



# Forensic Science Regulator

## **Guidance: Bloodstain Pattern Analysis**

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## **1. Introduction**

### **1.1 Background**

- 1.1.1 Bloodstain pattern analysis (BPA) is the examination of the location, size, shape and distribution of bloodstains. Taken together with knowledge of the predictable behaviour of liquid blood in response to forces, such as the cohesive forces of surface tension and viscosity, external forces (such as impact and movement), gravity and air resistance, BPA can be used to provide information regarding the event or event(s) that created the bloodstain or bloodstain patterns.
- 1.1.2 This document replaces the previously published guidance 'Code of Practice and Conduct Bloodstain Pattern Analysis FSR-C-102'.

### **1.2 Scope**

- 1.2.1 This document provides guidance and recommendations for BPA where it is applied in a forensic context.

### **1.3 Terms and definitions**

- 1.3.1 The terms and definitions set out in the Forensic Science Regulator's Code of Practice version 2 [1] (the Code) apply to this document. Additional terms and definitions used in this document are listed in the glossary.
- 1.3.2 This guidance and the Code refer to a forensic unit, a forensic unit may be comprised of only one practitioner.
- 1.3.3 The word 'shall' has been used in this document where there is a corresponding requirement in the Code, the word 'should' has been used to indicate generally accepted practice, and the word 'may' has been used for recommendations. Recommendations have been used to indicate what ideal practice is when it is practicable.

- 1.3.4 The BPA terms and definitions outlined in the AAFS Standards Board (ASB) Technical Report 033 [2] should be used as good practice. These can be supplemented with additional terms, providing those terms are defined.

## **2. Personnel**

**(Code s21)**

### **2.1 Qualifications**

- 2.1.1 To meet the requirement to define and document the minimum qualifications and experience for bloodstain pattern practitioners, a forensic unit may choose to align with the requirements set out in American National Standards Institute (ANSI)/AAFS Standards Board (ASB) Standard 032, 'Standards for a Bloodstain Pattern Analyst's Training Program' [3].

### **2.2 Competency Levels**

**(Code s93.4.2)**

- 2.2.1 Competency levels shall be defined and may be based on the following levels:
- a. Analyst – competency in the recognition, preservation and documentation of the presence or absence of blood. Knowledge of searching and screening techniques for bloodstains is a prerequisite to the identification of bloodstains.
  - b. Expert – competency of an analyst is a prerequisite. Competency in the analysis, classification, interpretation, evaluation, and reconstruction of bloodstains and bloodstain patterns and reporting at the activity level.
  - c. Mentor/Trainer – an Expert with the competency to train and mentor personnel.
- 2.2.2 The forensic unit must record the competency level at which a BPA practitioner is authorised to work.

### **2.3 Training**

- 2.3.1 Demonstration of the necessary training at each of the competency levels described above should include the following topics:

## **Analyst**

### **2.3.2 Analyst training should include the following:**

- a. Knowledge of the forensic unit's quality management system, including awareness of relevant policies and procedures.
- b. Requirements necessary for compliance with the FSR Code, including validation processes and inter- and intra- forensic unit proficiency testing (PT).
- c. Health and safety issues associated with blood.
- d. Development of effective examination and search strategies.
- e. Cognitive bias effects that may influence case assessment, strategy-setting, searching and recording bloodstains, methods to manage case information, and methods to mitigate and minimise the effect of contextual bias on classification of bloodstains.
- f. Bloodstain classification methods and terminology.
- g. Effects of surface characteristics on the appearance of bloodstains.
- h. The potential effect of searching methods, chemical testing, and enhancement techniques on BPA and other evidence types.
- i. Methods of documenting bloodstains and bloodstain patterns, for example, digitally by video, photography or modelling, or by sketching and note taking.
- j. Methods for the effective preservation, collection and representative sampling of bloodstains and bloodstain patterns.
- k. The inter-relationship between BPA and other types of evidence.

### **2.3.3 For capturing digital material such as images, video and/or 3D modelling, analysts should understand:**

- a. Quality, resolution and conditions required to be able to demonstrate the context e.g. relative location and dimensions and feature(s) of interest e.g. bloodstain morphology and bloodstain pattern clearly; and
- b. How any processing undertaken could affect the digital material.

## **Expert**

- 2.3.4 In addition to the topics for the analyst, training of an expert should include the following:
- a. Cognitive bias effects that may influence the provision of opinion in BPA, methods [4] to manage case information, and methods to mitigate and minimise the effect of contextual bias on classification, interpretation and evaluation of bloodstains and bloodstain patterns.
  - b. Review of historical developments and available data in BPA.
  - c. Blood composition and related human anatomy and physiology.
  - d. Bloodstain pattern classification methods and terminology.
  - e. Scientific principles, including physics and fluid mechanics, as they relate to BPA.
  - f. Blood dynamics, including influence on drop formation, oscillation, flight paths, accompanying drops and secondary spatter.
  - g. Bloodstain pattern principles and their application to BPA, including application of objective methods to classify bloodstains and bloodstain patterns.
  - h. Relationship between the physical appearance of bloodstain patterns (size, shape, distribution, and location) and the mechanism(s) by which they were created.
  - i. Awareness of injuries and wounding, and their relationship to bloodstain pattern formation, including patterns resulting from a range of injury types such as blood arising from damaged blood vessels, blood in airways.
  - j. Scientific method and its application to BPA.
  - k. Effect of environmental and biological factors on the formation and/or drying time of bloodstains and bloodstain patterns.
  - l. Application of BPA in the reconstruction of bloodletting events.
  - m. Mathematical methods in BPA.
  - n. Methods for the measurement of individual bloodstains.
  - o. Trigonometric methods for area of origin determination.



- p. Hypothesis testing and evaluation of hypotheses that are unbiased and attempt to test the prosecution and defence hypotheses, where available, and other viable mechanisms, including using reconstructive experiments.
- q. BPA experimentation (which can include simulated scenarios), reference databases, reflecting a range of case scenarios and factoring in error rates, limitations and reliability [5], [6], [7].
- r. Investigative or evaluative reporting of BPA findings, conclusions, and opinions by written and/or verbal methods including the limitations of BPA and the application of experiments and reconstruction where necessary.
- s. Legal obligations pertaining to BPA, including court rulings that are relevant to the interpretation, evaluation and reporting of BPA.

2.3.5 As required by the standards of conduct (Code, section 34.1.2f) maintaining and developing relevant knowledge in BPA could be achieved through CPD, and awareness of the relevant texts, journals and other professional literature.

#### **Mentor/Trainer**

- a. A mentor/trainer is an experienced, active practitioner in the field of BPA. The level of competence commensurate with their mentor/trainer role should be defined by the forensic unit or a relevant professional body, such as the International Association of Bloodstain Pattern Analysts (IABPA).
- b. In addition to casework, and as required by the standards of conduct (Code, section 34.1.2f), a BPA mentor/trainer shall maintain a record of developments in BPA research and relevant published papers as part of their CPD.

2.3.6 The mentoring programme should reflect the level of competency being sought and can include, but is not limited to, the following:

- a. an evaluation of the required training objectives,
- b. review of completed bloodstain examinations/casework relevant to the role,
- c. supervised undertaking of BPA and,

- d. observation of other practitioners examining or reporting BPA and/or giving BPA evidence in court.

## **2.4 Competency Assessment**

- 2.4.1 The requirements for competency and ongoing competency for each role, including those authorised to give opinions, may use the principles set out in the ANSI/ASB Standard 032 [2].
- 2.4.2 Training and competency assessments should reflect the level and types of BPA carried out by the practitioner, for example laboratory-based and/or at incident scenes.
- 2.4.3 Successful completion of competency testing is needed before a BPA practitioner can be authorised to undertake BPA examinations or render any expert opinion. Use of a competency framework (competency demonstrated through peer reviews, regular competency assessment and PT) allows competency to be demonstrated and documented.

## **2.5 Training and Experience of Practitioners**

- 2.5.1 A training record shall be kept for each practitioner (Code, section 93.4.5) and this should include their range of experience and competency in terms of BPA examinations, case numbers/types involving BPA, as well as a record of participation in conferences, CPD, and membership of relevant professional bodies.

### **Casework Experience**

- 2.5.2 The forensic unit should keep a record of the numbers and types of BPA examinations/cases, identify any issues that may have arisen in previous years, for example, in terms of quality management system non-conformances, and use these for training, development and method/process improvements. Where case studies are deemed to be of benefit to the wider BPA community the forensic unit should seek to publish their findings.

### **Continuing Education Requirements for a BPA Practitioner**

- 2.5.3 Defining the requirements for maintaining BPA competency could include completion of regular examinations, including specifying the minimum number of cases to be examined/reviewed per year, the period at which competency lapses, and defining what is required to regain competence. Forensic units may choose to base their guidelines on the Bloodstain Pattern Analysis Training Program standards published by the Academy Standards Board, BPA consensus body [3].
- 2.5.4 Ongoing competence should be supported by CPD and knowledge transfer including, for example, completion of PTs, review of case studies, incident scene debriefs, professional conferences, internal and external seminars and/or workshops.
- 2.5.5 It is recommended that Expert and Mentor/Trainer practitioners performing BPA obtain membership, at the appropriate level, of at least one professional body that covers BPA, such as the IABPA. Where possible, the forensic unit should provide financial support.

## **3. Selection of Test Methods**

**(Codes 24.2)**

### **3.1 Examining Bloodstain Patterns**

- 3.1.1 Methods in BPA should allow the practitioner to:
  - a. Devise and develop an examination strategy taking into account other evidence types, this may include liaising with other practitioners;
  - b. Preserve bloodstain evidence, for example, fragile or vulnerable bloodstain patterns;
  - c. Accurately record any items that will not be available for future examination or may be altered during testing; and
  - d. Complete records to enable a full independent review of the BPA findings and facilitate any future case review.

## **3.2 Documenting Bloodstain Patterns**

3.2.1 Methods that can be used for documenting bloodstain patterns include:

- a. Photography;
- b. Sketching;
- c. Measurements;
- d. Note-taking; and
- e. Image capture (for example, line drawing software, video, 3D imaging).

## **3.3 Identification of Bloodstain Patterns**

3.3.1 Methods to identify bloodstain patterns include:

- a. Determining the basis for classification for example, Objective Criteria [8] or the National Institute of Standards and Technology, Organization of Scientific Areas Committees (OSAC) Bloodstain Pattern Classification Process Map [9];
- b. Use of defined terminology.
- c. Determining the relationship between an individual bloodstain pattern and possible causal mechanisms;
- d. Recognition of physical, physiological, and chemical altering effects;
- e. Securing wetted items to minimise alteration of bloodstain patterns;
- f. Interpretation of voids, shadowing and limiting angles;
- g. Consideration of the limitations of attempting to determine the sequence of deposition, aging and drying times of bloodstains;
- h. Determination of stain directionality;
- i. Determination of the area of origin by:
  - i. string method;
  - ii. tangent method;
  - iii. directional analysis;
- j. Using BPA as a basis for sample selection for further testing (for example, DNA profiling);

- k. Use of assistive technology, such as, microscopy, specialist lighting and scanning to examine and evaluate bloodstains;
- l. Awareness of the difficulties commonly encountered in the examination of bloodstain patterns (for example; bloodstains on dark, patterned, or textured surfaces; small bloodstains, particularly at incident scenes where microscopy is not generally possible) and the potential need for additional searching; and,
- m. Determination of valid conclusions from bloodstain and bloodstain pattern features.

### **3.4 Enhancing or Revealing Bloodstains**

3.4.1 Enhancing bloodstaining and/or revealing non-visible bloodstaining may include:

- a. Chemical enhancement methods such as luminol, leuco crystal violet, acid black, leucomalachite green, and acid yellow.
- b. Use of alternative light sources such as infrared light.

3.4.2 Determining the most appropriate method for enhancing or revealing bloodstains may require consideration of some or all of the following:

- a. The level and type of enhancement required, for example visualisation of potential dilution of blood where cleaning is suspected, compared to enhancement of marks in blood;
- b. Recognition of health and safety considerations;
- c. The specific requirements and limitations of the methods, such as the need to exclude ambient light or application in a specific temperature range;
- d. The surface the bloodstaining is on, e.g. colour, texture, horizontal/vertical;
- e. False negative and false positive reactions with substances other than blood.

## **4. Validation**

**(Code s24)**

### **4.1 General**

- 4.1.1 The Regulator's requirements for validation are set out in the Code. Forensic units may find the specific validation requirements for BPA as defined in ANSI/ASB Standard 072 [10] useful in assisting them to meet the requirements in the Code. Known source/reference material should be used for BPA validation.
- 4.1.2 BPA is an interpretive method; however, it is based upon well-established scientific principles, supported by scientific literature extending back over 100 years.
- 4.1.3 The main areas of published scientific study that form the foundation of BPA include the following:
- a. Ageing blood
  - b. Biomechanics
  - c. Clothing and fabric
  - d. Environmental factors
  - e. Error rates
  - f. Expired (exhaled) blood
  - g. Firearms
  - h. Fluid dynamics
  - i. Impact patterns
  - j. Management of bias in BPA examinations
  - k. Maths and physics
  - l. Objective classification methods
  - m. Other patterns
  - n. Reconstruction
  - o. Scientific theory
  - p. Searching and enhancement
  - q. Sequencing

- r. Software
- s. Target surface effects
- t. Transfer patterns

- 4.1.4 Many of these areas are supported by numerous key scientific papers listed in the NIST OSAC BPA Bibliography [11]. It is therefore considered that BPA is soundly based on well-established scientific principles and peer-reviewed methodology.
- 4.1.5 Where a novel method used by the forensic unit is not referenced in the peer-reviewed scientific literature (for example, a new software method) then following completion of a validation study the forensic unit should seek to publish their findings for the benefit of the wider BPA community and to allow others to verify and build on their work.
- 4.1.6 Demonstrating that the procedures used by the forensic unit generate consistent and valid results at the laboratory and/or at incident scenes, as applicable, can be achieved by delivering successful outcomes against exercises which test the:
- a. Identification of assorted bloodstains on target surfaces – drips, wipe, etc.;
  - b. Identification of assorted bloodstain patterns on target surfaces – impact bloodstain patterns, cast-off bloodstain patterns, etc.;
  - c. Identification of the angle of impact of assorted blood spatter on target surfaces;
  - d. Identification of the area of convergence and area of origin of impact bloodstain patterns, including using the stringing/tangent method identification if used; and,
  - e. Completion of an interpretation exercise based on a case or simulated case scenario examining bloodstain patterns on an item(s) or at an incident scene.
- 4.1.7 Validation documents are living documents and should be reviewed annually and updated with the results, for example, of collaborative exercises, PTs, audits and non-conformances.

## 4.2 Verification

(Code s24.9.11 – 24.9.17)

- 4.2.1 Verification is the confirmation, through assessment of existing objective evidence or through experiment, that a method is fit (or remains fit) for the specific purpose intended.
- 4.2.2 For BPA, verification of the methods and processes can be demonstrated, as a minimum, though the examination of bloodstains or bloodstain patterns in known scenarios, such as on items or at simulated incident scenes. The acceptance criteria for the exercise should be clearly defined in advance and practitioners, with a range of experience, should participate and achieve expected outcomes.

## 4.3 Measurement uncertainty

(Code s25)

- 4.3.1 Where testing is performed, the forensic unit is required to evaluate measurement uncertainty. Methods in BPA that require measurement include:
- a. Size, shape and distribution measurements of individual bloodstains;
  - b. Area of origin calculations;
  - c. Angle of impact measurements; and.
  - d. Relevant performance data from PTs.

## 4.4 Equipment

- 4.4.1 The types of equipment used for BPA (see, for example, NIST OSAC Guidelines Section 3: Equipment, Materials and Reagents [12]) may include equipment for distance and angle measuring, light sources, search, enhancement and magnification.
- 4.4.2 Software programs may include:
- a. Directional analysis software; and
  - b. Image analysis software.



## 4.5 Assuring the Quality of Test and Calibration Results

### (Code s20 and s93.13)

- 4.5.1 The forensic unit shall have a procedure for carrying out appropriate checking and review throughout each stage of the BPA examination or case (Code, section 20.1.1), this includes checks of the examination strategy, independent critical findings checks (open or blind) peer review and administrative checks (Code, section 20.1.4). Practitioners should avoid recording opinions or conclusions on BPA documentation, such as images, sketches or diagrams, in order to support an independent peer check of the findings.
- 4.5.2 The forensic unit shall have a documented procedure for difference resolution between practitioners within the unit (Code, section 20.4.2) and, where practicable, between external practitioners and those within the forensic unit.
- 4.5.3 When defining the requirements for the audit schedule the forensic unit may include attendance at a specified frequency to audit the activities undertaken at incident scenes. This audit activity should be tied into the competency review for each BPA practitioner, along with audits of the associated BPA records in order to ensure that they support a remote or independent interpretation of the bloodstain patterns.
- 4.5.4 Where possible, PTs should cover a range of BPA examinations, for example classification, measurement, interpretation, evaluation of bloodstains and bloodstain patterns and provision of opinion as specified by the forensic unit's PT schedule.

## 5. Reporting Results

### (Code s31)

- 5.1.1 It is recommended that a BPA summary report or statement references all information that is relevant to the BPA examination (for example, see ANSI/ASB Standard 031 [13]), such as:
- Background case information and material provided for example medical/ DNA/ incident scene reports, environmental conditions, locations searched, description of items/exhibits.

- b. The limitations of the assessment of BPA including from digital material such as photographs.
- c. Data collated in the course of the BPA examination that provide the basis for conclusions. These could include measurements such as stain size, error rates, areas of origin, dimensions relating to the item/incident scene, heights of bloodstains and/or distribution of a bloodstain pattern.
- d. Sketches, scene diagrams, scans, video and plans. If any reconstructive visual aid is used, such as 3D representation or simulation, they should demonstrate both the prosecution and defence propositions, where available, to mitigate against the potential for bias.
- e. Terms and definitions relating to the reported bloodstain and bloodstain patterns (see section 1.3.4).
- f. The results of other tests that impact on the BPA examination, such as DNA results from blood samples and/or presumptive testing to identify blood.
- g. The test parameters and results of any chemical enhancement of bloodstains.
- h. The location of collected and/or tested bloodstain samples relevant to BPA.
- i. Conclusions relating to reported interpretations or evaluations, including a clear statement if an opinion is being reported.
- j. The basis upon which a BPA opinion(s) has been made, along with the limitations of that opinion and any relevant reference(s). Where an interpretation has been derived from photographs, or other digital media, the limitations of the examination and any assumptions must be made clear.
- k. Any information that has been relied on to form a BPA opinion(s) and that could alter the opinion if it were to change should be stated.

## **6. Acknowledgements**

- 6.1.1 This guidance has been developed from and replaces the Regulator's Codes of Practice and Conduct: Bloodstain Pattern Analysis (FSR-C-102). This guidance has been reviewed by the Regulator's Distribution working group, a sub-group of the Biology Specialist Group (BIOSG).

## **7. Review**

- 7.1.1 This document is subject to review. Please send any comments to [FSREnquiries@forensicscienceregulator.gov.uk](mailto:FSREnquiries@forensicscienceregulator.gov.uk).

## **8. Modification**

- 8.1.1 This is the first issue of guidance published under section 9 of the Forensic Science Regulator Act.
- 8.1.2 The PDF is the primary version of this document.
- 8.1.3 The Regulator uses an identification system for all documents. In the normal sequence of documents this identifier is of the form 'FSR-###-####' where (a) (the first three '#') indicate letters to describe the type of document and (b) (the second four '#') indicates a numerical code to identify the document. For example, this document is FSR-GUI-0021, and the 'GUI' indicates that it is a guidance document. Combined with the issue number this ensures that each document is uniquely identified.
- 8.1.4 If it is necessary to publish a modified version of a document (for example, a version in a different language), then the modified version will have an additional letter at the end of the unique identifier. The identifier thus becoming FSR - ### - #### - #.
- 8.1.5 In the event of any discrepancy between the primary version and a modified version then the text of the primary version shall prevail.

## 9. References

- [1] Forensic Science Regulator, “Code of Practice version 2,” 2025. [Online]. Available: <https://www.gov.uk/government/publications/forensic-science-activities-statutory-code-of-practice-version-2>. [Accessed 26 June 2025].
- [2] American Academy of Forensic Sciences, “ASB Technical report 033, Terms and definitions in bloodstain pattern analysis,” 2017. [Online]. Available: <https://www.aafs.org/asb-standard/terms-and-definitions-bloodstain-pattern-analysis>. [Accessed 8 August 2023].
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- [13] American Academy of Forensic Sciences, “ANSI/ASB Standard 031, Standard for Report Writing in Bloodstain Pattern Analysis,” 2020. [Online]. Available: <https://www.aafs.org/asb-standard/standard-report-writing-bloodstain-pattern-analysis>. [Accessed 8 August 2023].

## 10. Abbreviations and Acronyms

Abbreviation	Meaning
AAFS	American Academy of Forensic Sciences
ANSI	American National Standards Institute
ASB	AAFS Standards Board
BPA	Bloodstain Pattern Analysis
CPD	Continued Professional Development
FSR	Forensic Science Regulator
IABPA	International Association of Bloodstain Pattern Analysts
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
NIST	National Institute of Standards and Technology
OSAC	Organization of Scientific Area Committees
PT	Proficiency test

## 11. Glossary

Active Practitioner	A practitioner who is actively involved in bloodstain pattern training and/or BPA casework and/or performing technical reviews of BPA casework.
Mentorship	A programme administered under the direction of a competent and active bloodstain pattern practitioner during the course of a BPA trainee's training.
Professional Organisations/ Bodies	Organisations recognised by the general scientific community that devote a portion of their subject matter to the science of BPA, for example, the American Academy of Forensic Sciences (AAFS), the Canadian Society of Forensic Science (CSFS), the International Association of Bloodstain Pattern Analysts (IABPA), the International Association for Identification (IAI) and the Chartered Society of Forensic Sciences (CSFS).

## 12. Further Reading

American National Standards Institute/ AAFS Standards Board (2019). Standard 030, Standard for a Quality Assurance Program in Bloodstain Pattern Analysis. Available at: <https://www.aafs.org/asb-standard/standard-quality-assurance-program-bloodstain-pattern-analysis> [Accessed 26 June 2025].

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