solution. Then add to HFE 7100.

NINHYDRIN

CHEMICALS: Ninhydrin (triketohydrindene hydrate, 2,2-dihydroxy-1,3-indandione, 2,2-dihydroxy-1H-indene-1,3 (2H)-dione, ninhydrin hydrate), ethyl acetate (ethyl ester), **absolute ethanol** (water-free ethanol), Glacial acetic acid (water-free acetic acid), heptane, methanol petroleum ether,
Isopropyl alcohol

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Ninhydrin is irritating to the skin, eyes, and lungs. It may be hazardous if skin becomes sensitized.

Ethyl acetate is flammable and is hazardous in case of ingestion or inhalation and may cause skin irritation. It may be toxic.

Methanol and ethanol are flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. They may be mutagenic or toxic.

Glacial acetic acid is flammable and is strongly irritating to eyes, nose, and throat and can cause skin burns upon contact. It may be mutagenic or toxic.

Heptane is flammable and is slightly irritating to the eyes skin. It may be toxic.

Petroleum ether is flammable and is irritating to the eyes. It is slightly irritating to the skin and may be absorbed through the skin. It may be toxic.

Isopropyl alcohol is flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. It may be toxic.

STORAGE: Dark bottles for the stock solution and clear or dark bottles for the working solution.

MAINTENANCE OF EQUIPMENT: Due to the staining nature of ninhydrin, it is important to wash all equipment in a mild detergent.

FORMULA I:

7.5 g ninhydrin
25 mL ethyl acetate
75 mL **absolute** ethanol
3.0 mL glacial acetic acid
897 mL heptane
Dissolve ninhydrin in ethyl acetate. Add **absolute** ethanol, glacial acetic acid, and heptane and mix in dark bottle.

FORMULA II:

4 g ninhydrin
20 mL **absolute** ethanol (or methanol)
480 mL petroleum ether
Dissolve ninhydrin in **absolute** ethanol. Add petroleum ether and mix in dark bottle.

FORMULA III:

5 g ninhydrin
30 mL **absolute** ethanol (or methanol)
40 mL isopropyl alcohol
930 mL petroleum ether
Dissolve ninhydrin in **absolute** ethanol. Add isopropyl alcohol and petroleum ether and mix in dark bottle.

FORMULA IV:

30 g ninhydrin
300 mL **absolute** ethanol
3.7 L heptane (or 3.6 L heptane and 100 mL glacial acetic acid)
Dissolve ninhydrin in **absolute** ethanol. Add heptane and mix in dark bottle.

PHYSICAL DEVELOPER

CHEMICALS: Silver nitrate, ferric nitrate, ferrous ammonium sulfate, citric acid, n-dodecylamine acetate, synperonic N, maleic acid

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Silver nitrate is a strong irritant to the skin and eyes, hazardous if inhaled, and may be absorbed through the skin. It is oxidizing and corrosive. It is toxic and repeated exposure can lead to chronic respiratory irritation and lung damage.

Ferric nitrate is a strong irritant to the skin and eyes and hazardous if inhaled or ingested. Repeated exposure can be toxic and lead to chronic respiratory irritation.

Ferrous ammonium sulfate is an irritant to skin and eyes and is slightly hazardous if inhaled or ingested. It may be toxic.

Citric acid is irritating to eyes, lungs, and skin and can cause burns and blindness.

Dodecylamine acetate is corrosive to skin and eyes and hazardous if inhaled or ingested. It may be toxic.

Synperonic is a severe irritant to eyes and skin and hazardous if inhaled or ingested.

Maleic acid is corrosive and hazardous in case of eye or skin contact, inhalation, or ingestion. It can be absorbed through the skin. It may be toxic. It may explode in case of mechanical impact or release hydrogen gas when in contact with metals.

STORAGE: Store in dark bottles in a refrigerator. Keep out of sunlight. Do not freeze.

MAINTENANCE OF EQUIPMENT: Wash all containers in mild detergent. Do not use abrasives on any glassware items; rinse thoroughly.

FORMULA I: Commercial solution (use mixing instructions that come with reagents or the following formula)

Use clean glassware.

Working Solution
5 mL Solution A
90 mL Solution B

Combine and stir for one minute

Maleic Acid Solution
25 g maleic acid
1 L distilled water

FORMULA II: *Use clean glassware.*

Stock Solution
4 g n-dodecylamine acetate
4 g synperonic N
1 L distilled water
Stir for at least 30 minutes

Solution A
10 g silver nitrate
50 mL distilled water
Protect from sunlight. Stir for one minute and store in dark bottle.

Solution B

30 g ferric nitrate
80 g ferrous ammonium sulfate
20 g citric acid
900 mL distilled water
Add solids in order, one at a time. Stir until dissolved and for an additional 5 minutes.

Working Solution
Add 40 mL of Stock Solution to 900mL of Solution B and stir thoroughly. Verify that all crystals in Solution A have dissolved then add 50 mL of Solution A to the mixture.

Maleic Acid Solution
25 g maleic acid
1 L distilled water

SHELF LIFE:

Working Solution:	End of day
Solution A:	1 day
Solution B:	6 weeks

FORMULA III: *Use clean glassware.*

Stock Solution
2.7 g n-dodecylamine acetate
4 g synperonic N

1 L distilled water
Stir for at least 30 minutes

Solution A
10 g silver nitrate
50 mL distilled water
Protect from sunlight. Stir for one minute and store in dark bottle.

Solution B
30 g ferric nitrate
80 g ferrous ammonium sulfate
20 g citric acid
900 mL distilled water
Add solids in order, one at a time. Stir until dissolved and for an additional 5 minutes.

Working Solution
Add 40 mL of Stock Solution to 900mL of Solution B and stir thoroughly. Verify that all crystals in Solution A have dissolved then add 50 mL of Solution A to the mixture.

Maleic Acid Solution
25 g maleic acid
1 L distilled water

SHELF LIFE:

Working Solution:	End of day
Solution A:	1 day
Solution B:	Several weeks

RAM (RHODAMINE 6G, ARDROX, MBD)

CHEMICALS: Rhodamine 6G (basic red 1) , MBD (7(p-methoxybenzylamino)-4-nitro2,1,3-benzoxadiazole), Ardrox P-133D (tracer tech P-133D), methanol, isopropyl alcohol, acetonitrile (methyl cyanide), petroleum ether, acetone (propanone), ethanol

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Rhodamine 6G is an irritant and hazardous to skin and eyes or if inhaled. It is very hazardous if ingested.

MBD is an irritant to skin and eyes and is slightly hazardous if inhaled or ingested.

Ardrox is an irritant if touched, inhaled, or ingested and may be absorbed through the skin. Keep away from strong oxidizing agents and open flame.

Methanol and ethanol are flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. They may be mutagenic or toxic.

Isopropyl alcohol is flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. It may be toxic.

Acetonitrile is an irritant to eyes and skin and hazardous if inhaled or ingested and can be absorbed through the skin. It may be toxic to many organs including the reproductive system.

Petroleum ether is flammable and is irritating to the eyes. It is slightly irritating to the skin and may be absorbed through the skin. It may be toxic.

Acetone is an irritant to eyes and skin and hazardous if inhaled or ingested and can be absorbed through the skin. It may be toxic to many organs including the reproductive system. Repeated or prolonged exposure can lead to organ damage.

STORAGE: Dark bottles

MAINTENANCE OF EQUIPMENT: Wash all equipment in mild detergent.

FORMULA I:

Stock Solution 1
1 g Rhodamine 6G
1 L ethanol (or methanol)
Combine and stir thoroughly. Store in dark bottle.

Stock Solution 2
1 g MBD
1 L acetone
Combine and stir thoroughly. Store in dark bottle.

Working Solution
3 mL Stock Solution 1
2 mL Ardrox P-133D
7 mL Stock Solution 2
20 mL ethanol (or methanol)
10 mL isopropyl alcohol
8 mL acetonitrile
950 mL petroleum ether

Combine the reagents in order and store in dark bottle.

SHELF LIFE: Working Solution: 6 months

RHODAMINE 6G

CHEMICALS: Rhodamine 6G (basic red 1)
Methanol
Ethanol

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Rhodamine 6G is an irritant and hazardous to skin and eyes or if inhaled. It is very hazardous if ingested.

Methanol and ethanol are flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. They may be mutagenic or toxic.

STORAGE: Dark bottles

MAINTENANCE OF EQUIPMENT: Wash all equipment in mild detergent.

FORMULA I:

Stock Solution 1
1 g Rhodamine 6G
1 L ethanol (or methanol)
Combine and stir thoroughly. Store in dark bottle.

Working Solution
Use as is or dilute with additional ethanol (or methanol) to desired concentration.

SILVER NITRATE

CHEMICALS: Silver nitrate
Ethanol

Glacial acetic acid

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Silver nitrate is a strong irritant to the skin and eyes, hazardous if inhaled, and may be absorbed through the skin. It is oxidizing and corrosive. It is toxic and repeated exposure can lead to chronic respiratory irritation and lung damage.

Ethanol is flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. It may be mutagenic or toxic.

Glacial acetic acid is flammable and is strongly irritating to eyes, nose, and throat and can cause skin burns upon contact. It may be mutagenic or toxic.

STORAGE: Store in dark bottles. Keep out of sunlight.

MAINTENANCE OF EQUIPMENT: Wash all equipment in mild detergent.

FORMULA I:

30 g silver nitrate
100 mL distilled water
1 L ethanol
Dissolve silver nitrate in water, then add ethanol. Store in dark bottle.

FORMULA II:

60 g silver nitrate
100 mL distilled water
890 mL ethanol
10 mL glacial acetic acid
Dissolve silver nitrate in water, then add ethanol and acetic acid. Store in dark bottle.

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FORMULA III: 60 g silver nitrate
990 mL distilled water
10 mL glacial acetic acid
Dissolve silver nitrate in water, then add acetic acid. Store in dark bottle.

FORMULA IV: 30 g silver nitrate
1 L distilled water
Dissolve silver nitrate in water. Store in dark bottle.

SMALL PARTICLE REAGENT (SPR)

CHEMICALS: Molybdenum disulfide
Kodak Photo-Flo 600 Solution

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Molybdenum disulfide may be an irritant to eyes, skin, and lungs and may be harmful if swallowed or inhaled.

Photo-Flo may cause eye irritation and is toxic if ingested.

STORAGE: Dark or clear bottles

MAINTENANCE OF EQUIPMENT: Wash all equipment in mild detergent.

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FORMULA I:

30 g molybdenum disulfide
1 L distilled water
2 drops Kodak Photo-Flo 600 Solution
Dissolve molybdenum disulfide in water then add Photo-Flo and mix. Agitate repeatedly during use.

SODIUM HYDROXIDE

CHEMICALS: Sodium hydroxide (caustic soda)

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Sodium hydroxide is corrosive to skin and eyes and very hazardous if inhaled or ingested. Over-exposure can result in severe damage. It may be toxic and repeated exposure may result in organ damage.

STORAGE: Dark bottles

MAINTENANCE OF EQUIPMENT: Wash all equipment in mild detergent.

FORMULA I:

4 g sodium hydroxide
1 L distilled water
Dissolve sodium hydroxide in water for a .1N solution. Store in dark bottle.

ZINC CHLORIDE

CHEMICALS: Zinc chloride
Solvent (same as used when item was processed with ninhydrin)

Ethanol
Heptane

SAFETY: Use a fume hood and wear gloves, a lab coat, and eye protection when working with chemicals.

Zinc chloride is very hazardous if ingested, inhaled, or comes in contact with skin or eyes. It may be mutagenic or toxic. Repeated inhalation may result in lung damage.

Ethanol is flammable, irritating to the eyes, skin, and lungs, and can be absorbed through the skin. It may be mutagenic or toxic.

Heptane is flammable and is slightly irritating to the eyes skin. It may be toxic.

See ninhydrin Safety section for additional information.

STORAGE: See ninhydrin section

MAINTENANCE OF EQUIPMENT: Wash all equipment in mild detergent.

FORMULA I: 7.5 g zinc chloride
500 mL solvent (use same solvent as used during ninhydrin application)
Dissolve zinc chloride in solvent.

FORMULA II: 15 g zinc chloride
200 mL ethanol
800 mL heptane
Dissolve zinc chloride in ethanol then add heptane. Store in dark bottle.

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