

BLOODSTAIN PATTERN ANALYSIS



TEST METHODS

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FOREWORD

Bloodstain pattern analysis (BPA) performed by the Indiana State Police (ISP) Forensic Services Division (FSD) aims to identify any bloodstain patterns present and classify the patterns based on their physical characteristics. All observations are recorded in case notes and summarized in a report (i.e., Certificate of Analysis, Forensic Scientist (FS) Field Service Report, or Crime Scene Investigator (CSI) Records Management System (RMS) Incident Report).

BPA is conducted by trained and skilled FSs and CSIs who shall have a minimum of a baccalaureate degree and should have successfully completed college coursework covering subject areas such as trigonometry, biology, physics, and chemistry. Mathematics courses higher than trigonometry (such as pre-calculus, calculus, etc.) shall meet this requirement since trigonometry acts as a foundational prerequisite for those courses. The FSs are civilian, and the CSIs are sworn or civilian ISP employees. These FSs/CSIs have participated in the extensive formalized training program under the direction of the FSD. The BPA training program is divided into non-porous and textile analyses. Due to the required microscopic examination of textile surfaces during BPA, textile items shall only be examined at a Regional Laboratory by qualified FSs. Therefore, CSIs shall only be trained in non-porous analysis, and FSs shall be trained in both non-porous and textile analyses. During the training program, the new FS/CSI must successfully complete testing consisting of written tests, oral examinations/reviews, mock trial or panel, and competency sample analyses. It is recommended that the trainee successfully complete a 40-hour basic BPA course, approved by the FSD Commander. Examination of bloodstain pattern evidence will begin upon completion of the training program and authorization by the FSD Commander. Additionally, all FSs and CSIs shall participate in proficiency testing from an accredited vendor yearly and should complete a minimum of eight hours of documented training related to BPA yearly. Continuing education may include, but is not limited to, attending professional conferences, seminars, webinars, and/or workshops.

The analysis of bloodstain patterns at scenes and on evidence may not always be definitive. Each FS/CSI is expected to use their training, experience, and education to support conclusions, opinions, and interpretations.

This test method is a general approach to the examination of BPA evidence and the conclusions, opinions, and interpretations as they relate to these examinations. Deviations from procedure may be employed with the approval of a supervisor trained in BPA. The deviation, justification, and supervisor's approval shall be documented in the case notes.

The following procedures are to be used by authorized FSs/CSIs when examining scenes of bloodshed, evidentiary items, and photographs for the purpose of issuing a BPA report.

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1. Identification of Blood Serology Methods

1.1. Scope: This test method is designed for the guidance of FSs/CSIs who assist with investigations where bloodstains occur as physical evidence in alleged criminal activities where BPA is requested. The scope of this type of evidence includes but is not limited to the following: identification of blood and identification of human blood. This test method may be expanded or altered as new techniques and/or new analyses are found applicable and validated.

1.2. Precautions/Limitations:

1.2.1. Evidence

- 1.2.1.1. Stained materials may be frozen, refrigerated, or stored at room temperature in a dry environment. Items to be analyzed for latent prints should not be frozen or refrigerated.
- 1.2.1.2. Stains that are still moist shall be air dried in a secure area before submission.
- 1.2.1.3. Clean paper or cardboard containers shall be used to package dried evidence. Plastic containers shall not be used because they hold moisture which often leads to putrefaction of biological materials. Each item should be placed in separate containers from the point of collection.
- 1.2.1.4. If multiple items are placed in one container at time of collection, they may be submitted in the single, original package.
- 1.2.1.5. Specific examinations performed on items of serological evidence shall be determined by FSD personnel.

1.3. Related Information:

- 1.3.1. Crime Scene Investigation Procedures Manual; Hemastix
- 1.3.2. Biology Casework Test Method; Serology Section
- 1.3.3. Reagent Preparation Manual
- 1.3.4. Biology Worksheet Manual

1.4. Instruments:

- 1.4.1. Balances – An analytical balance used for preparation of analytical reagents and buffers.
- 1.4.2. Alternate light source (ALS) – A light source to aid in the location of stains and trace evidence by use of various wavelengths of light.
- 1.4.3. Miscellaneous Laboratory Equipment – Supportive laboratory equipment including ovens, incubators, pipettors, rotators, stirring/heating plates, vortex mixers, vacuum pumps, UV lights, and refrigerators/freezers for storing of reagents, buffers, and evidence.

1.5. Reagents/Materials:

- 1.5.1. Distilled Water
- 1.5.2. Hemastix Blood ID Reagent Strips
- 1.5.3. HemDirect Hemoglobin Cassettes
- 1.5.4. HemDirect Hemoglobin Buffer
- 1.5.5. 3% H₂O₂
- 1.5.6. Luminol Powder

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1.5.7. Phenolphthalein Stock Solution

1.5.8. Phenolphthalein Working Solution

1.5.9. Spray Bottle

1.6. Hazards/Safety:

1.6.1. All chemicals shall be handled in a safe method as referenced in the specific SDS.

1.6.2. Preparation of the Phenolphthalein Stock Solution shall be performed in a chemical fume hood.

1.6.3. Universal precautions shall be in use whenever biological materials are being handled.

1.6.4. Extreme caution shall be used when handling liquid body fluid samples.

1.6.5. Biological waste shall be disposed of in the appropriate waste receptacle.

1.7. Reference Materials/Controls/Calibration Checks:

1.7.1. HemDirect Hemoglobin tests shall be performance checked before use in casework.

1.7.1.1. Each new lot of HemDirect Tests shall be analyzed with a 1:10 dilution of human blood dried on filter paper or a 1:500 dilution of liquid human blood. A positive result as described in the HemDirect test method shall be obtained before use in casework.

1.7.2. Running known controls with each test ensures the accuracy and specificity of the test results. See the specific test procedure for the appropriate controls to be run.

1.8. Procedures/Instructions:

1.8.1. Hemastix, Presumptive Test for Blood

1.8.1.1. **Principle:** Hemastix is a presumptive test for the presence of blood. Confirmatory testing must be performed at the laboratory for conclusive identification. Hemastix is a very sensitive test for blood; however, the CSI should be mindful of false positives.

1.8.1.2. Procedure

1.8.1.2.1. Positive and negative control tests shall be conducted prior to testing questioned bloodstains and be documented in the Field Guide and Notes. Photographs of controls should also be considered.

1.8.1.2.2. A positive result will result in a green color. A weak positive result will show faint, slow-developing green color. A negative control results in no reaction.

1.8.1.2.3. For questioned, stains, moisten the cotton tip of a swab with distilled water. Swab a small portion of the suspected bloodstain, enough to see it on the cotton tip.

1.8.1.2.4. Rub the stained swab directly on the pad of the Hemastix. The development of a green color indicates the possible presence of blood. The results shall be documented in the Field Guide and Notes and should be documented with photography.

1.8.1.2.5. The only stains that should be tested in the field are those where additional stains are available for collection and submission to a Regional Laboratory for DNA testing.

1.8.2. Phenolphthalein (Kastle-Meyer Reagent), Presumptive Test for Blood

1.8.2.1. **Principle:** Phenolphthalein is an oxidizable organic molecule, which can be oxidized by free hydroxyl ions liberated by peroxidase-like action. The heme group of hemoglobin possesses a peroxidase-like activity, which may catalyze the breakdown of hydrogen

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peroxide to form free hydroxyl radicals. Phenolphthalin (reduced form) is oxidized by the free hydroxyl ions to phenolphthalein (oxidized form), producing a pink color.

Phenolphthalein (abbreviated Phe on controlled worksheets) is a presumptive test for the presence of blood. Confirmatory testing shall be performed for conclusive identification. Phenolphthalein has been shown to give false positives or weak reactions with various oxidizing agents, plant material, etc.

1.8.2.2. Procedure

- 1.8.2.2.1. Rub the suspected bloodstain with a piece of filter paper or a cotton swab or make a small cutting of the suspected bloodstain and place on white filter paper or in a white spot plate well.
- 1.8.2.2.2. Add one to three drops of the phenolphthalein working solution to the stain.
- 1.8.2.2.3. Wait 10-15 seconds, assuring no pink color develops at this time.
- 1.8.2.2.4. Add one to three drops of 3% Hydrogen Peroxide.
- 1.8.2.2.5. Upon addition of the Hydrogen Peroxide an immediate pink color is indicative of the possible presence of blood.

- 1.8.2.3. Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use and prior to use on evidence. Lot numbers and/or preparation dates of reagents shall also be recorded.

1.8.3. Luminol, Presumptive Test for Blood

- 1.8.3.1. **Principle:** Luminol is a presumptive test designed to process large areas where stains are not readily visible. Luminol works best on old stains (where the heme group has been converted to hemin) and while it does soak the area tested, it should not interfere with additional testing. In the luminol test, the hemin acts as a catalyst, triggering the oxidation of luminol by hydrogen peroxide in an alkaline solution.

Confirmatory testing shall be performed for conclusive identification. Luminol has been shown to give false positives with certain metal compounds, plant peroxidases and some cleansers, especially cleansers which contain hypochlorite (bleach). Luminol is an alternative method that can be used on items where bloodstains are not easily visible.

1.8.3.2. Procedure

- 1.8.3.2.1. Prepare the luminol solution by adding the contents of the powdered luminol tube (8 oz size) to 8 oz (250 ml) of distilled water in a plastic reagent bottle. Alternate powdered luminol tubes are available in 4 oz and 16 oz sizes. If these are used, add the corresponding amount of distilled water, 4 oz (125 ml) or 16 oz (500 ml).
- 1.8.3.2.2. Gently mix the powder and distilled water with a gentle swirling action in order to avoid mixing an excessive amount of air or oxygen into the solution.
- 1.8.3.2.3. Transfer the luminol solution into a fine mist spray bottle. Any unmixed powder remnants should be left in the bottom of the plastic reagent bottle and not transferred into the spray bottle to avoid clogging the sprayer.
- 1.8.3.2.4. The mixed luminol solution should be used within about 20 - 30 minutes.
- 1.8.3.2.5. All individuals present during testing shall wear gloves, eye protection and a surgical mask or equivalent.

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- 1.8.3.2.6. Spray the area of interest in the dark until well-soaked. Luminol's reaction with a true bloodstain produces a luminescent glow, frequently in patterns such as spatters, smears, wipes or drag marks, or even footwear impressions.
 - 1.8.3.3. Any remaining luminol solution cannot be stored for later use because the reagent will lose potency. The remaining luminol solution can be disposed of by washing it into the sink with a large quantity of water. Also, be sure to clean out the spray bottle and nozzle with clean water, as any luminol remaining in the sprayer will form a difficult-to-remove clog.
 - 1.8.3.4. Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use and prior to use on evidence or at a crime scene. Lot numbers of reagents shall also be recorded.
- 1.8.4. HemDirect Hemoglobin Test, Confirmatory Test for Human Blood**
- 1.8.4.1. **Principle:** Human blood reacts with an anti-human hemoglobin antibody, which forms a red line in the "test" region of the HemDirect cassette.
 - 1.8.4.2. Procedure**
 - 1.8.4.2.1. Place a ~2mm² cutting, a few flakes, a few drops of liquid blood diluted to 1:500, or ~1/8 of a swab in the tube of supplied extraction buffer. The cutting shall remain in the buffer solution for 5 minutes. A maximum extraction time of 10 minutes may be utilized for inhibited samples.
 - 1.8.4.2.2. Add three drops of the extraction buffer/sample mix with the provided pipette to the sample well of the cassette.
 - 1.8.4.2.3. A positive result may be recorded as soon as red lines are observed in both the "C" (control) and "T" (test) regions.
 - 1.8.4.2.4. Negative results (a red line in only the "C" region; no line in the "T" region) should be confirmed after 10 minutes.
 - 1.8.4.2.5. If a line in the "C" region does not appear after 10 minutes, test results are invalid and shall be repeated.
 - 1.8.4.3. Each new lot of HemDirect kits shall be performance checked before use. Additional testing of reagents with positive and negative controls before use on evidence is not required. Lot numbers of reagents and the result of the internal positive control shall be recorded.

2. Non-Porous Bloodstain Pattern Analysis

- 2.1. Scope:** This test method is designed for FSD personnel to assist investigations into a variety of alleged criminal activities, where bloodstain patterns may be present at crime scenes and/or on physical evidence involving non-porous surfaces. During the examination for potential areas of bloodstain pattern evidence, appropriate notes and photographs shall be taken regarding the evidence unless no bloodstains are observed. It is not required that the actual stained area be retained after analysis is complete.

2.2. Precautions/Limitations:

- 2.2.1.** Evidence should be handled in a manner that will not alter the appearance of stains. Staining should be documented via notes and photographs prior to any marking, serological testing, or sampling.

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2.2.2. Not all bloodstains exhibit discernable patterns or are suitable for informative conclusions, opinions, or interpretations. A number of factors may limit the ability to draw conclusions regarding the classifications of some bloodstain patterns. These factors may include, but are not limited to:

- Quantity and quality of stains present
- Environmental factors
- Effect of target surface features
- Limiting factors on measurements and calculations
- Nature of the injuries or wounds
- Clean-up activities after stains were deposited
- Effect(s) of first responders on the scene and other evidence

Therefore, it is not possible, nor practical, to describe every bloodstain that may have been observed or noted during the investigation of a bloodshed event.

2.2.3. Bloodstain patterns created from different mechanisms or forces can have similar or indistinguishable features.

2.2.4. A single mechanism can create bloodstain patterns with different features depending on:

- Volume of liquid blood involved
- Amount of force
- Presence or absence of intervening objects
- Features and orientation of the target surface

2.2.5. A single area may contain multiple overlapping patterns and classification may not be possible.

2.2.6. Measurements are approximate and considered qualitative unless they are pertaining to impact angles and area of origin. Therefore, uncertainty of measurement is only applied when calculating impact angles and area of origin.

2.2.7. No reconstructive experimentation should be performed.

2.2.8. Any reference to conclusions from other forensic reports are considered to be summary statements only. Refer to the referenced forensic report and/or respective reporting analyst for a more complete discussion of the specific conclusion.

2.2.9. Unless otherwise noted, statements of "spatter stains" indicate that these stains were observed on a particular item; however, they were not deposited in a manner to be able to determine the specific mechanism for deposition. Spatter stains do not necessarily indicate a violent act occurred near a particular item or individual, only that airborne droplets of blood were created when a force was applied to liquid blood.

2.2.10. Any additional information, statements, or evidence received after the completion of the report may change the results/opinions/conclusions stated within the notes and report.

2.3. Related Information:

2.3.1. Bloodstain Pattern Analysis Worksheet Manual

2.3.2. Crime Scene Investigation Procedures Manual

2.3.3. General Policy 069 – Utilization of Forensic Scientists for Field Service

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2.4. Instruments/Equipment:

- 2.4.1. Camera with associated equipment (tripods, lenses, flashes, etc.)
- 2.4.2. iPad
- 2.4.3. Infrared (IR) camera
- 2.4.4. Various size scales
- 2.4.5. Magnifier loupe with scale
- 2.4.6. Tape measure
- 2.4.7. Caliper
- 2.4.8. String
- 2.4.9. Level
- 2.4.10. Tape
- 2.4.11. Markers
- 2.4.12. Protractor
- 2.4.13. Scientific calculator

2.5. Hazards/Safety:

- 2.5.1. When an FS is processing a crime scene for bloodstain patterns, all the requirements noted in General Policy (GEN) 069 Utilization of Forensic Scientists for Field Service shall be followed.
- 2.5.2. Universal precautions shall always be used during the processing of biological evidence. FSs/CSIs shall wear appropriate personal protective equipment.

2.6. Reference Materials/Controls/Calibration Checks:

- 2.6.1. Digital Caliper Certification
- 2.6.2. Measurement Uncertainty
 - 2.6.2.1. Each FS/CSI's measurements from the impact angle portion of the proficiency test and a 99% confidence interval will be used for the measurement uncertainty calculation.
 - 2.6.2.2. Measurement uncertainty will be reevaluated annually.

2.7. Procedures/Instructions:

- 2.7.1. All items of evidence shall be marked with the proper case number, item number, and other identifying marks when possible.
- 2.7.2. **Examination process:**
 - 2.7.2.1. Bloodstain pattern analysis shall utilize a stepwise, feature based methodology that provides data supported interpretations. This method shall also incorporate a linear sequential unmasking - expanded approach to minimize contextual bias due to task irrelevant data.
 - 2.7.2.2. A visual exam shall be performed in which the FS/CSI attempts to identify any bloodstains present and document the observed characteristics such as size, shape, and distribution via photographs and notes. Based upon these characteristics, the FS/CSI shall then classify the stains into pattern types where appropriate. Examination can be assisted with

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the use of ALS, stereomicroscopes, loupes, and/or calipers. It may not always be possible to classify a stain into one specific pattern or to classify it at all. All patterns that cannot be excluded should be clearly documented.

- 2.7.2.3. Once the stains are classified into possible pattern types, any additional information available should also be evaluated, which includes but is not limited to: DNA analysis results, autopsy/injury information, or any additional case information. The FS/CSI shall then refine the classifications that could not be excluded previously based on this additional information when possible. All observations and conclusions shall be recorded in the case notes.
- 2.7.2.4. If additional case information indicates that a pattern type should have been included previously but was not, a referee analysis shall be performed. However, a pattern type shall not be included based solely on contextual information (i.e. no observable features to support that pattern type).
- 2.7.2.5. If the FS/CSI is not performing their own serological examinations, they should wait to issue the BPA report until after the Certificate of Analysis or report containing the associated serology testing has been issued. And, if possible, after all other forensic reports have been issued.

2.7.3. When analysis is performed at the crime scene, a CSI RMS Incident Report or a FS Field Service Report shall be completed.

2.7.4. Records:

2.7.4.1. Photographic:

- 2.7.4.1.1. A digital camera or iPad and associated equipment (tripods, lenses, flashes, etc.) shall be used to complete the photography needed to document the evidence and/or crime scene. The photographs should be taken with the camera set in JPEG format and with the resolution being set at the highest available setting. The digital files from the camera shall be stored on a secure electronic medium as per FSD's policy.
- 2.7.4.1.2. Overall, mid-range, close-up, and technical photos of staining should be taken to establish location and position of staining.
- 2.7.4.1.3. Stains on dark surfaces may be photographed using IR cameras to better visualize and document the staining.
- 2.7.4.1.4. If no staining is observed, photographs are not required.

2.7.4.2. Notes:

- 2.7.4.2.1. Notes shall include item and stain descriptions. Sketches should be included when appropriate, or an annotated image of the item.
- 2.7.4.2.2. The features that should be considered for inclusion in notes include, but are not limited to, the following:
 - Size: size of the overall pattern, when appropriate, and size range of individual stains within the overall pattern. Measurements shall be in metric units.
 - Shape: shape of the overall pattern and shape(s) of individual stains within the overall pattern
 - Distribution: how the individual stains are arranged (e.g. random, radiating, linear, curvilinear) and specific features within the overall pattern (e.g. change in stain

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density along the pattern, change in stain size or shape on one side compared to the other, if stains show an area of convergence)

-Appearance: blood coloration (e.g. consistent or inconsistent), edge characteristics (e.g. smooth, scalloped, spines, undefined), possible diluted appearance, clotted, flaking, alterations

-Directionality: when applicable for individual stains, patterns, and flows (with gravity vs against)

-Location: on the item (right/left/top/bottom) or within the scene (located within proximity to other staining or decedent)

-Target surface features: smooth or textured, fixed or moveable, vertical or horizontal

-Classification or not with reasoning provided based on the examined stain evidence

2.7.5. Analysis:

2.7.5.1. Classification:

2.7.5.1.1. The features described below are considered a general guide and are used in conjunction with training, experience, and comparison to features of bloodstain patterns created from known mechanisms. These patterns may also contain altered stains (e.g. wipes, perimeter stains), blood clots, flows, serum stains, or voids.

2.7.5.1.2. Backspatter Pattern:

-Requires the presence of spatter stains

-Distribution: random or radiating distribution, generally not linear or curvilinear

-Appearance: stains may have a lighter color if cerebral-spinal fluid is present

-A documented entrance gunshot wound is required to definitively limit classification to this pattern. May contain other materials such as bone, hair, fibers, or ammunition components.

2.7.5.1.3. Cast-off Pattern:

-Requires the presence of spatter stains

-Distribution: generally a linear or curvilinear distribution but may sometimes appear radiating. Stain size generally decreases along the pattern while elongation and distance between stains increases.

2.7.5.1.4. Drip Pattern:

-Requires the presence of spatter stains and a parent stain. The parent stain must be on a horizontal surface, but the spatter stains can be on horizontal or vertical surfaces.

-Distribution: spatter stains are in a radiating distribution. Spatter stains on vertical surfaces may be distributed in a "V" or "M" shape.

-Appearance: the edges of the parent stain may be smooth or scalloped but typically do not have spines on smooth surfaces. In general, spatter stains near the parent stain may have irregular shapes and are generally larger than the spatter stains farther away.

-Drip stains may surround the parent stain. May not always be able to discern between drip pattern, projected pattern, or splash pattern. Can use "large volumes of free-falling blood" if uncertain.

2.7.5.1.5. Drip Stain:

-Shape: circular on horizontal surfaces, elliptical on non-horizontal surfaces

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- Size: can generally be 10-25mm on smooth, non-porous surfaces
- Appearance: edges that are smooth, scalloped, or have spines are possible. Stains on rough surfaces will tend to have more spines.

2.7.5.1.6. **Drip Trail:**

- Requires the presence of multiple drip stains (generally, at least three drip stains)
- Distribution: typically linear to curvilinear distribution of drip stains
- Size: the pattern can progress from one location to a different one
- Edge features may be present that can indicate direction of travel

2.7.5.1.7. **Expiration Pattern:**

- Requires the presence of spatter stains
- Distribution: radiating or random distribution, generally not linear or curvilinear
- Appearance: the presence of saliva can cause bubble rings within some stains, lighter color of some stains, ligament strands/line structures/possible mucus connecting one or more stains
- Documented blood in the airway or a documented injury to the nose, mouth, or other respiratory system can support this classification, but the absence of this information should not alone cause the pattern to be excluded.

2.7.5.1.8. **Forward Spatter Pattern:**

- Requires the presence of spatter stains
- Distribution: random or radiating distribution, generally not linear or curvilinear
- Appearance: stains may have a lighter color if cerebral-spinal fluid is present
- A documented exit gunshot wound is required to definitively limit classification to this pattern. May contain a bullet defect within the immediate vicinity but the absence of a bullet defect does not necessarily exclude this pattern type

2.7.5.1.9. **Impact Pattern:**

- Requires the presence of spatter stains
- Distribution: radiating or random distribution, generally not linear or curvilinear
- Appearance: if a parent stain from the blood source that was impacted is present, the edges of the parent stain may have spines or streaks and have inconsistent internal coloration
- Documented blunt force injuries can support this classification, but the absence of this documentation should not alone exclude it

2.7.5.1.10. **Insect Stain:**

- Some stains may have features similar to spatter stains. The type of insect involved affects the features of the stains.
- Shape: Can be circular to elliptical with some stains having wavy tails. Stains on horizontal surfaces may be irregularly shaped or be wavy lines extending from a blood source
- Size: generally 1-2mm or less. Wavy lines extending from a blood source are generally 3mm wide or less.

2.7.5.1.11. **Pool:**

- Size: generally multiple inches to multiple feet wide, depending on the volume of blood
- Shape: irregular shape but has smooth edges, unless they have been altered or affected by the target surface
- Typically has consistent internal coloration. Serum separation, blood clots, and/or flaking may be observed.

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2.7.5.1.12. **Projected Pattern:**

- Typically requires the presence of spatter stains; however, some stains may be greater than 5mm and have enough volume for flows to occur
- Size: generally contains stains of various sizes but can have stains with consistent sizes too
- Distribution: typically linear to curvilinear but sometimes radiating. Curvilinear distributions can have undulating or inverted U patterns
- On horizontal surfaces, stains 1cm or larger may have spines on their edges and be surrounded by satellite stains. A documented injury to a major blood vessel can support this classification, but the absence of this documentation should not alone exclude it. May be difficult to distinguish between a projected pattern, drip pattern, or splash pattern. Can use "large volumes of free-falling blood" if uncertain.

2.7.5.1.13. **Satellite Stains:**

- Requires the presence of spatter stains
- Distribution: radiating or random but not linear or curvilinear. When on a vertical surface, there may be a bowl-shaped void in the center.
- Appearance: some stains may be irregularly shaped
- When on non-moveable objects like walls and floors, these stains will be in the immediate vicinity of the parent stain, unless the parent stain has been removed. When a parent stain from a large volume of free-falling blood is present at the scene, satellite stains must be considered for moveable objects collected from the scene or that may have been removed from the scene

2.7.5.1.14. **Spatter:**

- Size: generally 5mm or smaller, but larger stains are possible
- Shape: circular to elliptical
- Appearance: trailing edge for elliptical stains can be smooth, have a single tail, or be jagged. The directionality is determined by the trailing edge.

2.7.5.1.15. **Splash Pattern:**

- Requires the presence of spatter stains and a parent stain. The parent stain must be on a horizontal surface, but the spatter stains can be on horizontal or vertical surfaces.
- Distribution: spatter stains are in a radiating distribution
- Size: besides the spatter stains, typically has many other circular to elliptical stains of various sizes, and the parent stain can be multiple inches wide
- On horizontal surfaces, the parent stain and stains 10mm or larger may have spines on their edges and be surrounded by satellite stains. May be difficult to distinguish between a splash pattern, drip pattern, and projected pattern. Can use "large volumes of free-falling blood" if uncertain.

2.7.5.1.16. **Swipe:**

- Shape: generally an irregular shape, but some stains or parts of stains may have a wide, linear shape
- Appearance: some edges may be well-defined while others may not be and show feathering. Areas of the stain shall have internal striations or uneven coloration
- There may not be sufficient features to determine the direction of movement. Features that can assist in determining the direction of movement include a buildup of blood along some parts of the edges ("plowing", "pushing", "pushed blood"), or feathering on one end of the stain. It may not always be possible to definitely discern a swipe from a wipe, so concluding wipe/swipe is also acceptable.

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2.7.5.1.17. **Transfer Stain:**

- Shape: generally an irregular shape but some stains or parts of stains may have recognizable shapes
- Appearance: edges of the stain can be defined or undefined. The stain may have areas of uneven coloration
- There may not always be enough features present to determine the original blood-bearing object. Assigning the stain to a type of object shall only occur when the stain contains fine details specific to the object (e.g., apparent ridge detail, fine lines of an apparent fabric impression, or repeating geometric shapes of apparent footwear). The difference between a transfer stain and a swipe is that a swipe contains features of lateral movement along the target surface while a transfer stain does not.

2.7.5.1.18. **Wipe (alteration):**

- A perimeter stain must be present.
- Shape: generally an irregular shape, but some stains or parts of stains may have a wide, linear shape
- Appearance: some edges may be well-defined while others may not be and show feathering. Areas of the stain shall have internal striations or uneven coloration
- There may not be sufficient features to determine the direction of movement. Features that can assist in determining the direction of movement include a buildup of blood along some parts of the edges ("plowing", "pushing", "pushed blood") or feathering on one end of the stain. It may not always be possible to definitely discern a swipe from a wipe, so concluding wipe/swipe is also acceptable.

2.7.5.1.19. When physical characteristics are insufficient and/or uncertainty is present to reasonably classify stains as a specific pattern classification, it is recommended that the FS/CSI conservatively refer to the stains by a more general classification and/or the physical characteristics present (i.e. spatter as opposed to impact pattern or cast-off). And if it is not possible to provide any sort of classification, that shall be noted with an explanation for why classification could not be made.

2.7.5.2. **Sequencing:**

- 2.7.5.2.1. The sequencing of bloodstain patterns can be beneficial in determining a possible relative chronological order of events. It should not, however, be solely utilized to determine an absolute chronology due to the numerous variables involved with the drying and depositions of bloodstains. Sequencing can involve a determination of which pattern type may have occurred first or a determination about movement/alteration within the pattern type.
- 2.7.5.2.2. Features/observations that may assist with sequencing would indicate disruptions within the features of one pattern type as a direct result of the other pattern type, movement of the target surface, and/or alteration of the pattern. Examples may include, but are not limited to, voids, flow patterns, flaking, perimeter stains, wipes/swipes, clotting, and serum separation. All conclusions for sequencing shall be supported with feature-based observations.

2.7.5.3. **Impact Angle:**

- 2.7.5.3.1. Label each selected stain with a unique identifier. Place a metric scale adjacent to each stain and a horizontal level line under each stain. Photograph each stain.
- 2.7.5.3.2. To determine the angle of impact, take measurements using a magnifier loupe with a scale, caliper, or ruler with 0.5mm increments or smaller. Measure the width and

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length of individual stains within a pattern. The calculated measurement uncertainty shall be included with impact angle results. Utilize a scientific calculator to complete the angle of impact calculation using the following formula:

$$\sin^{-1}(\text{width/length}) = \text{angle of impact}$$

2.7.5.4. Area of Convergence:

- 2.7.5.4.1. Select individual spatter stains in a representative distribution spanning the pattern. Stains selected should have upward directionality and be well formed. Draw a line or place a string along the direction of travel. The area where the lines or strings converge is the area of convergence. Record the location range.

2.7.5.5. Area of Origin:

- 2.7.5.5.1. **Tangent Method:** The tangent will give the height (distance) from the area of convergence in three-dimensional space. The calculated measurement uncertainty shall be included with area of origin results. Use the following formula:

$$\tan(\theta) = H/D \text{ or } H = \tan(\theta)D$$

θ = angle of impact

D = distance to area of convergence

H = height (distance) from target surface

- 2.7.5.5.2. **Stringing Method:** Using a protractor, a string is pulled away from the leading edge of each selected stain at the angle of impact. Attach the string to a yard stick or dowel assembled perpendicular to the target surface at the area of convergence. A tripod is suggested for attaching the yard stick and/or string to. When completed, the strings will encompass the area of origin in three-dimensional space. Record the range of distance and photograph. The calculated measurement uncertainty shall be included with area of origin results.

2.8. References:

- 2.8.1. Wolson, Toby L. (Ed.). (2025, 1st edition). *Handbook of Bloodstain Pattern Analysis*. CRC Press.
- 2.8.2. Bevel, Tom, & Gardner, Ross M., (2008, 3rd edition). *Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction*. CRC Press.
- 2.8.3. ASB Technical Report 033, First Edition 2017, Terms and Definitions in Bloodstain Pattern Analysis.
- 2.8.4. ANSI/ASB Standard 030, First Edition 2019. Standard for Quality Assurance Program in Bloodstain Pattern Analysis.
- 2.8.5. ANSI/ASB Standard 031, First Edition 2020. Standard for Report Writing in Bloodstain Pattern Analysis.
- 2.8.6. ANSI/ASB Standard 032, Second Edition 2026. Standards for a Bloodstain Pattern Analyst's Training Program.

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- 2.8.7. ANSI/ASB Standard 072, First Edition 2019. Standard for Validation of Procedures in Bloodstain Pattern Analysis.
- 2.8.8. ANSI/ASB Standard 157, First Edition 2023. Required Components for a Proficiency Testing Program in Bloodstain Pattern Analysis.
- 2.8.9. ANSI/ASB Standard 158, First Edition 2023. Standard for Developing Standard Operating Procedures in Bloodstain Pattern Analysis.
- 2.8.10. ANSI/ASB Standard 198, First Edition 2025. Standard for the Technical Review of Bloodstain Pattern Analysis Reporting.
- 2.8.11. OSAC 2022-S-0030 Standard for Methodology in Bloodstain Pattern Analysis.
- 2.8.12. Dror, I.E., and Kukucka, J., "Linear Sequential Unmasking-*Expanded* (LSU-E): "A general approach for improving decision making as well as minimizing noise and bias." *Forensic Science International. Synergy* vol. 3 100161. 13 Aug. 2021
- 2.8.13. National Commission on Forensic Science, "Ensuring the forensic analysis is based upon task-relevant information".
- 2.8.14. Hicklin, R. Austin, et al., 2021. Accuracy and reproducibility of conclusions by forensic bloodstain pattern analysts. *Forensic Science International* 325 (2021) 110856.
- 2.8.15. Osborne, Nikola K. P., et al., 2016. Bloodstain pattern classification: Accuracy, effect of contextual information and the role of analyst characteristics. *Science and Justice* 56 (2016) 123-128.
- 2.8.16. D. Attinger, et al. 2013. Fluid dynamics topics in bloodstain pattern analysis: Comparative review and research opportunities. *Forensic Science International* (2013)
- 2.8.17. Williams, Elisabeth M. P., et al., 2019. The Dynamics of Blood Drop Release from Swinging Objects in the Creation of Cast-Off Bloodstain Patterns. *Journal of Forensic Sciences*, March 2019, Vol. 64, No. 2.

3. Textile Bloodstain Pattern Analysis

- 3.1. **Scope:** This test method is designed for FSD personnel to assist investigations into a variety of alleged criminal activities, where bloodstain patterns may be present at crime scenes and/or on physical evidence involving textile surfaces. During the examination for potential areas of bloodstain pattern evidence, appropriate notes and photographs shall be taken regarding the evidence unless no bloodstains are observed. It is not required that the actual stained area be retained after analysis is complete.
- 3.2. **Precautions/Limitations:**
 - 3.2.1. Evidence should be handled in a manner that will not alter the appearance of stains. Staining should be documented via notes and photographs prior to any marking, serological testing, or sampling.
 - 3.2.2. Not all bloodstains exhibit discernable patterns or are suitable for informative conclusions, opinions, or interpretations. A number of factors may limit the ability to draw conclusions regarding the classifications of some bloodstain patterns. These factors may include, but are not limited to:
 - Quantity and quality of stains present
 - Environmental factors

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- Effect of target surface features
- Limiting factors on measurements and calculations
- Nature of the injuries or wounds
- Clean-up activities after stains were deposited
- Effect(s) of first responders on the scene and other evidence

Therefore, it is not possible, nor practical, to describe every bloodstain that may have been observed or noted during the investigation of a bloodshed event.

- 3.2.3.** Bloodstain patterns created from different mechanisms or forces can have similar or indistinguishable features.
- 3.2.4.** A single mechanism can create bloodstain patterns with different features depending on:
- Volume of liquid blood involved
 - Amount of force
 - Presence or absence of intervening objects
 - Features and orientation of the target surface
- 3.2.5.** A single area may contain multiple overlapping patterns and classification may not be possible.
- 3.2.6.** Measurements are approximate and considered qualitative.
- 3.2.7.** No reconstructive experimentation should be performed.
- 3.2.8.** Any reference to conclusions from other forensic reports are considered to be summary statements only. Refer to the referenced forensic report and/or respective reporting analyst for a more complete discussion of the specific conclusion.
- 3.2.9.** Unless otherwise noted, statements of “spatter stains” indicate that these stains were observed on a particular item; however, they were not deposited in a manner to be able to determine the specific mechanism for deposition. Spatter stains do not necessarily indicate a violent act occurred near a particular item, only that airborne droplets of blood were created when a force was applied to liquid blood.
- 3.2.10.** Any additional information, statements, or evidence received after the completion of the report may change the results/opinions/conclusions stated within the notes and report.
- 3.2.11.** The surfaces of clothing constantly change as individuals move while wearing the clothing. This changing, three-dimensional nature of clothing can have significant effects on stains and patterns. A pattern created by a single event can have different features as the stains are deposited on target surfaces with different orientations.
- 3.2.12.** Limited conclusions can be drawn from textile surfaces for various reasons:
- Limited published research on the interactions of liquid blood on textiles
 - Textile surfaces allow for the possibility of stain size and shape alteration due to spreading and/or wicking
 - A limited amount of detail available to discern between specific pattern classifications due to surface effects
 - Chemical and mechanical finishes applied to many textiles can influence the interaction the textile has with blood

3.3. Related Information:

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3.3.1. Bloodstain Pattern Analysis Worksheet Manual

3.4. Instruments/Equipment:

- 3.4.1. Ruler**
- 3.4.2. Loupe**
- 3.4.3. Caliper**
- 3.4.4. Camera**
- 3.4.5. iPad**
- 3.4.6. IR Camera**
- 3.4.7. Foster + Freeman Crime-lite® ML2**
- 3.4.8. LEEDS LSV2**
- 3.4.9. Stereomicroscope**

3.5. Hazards/Safety:

- 3.5.1.** Universal precautions shall always be used during the processing of biological evidence. FSs shall wear appropriate personal protective equipment.

3.6. Reference Materials/Controls/Calibration Checks:

- 3.6.1.** Digital Caliper Certification

3.7. Procedures/Instructions:

- 3.7.1.** All items of evidence shall be marked with the proper case number, item number, and other identifying marks when possible.

3.7.2. Examination process:

- 3.7.2.1.** Bloodstain pattern analysis shall utilize a stepwise, feature based methodology that provides data supported interpretations. This method shall also incorporate a linear sequential unmasking - expanded approach to minimize contextual bias due to task irrelevant data.
- 3.7.2.2.** A visual exam shall be performed in which the FS attempts to identify any bloodstains present and document the observed characteristics such as size, shape, and distribution via photographs and notes. Based upon these characteristics, the FS shall then classify the stains into pattern types where appropriate. Examination can be assisted with the use of ALS, stereomicroscopes, loupes and/or calipers. It may not always be possible to classify a stain into one specific pattern or to classify it at all. All patterns that cannot be excluded should be clearly documented.
- 3.7.2.3.** Once the stains are classified into possible pattern types, any additional information available should also be evaluated, which includes but is not limited to: DNA analysis results, autopsy/injury information, or any additional case information. The FS shall then refine the classifications that could not be excluded previously based on this additional information when possible. All observations and conclusions shall be recorded in the case notes.
- 3.7.2.4.** If additional case information indicates that a pattern type should have been included previously but was not, a referee analysis shall be performed. However, a pattern type

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shall not be included based solely on contextual information (i.e. no observable features to support that pattern).

- 3.7.2.5. If the FS is not performing their own serological examinations, they should wait to issue the BPA report until after the Certificate of Analysis or report containing the associated serology testing has been issued. And, if possible, after all other forensic reports have been issued.

3.7.3. Records:

3.7.3.1. Photographic:

- 3.7.3.1.1. A digital camera or iPad and associated equipment (tripods, lenses, flashes, etc.) shall be used to complete the photography needed to document the evidence and/or crime scene. The photographs should be taken with the camera set in JPEG format and with the resolution being set at the highest available setting. The digital files from the camera shall be stored on a secure electronic medium as per FSD's policy.
- 3.7.3.1.2. Overall, mid-range, close-up, and technical photos of staining should be taken to establish location and position of staining.
- 3.7.3.1.3. Stains on dark surfaces may be photographed using IR cameras to better visualize and document the staining.
- 3.7.3.1.4. If no staining is observed, photographs are not required.

3.7.3.2. Notes:

- 3.7.3.2.1. Textile composition information from manufacturer's tag and textile treatment, if applicable (e.g. UV resistance, wrinkle resistance, etc.)

3.7.3.2.2. Macroscopic:

- 3.7.3.2.2.1. Notes shall include item and stain descriptions. Sketches should be included when appropriate, or an annotated image of the item.
- 3.7.3.2.2.2. The features that should be considered for inclusion in notes include, but are not limited to the following:
- Size: size of the overall pattern, when appropriate, and size range of individual stains within the overall pattern. Measurements shall be in metric units.
 - Shape: shape of the overall pattern and shape(s) of individual stains within the overall pattern
 - Distribution: how the individual stains are arranged (e.g. random, radiating, linear, curvilinear) and specific features within the overall pattern (e.g. change in stain density along the pattern, change in stain size or shape on one side compared to the other)
 - Appearance: blood coloration (e.g. consistent or inconsistent), edge characteristics (e.g. smooth, scalloped, spines, undefined), possible diluted appearance, clotted, flaking, alterations
 - Directionality: may not be discernable on many textile substrates and caution should be used if making a directionality determination. Observations to support directionality should also consider whether the observed edge

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characteristics could be target surface effects rather than indications of direction

-Location: clothing/fabric locations are described under the assumption that it was worn/used in the normal manner unless otherwise noted.

-Target surface features: smooth or textured, fixed or moveable, vertical or horizontal

-Classification or not with reasoning provided based on the examined stain evidence

3.7.3.2.3. Microscopic:

3.7.3.2.3.1. Analysis using a stereomicroscope shall be performed. Microscopic analysis on fabrics may provide additional staining detail to differentiate between spatter or transfer stains.

3.7.3.2.3.2. Observations may include: coated fibers, microsatellites, fabric construction (e.g. weave, knit, etc.), rim features, color consistency, and penetrates the fabric construction or sits on top of the yarns.

3.7.4. Analysis:

3.7.4.1. Classification:

3.7.4.1.1. Drip Stain:

-Shape: circular on horizontal surfaces, elliptical on non-horizontal surfaces

-Size: generally on 10-25mm but typically smaller on textile surfaces

-Appearance: individual stains have edges which are smooth, scalloped or have spines; however, textile surfaces may obscure these edge characteristics

3.7.4.1.2. Saturation Stain:

-Size: generally multiple inches or larger

-Shape: irregularly shaped

-Depending on the volume of blood present as well as the features of the textile material, the stain may have a variable or lighter coloration to it

3.7.4.1.3. Spatter:

-Size: generally 5mm or smaller, although larger stains are possible

-Shape: circular to elliptical. Stains on textile material may not exhibit features of directionality

-Appearance: individual stains penetrate into the construction of textiles. Occasionally there may be microsatellites

3.7.4.1.4. Swipe:

-Shape: generally has an irregular shape but some stains or parts of stains may have a wide linear shape

-Appearance: some edges of the stain may be well-defined while others may not be and show feathering. Areas of the stain shall have internal striations or uneven coloration to indicate lateral movement. Textiles may bunch up while this pattern is being created causing random internal voids with sharp, well-defined edges. There may be areas of light staining separated from the edges of the main area(s) of staining

-Most of the staining will be on the surface of the textile with little to no penetration into the construction of the textile. Although there may be clear features of lateral

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movement of a blood-bearing object along the target surface, there may not be sufficient details to determine direction of movement. Features that can be used to assist in determining direction of travel include a buildup of blood along one side of the yarns or orientation of fibers above the surface of the fabric in the direction of movement. May not always be possible to definitely discern a swipe from a wipe, so concluding wipe/swipe is also acceptable.

3.7.4.1.5. **Transfer Stain:**

- Shape: generally has an irregular shape but some stains or parts of stains may have recognizable shapes

- Size: variable sizes. Depending on the nature of the original blood-bearing object as well as the amount of pressure involved in the contact, individual stains may be in the same size range as spatter stains

- Appearance: edges of the stain may be defined or undefined. The stain may have areas of uneven coloration. Textiles may bunch up during pattern creation causing random internal voids with sharp, well-defined edges. Depending on the nature of the contact and textile properties, staining may or may not penetrate into the construction of the textile. Some stains only have light staining on just the surface of the yarns. Fibers raised above the surface of the fabric may be pressed down on the fabric surface within the areas of staining. Coated fibers may also be observed.

3.7.4.1.6. **Wipe (alteration):**

- Shape: generally has an irregular shape but some stains or parts of stains may have a wide linear shape

- Appearance: must have a perimeter stain or parent stain present to support the stain deposition before movement/alteration of the stain occurred. Some edges of the stain may be well-defined while others may not be and show feathering. Areas of the stain shall have internal striations or uneven coloration to indicate lateral movement. Textiles may bunch up while this pattern is being created causing random internal voids with sharp, well-defined edges. There may be areas of light staining separated from the edges of the main area(s) of staining

- Although there may be clear features of lateral movement of a blood-bearing object along the target surface, there may not be sufficient details to determine direction of movement. Features that can be used to assist in determining direction of travel include a buildup of blood along one side of the yarns or orientation of fibers above the surface of the fabric in the direction of movement. It may not always be possible to definitely discern a swipe from a wipe, so concluding wipe/swipe is also acceptable.

3.7.4.2. No impact angle, area of convergence, or area of origin analyses will be performed on textile items.

3.8. **References:**

- 3.8.1. Wolson, Toby L. (Ed.). (2025, 1st edition). *Handbook of Bloodstain Pattern Analysis*. CRC Press.
- 3.8.2. Bevel, Tom, & Gardner, Ross M., (2008, 3rd edition). *Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction*. CRC Press.
- 3.8.3. ASB Technical Report 033, First Edition 2017, Terms and Definitions in Bloodstain Pattern Analysis.
- 3.8.4. ANSI/ASB Standard 030, First Edition 2019. Standard for Quality Assurance Program in Bloodstain Pattern Analysis.

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- 3.8.5. ANSI/ASB Standard 031, First Edition 2020. Standard for Report Writing in Bloodstain Pattern Analysis.
- 3.8.6. ANSI/ASB Standard 032, Second Edition 2026. Standards for a Bloodstain Pattern Analyst's Training Program.
- 3.8.7. ANSI/ASB Standard 072, First Edition 2019. Standard for Validation of Procedures in Bloodstain Pattern Analysis.
- 3.8.8. ANSI/ASB Standard 157, First Edition 2023. Required Components for a Proficiency Testing Program in Bloodstain Pattern Analysis.
- 3.8.9. ANSI/ASB Standard 158, First Edition 2023. Standard for Developing Standard Operating Procedures in Bloodstain Pattern Analysis.
- 3.8.10. ANSI/ASB Standard 198, First Edition 2025. Standard for the Technical Review of Bloodstain Pattern Analysis Reporting.
- 3.8.11. OSAC 2022-S-0030 Standard for Methodology in Bloodstain Pattern Analysis.
- 3.8.12. Dror, I.E., and Kukucka, J., "Linear Sequential Unmasking-*Expanded* (LSU-E): "A general approach for improving decision making as well as minimizing noise and bias." *Forensic Science International. Synergy* vol. 3 100161. 13 Aug. 2021
- 3.8.13. National Commission on Forensic Science, "Ensuring the forensic analysis is based upon task-relevant information".
- 3.8.14. Hicklin, R. Austin, et al., 2021. Accuracy and reproducibility of conclusions by forensic bloodstain pattern analysts. *Forensic Science International* 325 (2021) 110856.
- 3.8.15. Osborne, Nikola K. P., et al., 2016. Bloodstain pattern classification: Accuracy, effect of contextual information and the role of analyst characteristics. *Science and Justice* 56 (2016) 123-128.
- 3.8.16. D. Attinger, et al. 2013. Fluid dynamics topics in bloodstain pattern analysis: Comparative review and research opportunities. *Forensic Science International* (2013)
- 3.8.17. Williams, Elisabeth M. P., et al., 2019. The Dynamics of Blood Drop Release from Swinging Objects in the Creation of Cast-Off Bloodstain Patterns. *Journal of Forensic Sciences*, March 2019, Vol. 64, No. 2.
- 3.8.18. Jiaying, Wu, Michielsen, Stephen, and Baby, Ruksana, 2019. Impact Spatter Bloodstain Patterns on Textiles. *Journal of Forensic Sciences*, May 2019, Vol. 64, No. 3.

4. Image Evidence

- 4.1. **Scope:** This test method is designed for FSD personnel to assist investigations into a variety of alleged criminal activities, where bloodstain patterns may be present at crime scenes and/or on physical evidence involving digital images. During the examination for potential areas of bloodstain pattern evidence, appropriate notes shall be taken regarding the evidence unless no bloodstains are observed.
- 4.2. **Precautions/Limitations:**
 - 4.2.1. Not all bloodstains exhibit discernable patterns or are suitable for informative conclusions, opinions, or interpretations. A number of factors may limit the ability to draw conclusions regarding the classifications of some bloodstain patterns. These factors may include, but are not limited to:

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- Quantity and quality of stains present
- Quality of stain documentation from the scene if not performed by the analyst themselves on site
- Environmental factors
- Effect of target surface features
- Limiting factors on measurements and calculations
- Nature of the injuries or wounds
- Clean-up activities after stains were deposited
- Effect(s) of first responders on the scene and other evidence

Therefore, it is not possible, nor practical, to describe every bloodstain that may have been observed or noted during the investigation of a bloodshed event.

- 4.2.2.** Bloodstain patterns created from different mechanisms or forces can have similar or indistinguishable features.
- 4.2.3.** A single mechanism can create bloodstain patterns with different features depending on:
 - Volume of liquid blood involved
 - Amount of force
 - Presence or absence of intervening objects
 - Features and orientation of the target surface
- 4.2.4.** A single area may contain multiple overlapping patterns and classification may not be possible.
- 4.2.5.** Measurements are approximate and considered qualitative unless they are pertaining to impact angles and area of origin. Therefore, uncertainty of measurement is only applied when calculating impact angles and area of origin.
- 4.2.6.** No reconstructive experimentation should be performed.
- 4.2.7.** Any reference to conclusions from other forensic reports are considered to be summary statements only. Refer to the referenced forensic report and/or respective reporting analyst for a more complete discussion of the specific conclusion.
- 4.2.8.** Unless otherwise noted, statements of "spatter stains" indicate that these stains were observed on a particular item; however, they were not deposited in a manner to be able to determine the specific mechanism for deposition. Spatter stains do not necessarily indicate a violent act occurred near a particular item or individual, only that airborne droplets of blood were created when a force was applied to liquid blood.
- 4.2.9.** Any additional information, statements, or evidence received after the completion of the report may change the results/opinions/conclusions stated within the notes and report.
- 4.2.10.** Digital images submitted for examination pose limits to the bloodstain pattern analyst. The stains and/or patterns observed in these images cannot be serologically tested unless portions were collected and submitted for testing. If stains and/or patterns were tested at the scene, please refer to the appropriate report.
- 4.2.11.** Conclusions are limited to the quality of the photographs submitted. For example, image resolution and the angle at which the photograph is taken. Photographs not taken at 90 degrees can skew stain size and appearance. Additionally, photographs must contain scales or stain measurements cannot be taken. Limited conclusions may still be drawn from photographs without scales.

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4.3. Related Information:

4.3.1. Bloodstain Pattern Analysis Worksheet Manual

4.4. Instruments/Equipment:

4.4.1. Computer with ability to open and view digital images

4.5. Hazards/Safety: N/A

4.6. Reference Materials/Controls/Calibration Checks:

4.6.1. Measurement Uncertainty

4.7. Procedures/Instructions:

4.7.1. All digital images shall be copied from the submitted portable storage devices to a secure electronic medium as per FSD's policy.

4.7.1.1. The date of this action shall be recorded.

4.7.1.2. The original digital image names shall not be modified.

4.7.2. Examination process:

4.7.2.1. Bloodstain pattern analysis shall utilize a stepwise, feature based methodology that provides data supported interpretations. This method shall also incorporate a linear sequential unmasking - expanded approach to minimize contextual bias due to task irrelevant data.

4.7.2.1.1. Digital images shall be evaluated for the presence of apparent blood stains.

4.7.2.1.1.1. Digital images that do not contain any apparent blood stains may be noted as such, either individually or as a grouped listing. No additional notes concerning specific photographic contents are required for these images.

4.7.2.1.1.2. Digital images that do contain apparent blood stains shall be noted with appropriate documentation. These images may be sorted and grouped together based on the stain grouping.

4.7.2.2. The FS will attempt to identify any apparent bloodstains present and document the observed characteristics such as size, shape, and distribution. Based upon these characteristics, the FS shall then classify the stains into pattern types where appropriate. It may not always be possible to classify a stain into one specific pattern or to classify it at all. All patterns that cannot be excluded should be clearly documented.

4.7.2.3. Once the stains are classified into possible pattern types, any additional information available should also be evaluated, which includes but is not limited to: DNA analysis results, autopsy/injury information, or any additional case information. The FS shall then refine the classifications that could not be excluded previously based on this additional information when possible. All observations and conclusions shall be recorded in the case notes.

4.7.2.4. If additional case information indicates that a pattern type should have been included previously but was not, a referee analysis shall be performed. However, a pattern type shall not be included based solely on contextual information (i.e. no observable features to support that pattern type).

4.7.2.5. If the FS is not performing their own serological examinations, they should wait to issue the BPA report until after the Certificate of Analysis or report containing the associated

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serology testing has been issued. And, if possible, after all other forensic reports have been issued.

4.7.3. Records:

4.7.3.1. Photographic:

4.7.3.1.1. Annotated photos – any image that is to be edited or annotated shall have the original image saved. The annotated image will then be saved with a naming convention that indicates that it has been edited (such as image 001_markup or image 002_flipped horizontally, etc.). Annotated image names should contain at least the original image name in addition to the edit description.

4.7.3.1.2. Notes:

4.7.3.1.2.1. Notes shall reference the specific images that support the documentation of stain size, shape, distribution, color, appearance, locations and conclusions for the pattern types.

4.7.4. Analysis:

4.7.4.1. Classification:

4.7.4.1.1. Classification of pattern types in digital images shall follow the guidelines stated herein for bloodstains observed on non-porous and textile surfaces, with considerations for the limitations of evaluating bloodstains in digital images.

4.7.4.2. Impact angle, area of convergence, and area of origin may only be calculated on non-porous surfaces within digital images.

4.7.4.2.1. Area of origin can only be calculated by the tangent method in digital images. The stringing method is not practical for digital images.

4.7.4.2.2. See sections 2.7.5.3 through 2.7.5.5.1 to perform these calculations.

4.8. References:

- 4.8.1. Wolson, Toby L. (Ed.). (2025, 1st edition). *Handbook of Bloodstain Pattern Analysis*. CRC Press.
- 4.8.2. Bevel, Tom, & Gardner, Ross M., (2008, 3rd edition). *Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction*. CRC Press.
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- 4.8.5. ANSI/ASB Standard 031, First Edition 2020. Standard for Report Writing in Bloodstain Pattern Analysis.
- 4.8.6. ANSI/ASB Standard 032, Second Edition 2026. Standards for a Bloodstain Pattern Analyst's Training Program.
- 4.8.7. ANSI/ASB Standard 072, First Edition 2019. Standard for Validation of Procedures in Bloodstain Pattern Analysis.
- 4.8.8. ANSI/ASB Standard 157, First Edition 2023. Required Components for a Proficiency Testing Program in Bloodstain Pattern Analysis.

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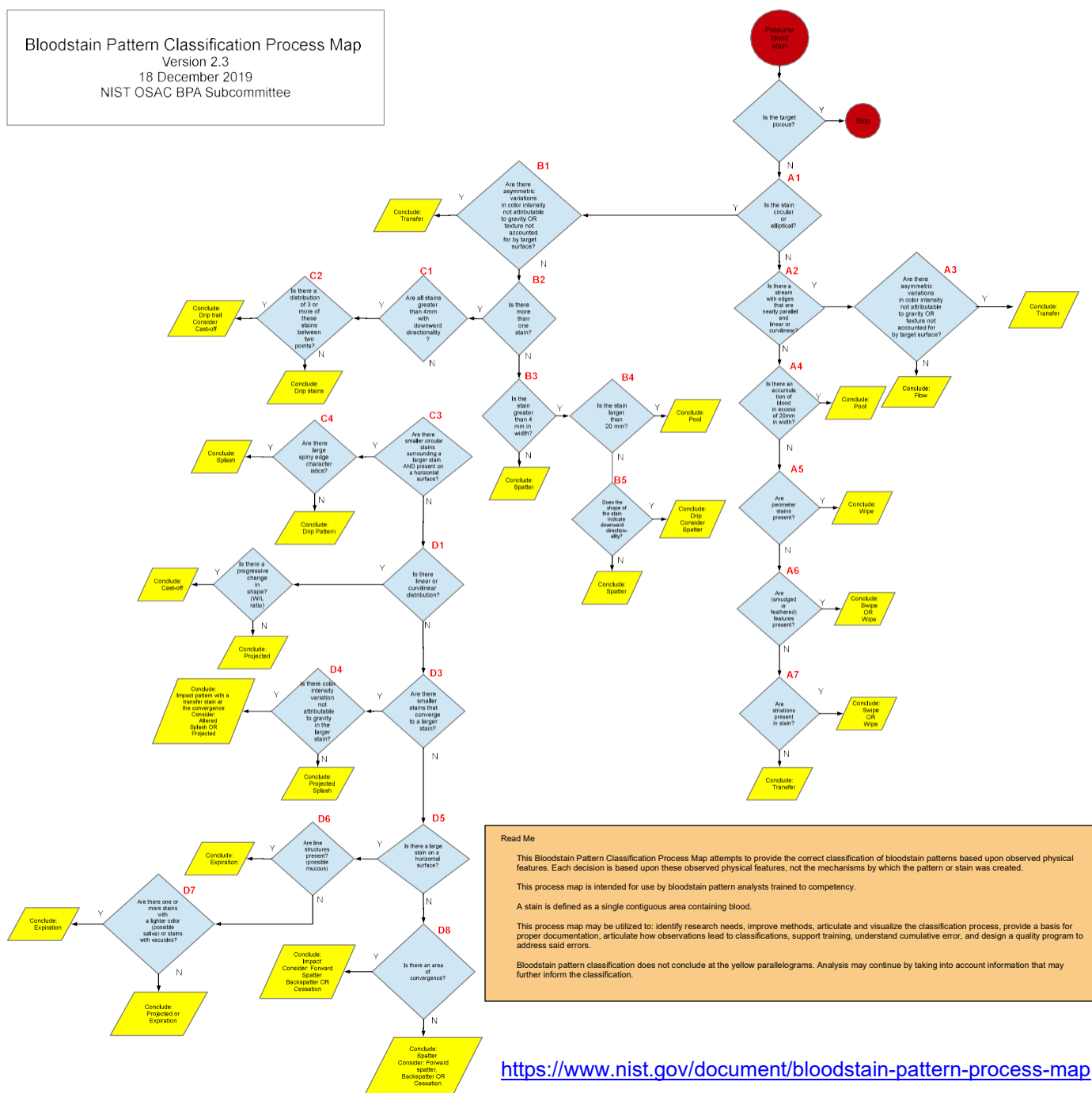
- 4.8.9. ANSI/ASB Standard 158, First Edition 2023. Standard for Developing Standard Operating Procedures in Bloodstain Pattern Analysis.
- 4.8.10. ANSI/ASB Standard 198, First Edition 2025. Standard for the Technical Review of Bloodstain Pattern Analysis Reporting.
- 4.8.11. OSAC 2022-S-0030 Standard for Methodology in Bloodstain Pattern Analysis.
- 4.8.12. Dror, I.E., and Kukucka, J., "Linear Sequential Unmasking-*Expanded* (LSU-E): "A general approach for improving decision making as well as minimizing noise and bias." *Forensic Science International. Synergy* vol. 3 100161. 13 Aug. 2021
- 4.8.13. National Commission on Forensic Science, "Ensuring the forensic analysis is based upon task-relevant information".
- 4.8.14. Hicklin, R. Austin, et al., 2021. Accuracy and reproducibility of conclusions by forensic bloodstain pattern analysts. *Forensic Science International* 325 (2021) 110856.
- 4.8.15. Osborne, Nikola K. P., et al., 2016. Bloodstain pattern classification: Accuracy, effect of contextual information and the role of analyst characteristics. *Science and Justice* 56 (2016) 123-128.
- 4.8.16. D. Attinger, et al. 2013. Fluid dynamics topics in bloodstain pattern analysis: Comparative review and research opportunities. *Forensic Science International* (2013)
- 4.8.17. Williams, Elisabeth M. P., et al., 2019. The Dynamics of Blood Drop Release from Swinging Objects in the Creation of Cast-Off Bloodstain Patterns. *Journal of Forensic Sciences*, March 2019, Vol. 64, No. 2.
- 4.8.18. Jiaying, Wu, Michielsen, Stephen, and Baby, Ruksana, 2019. Impact Spatter Bloodstain Patterns on Textiles. *Journal of Forensic Sciences*, May 2019, Vol. 64, No. 3.

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**APPENDIX 1
PROCESS MAP**

INDIANA STATE POLICE BLOODSTAIN PATTERN ANALYSIS TEST METHODS

Bloodstain Pattern Classification Process Map
Version 2.3
18 December 2019
NIST OSAC BPA Subcommittee



Note: This process map is intended to be used as an analysis tool only for non-porous surfaces

INDIANA STATE POLICE BLOODSTAIN PATTERN ANALYSIS TEST METHODS

APPENDIX 2 REPORT WORDING

REPORT WORDING RULES

These are general wording guidelines for commonly occurring test results. Alterations must be approved by a BPA supervisor. Many of the words in these guidelines that are in uppercase should be changed to reflect your results (e.g. PERSON, ITEM X, etc.). Words or phrases in [] are optional.

In this appendix, the word “subitem” refers to a part of a submitted item of evidence that is considered distinctly separate and would not be combined with other subitems for testing/analysis regardless of whether or not a sample is retained.

REPORT FORMATTING WHEN USING JUSTICE TRAX

1. Reports shall be typed into a Word document with specific formatting.
2. The Word document shall have no indents, tabs special formatting, or font/size changes. The report shall be written in default Normal style.

GENERAL REPORT FORMATTING

1. **Original items** and their descriptions shall be bolded and underlined. Multiple original items shall be separated with a horizontal line of underscores.
2. **Subitems** and their descriptions (if applicable) may be bolded.
 - a. Subitem headers and required formatting (bold, underlined, or italicized) are required when you have different tiers in the same report.
3. **Sub-subitems** may be grouped by results under underlined headings.
4. Line breaks: At least one blank line shall separate all items, subitems, and other individual results. Multiple blank lines may be used to enhance clarity or readability.

GENERAL REPORT RULES

1. Report wording may be altered with the approval of a BPA supervisor.
2. The appropriate appendix with appropriate definitions and explanations shall be attached to the end of each report. Reports in which the entire request has been withdrawn do not require an appendix.
3. Serology results shall be reported prior to any patterns for each item.
4. No serology statement is needed if no serology testing is performed.
5. Item numbers shall include all leading zeroes.
6. Items shall be reported in numerical order.
7. Item descriptions in the results section:
 - 7.1. The description of each item shall be similar, but need not be identical, to the item description in the submission section.
 - 7.2. The description shall not include the packaging.

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- 7.3. The description shall include the number of samples in parentheses when it is not otherwise apparent.
8. The significant contents of an item shall be listed in the results section.
 9. Similar results within an item may be grouped together.
 10. All submitted samples in an item not examined shall be described as not examined in the report using the appropriate wording.
 11. Stains that have the obvious and reasonable appearance of being blood due to the physical characteristics present, scene context, and the FS's/CSI's knowledge, training, and experience may be referred to as being blood if combined with a preceding qualifier such as "apparent", "appeared to be", etc. even when no serology testing has been performed. The qualifying statement indicating stains were not tested shall be included.
 12. When obvious physical characteristics are insufficient and/or scene context is limited to reasonably refer to stains as "apparent blood" etc., it is recommended that the FS/CSI conservatively refer to them as only "stain(s)" and by the physical characteristics present.
 13. Origin determinations may appear in scene specific reports but should refrain from specifying whose blood created the pattern(s) until the completion of confirmatory laboratory testing (e.g. DNA, pathology, and latent prints).
 14. When overlapping/complex bloodstain patterns are present, a combination of the report wordings should be used.
 15. The absence of bloodstains, when relevant to the conclusions, should be reported.
 16. Example wording includes millimeters for the measurement units, but other acceptable units include centimeters, inches, and feet.

SEROLOGY STATEMENTS

Citations shall refer to the Report Appendix to reflect the test(s) supporting the result.

NEGATIVE RESULT

No blood was detected.^{A or A/B or B or C}

POSITIVE CONFIRMATORY RESULT

Human blood was confirmed.^D

POSITIVE PRESUMPTIVE RESULT

Blood was indicated by presumptive testing.^{A or A/B or B or C}

NEGATIVE CONFIRMATORY RESULT

In addition to positive presumptive result.

Confirmatory testing was negative for human blood.^D

INCONCLUSIVE PRESUMPTIVE RESULTS

When luminol tests positive but phenolphthalein tests negative

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Testing for the possible presence of blood was inconclusive.^{A/B}

ADDITIONAL AREAS OF STAINING OBSERVED BUT NOT ANALYZED

This statement is placed at the end of the item.

Additional areas of staining were observed.

NO STAINING WAS OBSERVED

No [blood]stains were observed.

BEGINNING OF REPORT STATEMENTS

COMMENT IF NO TESTING OF STAINS WAS PERFORMED

To be included at the beginning of the report. Exercise caution when using terms such as “blood” and “bloodstain” unless serology testing results indicate the presence of blood.

The term “blood” in this report refers to possible or apparent bloodstains based on physical appearance, no presumptive chemical testing was performed on the stains [at this time].

COMMENT IF CLOTHING ITEMS ARE PRESENT

Unless otherwise noted, clothing is assumed to be worn in the traditional fashion.

ITEMS NOT EXAMINED

ITEMS OR SUBITEMS NOT EXAMINED

For subitems not examined, the statement is placed at the end of the item.

The ITEMDESCRIPTION (ITEM X) was not examined.

WITHDRAWAL STATEMENTS

The request for Bloodstain Pattern Analysis was withdrawn by John Smith, Police Department, on Date. The item(s) will be returned to the submitting agency.

The request for laboratory examination was withdrawn per information found in MyCase, Cause Number: CAUSE NO, DATE. The item(s) will be returned to the submitting agency. If analysis is needed, please re-submit the item(s) to the Forensic Services Division.

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BLOODSTAIN PATTERN STATEMENTS

NO PATTERNS

No discernable pattern was detected on ITEM X.

Due to the limited quantity of [blood]staining on ITEM X, no apparent bloodstain patterns could be determined.

SPATTER

A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm round/elliptical/oval [blood]stains in a radiating/random distribution, which is consistent with being spatter. [The overall pattern measured approximately Xmm by Xmm.]

IMPACT PATTERN

A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm round/elliptical/oval [blood]stains in a radiating distribution, which is consistent with being an impact pattern. [The overall pattern measured approximately Xmm by Xmm.]

CAST-OFF PATTERN

A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm round/elliptical/oval [blood]stains in a linear/curvilinear distribution, which is consistent with being a cast-off pattern. [The overall pattern measured approximately Xmm by Xmm.]

EXPIRATION PATTERN

A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm round/elliptical/oval [blood]stains in a random distribution [with some stains having a lighter color, with line structures (possible mucous strands), with bubble rings,] which is consistent with being an expiration pattern.

PROJECTED PATTERN

A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm round/elliptical/oval [blood]stains in a random/radiating/linear/curvilinear distribution with flows, which is consistent with being a projected pattern. [The overall pattern measured approximately Xmm by Xmm.]

SPLASH PATTERN

A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm circular/elliptical/spinous [blood]stains surrounding a Xmm by Xmm [blood]stain with spiny edge characteristics, which is consistent with being a splash pattern. [The overall pattern measured approximately Xmm by Xmm.]

DRIP PATTERN

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A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm circular/elliptical [blood]stains surrounding a Xmm by Xmm [blood]stain, which is consistent with being a drip pattern. [The overall pattern measured approximately Xmm by Xmm.]

DRIP STAIN

A round [blood]stain measuring approximately Xmm was observed and is consistent with being a drip stain.

DRIP TRAIL

[Approximately] #OFSTAINS round [blood]stains in a linear distribution were observed and measured approximately Xmm to Xmm, which is consistent with being a drip trail. [The overall pattern measured approximately Xmm by Xmm.]

FLOW

A flow/flows was/were observed [that are/is consistent with gravity] [that indicated the item or person moved or were moved after blood flow was initiated].

SATURATION STAIN

A [heavy] [blood]stain was observed and measured approximately Xmm by Xmm, which is consistent with being a saturation stain.

WIPE/SWIPE

A [irregularly shaped or observed shape] [blood]stain with smudged/feathered features/striations was observed and measured approximately Xmm by Xmm, which is consistent with being a wipe/swipe.

A [irregularly shaped or observed shape] [blood]stain with a perimeter stain measuring Xmm and smudged/feathered features/striations was observed and measured approximately Xmm by Xmm, which is consistent with being a wipe.

VOID

A void area was observed, which measured approximately Xmm. The void is consistent with the presence of an intermediate target being present during the time of blood deposit.

TRANSFER STAIN

A [blood]stain was observed [with variations in color intensity] [lines of demarcation, ridge detail, other appearance observations to support possible object], which is consistent with being a transfer stain, possibly from a GENERALOBJECT [straight-edged instrument, a blunt object, etc.]. The stain measured approximately Xmm by Xmm.

A [blood]stain was observed with variations in color intensity, which is consistent with being a transfer stain; however, the possible source of the transfer stain could not be determined. The stain measured approximately Xmm by Xmm.

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CONSISTENT WITH MORE THAN ONE PATTERN TYPE

It is the analyst's discretion to report out the specific pattern types or a more general classification (e.g. spatter).

A pattern was observed consisting of approximately #OFSTAINS of approximately Xmm to Xmm [appropriate stain descriptions], which is consistent with being either PATTERN TYPE A or PATTERN TYPE B. Due to the features observed, neither pattern classification can be excluded as the potential mechanism for this pattern.

ANGLE OF IMPACT

Angle to the nearest whole degree.

The angle of impact was determined to be approximately X°.

AREA OF CONVERGENCE AND AREA OF ORIGIN

The area of convergence for this bloodstain pattern was determined to be approximately X - X.

The area of origin for this bloodstain pattern was determined to be approximately X.

The blood source for the pattern appears to have originated from LOCATION [near the floor/near the doorknob/near light switch, etc.].

OTHER

FOR MOVEMENT OF VICTIM

The bloodstaining on ITEM X is consistent with the victim moving or being moved after blood flow was initiated.

ALTERATION

The PATTERN TYPE appeared to be altered by a wipe.

SEQUENCING

This statement is placed at the end of the item. Use caution when reporting sequenced patterns.

PATTERN1 appeared to occur before/after PATTERN2 based upon the following observed characteristics: [appropriate stain descriptions].

Flow patterns indicate movement of the position of X from Y to Z.

INDIANA STATE POLICE BLOODSTAIN PATTERN ANALYSIS TEST METHODS

END OF REPORT STATEMENTS

COMMENT AT CONCLUSION OF REPORT

The observations, conclusions, opinions, and interpretations in this report are based on the evidence, which was visually examined through DATE. The submission of any additional evidence may affect these observations, conclusions, opinions, and interpretations.

MEASUREMENT OF UNCERTAINTY

Required to be included in any report detailing results and measurements for Impact Angles and/or Area of Origin. The measurement uncertainty in effect when the measurements were taken shall be used.

Based on a 99% confidence interval, the Impact Angle/Area of Origin calculation[s] contain an uncertainty of $\pm$ Xmm.

REFERENCES FOR CONTEXTUAL INFORMATION/REFINEMENT

All reports should be properly referenced with the author's name, date issued or laboratory request number.

The following information was referenced during the course of analysis: [examples include other forensic discipline reports such as biology, DNA, latent prints, etc.; autopsy/pathology reports; crime scene/investigator reports, etc.].

REQUEST FOR ADDITIONAL INFORMATION

Additional information is needed regarding [list needed information] before conclusions can be drawn from item X.

INDIANA STATE POLICE BLOODSTAIN PATTERN ANALYSIS TEST METHODS

The Appendix below will be added to all BPA Requests in Justice Trax after the analyst's signature, formatted as a stand-alone page.

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BLOODSTAIN PATTERN ANALYSIS

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Bloodstain Pattern Report Appendix

The following includes supplemental information on bloodstain pattern analysis performed at the Indiana State Police Forensic Services Division (FSD) and definitions of commonly used terms. Not all terms referenced in this appendix may apply to the examination in the associated case report. Please contact the reporting analyst with specific questions regarding the bloodstain pattern analysis in this case.

Serological testing: Citations in the report refer to the test(s) listed below.

Presumptive testing indicates the possible presence of blood.

- A. Kastle-Meyer/phenolphthalein chemical test
- B. Luminol/Bluestar luminescence test
- C. Hemastix Blood ID reagent strips

Confirmatory testing identifies the substance as human blood.

- D. HemDirect™ immunological test + Kastle-Meyer/phenolphthalein test

Limitations: The observations and conclusions contained in this report may be limited in any of the following ways:

- 1. It is not possible, nor practical, to report/describe every bloodstain that may have been observed/noted during the investigation of a bloodshed event.
- 2. Measurements are approximate and were made using any of the following tools: rulers, loupes, digital calipers. Uncertainty of measurement is only applied when calculating impact angles and area of origin.
- 3. Visual macroscopic and stereo microscopic examinations are routinely performed. No reconstructive experimentation has been performed unless noted specifically in the case report.
- 4. Digital images submitted for examination pose limits to the reporting analyst. The stains/patterns observed in these images cannot be tested for serological fluids unless portions were collected for submission. If stains/patterns were tested at the scene, please refer to the report/notes generated by the testing analyst/investigator. Additionally, the analysis of digital images may be limited by the resolution of photography equipment and/or proper documentation available within the images.
- 5. Any references to conclusions from other forensic reports are considered to be summary statements only. Refer to the referenced forensic report and/or the respective reporting analyst for a more complete discussion of the specific conclusion.
- 6. Unless otherwise noted, statements of "spatter stains" indicate that these stains were observed on a particular item; however, they were not deposited in a manner to be able to determine the specific mechanism for deposition. Spatter stains do not necessarily indicate a violent act occurred near a particular item, only that airborne droplets of blood were created when a force was applied to liquid blood.
- 7. Any additional information, statements, or evidence received after the completion of this report may change the results/opinions/conclusions stated herein.

Terms and Definitions: *AAFS Standards Board – ASB Technical Report 033, First Edition, 2017. Full version can be located at <http://asb.aafs.org>*

Accompanying Drop – A small blood drop produced as a by-product of drop formation.

Altered Stain – A bloodstain with characteristics that indicate a physical change has occurred.

Angle of Impact – The angle (alpha), relative to the plane of a target, at which a blood drop strikes the target.

Area of Convergence – The space in two dimensions to which the directionalities of spatter stains can be retraced to determine the location of the spatter producing event.

Area of Origin – The space in three dimensions to which the trajectories of spatter can be utilized to determine the location of the spatter producing event.

Backspatter Pattern – A bloodstain pattern resulting from blood drops which can be produced when a projectile creates an entrance wound.

Blood Clot – A gelatinous mass formed by a complex mechanism involving red blood cells, fibrinogen, platelets, and other clotting factors.

Bloodstain – A deposit of blood on a surface.

Bloodstain Pattern – A grouping or distribution of bloodstains that indicates through regular or repetitive form, order, or arrangement the manner in which the pattern was deposited.

Bubble Ring – An outline within a bloodstain resulting from air in the blood.

Cast-off Pattern – A bloodstain pattern resulting from blood drops released from an object due to its motion.

Cessation Pattern – A bloodstain pattern resulting from blood drops released from an object due to its abrupt deceleration.

Directionality – The characteristic of a bloodstain that indicates the direction blood was moving at the time of deposition.

Directional Angle – The angle (gamma) between the long axis of a spatter stain and a defined reference line on the target.

Drip Pattern – A bloodstain pattern resulting from a liquid that dripped into another liquid, at least one of which was blood.

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Drip stain – A bloodstain resulting from a falling drop that formed due to gravity.

Drip Trail – A bloodstain pattern resulting from the movement of a source of drip stains between two points.

Edge Characteristic – A physical feature of the periphery of a bloodstain.

Expiration Pattern – A bloodstain pattern resulting from blood forced by airflow out of the nose, mouth, or a wound.

Flow – A bloodstain resulting from the movement of a volume of blood on a surface due to gravity or movement of the target.

Forward Spatter Pattern – A bloodstain pattern resulting from blood drops which can be produced when a projectile creates an exit wound.

Impact Pattern – A bloodstain pattern resulting from an object striking liquid blood.

Insect Stain – A bloodstain resulting from insect activity.

Parent Stain – A bloodstain from which a satellite stain(s) originated.

Perimeter Stain – An altered stain consisting of its edge characteristics, the central area having been partially or entirely removed.

Pool – A bloodstain resulting from an accumulation of liquid blood on a surface.

Projected Pattern – A bloodstain pattern resulting from the ejection of blood under hydraulic pressure, typically from a breach in the circulatory system.

Satellite Stain – A smaller bloodstain that originated during the formation of the parent stain as a result of blood impacting a surface.

Saturation Stain – A bloodstain resulting from the accumulation of liquid blood in an absorbent material.

Serum Stain – The stain resulting from the liquid portion of blood (serum) that separates during coagulation.

Spatter Stain – A bloodstain resulting from an airborne blood drop created when external force is applied to liquid blood.

Splash Pattern – A bloodstain pattern created from a large volume of liquid blood falling onto a surface.

Swipe – A bloodstain resulting from the transfer of blood from a blood-bearing surface onto another surface, with characteristics that indicate relative motion between the two surfaces.

Target – A surface onto which blood has been deposited.

Transfer Stain – A bloodstain resulting from contact between a blood-bearing surface and another surface.

Void – An absence of blood in an otherwise continuous bloodstain or bloodstain pattern.

Wipe – An altered stain resulting from an object moving through a preexisting wet bloodstain.

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APPENDIX 3 ASB TERMINOLOGY LIST

(Published in ASB Technical Report 033, First Edition 2017 – Terms and Definitions in Bloodstain Pattern Analysis: AAFS Standards Board is the copyright holder and publisher. Full version can be located at <http://asb.aafs.org>)

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Drip stain – A bloodstain resulting from a falling drop that formed due to gravity.

Drip Trail – A bloodstain pattern resulting from the movement of a source of drip stains between two points.

Edge Characteristic – A physical feature of the periphery of a bloodstain.

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Serum Stain – The stain resulting from the liquid portion of blood (serum) that separates during coagulation.

Spatter Stain – A bloodstain resulting from an airborne blood drop created when external force is applied to liquid blood.

Splash Pattern – A bloodstain pattern created from a large volume of liquid blood falling onto a surface.

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Swipe – A bloodstain resulting from the transfer of blood from a blood-bearing surface onto another surface, with characteristics that indicate relative motion between the two surfaces.

Target – A surface onto which blood has been deposited.

Transfer Stain – A bloodstain resulting from contact between a blood-bearing surface and another surface.

Void – An absence of blood in an otherwise continuous bloodstain or bloodstain pattern.

Wipe – An altered stain resulting from an object moving through a preexisting wet bloodstain.

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**APPENDIX 4
TEXTILE TERMINOLOGY LIST**

Absorbent – soaks into the fiber

Adsorbent – thin coating on the surface of the fiber

Coated fiber – coating of a staple fiber by blood during the transfer process

Fabric – yarns that are woven or knitted together

Felt – a non-woven fabric made by matting, condensing, and pressing fibers together instead of weaving or knitting them. Common examples include peacoats, some types of gloves, hats, and slippers

Fiber – smallest unit of a textile; length is greater than its diameter

Knit – made from continuous yarn with interlocking loops. Common examples include sweaters and t-shirts.

Microsatellite stains – microscopic spherical stains observed in the staple fibers near parent spatter stains

Non-woven – felted, needle punch textiles

Plain weave – one over one under warp/weft pattern resulting in a checkerboard-like structure known for high density and strength. Common examples include button-down shirts, bedsheets, tablecloths, canvas, and upholstery.

Rim feature – edges of the stain are darker than the center and can be indicative of spatter stains

Satin weave – the warp or weft predominates the surface, creating a smooth, glossy top and dull back fabric. Common examples include coat linings, night gowns, athletic shorts, and scarves.

Spreading – when the bulk of the liquid overtakes the surface tension forces, allowing the liquid to be distributed over a larger surface area on a fabric's surface; can lead to wicking

Staple fibers – fibers of defined length, generally 1/2in to 1/8in; often are natural fibers

Textile – a type of cloth or woven/knitted fabric

Twill weave – weft yarn passes over one or more warp yarns and then passes under two or more warp yarns creating a diagonal weave often observed in pants and denim

Warp – long yarn running vertically up and down the fabric, defines the vertical pattern repeat

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Weft – the yarn passing horizontally across the fabric, generally shorter and defines the horizontal pattern repeat

Wicking – capillary action between the fibers and within the yarns where the adhesive forces between the liquid and surface of the fiber exceed the cohesive forces of the blood

Yarn – a number of fibers spun together

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**APPENDIX 5
FIBERS GLOSSARY**

Acetate – A manufactured fiber in which the fiber-forming substance is cellulose acetate.

Acrylic (Orlon) – Synthetic fibers made from a polymer with an average molecular weight of ~ 100,000.

Cotton – Soft, fluffy stable fiber composed of cellulose.

Linen – fiber made from the stalks of the flax plant.

Nylon – A manufactured fiber in which the fiber forming substance is a long-chain synthetic polyamide.

Olefin – Synthetic fiber made from a polyolefin such as polypropylene or polyethylene.

Polyester – Synthetic fiber derived from coal, air, water, and petroleum; formed from a chemical reaction between an acid and alcohol.

Ramie – Fiber made from the stalks of the Chinese Nettle plant.

Rayon (Lyocell, Modal, and Viscose) – Manufactured regenerated cellulose fiber. Made from purified cellulose that has been chemically converted into a soluble compound which is then made into filaments which are chemically solidified. Considered to be a semi-synthetic fiber.

Silk – A natural protein fiber cultivated from the cocoon of the mulberry silkworm larva.

Spandex (Elastane, Lycra) – A manufactured fiber (synthetic) in which the fiber forming substance is a long-chain synthetic polymer comprised of at least 85% of a segmented polyurethane.

Wool (Angora, Cashmere, Mohair, and Qiviut) – Textile fiber obtained from sheep and other animals.

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APPENDIX 6 PROFICIENCY TESTING

Forensic Bloodstain Pattern Analysis personnel authorized to perform casework shall participate in an open proficiency testing program. The Bloodstain Pattern Analysis Supervisor shall review, approve, and oversee the proficiency testing program.

1. Proficiency Tests

- a. Individuals qualified in Bloodstain Pattern analysis shall complete a proficiency test annually from a provider that meets the requirements specified in the FSD Quality Assurance Manual.

2. Results

- a. Documentation of proficiency test results shall, where appropriate, include the following:
 - i. Test set identifier
 - ii. Identity of individual taking the test
 - iii. Dates of analysis and completion
 - iv. Copies of all data sheets, notes, and photographs
 - v. Computer imaging data
 - vi. Results/conclusions

3. Review

- a. Proficiency test results shall be evaluated based on the following criteria:
 - i. All reported patterns are correct or incorrect
 - ii. All reported angles are within five degrees or three standard deviations of the mean, using whichever one provides the larger range.
 - iii. All results reported as inconclusive or uninterpretable shall be interpreted using the same criteria as case work
 - iv. The basis for inconclusive or uninterpretable results shall be documented
- b. Upon completion of each proficiency test, the Bloodstain Pattern Analysis Supervisor shall give written notification to the individual. A copy of the notification shall be uploaded to the network drive. The notification shall address:
 - i. The type of case and its identification number
 - ii. The date of the test
 - iii. The results of the test
- c. If upon review of a proficiency test a discrepancy is found, the Bloodstain Pattern Analysis Supervisor shall notify the Biology Section Supervisor/CSI Supervisor, the Quality Assurance Manager, and the Director of Forensic Analysis. After consultation with the Unit Supervisor, the Quality Assurance Manager shall notify the FSD Commander of the situation along with a recommendation of corrective action.

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**APPENDIX 7
DIGITAL CALIPER CERTIFICATION**

1. Gauge Blocks

- a. All gauge blocks shall be calibrated externally by a vendor accredited under ISO 17025 prior to being put into service. The scope of the vendor's accreditation shall be applicable to the calibration requested.
 - i. The vendor shall provide calibration certificates that contain the measurement results, measurement uncertainty, and evidence of ISO 17025 accreditation.
- b. Gauge blocks shall never be recalibrated. If there exists observable evidence of significant change (corrosion, damage, etc.) the block(s) shall be taken out of service and replaced.

2. Digital Calipers

- a. The performance check of digital calipers shall be done annually utilizing the appropriate gauge blocks. These gauge blocks shall be either provided by the manufacturer or have a NIST traceable certificate.
- b. This performance check shall be documented in the instrument's maintenance file.
- c. The performance check of the caliper shall be checked with at least two different gauge blocks prior to use to ensure that it is functioning properly.
 - i. The gauge blocks shall be kept in the appropriate case when not in use.
- d. The digital caliper shall be considered functional if it is within $\pm 0.03\text{mm}$ of the standard gauge blocks being used for the performance check.