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1. **INTRODUCTION**

1.1.1 This appendix provides further explanation of some of the requirements of the Forensic Science Regulator’s Codes [A] specifically pertaining to bloodstain pattern analysis (BPA).

1.1.2 This appendix should be read alongside the Codes [A], ISO/IEC 17020:2012 [B], ISO/IEC 17025:2005 [C], ILAC-G19:08/2014 [D] and UKAS® LAB 13: 2001 [E] and will generally follow the heading titles used in the Codes with cross references to ISO/IEC 17025:2005 and ISO/IEC 17020:2012 given in parentheses where appropriate.

2. **SCOPE**

2.1.1 This specifically relates to the classification, identification and/or interpretation and evaluation of bloodstain patterns, including bloodstain pattern analysis at crime scenes and in the laboratory.

2.1.2 Knowledge of searching and screening techniques for bloodstains is a precursor requisite to the identification of bloodstains.

3. **IMPLEMENTATION**

3.1.1 This appendix is available for incorporation into a provider’s quality management system from the date of publication.

3.1.2 The Forensic Science Regulator requires that the Codes and compliance to the requirements set out in this appendix against the specified ISO/IEC 17025 / ISO/IEC 17020 clauses are included in the provider’s schedule of accreditation by October 2017 as detailed in the statement of requirements in the Codes [A].

4. **MODIFICATION**

4.1.1 This is the first issue of this document.

5. **TERMS AND DEFINITIONS**

5.1.1 The terms and definitions set out in the Codes [A] apply to this appendix. The terms and definitions employed in this appendix are listed in the Glossary at the end of this appendix.
5.1.2 The terminology is the language used in International Standards with regards to the use and meaning of the words, 'shall', 'should' and 'may':

a. the word 'shall' has been used in this document where there is a corresponding requirement in ISO/IEC 17025, ISO/IEC 17020 or the Codes [A];

b. the word 'should' has been used to indicate generally accepted practice;

and

c. the word 'may' has been used for recommendations in blood pattern analysis – recommendations have been used to indicate what ideal practice is when it is practicable.

6. Personnel (ISO/IEC 17025:2005 ref. 5.2; ISO/IEC 17020:2012 ref. 6.1.1)

6.1 Qualifications

6.1.1 Minimum qualifications and experience for bloodstain pattern practitioners shall be sufficiently defined and documented by the organisation.

6.2 Competency Levels

6.2.1 Competency levels shall be defined. Organisations may base these levels on the following:

a. analyst – competency in the recognition, preservation and documentation of bloodstain pattern evidence;

b. expert – competency in the analysis, evaluation, interpretation and reconstruction of bloodstain pattern evidence, including the reporting of evidence of opinion; and

c. mentor/trainer – an expert with the competency to train and mentor personnel.

6.2.2 The organisation shall formally document the authorisation process for bloodstain pattern analysis (BPA) practitioners and this shall specify the competency level at which they are authorised to work.
6.3 Training

6.3.1 The training requirements for bloodstain pattern practitioners shall be documented for all competency levels as defined by the organisation.

6.3.2 The training required to develop competency shall include instruction in all facets of BPA (SWGSTAIN, 2008) relevant to the desired level of competency. The topics of training should include the following for the competency levels suggested in section 6.2.1.

Analyst

6.3.3 Analyst training should include the following:

a. health and safety issues associated with BPA;
b. the history of BPA;
c. scientific principles as they relate to BPA;
d. the scientific method and its application to BPA experimentation;
e. the principles of physics and fluid mechanics as they relate to BPA;
f. bloodstain classification and terminology;
g. bloodstain pattern principles and their application to BPA;
h. blood composition and related human anatomy and physiology;
i. injury and wounding, and their relationship to bloodstain pattern formation;
j. the effects of surface characteristics on the resulting bloodstain patterns;
k. the effect of environmental factors on the formation and/or drying time of bloodstain patterns;
l. the characteristics of blood dynamics, including drop formation, oscillation, droplet flight paths, accompanying drops and secondary spatter;
m. the relationship between the physical appearance of bloodstain patterns (size, shape, distribution, and location) and the mechanism by which they were created;
n. the potential impact of searching methods, chemical testing, and enhancement techniques on BPA and other evidence types;

---

1 The training course is required to meet the requirements of the International Association of Bloodstain Pattern Analysts (IABPA) if professional membership of the IABPA is sought or required by the practitioner.
methods of documenting bloodstain pattern evidence, for example, video, photography, sketching and note taking;

methods for the preservation and collection of bloodstain pattern evidence;

the relationship between bloodstain pattern evidence and other types of evidence; and

development of examination and search strategies.

Expert

6.3.4 In addition to the topics for the analyst, training of an expert should include the following:

a. mathematical methods in BPA;

b. methods for the measurement of individual bloodstains;

c. trigonometric methods for impact spatter origin determination;

d. bloodletting injuries and their potential effects on the potential bloodstain patterns;

e. the application of BPA to the reconstruction of bloodletting events;

f. the 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;

g. how to review case information in order to aid BPA, understanding the limitations of that information, such that some may be missing or incorrect;

h. the legal obligations (FSR-I-400) [G] pertaining to BPA, including court rulings that are relevant to BPA evidence;

i. hypothesis testing\(^2\) and evaluation of hypotheses using reconstructive experiments;

j. an awareness of cognitive effects that may influence case assessment, interpretation and opinions, see FSR-G217 [H] and Zajac et al. (2015) [J]; and

k. laboratory experimentation and various BPA case scenarios.

---

\(^2\) Hypothesis testing should be unbiased and attempt to test both prosecution and any reasonable defence hypotheses, either known or unknown.
6.3.5 The practitioner shall be aware of the relevant texts, journals and other professional literature, in order to understand and maintain relevant knowledge in BPA.

Mentor/Trainer

a. A mentor/trainer shall be an active practitioner in the field of BPA, with a minimum defined level of ongoing casework experience as a qualified bloodstain pattern practitioner.

b. In addition to casework a BPA mentor/trainer shall have an awareness of research, new developments and published papers.

6.3.6 Each area of instruction shall have documented objectives and shall have a formal assessment of the trainee’s knowledge and/or competency (for example, written test, practical test and/or oral test).

6.3.7 During the course of training, a BPA trainee and trainer/mentor shall document and participate in a mentorship. This mentoring programme should include, but is not limited to, the evaluation of the required objectives, the review of completed casework, supervised BPA and the observation of court testimony.

6.3.8 A training record shall be kept for each trainee.

6.4 Competency Assessment

6.4.1 The organisation shall determine and document the requirements for competency for each role, as set out in section 6.3.2, including those authorised to give opinions and interpretations (UKAS® LAB 13: 2001) and using the guidance provided by the Scientific Working Group on Bloodstain Pattern Analysis (SWGSTAIN, 2008).

6.4.2 Before being authorised to undertake independent analysis or render any expert opinion a BPA trainee shall participate in and successfully complete an objective assessment of their competency. This assessment shall be defined within a documented competency framework. Records of the assessment, and subsequent authorisation, shall be maintained.

3 Competency demonstrated through peer reviews, regular competency and proficiency tests.
Continuing Education Requirements for a BPA Practitioner

6.4.4 BPA practitioners shall maintain their competency through ongoing regular casework according to the guidelines laid down by the organisation, including specifying the minimum number of cases examined/reviewed per year and the period at which competency lapses, and defining what is required to regain competence.

6.4.5 Ongoing competence should be supported by continual professional development (CPD) and knowledge transfer including, for example, review of case studies, scene debriefs, professional conferences, internal and external seminars and/or workshops.

6.4.6 It is recommended that personnel performing BPA belong to at least one professional organisation that covers BPA.

6.5 Job Descriptions (ISO/IEC 17025:2005 ref. 5.2.4; ISO/IEC 17020:2012 ref. 5.2.7)

Scope of Work Relating to Bloodstain Pattern Analysis

6.5.1 The job description for a bloodstain pattern practitioner shall be specified. This could be covered in a wider job description or other specified documentation.

6.5.2 Duties may include:

a. collection and preservation of bloodstain pattern evidence;
b. documentation of bloodstain patterns;
c. interpretation of bloodstain patterns;
d. case-specific experimentation;
e. reconstruction;
f. report writing; and
g. presentation of evidence in court.

7. Accommodation and Environmental Conditions (ISO/IEC 17025:2005 ref. 5.3; ISO/IEC 17020:2012 ref. 6.2.1)

7.1.1 The organisation shall:
a. specify conditions required for the safe handling of bloodstain evidence items;
b. specify procedural guidelines for best practice to preserve and avoid contamination of bloodstained evidence items; and
c. have access to facilities to perform case-specific examination and experimentation.

8. **Selection of Methods** (ISO/IEC 17025:2005 ref. 5.4.2; ISO/IEC 17020:2012 ref. 7.1)

8.1.1 End-user requirements for bloodstain pattern evidence shall be described.

8.1.2 The appropriate methods and their limitations shall be specified and documented. These will include the following.

8.1.3 Techniques and strategies for examining bloodstain patterns to:

a. devise and develop the examination strategy taking into account other evidence types; and
b. preserve bloodstain evidence, for example, the management of fragile or vulnerable bloodstain patterns.

8.1.4 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, video, 3D imaging).

8.1.5 Methods to identify individual patterns (see Table 1) that include:

a. the basis for classification;
b. the use of recommended terminology (SWGSTAIN, 2009) [K];
c. the relationship between an individual bloodstain pattern with its causal mechanism;
d. the recognition of physical, physiological, wetting and chemical altering effects;
e. the determination of directionality;
f. the interpretation of voids, shadowing and limiting angles;
g. the determination of valid conclusions from bloodstain pattern boundaries;
h. the determination of the area of origin;
i. calculating an area of origin of blood spatter:
   i. string method;
   ii. tangent method;
   iii. directional analysis;
j. limitations of attempting to determine the sequence, aging and drying times of bloodstains;
k. using BPA as a basis for sample selection for testing (for example, DNA profiling);
l. use of microscopy to examine and evaluate bloodstains;
m. securing wetted items to minimise alteration of bloodstain patterns; and
n. awareness of the difficulties commonly encountered in the examination of bloodstain patterns (for example, bloodstains on dark clothing, small bloodstains).

9. Validation (ISO/IEC 17025:2005 ref. 5.4.5; Inspection Methods and Procedures (ISO/IEC 17020:2012 ref. 7.1.1–7.1.4)

9.1.1 The requirements for validation are set out in the validation guidance to the Codes [L]. BPA is an interpretive method; however, it is based upon well-established scientific principles, supported by scientific literature extending back over 100 years.

9.1.2 The main areas of published scientific study that form the foundation of BPA include the following:
   a. aging blood;
   b. biomechanics;
   c. clothing and fabric;
   d. environmental factors;
   e. expired (exhaled) blood;
   f. firearms;
   g. fluid dynamics;
h. impact patterns;
i. maths and physics;
j. reconstruction;
k. scientific theory;
l. other patterns;
m. searching and enhancement;
n. sequencing;
o. software;
p. target surface; and
q. transfer patterns.

9.1.3 Each of these areas is supported by numerous key scientific papers listed in Bibliography (SWGSTAIN, 2012) [M].

9.1.4 It is therefore considered that the principles underpinning BPA are soundly based on well-established principles and scientific peer-reviewed methodology. The organisation shall document and demonstrate that it has validated its methods for providing an opinion for specified blood patterns using known source material.

9.1.5 As part of validation the organisation shall identify the methods to be used in BPA and confirm that they are within the scope of the published scientific literature.

9.1.6 Any novel method used by the organisation that is not referenced in the peer-reviewed scientific literature (for example, a new software method) will require validation.

9.1.7 The organisation shall demonstrate that the procedures used generate consistent and valid results. This shall reflect the various aspects of BPA undertaken at the laboratory and at crime scenes. In general these should comprise:

a. identification of assorted bloodstains on a target surface – drips, wipe, etc.;
b. identification of assorted blood patterns on a target surface – impact spatter, cast-off, etc.;
c. identification of the angle of impact of assorted blood spots on a target surface;
d. identification of the area of convergence of an impact pattern;
e. stringing/tangent method identification of the area of origin (if method is used); and
f. interpretation exercise based on a case scenario and blood patterns on an item(s).

Table 1 – Bloodstain pattern types

<table>
<thead>
<tr>
<th>Pattern formation mechanisms dominated by gravity</th>
<th>Drip pattern</th>
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<tbody>
<tr>
<td></td>
<td>Drip stain</td>
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<td>Drip trail</td>
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<td></td>
<td>Flow pattern</td>
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<tr>
<td></td>
<td>Pool</td>
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<td></td>
<td>Saturation</td>
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<tr>
<th>Pattern formation dominated by spatter mechanisms</th>
<th>Cast-off pattern</th>
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<tbody>
<tr>
<td></td>
<td>'Expiration'/exhaled pattern</td>
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<tr>
<td></td>
<td>Projected (for example, arterial)</td>
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<tr>
<td></td>
<td>Impact spatter</td>
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<td></td>
<td>Forward spatter</td>
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<td></td>
<td>Back spatter</td>
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<tr>
<td></td>
<td>Mist pattern</td>
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<tr>
<td></td>
<td>Satellite stain (secondary spatter)</td>
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</table>

<table>
<thead>
<tr>
<th>Pattern formation dominated by contact mechanisms</th>
<th>Transfer stain</th>
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<tbody>
<tr>
<td></td>
<td>Swipe pattern</td>
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<td></td>
<td>Wipe pattern</td>
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<table>
<thead>
<tr>
<th>Altered bloodstains for example, physical, chemical and physiological issues</th>
<th>Insect stain</th>
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<tr>
<td></td>
<td>Serum stain</td>
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<tr>
<td></td>
<td>Dilute</td>
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</tbody>
</table>

For a more comprehensive list refer to *Recommended terminology* (SWGSTAIN, 2009) [K].
9.2 Verification

9.2.1 Verification is based on the demonstration that practitioners can provide consistent, reproducible and valid results using the validated methods. These results shall be comparable with the results of other competent practitioners. For organisations with multiple sites carrying out BPA, this verification shall be carried out on each site.

9.2.2 Verification of the methods and processes shall as a minimum use known source / simulated samples, and shall be sent to practitioners across the complete range of competence and experience at the site(s) to demonstrate consistency and valid outcomes. The acceptance criteria for the exercise shall be clearly defined in advance.

Training and Experience of Practitioners

9.2.3 The organisation shall outline the training provided to practitioners, their range of experience and competency in terms of case numbers/types involving BPA. This could also include a record of participation by practitioners in conferences, CPD, membership of the International Association of Bloodstain Pattern Analysts.

Casework Experience

9.2.4 The organisation should outline the numbers and type of BPA cases dealt with at the site, 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.

9.2.5 The validation document is a living document and should be reviewed annually and updated with the results for example of collaborative exercises, proficiency tests, audits and non-conformances.

9.3 Uncertainty of Measurement (ISO/IEC 17025:2005 ref. 5.4.6, 5.4.6.2; ISO/IEC 17020:2012 ref. 6.2.7)

9.3.1 Those methods that require an estimation of uncertainty of measurement shall be listed. As a minimum the components that contribute to the uncertainty of
measurement (Laber et al., 2014) need to be identified and shall be determined, for example, for a length measurement, if critical.

9.3.2 These may include:

a. area of origin calculations;

b. size, shape and distribution measurements of individual bloodstains; and
c. directionality measurements.

9.4 Equipment (ISO/IEC 17025:2005 ref. 5.5, 5.51; ISO/IEC 17020:2012 ref. 6.2.1, 6.2.13)

9.4.1 The types of equipment used for BPA and their calibration requirements shall be specified. These may include equipment for distance measuring, angle measuring, and magnification.

9.4.2 Requirements for the use and validation of software programs for BPA shall be specified. Software programs may include:

a. directional analysis software; and

b. image analysis software.

9.5 Measurement Traceability (ISO/IEC 17025:2005 ref. 5.6; ISO/IEC 17020:2012 ref. 6.2.7) Use of Reference Materials (ISO/IEC 17025:2005 ref. 5.6.3.2; ISO/IEC 17020:2012 ref. 6.2.8)

9.5.1 The process to create reference material comprising bloodstain patterns that are created by the organisation and used as working standards for bloodstain identification shall be documented. This process shall ensure that the creation of the stain patterns are witnessed and catalogued by competent practitioners.

9.5.2 The requirements for the use of pattern exemplars for interpretation shall be specified.

9.6 Assuring the Quality of Test and Calibration Results (ISO/IEC 17025:2005 ref. 5.9); Inspection, Methods and Procedures (ISO/IEC 17020:2012 ref. 7.1.5)

9.6.1 A procedure for an independent assessment of any bloodstain pattern interpretation by a competent practitioner shall be specified.
9.6.2 A procedure for addressing any disagreements between the practitioner and the independent reviewer shall also be specified.

9.6.3 The organisation shall have a documented audit schedule specifying the range of blood pattern activities and practitioner roles that will be audited per annum. This may include the attendance at a specified frequency to audit the activities undertaken at the crime scene.

9.6.4 The organisation shall undertake at least one BPA proficiency test per site per year.

9.6.5 The organisation shall establish and document a yearly competency review (see 6.4.4 and 6.4.5).

10. Reporting the Results (ISO/IEC 17025:2005 ref. 5.10); Inspection Reports (ISO/IEC 17020:2012 ref. 7.4.2)

10.1.1 Any organisation-specific requirements for using standardised terminology for reporting bloodstain pattern evidence shall be defined. It is recommended these include the use of current good practice defined by SWGSTAIN (2009) [K].

10.1.2 It is recommended that a BPA results/summary report or statement includes any information that is relevant to BPA, such as the following:

a. Case information, including the background information as supplied during the course of the investigation and analysis, such as medical/DNA reports, environmental conditions, description of evidence and/or materials received.

b. The limitations of BPA from photographs.

c. Data collated in the course of the examination that provide the basis for subsequent conclusions; these could include:

i. the location where observations are recorded;

ii. measurements, such as areas of origin, room size, heights of bloodstains and distribution of a bloodstain pattern.

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4 This audit activity could be tied into the competency review for each BPA expert along with file audits containing good quality images so that the interpretation of the blood patterns is possible.
d. Sketches, scene diagrams and plans.

e. Descriptors of the reported stains and patterns.

f. The results of testing conducted to identify blood.

g. The results of any chemical enhancement of bloodstains.

h. The location of collected stain samples relevant to the BPA.

i. Conclusions and interpretations. When an opinion is reported, it shall be clearly marked as such.

j. The basis upon which the opinion has been made, along with any relevant reference(s).

k. Any information that is relied on to form an opinion and that could alter the opinion if it were to change should be stated.

10.1.3 For England and Wales statements provided for court purposes must comply with the legal obligations as set out in the Criminal Procedure Rules [P], Criminal Practice Directions [Q].

11. REVIEW

11.1.1 This document is subject to review in accordance with the Codes [A] and other appendices.

11.1.2 Please send any comments to the address as set out on the Internet site at: www.gov.uk/government/organisations/forensic-science-regulator or email: FSREnquiries@homeoffice.gsi.gov.uk
12. **GLOSSARY**

**Active practitioner**
An individual who is actively involved in bloodstain pattern training and/or BPA casework and/or performing technical reviews of BPA casework.

**Bloodstain pattern analysis analyst**
An individual who is an active practitioner in the field of BPA and is competent in the recognition, preservation and documentation of bloodstain pattern evidence.

**Bloodstain pattern analysis trainer/mentor**
An individual who is an active practitioner in the field of BPA with an appropriate level of casework experience as a qualified BPA analyst and having fulfilled all previously stated requirements for an expert BPA analyst who is competent to train and mentor other BPA practitioners.

**Bloodstain pattern analysis expert**
An individual who has successfully completed the prescribed course of study and is competent in the analysis, evaluation, interpretation and reconstruction of bloodstain pattern evidence, including the reporting of evidence of opinion.

**BPA**
Bloodstain pattern analysis

**Competency test**
A method used to demonstrate the successful completion of a BPA trainee’s course of study and for checking ongoing competence as a BPA practitioner. The competency test(s) may be administered incrementally and/or cumulatively.

**Mentorship**
A programme administered under the direction of a competent bloodstain pattern practitioner during the course of a BPA trainee’s training.
Professional organisations

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 Science (CSFS).

SWGSTAIN

The Scientific Working Group on Bloodstain Pattern Analysis comprised BPA experts from North America, Australia, New Zealand and Europe. SWGSTAIN served as a professional forum in which practitioners in BPA and related fields discussed and evaluated methods, techniques, protocols, quality assurance, education, and research. This group has been superseded and is now a subcommittee of the physics/pattern interpretation committee under the Organization of Scientific Area Committees (OSAC). The SWGSTAIN documents remain current until the OSAC subcommittees replace them over time.

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5 OSAC is part of an initiative by the National Institute of Standards and Technology (NIST) and the US Department of Justice (DOJ) to strengthen forensic science in the USA. The organisation is a collaborative body of more than 500 forensic science practitioners and other experts who represent local, state, and federal agencies; academia; and industry. OSAC is organised into 33 operating units based on discipline and purpose. OSAC fosters the development and promotion of technically sound, consensus-based documentary standards and guidelines that can be used to strengthen the practice of forensic science. http://www.nist.gov/forensics/osac/index.cfm
13. REFERENCES


B  BS EN ISO/IEC 17020:2012 *General criteria for the operation of various types of bodies performing inspection*.


14. FURTHER READING


15. **ACKNOWLEDGEMENTS**

15.1.1 This appendix was produced following the award of a competitive tender to the Institute of Environmental Science and Research Limited, which prepared the initial text.

15.1.2 Further assistance and review to produce this publication was supplied by Cellmark Forensic Services, Scottish Police Authority, LGC Forensics, Principal Forensics Ltd, Forensic Science Ireland, ArroGen (formerly Manlove Forensics Ltd) Forensic Science Northern Ireland, Peter Lamb representing the International Association of Bloodstain Pattern Analysts and the Forensic Science Regulation Unit.