



# **Best Practice Manual for Fingerprint Examination**

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## Background

This Best Practice Manual (BPM) belongs to a series of 10 BPMs issued by the European Network of Forensic Science Institutes (ENFSI) in November 2015. The series covers the following forensic disciplines:

1. Forensic Examination of Digital Technology
2. Forensic Examination of Handwriting
3. Chemographic Methods in Gunshot Residue Analysis
4. Road Accident Reconstruction
5. Microscopic Examination and Comparison of Human and Animal Hair
6. Fingerprint Examination
7. DNA Pattern Recognition and Comparison
8. Application of Molecular Methods for the Forensic Examination of Non-Human Biological Traces
9. Forensic Recovery, Identification and Analysis of Explosives Traces
10. Forensic Investigation of Fire Scenes which have resulted in Fatalities\*
11. Forensic Investigation of Fire Scenes which involve the Clandestine Manufacture of Improvised or Homemade Explosive Devices\*
12. Forensic Investigation of Fire Scenes which Involve the Clandestine Manufacture of Illicit Synthetic Drugs\*

\* *The three specific areas on Forensic Investigation of Fire Scenes (numbers 10 -12) were combined into one BPM 'Investigation of Fire Scenes'.*

In the years 2014 and 2015, so-called Activity Teams have - in parallel - developed the 10 BPMs. The activities were performed within the project 'Towards European Forensic Standardisation through Best Practice Manuals (TEFSBPM)' and co-ordinated by the ENFSI Quality and Competence Committee. The realisation of the BPMs was supported by the Prevention of and Fight against Crime Programme of the European Commission – Directorate General Home Affairs (code: PROJECT HOME/2012/ISEC/MO/4000004278). The core project concept was that the BPMs will enhance the quality of the forensic services available to law enforcement and justice across Europe and thereby encourage forensic standardisation and cross-border cooperation between countries.

ENFSI expects that the issuing of this series will stimulate the improvement of already existing BPMs as well as the creation of new BPMs on disciplines that are not covered yet.

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## Official language

The text may be translated into other languages as required. The English language version remains the definitive version.

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# Best Practice Manual for Fingerprint Examination

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## 1. AIMS

This Best Practice Manual (BPM) aims to provide a framework of procedures, quality principles, training processes and approaches to forensic examinations. It can be used by Member laboratories of ENFSI and other forensic science laboratories to establish and maintain working practices in the field of forensic fingerprint examination that will deliver reliable results, maximise the quality of the information obtained and produce robust evidence. The use of harmonized methodologies and the production of more comparable results will facilitate the recognition of the results of laboratory activities across the Member States.

This BPM is aimed at practitioners in the field and assumes prior knowledge in the discipline. It is not a standard operating procedure (SOP) and addresses the requirements of the judicial systems in general terms only.

The BPM reflects the accepted practices at the time of writing.

## 2. SCOPE

Fingerprint examination is a complex process which consists of different phases: visualisation (detection), imaging and individualisation (ACE-V). However, this manual considers fingerprint examination from receipt of items into a laboratory to the delivery of a report as a seamless and interdependent process. It does not consider the recovery of fingermarks from the crime scene, although much of the information within the visualisation chapter (chapter 5) will still be relevant. It is recognised that arrangements within some jurisdictions preclude this integrated approach and consequently the manual considers each stage of the chain separately. Common terminology e.g. fingerprint, fingermark, tenprint is used throughout this manual however these terms also describe parts or contacts produced by other friction ridge skin, e.g. palms.

This BPM is an overarching document and sits above that of detailed SOPs, which describe detailed methods.

## 3. DEFINITIONS AND TERMS

For the purposes of this BPM, the relevant terms and definitions given in ENFSI documents, the ILAC G19 “Modules in Forensic Science Process”, and in standards such as ISO 9000, ISO 17000 and 17025, apply. See appendix 2 for the glossary.

## 4. RESOURCES

### 4.1 Personnel

People are the most important resource in any forensic examination. In order to allow staff to work effectively and efficiently, everyone involved in the process should understand the nature of the tasks and the qualities required to perform them. In this document, information is provided on key roles, responsibilities and required competencies.

#### 4.1.1 Roles and responsibilities

Due to variations in the size of different laboratories and the systems under which they operate, standardisation of staffing is difficult to achieve. It is accepted that an individual

may be responsible for more than one of the key roles. The roles that could be recognised for laboratories performing fingerprint examinations are as follows:

- *Laboratory Attendant*. An individual who performs basic laboratory tasks (e.g. preparation of reagents, cleaning of glassware, ordering supplies etc.) but who does not examine casework material.
- *Assistant/Laboratory Technician/Assistant Forensic Scientist*. An individual carrying out general casework examinations under the supervision of a Reporting Scientist and providing information to assist with the interpretation of the tests.
- *Reporting Scientist/Fingerprint Examiner/Fingerprint Practitioner*. The forensic scientist responsible in a particular case for directing the examination of the items submitted, undertaking the examination, interpreting the findings, writing the report and providing evidence of fact and opinion for the court.

#### 4.1.2 Practitioner Qualifications

The following qualifications are expected as the minimum requirement for the key roles defined above:

- *Laboratory Attendant*. A basic education, and the knowledge and practical skills required to perform allocated tasks safely and reliably under supervision and instruction.
- *Assistant/Laboratory Technician/Assistant Forensic Scientist*. Qualifications in a natural or applied science and a basic knowledge of the theories, analytical techniques and procedures applicable to the fingerprint examination process; the practical skills to operate specialist equipment and to carry out forensic fingerprint examination safely and reliably in compliance with laboratory protocols; and an understanding of the requirements of the criminal justice system.
- *Reporting Scientist/Fingerprint Examiner/Fingerprint Practitioner*. Qualifications in a natural or applied science, and acceptance as knowledgeable in the field through peer review and publication: knowledge of the theories, analytical techniques and procedures applicable to fingerprint examination; competence in the evaluation of results in fingerprint cases; and knowledge and experience of the requirements and procedures of the criminal justice system for the presentation of evidence, both written and oral.

#### 4.2 Training and Assessment

- Laboratories should have written standards of competence for each role, a documented training programme, and processes for assessing that trainees have achieved the required level of competence.
- Competence may be defined as the standards that should be achieved in order for the individual to undertake casework. Personnel will achieve the required level of competence through initial training before being authorised to undertake case work. They should also be subject to regular assessment to ensure that these competencies are maintained and developed.
- The assessment of competence can be accomplished through a number of different mechanisms including formal tests, undeclared trials, peer review of work, e.g. sample casework checking, etc.
- All reporting scientists and assistants should collect and maintain evidence supporting both their ongoing competence and proficiency. In addition to any formal assessment by their organisations, they should: read professional literature containing pertinent information relating to fingerprint examination; take part in

- appropriate events, e.g. workshops, seminars, training courses, etc.; and when possible, actively participate in research and development projects.
- All practitioners should be required to formally demonstrate continuing competence and proficiency at regular intervals.

## 5. METHODS: FINGERMARK VISUALISATION AND IMAGING [1, 2]

Chapter 5 deals specifically with the visualisation of marks within a laboratory. It provides advice and guidance on accommodation, equipment, health and safety and the processes which may be used. In addition, notes are provided with regards to a methodology for fingerprint visualisation which includes the use of sequences of processes. Guidance on the integration of fingerprint recovery with other forensic examinations is also included.

It should be noted that much of the information within Chapter 5 and Appendix 1 is sourced from the Fingerprint Visualisation Manual (FVM) 1<sup>st</sup> Edition [1] which was published in 2014 by the UK Home Office Centre for Applied Science and Technology (CAST). The FVM provides comprehensive guidance to practitioners within the field of fingerprint visualisation. This publication, along with its predecessors (Manual of Fingerprint Development Techniques (MoFDT), 1<sup>st</sup> and 2<sup>nd</sup> Editions) has been used worldwide within fingerprint laboratories since 1986. The change in name in 2014 reflects the change in working practices within fingerprint laboratories. In particular, it has been compiled with those seeking accreditation to the ISO 17025 standard in mind by including information that will help to raise practitioners' understanding of fingerprints and of the processes routinely used to visualise them. The ENFSI Fingerprint Working Group consider this a key reference document for those working within an enhancement laboratory, and the information contained within it will supplement the information provided within this BPM.

### 5.1 Equipment

The equipment available within any laboratory will depend on the type and quantity of items submitted. The following indicates the expected range of equipment to be found in a basic fingerprint laboratory:

- A fume cupboard rated to the appropriate standard for the processes used.
- Temperature and humidity controlled ovens for amino acid reagents.
- A humidity controlled cabinet for Superglue Fuming.
- A range of forensic light sources and viewing filters (for the eyes and/or the imaging system).
- General laboratory equipment including a range of appropriate glassware, measuring equipment etc.

Clearly the number of individual pieces of equipment will depend on the quantity of casework undertaken.

### 5.2 Reference materials

At the time of writing, there are no standard reference materials (e.g. test strips, positive controls, etc.) provided for use in fingerprint laboratories by accredited services.

### 5.3 Accommodation and environmental conditions

Fingerprint examinations should only be carried out in dedicated areas prepared for such examinations. Additional precautions should be taken if other forensic evidence is to be recovered, e.g. DNA. Maintaining a safe working environment is important both for the welfare of the examiner and the standard of the examination, as there may be hazards



from the item, chemicals and/or equipment. All laboratory work spaces should be compliant with current national Health and Safety at work legislation.

The following is a guideline for the basic accommodation and equipment that should be available:

#### 5.3.1 Administration and/or administrative reception area

This area should be physically separated from the laboratory and provide the appropriate space for the maintenance of records, file preparation, report writing etc.

#### 5.3.2 Technical reception

This area is for the unpacking of items for an initial examination. It may include areas such as a DNA sterile environment. In certain circumstances downdraught benches or other fume extraction may be considered. Lighting and bench space should be suitable for such examinations. No other examinations should be carried out in this area at the same time.

Hazardous items, such as those contaminated with radiological or pathogenic material, should not be accepted into the laboratory unless the facilities are set up to deal with such items.

#### 5.3.3 Storage of items

The storage area should be secure (lockable or restricted access) and contain appropriate shelving. The size of this area will depend on the type and number of items to be processed, and possibly on any local retention policies.

#### 5.3.4 Storage and disposal of chemicals

Chemical (including solutions and mixtures) should be stored in suitable containers (correctly labelled); under suitable conditions; separate from incompatible materials; and in suitable quantities. National and/or local rules applying to the disposal of used chemicals should be followed.

#### 5.3.5 Wet area

This area may contain a range of equipment associated with wet processes including fume cupboards, sinks, ovens, wet benches (with integral dyeing facilities), laboratory glassware washers etc. There should be enough space for all equipment and additional space (i.e. empty benches) as working areas. An allocated work area for certain processes may be appropriate.

#### 5.3.6 Dedicated areas

Some equipment may require dedicated facilities. For example, Vacuum Metal Deposition equipment requires special consideration due to factors such as operating noise and the weight of the equipment etc. Ideally pump equipment will be housed in an area separate from the examination chamber so that noise can be reduced to an acceptable level within the examination chamber area. Vehicle examination bays should be considered and where possible co-located with the laboratory.

#### 5.3.7 Reagent preparation

Depending upon health and safety requirements, this can be done either in fume cupboards or on the open bench within a wet area. Reagents should be suitably stored.

#### 5.3.8 Staining area

This may be done in fume cupboards or wet benches within a wet area. The area should have access to or include appropriate space for the drying of items. A repackaging area for treated items may be included.

#### 5.3.9 Dry area

This area is associated with general examination and processes such as powdering. There should be enough space for all equipment and additional space (i.e. empty benches) as work areas. An allocated work area for certain processes may be appropriate.

#### 5.3.10 Light source area

The area should be sufficiently large to accommodate: a range of light sources and ancillary equipment; a semi-enclosed viewing/imaging system (if used); an area for open- beam work; and imaging equipment to record visualised fingermarks. It should also have a means of excluding direct sunlight, e.g. blinds fitted at the windows.

#### 5.3.11 Imaging area

This is often within the light source area but may also be a separate imaging area which should be close to the laboratory.

#### 5.3.12 Cleaning and storage areas

There should be facilities for cleaning and storage of equipment. This may be separate to the laboratory, but can also be embedded within the wet area.

Where blood or body fluid contaminants are suspected as being present, equipment (including benches) should be thoroughly cleaned to minimise the risk of exposure to biohazards and cross-contamination between items.

### 5.4 Materials and reagents

Materials and reagents used in the processes are not given in this BPM. See Section 5.5.

### 5.5 Processes

An extensive range of processes exists for the laboratory visualisation of fingermarks. Most processes are destructive to the item to some extent and the customer sending the request should be made aware of this. These processes are generally targeted at specific constituents of the sweat or common contaminants forming the latent mark. Some are specific to particular surface types. Many of the processes may be used in sequence to maximise mark recovery and this should be documented in a fingerprint recovery plan.

A full description of the processes and in particular the preparation of reagents is outside of the scope of this manual. However, Appendix 1 contains brief information on the commonly used processes for which extensive validation data exists. Further information can be obtained from the recommended publication – The Fingerprint Visualisation Manual [1]. Formulation variations from those quoted in the above publication are acceptable provided all appropriate validation/verification has been undertaken.

Where marks have not been detected this cannot be taken as meaning the item has not been touched or handled. The following factors can be identified as possible factors:



- Donor. It is known that some individuals are better donors of marks than others. Factors affecting this are varied but include cleanliness, diet, health, age, physical stress etc. - all impact on the type and quantity of transferred material during contact.
- Substrate. Differing substrates have different mark retention properties due to its properties e.g. condition, texture etc.
- Environment. The temperature, humidity and other environmental factors will affect the persistence of the marks.
- Effectiveness of visualisation technique. Processes, particularly those relying on the presence of a particular substance in the mark, may be ineffective on some marks. Also where a targeted approach to detection has been used this may account for the failure to locate a mark.
- The surfaces have been accidentally or deliberately wiped or cleaned after deposition of the marks.
- The used development process was not appropriate or applied incorrectly.

#### 5.6 Processing of casework items

The following provides a general procedure for processing of casework items within the laboratory:

5.6.1 Items received should be packaged (See Chapter 11) and have a documented chain of custody. The condition in which the items are received, the appropriateness of packaging and any other relevant information which is considered to affect or compromise the fingerprint examination should be documented.

5.6.2 Where there is the potential to recover other forensic evidence the item should not be opened until other forensic specialists have been consulted and a forensic recovery plan agreed.

5.6.3 Appropriate personal protective equipment should be worn at all times. For most laboratory activities this includes eyewear, gloves and lab coats as a minimum.

5.6.4 Firearms and improvised explosive devices must have documentation and verifiable confirmation that they have been made safe by a qualified individual.

5.6.5 Measures should be taken to avoid any contamination. Work space for initial item inspection should be clear from other case material. Surfaces should be clean and if appropriate covered with disposable paper or bench coat.

5.6.6 Items with known body fluid contamination should have an appropriate warning label. If required, further information should be sought before the item is opened to ensure appropriate facilities are being used.

5.6.7 The appropriate glassware, containers etc. should be selected. All equipment should be clean.

5.6.8 The reagents to be used, as defined by the case assessment, should be checked. This may involve the use of a test strip or test mark to ensure that the reagent is performing correctly.

5.6.9 All equipment in use in the laboratory should be calibrated on a regular basis and used according to manufacturers' instructions.

5.6.10 Packaging should be carefully opened and local procedures should be followed for retention of the original packaging (if it is not re-used).

5.6.11 The appearance of the items should be documented. This may be either through a written description or photographs. Care should be taken to use the correct terminology, descriptors etc. to ensure no misleading information is recorded.

5.6.12 Where the items do not match the description provided within the submission documents or the item label, this should be noted and dealt with appropriately.

5.6.13 Care should be taken to ensure that items can be readily identified both within the treatment phase and after. Multiple items or parts of an item should be marked in a suitable manner. Alternatively labelled trays could be used.

5.6.14 A Visual Examination (see Appendix 1) is now undertaken to locate any visible marks and other forms of forensic evidence. This may involve the use of specialised light sources.

5.6.15 Following the Visual Examination and an inspection of the surface, further visualisation processes are applied (see Appendix 1).

## 5.7 Documentation

All examinations must be suitably documented. The extent and detail of these notes may vary with the items concerned however should as a minimum include the following:

- Date and location of the examination.
- Persons involved in the examination.
- Type and condition (contaminated, uneven etc.) of the surface bearing the mark.
- Whether marks are detected or not.
- Location of the marks.
- Observed differences in appearance of mark when treated with development processes applied in sequence.

## 5.8 Process selection

Most surfaces can be effectively examined using processes in sequence. Clearly such an approach increases the time and cost of an examination but it also maximises the potential to recover marks. In general, sequential approaches are usually adopted for serious crime. The order that processes are used is important and general guidelines for sequential processing can be found in Appendix 1.

The criteria for fingerprint visualisation process selection is determined by a number of factors. Those relating to the item include:

- the substrate (e.g. material(s), size, shape, colour, porosity, texture, condition);
- the type(s) of mark (e.g. latent, blood, grease);
- the environment to which the item has been exposed (e.g. rain, heat);
- the likely age of the mark(s).

There may be other constraints or limitations that need to be considered including:

- local policy;
- timeliness;
- the need for recovery of other evidence types;
- health and safety;
- evidence recovery location (laboratory or scene)
- resources;
- availability of processes.

#### 5.9 Packaging of examined items

On completion of the examination the items should be carefully repackaged following local procedures for retention of the original packaging (if it is not re-used).

All items that have been subjected to laboratory examinations should bear a Health and Safety warning if necessary. For example, this should advise that the items have been treated with chemicals and therefore pose a possible risk. See section 11.2 for general packaging guidelines.

#### 5.10 Recovery

This section deals with the process of assessing detected marks, documenting their position and arranging recovery.

##### 5.10.1 Locating marks

- Marks may be visible prior to the application of any visualisation process. They may also become visible during the application of a process.
- A person competent in the use of optical processes, such as Visual and Fluorescence Examination and having a basic competency in ridgeology, should inspect the surface for marks at all stages of a the sequential recovery plan. This may include the use of equipment such as suitable lighting and imaging devices.
- During a Visual Examination, a range of lighting set-ups should be considered. For example, oblique lighting of items may reveal raised or indented marks that are otherwise difficult to see. Light sources should therefore be directed from various angles. Also, transparent items may reveal marks by observing transmitted light through the surface.

##### 5.10.2 Recovering marks

- Once a mark is located, an assessment is made as to whether it should be recovered according to a detailed standard operating procedure of the laboratory.
- Criteria may be set, for example marks will be assessed as comparable only if they show particular patterns or have a particular number of specific features. The criteria for selection will ensure a degree of consistency in the recovered marks. Such criteria may be based on establishing thresholds.
- Marks may otherwise be assessed based on the experience of the examiner. In such cases suitable audits and trials should be regularly undertaken to ensure reproducibility, repeatability and accuracy of all examiners within the agency. Ideally similar trials should involve all examiners within a jurisdiction.

##### 5.10.3 Mark Selection

The selection strategy will be determined by the case assessment. In most cases all marks which have been assessed as suitable for comparison will be selected. Case documentation

should clearly state the approach undertaken and this has to be disclosed to the customer in full agreement.

#### 5.10.4 Mark documentation

Once the marks have been selected, the next stage is to identify them with a unique reference. For referencing marks, there are many factors to consider, including:

- Ensuring there is sufficient information to clearly identify the marks and how they have been visualised;
- A permanent method of identifying marks that will not fade or detach during subsequent processing or storage.

Documentation may take various forms. The central principle is that an individual should be able to visualise the location of a mark from the notes and/or images without reference to the item. This is of particular importance if the item or surface will not be available at a later date. One specific recording method is unlikely to succeed in all cases. The following are considered to be suitable:

- Sequential photography;
- Sketches;
- Written description.

In all cases of photography scales are essential. The need to record dimensions will vary, but where this is done they should use metric measurements to a realistic level of accuracy.

Where possible, a judgement of mark direction should be included in order to determine the potential value of the mark concerning past events (activity level). It could be indicated by an arrow.

#### 5.10.5 Critical Findings Check

A procedure should be adopted to ensure that all marks meeting the criteria have been recovered, for example by performing a regular random check.

#### 5.10.6 Photography or Imaging

Marks may be photographed using a range of imaging systems e.g. SLR cameras, flatbed scanners etc. A detailed guideline is presented on pages 3.3.16 – 3.3.26 in The Fingerprint Visualisation Manual [1] and the general requirements are given below:

- Operators should be trained to competence in order to perform forensic fingerprint photography and image enhancement.
- The selected capture resolution should allow reproduction of the features of interest within the mark and be compatible with the resolution requirements of local, national or international databases.
- The original image should be acquired in a non-lossy format.
- A scale including the numbers should be visible in the image.
- The identifying number of the mark should be visible at least in one of the images of the mark.
- Additional information, for example, identity of the photographer, case references, should be attached, endorsed or visible in the image.
- Imaging systems should retain at least one captured image (master copy) that is not accessible by the user. Any optimisation should be carried out on a working copy whereby the audit trail is retained.

#### 5.10.7 Lifting/casting

There is a risk that ridge detail may be lost during any lifting process. Wherever possible and practical, marks should be imaged in situ prior to lifting. Appendix 1 and the Fingerprint Visualisation Manual [1], contain more information about commonly used lifting and casting methods.

#### 5.10.8 Receiving Recovered Marks

Marks may be received from other agencies or colleagues. On receipt the lifted or photographed marks should be checked to ensure the chain of custody and if they comply with the guidelines above. An inspection should be carried out to verify that the lift or photograph is consistent with the details in the submission form or work sheets supplied. Discrepancies or apparent inconsistencies should be noted and if appropriate no examination will be initiated.

### 6. METHODS: INDIVIDUALISATION: ANALYSIS, COMPARISON, EVALUATION AND VERIFICATION [3]

This section deals with the examination of marks and the prints of individuals with the aim of determining or excluding a common source. Within this manual it is recognised that currently there are three different approaches to evaluate the strength of the fingerprint evidence:

1. *Numerical approach*: a fixed number of features is required by the legislation of the country or by the policy of the institute to compare the mark with a reference print.
2. *Holistic approach*: the quantity and the quality of the features have to be evaluated by the practitioner. If the quantity and quality of the information is considered as sufficient the mark is compared to a reference print.
3. *Probabilistic approach*: reporting the evidential value of a comparison under two mutually exclusive hypotheses at source level. The evidential value is evaluated by subjective probability assignment and/or calculated using software based on a probabilistic model.

#### 6.1 Analysis Phase

The analysis phase constitutes the first stage of the process. During this phase the mark will be examined prior to examination of any reference print. Appropriate equipment is selected to aid this examination. Examiners should use sufficient quality digital images of the mark and the reference print.

The following information will be sought:

- 6.1.1 Whether the mark is consistent with having been made by a volar surface.
- 6.1.2 Whether the possible anatomical origin of the mark can be determined. Such determinations are made from the general appearance, ridge flow, presence of patterns and pattern elements, location on the surface of item, and relationship to other surrounding marks.
- 6.1.3 Whether there is any observable distortion, which may lead to uncertain minutiae, artefacts, false minutiae, etc.
- 6.1.4 Whether there is any superimposition.
- 6.1.5 Whether the effects of the visualisation processes are apparent e.g. over powdering (the excessive application of powder to the extent that detail is obscured).
- 6.1.6 Whether there is sufficient quality in the mark to identify the ridge flow, minutiae, pores, interpapillary ridges, ridge shape, etc. [4].
- 6.1.7 Depending upon the approach, the key parameters that should be recorded are:

- Quality of the mark (clarity of the ridge detail);
- Amount of distortion in the mark;
- Estimation of the pattern type;
- Pattern elements such as deltas or cores;
- Possible anatomical origin of the mark;
- Documenting the number and type of minutiae;
- Recording pores, incipient ridges, scars, creases, etc.;
- Making an estimation of the rarity of the pattern and the combination and type of features found in the mark.

The information recorded during analysis will be used during the comparison phase.

The information may be recorded using confidence levels assigned to features in the mark using different colours, according to SOPs. This could be in accordance with the GYRO system [5]. At the conclusion of the analysis phase all of the collected information should be utilised to form a conclusion about the sufficiency of the mark for comparison.

If it is possible to estimate the mechanism by which the mark has been deposited onto the surface, mark positioning should be recorded as well. Information regarding the deposition mechanism can be obtained through simulation. The outcome of the simulation could result in information on the position of the finger or hand at the time of deposition. It is essential that such experiments are carried out in a balanced and transparent way and that possible mechanisms are investigated. Inferred activity extends the interpretation to infer the action in which the donor was engaged, for example gripping a window frame whilst climbing through, holding and carrying an item etc. In order to provide a balanced view it is essential that possible activities are considered.

For fingermarks associated with blood, a specific case for interpretation on activity level is whether a mark has been made in or with blood. This is a complex process and the current literature at the time of writing is inconclusive concerning interpretation of such marks. The evidential value of such an opinion is clearly important and caution must be taken in reporting to the finder of facts.

## 6.2 Comparison

The first step in the comparison phase is to establish whether the mark and the reference print are reproducing approximately the same area of friction ridge skin. The objective of the comparison is to determine the correspondences and/or dissimilarities between the features found during the analysis of the mark and the features found during the analysis of the reference print.

It is common for the comparison to start by orienting the mark in order to facilitate the comparison between the ridge flow and the placement of cores and deltas (if any) considering distortion factors. After the orientation of the mark has been set the corresponding ridge endings, bifurcations, points including possible dissimilarities are encoded.

A comparison is made by selecting information (e.g. ridge flow, features) in the mark and then searching for them in the reference print. The outcome of the comparison phase has to be recorded including similarities and dissimilarities.



For every dissimilarity found during comparison a technical explanation should be given or a conclusion of different source of the mark and the reference print has to be considered. If the ridge flow is discernible it should be used to locate the features.

When performing the comparison using any additional features that were not encoded during the analysis phase, they should be clearly documented according to the institute's SOPs.

A copy of the reference prints and marks used for comparison should be recorded in the case file, together with the individual notes.

### 6.3 Evaluation

During this phase the evidential value of the corresponding features between the mark and the reference print is estimated. In the evaluation phase the observations made during the comparison phase are considered. The likelihood of the corresponding

information present in the mark and the print is estimated given the hypothesis that the mark and print are originating from the same source or a different source.

If the pattern or features in the mark do not correspond to the pattern or features of all the reference prints of a donor, he/she is excluded as the donor of the mark. This conclusion is a categorical exclusion. This conclusion is common to all three previously mentioned approaches. In such cases the mark is subject to further investigation. In case of a comparison with a potential suspect the conclusion should be verified by a second expert, according to the institute's SOPs.

According to the holistic and the numerical approaches, the basis of fingermark individualisation is that an examiner has located a corresponding configuration of sufficiently discriminating features between the mark and the reference print which, in his/her experience and training to competence, could not have originated from another source than that of the reference print. The determination that the mark and the reference print originate from the same source is an expert opinion and requires verification by another examiner, according to the institute's SOPs.

According to the probabilistic approach, the outcome of the evaluation phase is the estimation of the evidential strength of the findings under two mutually excluding hypotheses. The evidential strength can be computed using a statistical model or can be estimated based on the knowledge and experience of the examiner. The evidential strength is reported as a likelihood ratio which can be calculated or expressed by using a verbal scale and/or a numerical scale. The conclusion is based on the subjective interpretation of the examiner and requires verification by another examiner, according to the institute's SOPs.

Evaluation should be carried out as follows:

- The correspondence and the dissimilarity of the features found during comparison is checked and recorded.
- The examiner should investigate any dissimilarities. By definition a mark will be subject to various factors that will cause it to be dissimilar from the reference print taken under ideal conditions. These factors may include:
  - o Distortion. The friction ridge skin areas are flexible. Thus the mark will often be distorted; the degree of distortion being related to the activity of the individual at the time the mark was deposited, to the position of the papillary skin, to the

- pressure applied to deposit the mark to the surface of the item, etc.
- o Superimposition. In this case a mark is overlaid on another mark, resulting in crossing ridge flows.
- Where there is a difference in the ridge flow, shape of a feature, relative position of a feature or other difference between the mark and print the examiner should be able to explain the differences encountered.
- Any explanation proposed in relation to dissimilarities should be supported by observations made during the analysis phase. For example, features may be present in the print but not the mark. There are a number of mechanisms, for example deposition pressure differences between the generation of the mark and the print, that causes differences in the appearance of the features. Certain features e.g. subsidiary ridges may also not be reproduced in a mark. During comparison this may be noted. Such an occurrence has to be addressed during the evaluation unless the mechanism by which it occurs can be determined.
- Once a conclusion has been established to the satisfaction of the examiner this should be documented. The notes may take various forms from annotated photographs to simple abbreviated notes. However, all notes should provide the following:
  - o Details of the specific set or copy of fingerprints used in the evaluation if different from the comparison.
  - o Details of the corresponding area of friction ridge skin. Details of the types and number of corresponding features on which the conclusion regarding the evidential value has been based. This may not be the same as the total number of features considered.
  - o A visual record for example through annotated photographs of the features used.

Because of objective limitation in the quality and quantity of the mark and/or the reference prints, the conclusion of the evaluation phase can differ according to the different approaches. When no categorical opinions are expressed, laboratories may either report the comparison as inconclusive (numerical and holistic approaches) or by providing an expression of the weight to be assigned to the findings. The SOPs of the laboratories should clarify the nature of the conclusions that can be reached by the examiners in these situations.

#### 6.4 Databases and searching

Marks may be searched against databases using AFIS technologies. This section deals with maintenance and use of such databases.

##### 6.4.1 AFIS systems

AFIS technology is only efficient, if it supports the local processes, if the fingerprint practitioners working with AFIS are trained in the opportunities and limits of AFIS and if the interaction between AFIS and the local fingerprint database is fully understood in terms of qualitative and quantitative performance. The validation of AFIS according to ISO 17025 is highly recommended.

##### 6.4.2 Fingerprint Databases

Fingerprint databases enable:

- the search of crime scene marks;
- the identification of persons;
- the maintenance of criminal records etc.

Databases should be maintained in accordance with the prevailing data protection legislation. This section does not deal with the maintenance of criminal record databases.

#### 6.4.3 Tenprint vs. tenprint search

The principal purpose of this type of search is to confirm the identity of a subject who has given fingerprints under controlled conditions by comparing these with sets of tenprints already held on the database, or to create a new record if the subject is not already on the database. It is recognised that there are variations between AFIS systems. However for forensic use the systems should have the following facilities:

- The systems primary function is to aid the identification of individuals by generating a candidate list.
- Quality may be defined as the print revealing clearly defined pattern and features, being free of distortion and of consistent contrast. Each finger and area of palm should be subjected to quality checks.
- The recovery of multiple sets of fingerprints is encouraged to ensure that all volar surfaces are recorded.
- Finger assignment. A process should be in place to ensure that the correct fingers are recorded and the ability to correct if necessary.

#### 6.4.4 Mark ("latent print") vs. tenprint search

- The principal purpose of this type of search is to search a mark from an unknown subject against the tenprint sets on the database to create a list of possible respondents for comparison:
- Each agency using an AFIS will set a threshold level for the searching of crime-scene marks. The threshold will form the basis of mark selection for the search.
- Where there are large numbers of marks, standard operating procedures to limit the number of searches may be considered. These may include limiting the number of marks searched or restricting to those of greater evidential value. These informed decisions resulting in a limited number of searches should be documented.
- The case notes should document each mark that is submitted for search and the result. Where possible lists of the respondents checked should be kept for verification and/or accreditation purposes.
- If a match is obtained a documentation of the mark and respondent annotated with feature markers should be retained in the case file.

#### 6.4.5 Tenprint vs. mark ("latent print") search

- The principal purpose of this type of search is to search a tenprint set on the database against marks from unknown subjects to create a list of possible respondents for comparison. Each agency using an AFIS searches all new incoming tenprint cards against the unsolved marks stored into the database:
  - o The practitioners that are carrying out the comparison must be trained to competence and participate in proficiency testing according to the SOP's of the agency.

### 6.5 Verification

The term verification is used for different processes:

- A blind verification is an independent verification done by a second examiner using the ACE method, without knowing the conclusion of the first examiner.
- A verification is an independent verification done by a second examiner using the ACE method, knowing the conclusion of the first examiner.

- A critical findings check is a process whereby a second examiner goes through the ACE method used by the first examiner, in order to check the conclusions of the first examiner.

The verification stage of the ACE-V process should be a well documented independent verification. The verification should follow a blind process to minimize the risk of errors due to bias (contextual information).

Verification should be done on all inclusive conclusions reached by the first examiner.

Inclusive conclusions are considered the following:

- individualisations
- likelihood ratios greater than 1

Depending on the organisation of the agency and its manpower, verification should also been done on:

- conclusions of exclusions;
- likelihood ratios smaller than 1;
- inconclusive conclusions;
- findings arising from the visualisation phase of conclusions following the analysis phase.

#### 6.6 Conflict resolution policy

Agencies should have a written procedure to handle differences in conclusions reached by the examiners as a result of the ACE-V process. The conflict resolution policy should reflect the accuracy and applied tolerances of the ACE-V process, as declared by the agency and as demonstrated in the validation, and should address the necessary steps to determine the solution of the conflict.

## 7. **VALIDATION AND ESTIMATION OF UNCERTAINTY OF MEASUREMENT**

The laboratory should aim to use validated methods and procedures for the examination and interpretation of results in fingerprint casework. Before a validation process can be started the critical aspects of the method or procedure should have been identified and the limitations defined. All these aspects should be combined into an overall validation plan.

The validation should be carried out in compliance with chapter 5.4.5 of the ISO 17025 standard. At the time of writing there are no published standards concerning procedures used in the fingerprint field.

During a validation test, it is important to investigate the following (among others):

- accuracy;
- precision;
- range;
- repeatability;
- reproducibility;
- robustness.

The values associated with this list of parameters should be determined throughout the validation process.

### 7.1 Validation – Visualisation

The key parameters written down in the validation plan should be assessed in a structured, organised format. The validation study should be fit for purpose. Before a validation is carried out, keep in mind:

- the number of variables;
- the type of substrate;
- the number of test prints from different donors;
- aging of the marks;
- environmental exposure.

During the validation it is highly recommended to vary only one key parameter throughout an experiment. If the validation is carried out on test prints from donors, the number and the variability of the donors should be relevant and consistent with the casework.

The use of depletion series could give more information on the detection limits and aging of the prints could better model the realistic scenario. All this information can also be obtained by varying concentration and chemical composition of a reference solution.

The surfaces tested during the validation process should be representative of operational ones.

If the technique is a refinement of an existing technique, or the technique is new for a substrate for which processes already exist, one or more of the following benefits should be demonstrable:

- o it should have a higher quantity of mark development;
- o it should have higher quality mark development;
- o it should be easier to use;
- o it should be safer to use;
- o it should be cheaper to use.

A new technique should be published in a peer reviewed journal.

Comprehensive best practice guidance for validation of fingermark visualisation processes can be found in the literature [6,7]. Information relating to the validation of processes within the Fingermark Visualisation Manual [1] is available of the UK government's website [8].

### 7.2 Validation – Imaging

The purpose of imaging is to obtain an image of a mark at best quality for comparison. Special attention should be given to sharpness, focus and contrast between the ridges and the furrows, etc.

For the validation of the imaging process the following key parameters should be taken into consideration: the imaging equipment, the environment, the surface, the detection method, the wavelength and power of the light source and interaction with the AFIS system. The same marks from the validation of detection methods can be used for the validation of the imaging technique.

Part of the imaging process is the digital enhancement of marks; this part is highly dependent on the software used by the institute. The validation has to be done by using the same software available to the practitioner. Digital enhancements should be carried out by staff competent in those processes and able to explain the potential impact of those

enhancements on the image of the mark. Any alterations to a copy of the original image via enhancement processes should be tracked and the original image should be stored separately.

### 7.3 Validation – Individualisation process

The purpose of the individualisation process is to measure the evidential value of the comparison. The most commonly used method is the ACE-V process (see Chapter 6).

For the validation of the individualisation process the following key parameters should be taken into consideration: the competence of the examiners, the approach (numerical, holistic or probabilistic), the working environment, the equipment (hardware/software) and the contextual information (bias).

### 7.4 Estimation of uncertainty of measurement

The estimation of uncertainty can be determined at the end of the validation process.

## 8. PROFICIENCY TESTING

Proficiency tests (PT) and collaborative exercises (CE) should be used to test and assure the quality of fingerprint processes and the competence of the practitioners within an organisation. The document called “Guidance on the conduct of proficiency tests and collaborative exercises within ENFSI” (QCC-PT-001 issue number 001 27/06/2014) provides information for the ENFSI Expert Working Groups (EWGs) on how to organise PTs and CEs for their members.

Depending on the used approach according to the local SOPs to evaluate the strength of the fingermark evidence (numerical versus holistic versus probabilistic approach), the result of a PT or CE in the field of individualization has to be interpreted to be correctly applied for a specific approach.

For accredited laboratories ISO 17025 requires laboratories to perform at least one PT/CE test per year.

## 9. CUSTOMER OR CASE REQUIREMENTS

Prior to the acceptance of a case for examination it is necessary to determine the examination strategy. This chapter provides advice on how this may be achieved.

Case requirement refers to the intelligence or evidential findings that are sought by the customer. The term customer requirement includes the latter but also considers such issues as cost, turnaround time, value for money considerations etc.

All laboratories should ensure that the following basic information is supplied with submissions or is otherwise obtainable, this includes:

- The details of the incident for example the location and a brief outline of the incident. This may be brief but should include all information that may be considered relevant to the examination requested. In complex cases statements of witnesses may be of assistance.
- A location of seizure of items, or recovery of marks and likely connection to the incident. This is particularly relevant in large cases where selection may be



appropriate. It will also assist in the case assessment ensuring that the most appropriate course of action is taken.

- An outline of the examination required. This should be more than a simple request for fingerprint examination. The customer should indicate how the fingerprint evidence will be utilised within the case.
- A note of any other forensic examinations, need to preserve items etc. Constraints on the examination should be clearly noted within case notes. This is particularly relevant when the most effective course of action has been excluded.
- Whether the examination is intended to generate intelligence or evidence.
- A completion date for the examination. Basic scheduling information is essential for efficient management of case loads. Care should be taken to ensure that dates specified are reflective of the investigative or judicial proceedings.
- The priority that may be assigned to the case. Customers and relevant practitioners should advise on the priority of the examination against other submissions or other examinations in the specific case.

Information disclosed to the practitioners should be strictly limited to that required for them to conduct their examinations effectively in order to minimize the effects of contextual bias.

## 10. INITIAL EXAMINATION

The aim of this phase is to establish what is technically and practically possible. The wide range of fingermark visualisation processes, and the ability to use them in sequence, requires that the decisions of the examiner are recorded for the purposes of transparency and traceability. It also includes an assessment of the effectiveness of the proposed examination and whether it will fulfil the aims and requirements of the customer.

A case assessment will take place prior to any examination. In the first instance it may refer only to the visualisation stage. If marks are recovered a second assessment may be carried out prior to the search or comparative process. The plan coming from case assessment should be continually reviewed.

The approach to case assessment will be the same regardless of the objectives. However, it may be influenced by the policies and the capacity of the laboratories and/or the judicial systems in which they operate.

The responsible persons for case assessments should be identified according to internal procedures.

### 10.1 Carrying out the assessment

Assessment may be carried out by consideration of the requirements of the investigation and the technical feasibility of the examination. The considerations should be recorded in the case notes and be available for review.

### 10.2 Technical Feasibility

The assessment should take into account the availability of facilities to visualise and recover marks. This assessment should be based on the SOPs of the laboratory as this will reflect the validated and approved processes available. However the laboratory should have a procedure for the use of non-accredited processes. Those conducting the assessment should require an in-depth knowledge of the processes and the equipment.

Various factors may be taken into consideration when carrying out a case assessment:

10.2.1 Preservation. How the items have been preserved.

10.2.2 Detectability. The likelihood of persistence of a particular mark on an item given the history of the item. The history may include timings of events, nature of the substrate, handling etc.

10.2.3 Technique effectiveness. Information with regard to the effectiveness of particular processes or sequences of processes on the substrates concerned.

10.2.4 Determination of mark positioning relating to the incident. The positioning of a mark on the items given the information relating to the incident.

10.2.5 Inappropriate handling risks. The likelihood of the mark being overlaid, distorted or obscured by the action of excessive handling. The possibility of transfer of the mark from an item to another item.

10.2.6 Multi-disciplinary examination of the case.

The case assessment should be documented and be available for review. Where appropriate the case assessment should be referred to in reports and statements.

## **11. HANDLING ITEMS**

The section provides an overview of the requirements for handling of items.

### **11.1 Receiving of items for examination**

The items to be examined have to be transferred to the laboratory, together with an application for examination, explaining the criminological relevance of the examination to the investigation and stating the reasons for the examination. For this purpose a prescribed (digital) form can be used.

The items to be examined have to be listed clearly. Information should be given regarding the crime scene and time of offence, the presumed modus operandi, the seizure process and the origin of the evidential material.

It should be stated whether or not items to be examined may be damaged or destroyed during the examination purposes.

The priority of the examination should be indicated.

To ensure the appropriate sequence of examinations, an indication of the requirements for other types of evidence other than the fingermarks needs to be given.

### **11.2 Handling of items for examination**

One of the most important aspects of the recovery of physical evidence is that the evidential material is handled in such a way that the evidence is not damaged or destroyed. In case of digital transmission, the original image should be retained.

Items which have to be examined for marks should never be touched with bare hands. The wearing of gloves is essential, and it is good practice to change gloves regularly to minimise cross contamination.

Items retained for fingerprint visualisation should be touched as little as possible. If unavoidable, the item should only be touched where fingerprints are least probable. Besides the risk of leaving one's own fingerprints, there is also the risk of destroying or damaging existing marks on all items and in particular on smooth, non-porous surfaces. This can be caused either by incorrect handling, as described above, or by inappropriate packaging, as described below.

### 11.3 General packaging guidelines

When items have to be examined for marks and other physical evidence, it is important that the packaging meets the different requirements. Specialists in the various areas should be consulted as necessary.

In general, each item has to be packed individually to prevent physical evidence from being transferred, damaged and/or altered. The following guidelines should be followed:

11.3.1 Pressure from outside or tight packaging causing abrasion from the wrapping material should be avoided.

11.3.2 Ideally wet items should be dried before packing. Consideration should also be given to items that may sweat if stored in plastic containers. Packages holding moist items have to be packed in well-ventilated or "breathable" containers or materials, for example, paper bags.

11.3.3 If the moisture itself is not relevant to the crime the material has first to be dried at room temperature and in conditions where sufficient ventilation is available. During this process it has to be guaranteed that physical evidence is not being transferred by physical separation of victim- and offender-related material.

11.3.4 Items to be examined should be packed individually and carefully, ensuring that the containers are big enough and do not alter the evidential material mechanically or chemically.

11.3.5 The packaging should ensure the exclusion of loss, transfer or destruction of all, or part of, the items. Fingerprints on smooth surfaces, such as metal, glass or plastic, can be damaged very easily.

11.3.6 Items to be examined, such as weapons, ammunition or pieces of glass, should not be transported loose in paper or plastic bags. They should be packed/fixed in solid containers in such a way that the surfaces are prevented from rubbing against each other and personnel are not exposed to additional safety risks.

11.3.7 Dry items with porous surfaces, such as paper, can be packed in many ways, e.g. in plastic bags or envelopes, if they have to be examined for fingerprints only.

### 11.4 Labelling

Individual labelling of the items is very important to make sure that they can be clearly assigned to a specific case. Alternative methods can be used such as barcoding.

In general it is highly recommended that items should not have markings or labels directly affixed to them, by writing or sticking. Instead, a clear marking or label has to be fixed to the packaging and should include:

- the agency;
- the case/ file number;
- the item number;
- a short description of the piece of evidence;
- the date;
- the name of the officer who seized the item;
- an indication of type of evidence to be recovered.

The packaging should be marked/labelled with the above-mentioned details before an item is packed in order to avoid contaminating evidence by, for example, using writing material (which may cause impressions, damage or alterations).

If items cannot be packed because of their size, other appropriate marking methods have to be found, such as fixing an evidence card to the respective items showing the relevant details.

#### 11.5 Chain of custody/Continuity

All items seized should be accurately documented and a full audit trail should be kept at all times.

If items are passed on to other examiners, a transfer list (paper or electronic) or a similar document should be created. For example, both the transferor and the transferee should

sign a document, indicating their personal names, the names of their agencies and the date of transfer, so that the full audit trail is maintained.

#### 11.6 Storage

All items should be stored securely. In general, items should be stored in their original packaging in suitable laboratory conditions.

Items treated with chemical reagents should be packaged in accordance to health and safety guidelines and should have appropriate warning labels attached.

#### 11.7 Dispatch

As soon as the examination of the case has ended, the items should be returned to the customer or handled according to the national legislation.

## 12. **CASE REVIEW**

On completion, and prior to the notification of the findings or preparation of any report, the case should be reviewed by authorized personnel. The case files and all associated notes should be checked to ensure that the outcome of the case assessment has been followed.

Checks may include:

- the appropriateness of the case assessment;
- documentation of relevant quality checks;
- adequate recording of items prior to examination;
- consideration of alternative forensic approaches;

- a review of documentation;
- a review of the conclusions.

The review should be documented on completion.

### 13. PRESENTATION OF EVIDENCE

The overriding duty of those providing forensic evidence is to the court and to the administration of justice. As such, evidence should be provided with honesty, integrity, objectivity and impartiality. Evidence can be presented to the court either orally or in writing. Only information which is supported by the examinations carried out should be presented. Presentation of evidence should clearly state the results of any evaluation and interpretation of the examination. Written reports should include all the relevant information in a clear, concise, structured and unambiguous manner as required by the relevant legal process. Written reports must be peer reviewed. Witnesses should resist responding to questions that take them outside their field of expertise unless specifically directed by the court, and even then a declaration as to the limitations of their expertise should be made.

#### 13.1 Transparency

Reports and statements should give a full account of the examination. This may include a general explanation of the examination process as well as specific details relating to the case. Any limitations to the examination for example the use of a targeted approach should be made clear.

Interpretations should be clearly presented as an opinion of the examiner and its limitations made clear.

The basis used to reach the conclusion regarding the evidential value of the comparison should be of sufficient quality to be considered objective so that it can be presented to a criminal tribunal (court).

#### 13.2 Balance

All reports and statements should be written objectively. All relevant information should be made available to the court [9].

#### 13.3 Use of terminology

All used terminology should be explained in such a way that all parties can clearly understand.

#### 13.4 Explanation of the process

The examiner should be able to explain the full process of his/her field of expertise (visualisation, imaging and comparison). This should include the mechanisms by which processes work, an overview of the imaging processes being used, and the basis of fingerprint comparison and processes of evaluation.

## 14. HEALTH AND SAFETY

For health and safety follow national laws and local SOPs. The brief highlight is given in Appendix 1 for the individual visualisation processes, more information can be found in the Fingerprint Visualisation Manual [1].

## 15. REFERENCES

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## 16. AMENDMENTS AGAINST PREVIOUS VERSIONS

Not applicable



## APPENDIX 1: FINGERMARK VISUALISATION PROCESSES

Unless stated, all of the information within Appendix 1 is taken from the Fingerprint Visualisation Manual (FVM) [1]. It gives general guidelines for sequential processing and an overview of some fingerprint visualisation processes as outlined in Chapter 5 of the FVM.

### A1.1 Sequential Processing

#### A1.1.1 Introduction

The use of fingerprint visualisation processes in an appropriate order should be followed in order to maximise fingerprint evidence. The sequential processing charts, as outlined in Chapter 4 of the FVM should be used as a guide for maximising fingerprint recovery from a range of surface types. The charts are not reproduced within this BPM and are designed to be adaptable. Top level information describing the general purpose of different classes of processes is given, along with guidelines for sequential processing in the form of general rules.

The different optical, chemical and physical processes can be used on a wide variety of items and surfaces to visualise fingerprints. If they are used in the correct sequence, different properties or constituents of the fingerprints can be targeted without destroying the opportunity to maximise evidence from the remaining components.

The first part of this appendix groups processes depending upon their function. The second part describes general rules for sequential processing.

#### A1.1.2 Process Purpose

**(1) Surface Preparation Processes:** Their function is to create a surface that improves the chances of success of any subsequent visualisation technique. This may involve the removal of contaminants or potentially interfering substances, or separation of attached surfaces. While they are often carried out at the start of a processing sequence, they may be needed at a later stage to maximise recovery of obscured marks, e.g. processing of an item with tape attached may be treated before and/or after the tape is removed.

**(2) Visualisation of Fingermarks Processes:** Their function is to increase contrast between the mark and the background to the point where a mark becomes visible to the observer or detection system being employed. These processes may be optical, chemical or physical in nature.

**(3) Contrast Improvement Processes:** It may be possible to further increase the contrast between the mark and the background with the objective of maximising the amount of ridge detail visible. Optical processes (e.g. colour filtration) can be effective at enhancing detail developed with most chemical and physical processes. There are also a limited number of chemical processes that enhance specific chemical visualisation processes (e.g. physical developer enhancement).

**(4) Image capture:** Images should be captured of any marks that are visible prior to proceeding with any further processing. Subsequent processes may not reveal any additional ridge detail and may be detrimental to that which has already been revealed.

### A1.1.3 Rules for Sequential Processing

There is a basic rule that can be applied to sequential processing:

**Basic Rule:** *Processes should be used in the order of least to most destructive in order to maximise the opportunities for fingerprint recovery.*

This can then be supplemented by further rules, which form the basis for establishing the Fingerprint Evidence Recovery Plan.

**Rule 1:** *Optical processes should be used at the beginning of any processing sequence (and after each processes as required).*

Optical processes are generally non-destructive to the mark or substrate and can be used in any order. Optical processes include Colour Filtration; Fluorescence Examination, IR Reflection, Monochromatic Illumination, Multi-Spectral Imaging, UVC Reflection and Visual Examination.

**Rule 2:** *Liquid-free processes should be used before any liquid-containing processes.*

Liquid-free processes will not remove mark components but may physically hinder further enhancement. There are no clear rules about the order of these processes, but the charts in Chapter 4 of the Fingerprint Visualisation Manual show the order that is likely to be most effective for different surface types. Processes include Powders, Superglue Fuming and Vacuum Metal Deposition. (Special case: Superglue Fuming is known to reduce the effectiveness of Acid Dyes.)

**Rule 3:** *Organic solvent-based processes should be used before water-based processes.*

Organic solvent-based processes may dissolve some components of the mark and/or affect the substrate but are generally less destructive than water-based processes. Processes include DFO, Indandione and Ninhydrin. The order is important and DFO or Indandione must be applied before Ninhydrin.

**Rule 4:** *Water-based processes should be used at the end of any processing sequence.*

Water-based processes may cause significant staining or damage to the substrate and may dissolve water-soluble components of the mark. There are no clear rules about the order of these processes, but the charts in Chapter 4 of the Fingerprint Visualisation Manual show the order that is likely to be most effective for different surface types.

(Special case: Acid Dyes must be applied before other water-based processes as blood or other protein-rich contaminants targeted by acid dyes are water soluble. Processes include Basic Violet 3, Multi-Metal Deposition, Physical Developer, Physical Developer Enhancement, Powder Suspensions, Small Particle Reagent, Solvent Black 3 and Superglue Fluorescent Dye Staining.

### A1.2 The Processes

A summary of the following fingerprint visualisation processes is given:

Optical Processes:

- Colour Filtration;
- Fluorescence Examination;
- Infrared Reflection;
- Monochromatic Illumination;
- Multi-Spectral Imaging;
- Ultraviolet (UVC) Reflection;
- Visual Examination.

Chemical/Physical Processes:

- Acid Dyes;
- Basic Violet 3;
- DFO;
- Indandione;
- Lifting;
- Multi-Metal Deposition;
- Ninhydrin;
- Physical Developer;
- Physical Developer Enhancement;
- Powders;
- Powder Suspension;
- Small Particle Reagent;
- Solvent Black 3;
- Superglue Fluorescent Dye Staining;
- Superglue Fuming;
- Vacuum Metal Deposition.

PROCESS NAME:

## Colour Filtration

MAIN USES:

For use on any coloured fingermarks (treated or untreated) on all surface types, and/or marks on coloured backgrounds.

PROCESS OVERVIEW:

### Theory:

*Colour Filtration* is used to enhance fingermarks that are already visible in situations where the fingermark, the background, or both are coloured. The process utilises the colour characteristics of the mark and/or surface and involves selection of appropriately coloured filters and/or light sources to alter the contrast of the mark relative to the background. Two principal approaches can be used: colour enhancement to increase contrast of marks with surfaces of a single colour; and colour cancellation to reduce unwanted contrast between different regions of multi-coloured surfaces. *Monochromatic Illumination* is also described as a separate process because the colour filtration condition can be dynamically controlled over a broad wavelength range and the narrower bandwidths used allow greater colour discrimination.

### Practical:

- *Colour Filtration* is an optical process that involves simultaneously illuminating the mark and surface with an appropriate low-powered light source and viewing the outcome. A suitable viewing filter may also be required to obtain optimum results;
- It can be used safely and effectively in the laboratory and at scenes.

KEY PARAMETERS:

### Equipment:

- **Filters:** Process effectiveness will be determined by the range of coloured filters (or light sources) available.

<p>PROCESS NAME:</p> <h2>Fluorescence Examination</h2>
<p>MAIN USES:</p> <p>For use on all types of marks and on all surface types.</p>
<p>PROCESS OVERVIEW:</p> <p><b>Theory:</b>  <i>Fluorescence Examination</i> utilises differences in the fluorescent properties between the fingerprint and the background to produce fingerprints visible to either the eye or an imaging system. Chemical constituents within unprocessed fingerprints (mostly from contaminants rather than natural sweat), some processed fingerprints and some surfaces may fluoresce, whilst others may absorb light but do not fluoresce. Fingerprints that have been subjected to processes to make them fluoresce are usually brighter and easier to see than those found during an initial examination prior to any chemical processing, which may be extremely faint.</p> <p><b>Practical:</b></p> <ul style="list-style-type: none"> <li>• <i>Fluorescence Examination</i> is an optical process that uses specialist high-intensity light sources (visible and UV) to excite fluorescence and specialist filters to enable the practitioner to view it;</li> <li>• It can be used safely and effectively in a laboratory and at scenes, with appropriate precautions to protect eyes from high intensity light (see below).</li> </ul>
<p>KEY PARAMETERS:</p> <p><b>Equipment:</b></p> <ul style="list-style-type: none"> <li>• <b>Light Source:</b> The high-intensity light source must: (1) emit wavelengths of illumination to excite fluorescence within either the mark or background. Consideration must be given to the type of mark (chemically enhanced, latent etc.) and the surface being examined in order to determine appropriate wavelengths; (2) not emit perceptible stray light at the wavelengths at which the fluorescence is being viewed; (3) produce an intensity of illumination (i.e. power) at the surface that is high enough to produce a level of fluorescence that can be effectively observed. (High power densities of 10–100 mW cm<sup>-2</sup> are necessary to detect some fingerprints. This equates to a light source with an output power of 1–10 W across a search area 10 cm × 10 cm.);</li> <li>• <b>Goggles/glasses/filters:</b> The goggles, glasses or imaging filters must protect the eyes (if relevant) against the output illumination of the high-intensity light source whilst transmitting fluorescence from the item. (This usually means that transmission of the filter over the wavelength range of the illumination should be less than 10<sup>-4</sup> (or OD4 where OD = optical density)).</li> </ul> <p><b>Environment:</b></p> <ul style="list-style-type: none"> <li>• <b>Light levels:</b> The examination environment should be as dark as possible – stray light will interfere with examinations.</li> </ul> <p><b>Practitioner:</b></p> <ul style="list-style-type: none"> <li>• <b>Dark adaptation:</b> If viewing items with the eye, the operator must be suitably dark adapted before beginning <i>Fluorescence Examination</i>. This is most important when viewing weak marks such as those that may be observed during an initial <i>Fluorescence Examination</i>.</li> </ul>

PROCESS NAME:

## Infrared Reflection

MAIN USES:

For use on fingermarks developed by metallic/inorganic deposition processes on all surface types.

PROCESS OVERVIEW:

### Theory:

*Infrared Reflection* is used to enhance fingermarks that are already visible in situations where the fingermark is obscured by coloured, patterned backgrounds or where the surface has significantly darkened due to the action of heat. The process utilises differences in the infrared reflectivity of the mark and surface to provide additional contrast between them.

### Practical:

- *Infrared Reflection* is an optical process that involves simultaneously illuminating the mark and surface with a source outputting infrared radiation and viewing the effect using an infrared sensitive imaging system fitted with a filter that blocks visible light and transmits infrared;
- It can be used safely and effectively in the laboratory and at scenes.

KEY PARAMETERS:

### Equipment:

- **IR source:** The infrared radiation source must have output in the near infrared region of the spectrum in the wavelength range 700-1100 nm;
- **Imaging system:** The infrared imaging system must either: (1) be capable of directly detecting radiation in the near infrared region of the electromagnetic spectrum (e.g. CCDs with the IR blocking filter removed); or (2) be capable of converting radiation in the near infrared region of the electromagnetic spectrum (700-1100 nm) to a visible output (e.g. image converters);
- **Filters:** The infrared filter must block all visible radiation and transmit in the near infrared region of the spectrum. Band-pass and long-pass filters are appropriate; filters with cut-on wavelengths of 750 nm or greater generally give the best results.



PROCESS NAME: <b>Monochromatic Illumination</b>
MAIN USES:  For use on any other coloured fingerprints (treated or untreated) and/or marks on coloured backgrounds.
PROCESS OVERVIEW:  <b>Theory:</b> <i>Monochromatic Illumination</i> is used to enhance fingerprints that are already visible in situations where the fingerprint, the background, or both are coloured. The process utilises the colour characteristics of the mark and/or surface and involves the use of a filter capable of giving narrow band illumination from any portion of the visible spectrum that is adjusted to alter the contrast of the mark relative to the background. It is essentially a sub-process of <i>Colour Filtration</i> , but is described separately because the colour filtration condition can be dynamically controlled over a broad wavelength range and the narrower bandwidths used allow greater spectral discrimination of colours. The optimum discrimination of the mark may be obtained using conditions intermediate between the colour enhancement and colour cancellation conditions described for <i>Colour Filtration</i> .  <b>Practical:</b> <ul style="list-style-type: none"><li>• <i>Monochromatic Illumination</i> is an optical process that involves simultaneously illuminating the mark and surface with a low-intensity light of an appropriate narrow wavelength range and observing the outcome as the illumination wavelength is adjusted;</li><li>• It can be used safely and effectively in the laboratory and at scenes.</li></ul>
KEY PARAMETERS:  <b>Equipment:</b> <ul style="list-style-type: none"><li>• The linear variable filter - adjustable slit combination must: (1) allow narrow portions of the full range of the visible spectrum to be selected. Approximately 25 nm bandwidths are typical but this can vary; (2) allow the transmission of the selected narrow bandwidth portions of the visible spectrum onto the surface.</li></ul>

PROCESS NAME:

## Multi-Spectral Imaging

MAIN USES:

For use on any coloured fingerprints (treated or untreated) and/or marks on coloured backgrounds; also for use on fluorescent marks on fluorescing backgrounds

PROCESS OVERVIEW:

### Theory:

*Multi-Spectral Imaging* is used to enhance fingerprints that are already visible in situations where the fingerprint, the background, or both are coloured. The process utilises the colour characteristics of the mark and/or surface. Colour spectra are obtained for each region of interest and software used to discriminate the characteristic spectrum of the mark from that of the background. Because the process analyses the colour spectra of mark and surface across the visible spectrum, it is potentially capable of achieving greater discrimination between marks and backgrounds than *Colour Filtration* and *Monochromatic Illumination*, especially where multiple background colours are present. It can be used in conjunction with both *Visual Examination* and *Fluorescence Examination*.

### Practical:

- *Multi-Spectral Imaging* is an optical process that involves illuminating the area with a light outputting an appropriate wavelength range and collecting a series of images at different wavelengths. These images are then combined and analysed using computer software to extract the relevant information;
- It can be used safely and effectively in the laboratory, but it is normally considered impractical to use at scenes.

KEY PARAMETERS:

### Equipment:

- The effectiveness of the process is dependent on: (1) the filtration bandwidth achievable by the imaging system; (2) the software available for separating colour spectra; and (3) the expertise of the operator.

<p>PROCESS NAME:</p> <h2>Ultraviolet (UVC) Reflection</h2>
<p>MAIN USES:</p> <p>For use on latent fingerprints on all surface types, or fingerprints developed by <i>Superglue Fuming</i>.</p>
<p>PROCESS OVERVIEW:</p> <p><b>Theory:</b> <i>Ultraviolet (UVC) Reflection</i> utilises differences in the level of absorption and/or scattering of UVC radiation between the mark and the surface.</p> <p><b>Practical:</b></p> <ul style="list-style-type: none"><li>• <i>Ultraviolet (UVC) Reflection</i> is an optical process that involves simultaneously irradiating the mark and surface with a source outputting UVC radiation and viewing the effect using an ultraviolet sensitive imaging system fitted with a filter that blocks visible light and transmits ultraviolet. It can be used safely and effectively in the laboratory;</li><li>• Although it can be used at scenes this is generally less effective and safety measures are more difficult to achieve.</li></ul>
<p>KEY PARAMETERS:</p> <p><b>Equipment:</b></p> <ul style="list-style-type: none"><li>• <b>UVC Source:</b> The UVC radiation source must output in the short-wave ultraviolet region of the electromagnetic spectrum (100-280 nm);</li><li>• <b>Imaging system:</b> The UVC imaging system must: (1) be capable of directly detecting radiation in the short-wave ultraviolet region of the electromagnetic spectrum (100-280nm) reflected from the item being examined (e.g. back-thinned CCDs); or (2) be capable of converting radiation in the short-wave ultraviolet region of the electromagnetic spectrum (100-280nm) to a visible output (e.g. image converters);</li><li>• <b>Lenses:</b> The UVC compatible lens must transmit ultraviolet radiation in the region 200-400 nm in addition to transmitting visible and near infrared;</li><li>• <b>Filters:</b> The UVC filters must block extraneous wavelengths while allowing transmission of the output wavelengths of the UVC radiation source;</li><li>• <b>Safety:</b> The safe viewing enclosure must be designed so that the operator is not exposed to stray UVC radiation during use.</li></ul>

PROCESS NAME:

## Visual Examination

MAIN USES:

For use on all types of marks and on all surface types.

PROCESS OVERVIEW:

### Theory:

*Visual Examination* is used to visualise marks of many different types. Although some types of marks may be easily seen under standard room lighting, the process generally involves exposing the item/substrate to different lighting conditions in the visible region of the spectrum. The light falling on the article interacts with both the fingermark and with the surface and in situations where these two components have different optical properties the outcome of these interactions will also be different. Varying lighting angles and/or filters enables one signal (e.g. the outcome of the light/fingermark interaction) to be boosted and the other signal (e.g. the outcome of the light/surface interaction) to be suppressed, thus providing sufficient contrast between the two regions for the mark to be readily seen.

### Practical:

- *Visual Examination* is an optical process. Items are illuminated with an appropriate light source using a range of viewing conditions;
- It can be used safely and effectively in the laboratory and at scenes.

KEY PARAMETERS:

### Equipment:

- The effectiveness of the process will be influenced by the type of light source used, the lighting angle, and to a lesser extent by the use of specialist filters.

### Practitioner:

- The effectiveness of the process will be influenced by the competence and expertise of the practitioner.

PROCESS NAME: <b>Acid Dyes</b>
MAIN USES:  For use on bloody marks on all surface types.
PROCESS OVERVIEW:  <b>Theory:</b> <i>Acid Dyes</i> stain protein present in blood and other protein-rich contaminants to give a coloured or fluorescent product. They will not detect the constituents normally present in latent fingermarks and therefore must be used in sequence with other processes when blood-contaminated items or surfaces are examined.  Practical: <ul style="list-style-type: none"><li>• <i>Acid Dyes</i> are chemical processes that involve exposing the item or surface to three solutions in sequence;</li><li>• There are three main acid dyes: Acid Yellow 7; Acid Black 1; Acid Violet 17;</li><li>• All three can be used safely and effectively in a laboratory and at scenes.</li></ul>
KEY PARAMETERS:  <b>Options:</b> <ul style="list-style-type: none"><li>• <b>Dye formulations:</b> The three dye formulations will vary in effectiveness depending upon the colour of the item or surface and the surface porosity. In particular, Acid Yellow 7 must not be used on porous items.</li></ul> <b>Processing:</b> <ul style="list-style-type: none"><li>• <b>Fixing:</b> Blood must be suitably fixed prior to application of the acid dye to ensure that the blood is not dissolved. This takes at least 5 minutes depending upon the thickness of the blood;</li><li>• <b>Staining:</b> Ensure that items are stained for an appropriate length of time. (For Acid Black 1 or Acid Violet 17 this is normally 3-4 minutes; for Acid Yellow 7 this is normally 5-10 minutes);</li><li>• <b>Rinsing:</b> Ensure that excess dye has been removed from the background and greatest contrast achieved between the enhanced fingermarks and the background.</li></ul>

PROCESS NAME:

## Basic Violet 3

MAIN USES:

For use on latent and greasy marks on non-porous surfaces and some semi-porous adhesive surfaces.

PROCESS OVERVIEW:

### Theory:

*Basic Violet 3* stains some fatty constituents of sebaceous sweat, shed skin cells and some greasy contaminants resulting in visible fingermarks which are purple in colour. Some marks produced can be further enhanced by fluorescence.

### Practical:

- *Basic Violet 3* is a chemical process that involves applying a staining solution to the item or surface followed by rinsing;
- There are two main *Basic Violet 3* formulations: Basic Violet 3 (DOSS), and; Basic Violet 3 (Phenol);
- It can be used safely and effectively in a laboratory. Although it can be used effectively at scenes, its use is strongly discouraged due to the persistence of the hazardous dye.

KEY PARAMETERS:

### Options:

- **Dye formulations:** The two formulations will vary in effectiveness depending upon the type of surface.

### Processing:

- **Background staining:** *Basic Violet 3* may produce background staining, particularly if the surface has some porosity associated with it.

PROCESS NAME: <b>DFO</b>
MAIN USES:  For use on latent and bloody marks on porous and semi-porous surfaces.
PROCESS OVERVIEW:  <b>Theory:</b> <i>DFO</i> reacts with amino acids in latent fingerprints to give a fluorescent product. It also reacts with amine-containing compounds (mainly proteins) in blood.  <b>Practical:</b> <ul style="list-style-type: none"><li>• <i>DFO</i> is a chemical process that involves the application of a solution to the item or surface followed by use of a specialist oven to initiate the reaction. The resultant mark is highly fluorescent and must be viewed using <i>Fluorescence Examination</i>;</li><li>• It is not effective on items or surfaces that have been wetted, even if they have been subsequently dried;</li><li>• It can be used safely and effectively when used in a laboratory.</li></ul>
KEY PARAMETERS:  Equipments: <ul style="list-style-type: none"><li>• <b>DFO development oven:</b> A DFO development oven must: (1) be capable of maintaining an air temperature at approximately 100°C but of no less than 95°C within the oven whilst at equilibrium; and (2) provide close control and rapid recovery of temperature so that when the oven is set at 100°C at least 95°C is reached across all shelves. This must occur when fully loaded, in less than five minutes after the oven door, that has been open for one minute, is closed. The temperature within the oven must then be in excess of 95°C for the remaining processing time.</li></ul>



PROCESS NAME:

## Indandione\*

MAIN USES:

For use on latent and bloody marks on porous and semi-porous surfaces.

PROCESS OVERVIEW:

### Theory:

*Indandione* reacts with amino acids in latent fingermarks to give a fluorescent product. It also reacts with amine-containing compounds (mainly proteins) in blood.

### Practical:

- *Indandione* is a chemical process that involves the application of a solution to the item or surface followed by use of a specialist oven to initiate the reaction. The resultant mark is highly fluorescent and must be viewed using *Fluorescence Examination*;
- It is not effective on items or surfaces that have been wetted, even if they have been subsequently dried;
- It can be used safely and effectively when used in a laboratory.

KEY PARAMETERS:

There are several publications within the literature that demonstrate that Indandione can be used effectively using different heating methods and temperatures. The surrounding environment has an impact on the effectiveness of the process. There are also many formulations published and recent research has shown that those containing zinc chloride are likely to be most effective.

\* this process is not currently in Chapter 5 of the FVM, although will be in future updates. The information is taken from Chapter 6 of the FVM and best practice from published literature.

PROCESS NAME:

## Lifting

MAIN USES:

For lifting latent and some developed marks on non-porous and semi-porous surfaces.

PROCESS OVERVIEW:

### Theory:

*Lifting* operates by the transfer of material (powders, dust etc.) from the surface being examined onto the lifting medium. Lifting media are used to lift either traces of developed marks or undeveloped latent marks from the surface so that they can be examined and imaged under lighting conditions that give better contrast between mark and background than if viewed *in situ*.

### Practical:

- **Lifting** is a physical process involving applying a lifting medium to a surface and examining the resultant lift containing transferred material using optical processes;
- There are many lifting methods, including: (1) adhesive tapes; (2) gelatin lifts; (3) silicone rubber casting compound; and (4) epoxy resin;
- There is a risk that ridge detail may be lost during any lifting process. Wherever possible and practical, marks should be imaged *in situ* prior to lifting;
- It can be used safely and effectively in a laboratory and at the scene.

KEY PARAMETERS:

Options:

- **Lifting media:** due to the large variation in lifting media properties, their effectiveness will vary depending upon the type of mark and surface.

PROCESS NAME:

## Multi-Metal Deposition

MAIN USES:

For use on latent marks on plastic packaging (specifically cling film) and plasticised PVC (vinyl) only.

PROCESS OVERVIEW:

### Theory:

*Multi-Metal Deposition* visualises fingerprints because certain amino acids, fatty acids and proteins in fingerprints become charged under acidic conditions, which promotes selective deposition of gold from solution onto the ridges. The gold bound to the ridges is subsequently enhanced by further deposition of silver, resulting in dark grey-coloured marks, although they may appear gold at certain viewing angles. The process is particularly suited for use on cling film and some plasticised vinyl surfaces.

### Practical:

- *Multi-Metal Deposition* is a chemical process that involves exposing the item or surface to a sequence of two metal depositing solutions, interspersed with water washes;
- It can be used safely and effectively in a laboratory, but is not suitable for use at scenes.

KEY PARAMETERS:

### Equipment:

- **Condition:** any equipment coming into contact with the solutions must be clean and scratch free.

### Solutions:

- **Stability:** the colloidal silver working solution is unstable and will rapidly begin to form a cloudy solution which will eventually produce precipitation of silver at the bottom of the container. This process is accelerated by exposure to light.

### Processing:

- **Observation:** The effectiveness depends on close observation of fingerprint and background development and the condition of the processing solutions.

PROCESS NAME: <b>Ninhydrin</b>
MAIN USES:  For use on latent or bloody marks on porous or semi-porous surfaces.
PROCESS OVERVIEW:  <b>Theory:</b> <i>Ninhydrin</i> reacts with amino acids and other components in latent fingermarks to give a purple product. It also reacts with amine-containing compounds (mainly proteins) in blood.  <b>Practical:</b> <ul style="list-style-type: none"><li>• <i>Ninhydrin</i> is a chemical process that involves the application of a solution to the item or surface followed by use of a specialist oven (if possible) to increase the speed and effectiveness of the reaction;</li><li>• It is not effective on items or surfaces that have been wetted, even if they have been subsequently dried;</li><li>• It can be used safely and effectively in a laboratory. It can be used at scenes but precautions are required to mitigate the asphyxiate nature of the solvent and the effectiveness is significantly reduced with processing times being considerably increased.</li></ul>
KEY PARAMETERS:  <b>Equipment:</b> <ul style="list-style-type: none"><li>• <b>Ninhydrin development oven:</b> A Ninhydrin development oven must: (1) maintain air temperature within the oven whilst at equilibrium at <math>80 \pm 2^{\circ}\text{C}</math>; maintain relative humidity of <math>62 \pm 5\%\text{RH}</math> within the oven whilst at equilibrium; and (2) provide close control and rapid recovery of temperature and humidity across all shelves.</li></ul>

PROCESS NAME:

## Physical Developer

MAIN USES:

For use on latent marks on porous and semi-porous surfaces.

PROCESS OVERVIEW:

### Theory:

*Physical Developer* works by preferentially depositing silver metal onto fingerprint ridges resulting in grey/silver-coloured fingerprints. It is believed (but not proven by published peer-reviewed literature) to detect the presence of sebaceous trapped eccrine constituents which assist deposition of silver during development of the fingerprint.

### Practical:

- *Physical Developer* is a chemical process that involves exposing the item or surface to three solutions in sequence;
- It can be used safely and effectively when used in a laboratory.

KEY PARAMETERS:

### Equipment:

- **Condition:** any equipment coming into contact with the solutions must be clean and scratch free. For the solution containing silver nitrate, a non-metallic dish should be used.

### Processing:

- **Maleic Acid solution:** in order for *Physical Developer* to work as expected, an initial immersion in maleic acid solution for an appropriate amount of time is key for many porous surfaces.
- **Observation:** The effectiveness depends on close observation of fingerprint and background development and the condition of the processing solutions.

PROCESS NAME:

## Physical Developer Enhancement

MAIN USES:

For the enhancement of marks visualised with *Physical Developer*.

PROCESS OVERVIEW:

**Theory:**

*Physical Developer Enhancement* converts the grey-coloured fingermarks visualised using *Physical Developer* to a colour (black, blue or cream/white) that provides greater contrast between the developed mark and the background. The main processes are based on traditional wet photographic processes.

**Practical:**

- *Physical Developer Enhancement* is a chemical process that involves exposing the item or surface to solutions in sequence;
- *Physical Developer Enhancement* methods include: (1) Blue Toning; (2) Iodide Toning; and (3) Sulphide Toning;
- It can be used safely and effectively in a laboratory.

KEY PARAMETERS:

**Options:**

The three formulations vary in colour – which one is used will depend upon the desired result.

**Equipment:**

- **Condition:** Most dishes must be non-metallic.

PROCESS NAME:

## Powders

MAIN USES:

For use on latent marks on non-porous and semi-porous surfaces, and for the enhancement of marks visualised using *Superglue Fuming*. They are most effective on smooth, non-porous surfaces.

PROCESS OVERVIEW:

### Theory:

*Powders* develop fingermarks by preferential adhesion of fine particles to the deposited ridge detail. The adhesion of the particles is influenced by the presence of aqueous and/or fatty components in sweat, or by 'sticky' contaminants in the mark.

### Practical:

- *Powders* are physical processes that involves applying a dry powder to the item or surface using an appropriate applicator and observing how the deposition of powder progresses;
- It can be used safely and effectively at scenes and in a laboratory.

KEY PARAMETERS:

### Options:

There are many types of powder and several methods of application. The effectiveness of the various combinations differs considerably and is dependent upon the chemical and physical properties of the powder, the type of applicator and the competence of the operator (including the use of suitable illumination).



PROCESS NAME:  <b>Powder Suspension</b>
MAIN USES:  For use on latent and bloody marks on non-porous and semi-porous surfaces.
PROCESS OVERVIEW:  <b>Theory:</b> <i>Powder Suspension</i> consists of a fine powder dispersed through a concentrated detergent and wetting agent solution. This process was initially used for treating adhesive surfaces such as tapes; however, Powder Suspension is also effective on general non-porous and semi-porous substrates. When applied, the powder is selectively deposited along fingerprint ridges but the mechanism is unknown. Iron oxide and Carbon-based Powder Suspension yield black fingerprints and Titanium dioxide-based Powder Suspension produces white marks.  <b>Practical:</b> <ul style="list-style-type: none"> <li>• <i>Powder Suspension</i> is a chemical process that involves applying the Powder Suspension to the item or surface followed by a water wash;</li> <li>• There are many formulations based upon: (1) Iron oxide; (2) Carbon; and (3) Titanium dioxide;</li> <li>• It can be used safely and effectively in a laboratory and at scenes, although containment may be problematic if used on large areas at scenes.</li> </ul>
KEY PARAMETERS:  <b>Options:</b> <ul style="list-style-type: none"> <li>• <b>Formulations:</b> The three formulations will vary in effectiveness depending upon the colour of the item or surface and whether it is an adhesive surface or not.</li> </ul> <b>Chemicals:</b> <ul style="list-style-type: none"> <li>• <b>Type of powder:</b> there are many forms of iron-oxide powder available for purchase and care must be taken to ensure that the correct one is used, as others are ineffective.</li> </ul> <b>Processing:</b> <ul style="list-style-type: none"> <li>• <b>Background staining:</b> ensure that the stain can be rinsed adequately from the surface prior to treatment.</li> </ul>

PROCESS NAME:

## Small Particle Reagent

MAIN USES:

For use on latent marks on non-porous surfaces. It is especially effective on waxed surfaces and expanded polystyrene.

PROCESS OVERVIEW:

### Theory:

*Small Particle Reagent* is a suspension of molybdenum disulphide particles in a detergent solution. The molybdenum disulphide particles adhere to the fatty constituents of sweat and/or some contaminants to produce a grey fingerprint.

### Practical:

- *Small Particle Reagent* is a chemical process that involves the application of a mixture to the item or surface followed by a water wash;
- It can be used safely and effectively in a laboratory. Although it can be used safely at scenes, the effectiveness is likely to be reduced due to the application method.

KEY PARAMETERS:

### Processing:

- **Mixture uniformity:** the *Small Particle Reagent* mixture must be fully mixed immediately prior to use to ensure that all of the molybdenum disulphide powder is suspended in the liquid.

PROCESS NAME:

## Solvent Black 3

MAIN USES:

For use on latent and greasy marks on non-porous surfaces. It is most effective on grease contamination.

PROCESS OVERVIEW:

**Theory:**

*Solvent Black 3* is a dye which stains grease- and oil-contaminated fingermarks, and the fatty constituents of sebaceous sweat in latent fingermarks. The resultant marks are visible and blue-black in colour.

**Practical:**

- *Solvent Black 3* is a chemical process that involves exposing the item or surface to a staining solution followed by a water wash;
- It can be used safely and effectively in the laboratory. It can be used at scenes, so long as measures are taken to avoid the creation of flammable atmospheres.

KEY PARAMETERS:

**Processing:**

- **Background staining:** ensure that the stain can be rinsed adequately from the surface prior to treatment.

PROCESS NAME:

## Superglue Fluorescent Dye Staining

MAIN USES:

For the enhancement of marks treated with *Superglue Fuming*.

PROCESS OVERVIEW:

### Theory:

Fingermarks developed using *Superglue Fuming* can be enhanced in a variety of ways to make them more visible i.e. maximise the contrast between the developed mark and the background. One method is to use dyes which cause the superglue marks to fluoresce.

These stain the superglue marks in the same way as dyes stain textiles. The noodle-like structure of the superglue mark consists of fibres of poly-cyanoacrylate, which are similar to acrylic textile fibres as they contain several anionic groups. These anionic groups interact with the basic dye during the dyeing stage, increasing retention of the dye by the fibres. The resultant mark is highly fluorescent and must be viewed using *Fluorescence Examination*.

### Practical:

- *Superglue Fluorescent Dye Staining* is a chemical process that involves the application of a solution to the item or surface followed by washing with water;
- There are several formulations including: ethanol-based Basic Yellow 40 and Basic Red 14; and water-based Basic Yellow 40 and Basic Red 14;
- They can be used safely and effectively in a laboratory. Ethanol-based formulations are generally more effective than water-based ones. However, for safety reasons, water-based formulations are normally used at scenes.

KEY PARAMETERS:

### Processing:

- **Background staining:** ensure that the stain can be rinsed from the surface prior to treatment.

<p>PROCESS NAME:</p> <h2>Superglue Fuming</h2>
<p>MAIN USES:</p> <p>For use on latent marks on non-porous and semi-porous surfaces.</p>
<p>PROCESS OVERVIEW:</p> <p><b>Theory:</b></p> <p>Superglue vapour polymerises on some latent fingerprints to produce a white deposit. This polymerisation can be initiated by water and some other latent fingerprint constituents. Salts within fingerprints are important as they absorb moisture at high humidity.</p> <p><b>Practical:</b></p> <ul style="list-style-type: none"><li>• <i>Superglue Fuming</i> is a chemical process that involves exposing items or surfaces to superglue vapour at high humidity within a specialist superglue fuming cabinet (if possible);</li><li>• Some weakly developed fingerprints can be difficult to see, even on dark surfaces; use of subsequent enhancement is essential to reveal the maximum number of fingerprints although options may be limited at scenes;</li><li>• Process effectiveness reduces considerably on surfaces that have been previously wetted.</li><li>• It can be used safely and effectively in a laboratory using specialist equipment. Although it can be used at scenes there will be additional health and safety issues and the effectiveness is likely to be variable.</li></ul>
<p>KEY PARAMETERS:</p> <p><b>Processing:</b></p> <ul style="list-style-type: none"><li>• <b>Relative humidity:</b> <i>Superglue Fuming</i> is most effective when the relative humidity around the item is between 75 and 90 %;</li><li>• <b>Quantity of superglue:</b> The amount of superglue should be pre-determined for optimal development. The extent of development is dependent upon many factors including the type and quantity of items to be treated, the age of the marks, and the cleanliness and size of the cabinet;</li><li>• <b>Superglue evaporation temperature:</b> For an acceptable evaporation rate, the superglue should be heated to <math>120 \pm 20</math> °C.</li></ul>

PROCESS NAME:

## Vacuum Metal Deposition

MAIN USES:

For use on all types of marks on non-porous and semi-porous surfaces, and for the enhancement of marks developed by Superglue Fuming.

PROCESS OVERVIEW:

### Theory:

*Vacuum Metal Deposition* utilises vacuum coating technology for the thermal evaporation of metals and deposition of thin metal films. It is a sensitive process capable of detecting monolayers of fats in fingerprint deposits on smooth surfaces, although it is also capable of detecting most other types of fingerprint. Disturbances in the physical and chemical nature of the surface, including those associated with the presence of the fingerprint, are revealed by different rates of growth of the metal films.

### Practical:

- *Vacuum Metal Deposition* is a physical process that involves evaporating metals onto items in a high vacuum chamber;
- There are two *Vacuum Metal Deposition* processes: (1) gold/zinc; and (2) silver;
- The effectiveness of the process is highly dependent on the care and expertise of the operator;
- It can be used safely and effectively in a laboratory. It cannot be used at scenes.

KEY PARAMETERS:

### Processing:

- **Pressure within the chamber:** the vacuum metal deposition chamber must be capable of being pumped down to vacuum levels of  $1.5 \times 10^{-4}$  mbar or lower. The pressure should reach  $< 3.0 \times 10^{-4}$  mbar before gold or silver evaporation is initiated, and  $4 \times 10^{-4} \pm 1 \times 10^{-4}$  for zinc.

## APPENDIX 2: GLOSSARY

**ACCREDITATION:** Third-party attestation related to a conformity assessment body conveying formal demonstration of competence of the laboratory to carry out specific conformity assessment tasks.

**BIAS<sup>1</sup>:** Influence based on preferences, dislikes and/or irrelevant information, such as extraneous contextual details surrounding an event, rather than objective data.

**BLIND VERIFICATION<sup>1</sup>:** The independent application of the ACE process conducted by another examiner who has no prior knowledge of:

- a. the findings of previous examiners;
- b. the information on which any previous conclusions have been based; and
- c. any further information relating to case context or stakeholder communications.

Blind verification can form part of a risk management approach adopted to mitigate risks associated with cognitive bias.

**CHAIN OF CUSTODY:** The movement and location of physical evidence from the time it is obtained until the time it is presented in court.

**CHEMICAL PROCESS<sup>3</sup>:** a process where the principal interaction resulting in the visualisation of the fingerprint is chemical in nature, e.g. by means of a reaction between a chemical and the fingerprint or by a staining action.

**CLARITY<sup>2</sup>:** The visual quality of the friction ridge detail.

**COLLABORATIVE EXERCISE<sup>2</sup>:** An inter-laboratory comparison exercise to determine the performance characteristics of a method or procedure, to establish the effectiveness and comparability of new tests or measurement methods, or to assign values to reference materials and assess their suitability for use in specific test or measurement procedures.

**COMPETENCE<sup>1</sup>:** The skills, knowledge and understanding required to carry out tasks within a role, evidenced and assessed consistently over time through performance in the workplace.

**CONCLUSION<sup>1</sup>:** A result stemming from the examination and assessment of all available data within an impression whilst removing and/or limiting bias as much as is possible. The examiner will weigh up of all of the available information and come to their final opinion about the origin or otherwise of the unknown mark.

**CONTAMINANT<sup>3</sup>:** (1) a substance other than a naturally occurring constituent of sweat secretions from the skin that may be found in fingerprints or be the major constituent of them (e.g. grease, blood); (2) any substance not relevant to recovery and analysis of a particular evidence type, but that is present on the item or surface and may interfere with the recovery and analysis processes (e.g. dirt, drugs residue); (3) a substance capable of being transferred from surface to surface and that may cause a nuisance or hazard to those coming into unprotected contact with it (e.g. blood, processing chemicals).

**CONTAMINATION<sup>2</sup>:** The undesirable introduction of substances or trace material. For fingerprint examination this is the disruption of the true image of a mark from a secondary (physical) matrix source, for example, blood, grease.



**CORE<sup>2</sup>:** The approximate centre of a friction ridge pattern.

**CRITICAL FINDINGS<sup>1</sup>:** An outcome that meets one or more of the following criteria:

- a. has a significant impact on the conclusion reached and the interpretation and opinion provided;
- b. cannot be repeated or checked in the absence of the exhibit or sample;
- c. could be interpreted differently.

**CROSS-CONTAMINATION<sup>3</sup>:** the introduction of a substance not originally associated with a particular item or surface at the time that the event relevant to the crime occurred by subsequent transfer from another source (e.g. DNA picked up from one crime scene transferred to an item recovered from another).

**DATABASES<sup>2</sup>:** Collections of data and associated material designed to provide information rather than for archive, which are stored systematically in hard copy or electronic format and are, for example, used for:

- a. providing information on the possible origin of objects or substances found in casework; and/or
- b. providing statistical information.

**DELTA<sup>2</sup>:** A triangular type formation in the friction ridge flow, where ridges flowing in three different directions meet. Deltas are usually found in the bottom half of the finger impressions, offset to either the left or the right (or both). Two of the 'branches' of the delta will usually open out to enclose the core area. Deltas appear in all patterns except arches and also appear on various parts of the palm. Deltas can be classified as either 'open' or 'closed'.

**DEPOSITION PRESSURE<sup>2</sup>:** The pressure exerted when a mark or print is left, for example, heavier deposition pressure may result in the friction ridges appearing thicker and the furrows appearing very narrow when compared with a print left under controlled conditions.

**DETAIL<sup>2</sup>:** Information from within a friction ridge, which is used when making comparisons or searching. It can include anything that assists the practitioner to reach their conclusion. This can include scars, creasing, pore position, pore shape, thinness and thickness of friction ridges, and friction ridge shape.

**DEVELOPED<sup>2</sup>:** When a latent mark is subjected to chemical and/or physical treatments and an impression is made visible, then the mark is said to have been developed.

**DEVELOPMENT<sup>3</sup>:** a subset of visualisation where a process applied to the fingermark results in it becoming visible in a progressive way, producing a gradual change from invisible to clearly visible. Most chemical and physical processes can be considered to 'develop' fingermarks.

**DISCREPANCY<sup>2</sup>:** The apparent presence of friction ridge detail in one impression that does not exist in the corresponding area of another impression.

**DISTORTION<sup>2</sup>:** Variances in the reproduction of friction skin caused by factors such as pressure, movement, force, and contact surface (for example, stretching of carrier bag).

**ENHANCEMENT<sup>3</sup>:** the improvement of a fingermark that is already visible to some extent by the application of an additional process that either reveals additional ridge detail or makes that which is already visible more readily distinguishable from the background.

**ERROR<sup>1</sup>:** An outcome that is unexpected or wrong when the true answer is known. Errors can be categorised into various types, such as technical and administrative errors. If an error occurs then it can have a detrimental effect on the outcome of a comparison or search. There are various processes that can be used to minimise the different types of errors occurring, but these processes may vary from organisation to organisation.

**EVIDENCE RECOVERY<sup>3</sup>:** the process by which forensic evidence of any class is first located and then translated into a form suitable for comparison and/or analysis by a person competent in that class of forensic evidence.

**EXAMINATION<sup>3</sup>:** a focused inspection of an item or surface with the objective of locating particular types of evidence. This differs from the more cursory inspection that may be part of an initial assessment.

**EXCLUSION/EXCLUDED<sup>1</sup>:** There are sufficient features in disagreement to conclude that two areas of friction ridge impressions did not originate from the same donor or person.

**EXPLAINABLE DIFFERENCES<sup>2</sup>:** These are differences in the appearance of the mark or print that does not interfere with the identification process. These differences can include such things as size, thickness of ridges, distortion and some of the microscopic detail (pores and ridge shapes) being absent in one impression. They can all be explained, which can be annotated on the photographs and/or on the practitioner's notes.

**FEATURES<sup>2</sup>:** These are any notable part of the friction ridge detail. All information assisting with establishing the identification of an area of friction ridge detail can be termed as 'features'.

**FINGERMARK<sup>2</sup>:** An impression made by the finger, deposited under non-controlled conditions, for example, holding or lifting an item.

**FINGERPRINT<sup>2</sup>:** An impression of the friction ridges of all or any part of the finger from a known source.

**FIRST LEVEL DETAIL<sup>2</sup>:** First level detail refers to the friction ridge flow and/or pattern type.

**FRICTION RIDGE(S)<sup>2</sup>:** The friction ridges flow across the surface of the hands and feet to form friction ridge detail. The friction ridges may deviate instead of flowing constantly. The friction ridges have sweat pores along their summit.

**FRICTION RIDGE DETAIL<sup>2</sup>:** An area comprising the combination of friction ridge flow, friction ridge characteristics, and friction ridge structure to include creases.

**FRICTION RIDGE FLOW<sup>2</sup>:** The path and arrangement of the friction ridges across the surface of the hands and feet. The friction ridge flow on the top section of the fingers flows into patterns.

**FRICTION RIDGE SKIN<sup>2</sup>:** The fingers, palms of the hand, toes and the soles of the feet comprise an intricate system of friction ridges and furrows, which are known as friction ridge skin. The arrangement and sequencing of characteristics within friction ridge skin are unique to each individual, persist throughout life and are accepted as a reliable means of human identification. This type of skin is present to aid grip, assist touch and elevate the pores to aid temperature control.

**GYRO:** The GYRO documentation system offers a simple and efficient method for a friction ridge examiner to document the analysis and comparison stages of the ACE-V process. GYRO uses a colorcoding system to convey the analyst's degree of confidence in the existence of a feature and the degree of variation to which that feature may appear in a corresponding exemplar print.

**IDENTIFICATION:** This term is used in fingerprint comparison evidence and its use is familiar to the criminal justice system: A practitioner term used to describe the print as being attributed to a particular individual.

**IMAGE ENHANCEMENT<sup>3</sup>** (also 'image processing'): processes applied to an image post-capture with the objective of producing an image that improves the ability of an examiner to distinguish ridge detail from the background or to more clearly define fine detail within fingermarks. The term now generally applies to digital adjustments performed on electronic images.

**INCIPIENT RIDGE<sup>2</sup>:** An immature friction ridge that will appear as a thinner and shallower ridge than those surrounding it. The incipient ridge may or may not contain pores. Due to deposition pressure the incipient ridges may not appear in every impression, but they can be used when making comparisons. They are also known as nascent ridges, rudimentary ridges, subsidiary ridges or ghost ridges.

**INCONCLUSIVE<sup>1</sup>:** The determination that the level of agreement and/or disagreement is such that it is not possible either to conclude that the areas of friction ridge detail originated from the same donor, or to exclude the particular individual as a source for the unknown impression.

The outcome may be inconclusive for a number of reasons; these reasons should always be made clear as part of reporting the final outcome.

**INDIVIDUALISATION:** This term is used in fingerprint comparison evidence and its use is familiar to the criminal justice system: A practitioner term used to describe the mark as being attributed to a particular individual. There is sufficient quality and quantity of ridge flow, ridge characteristics and/or detail in agreement with no unexplainable differences that in the opinion of the practitioner two areas of friction ridge detail were made by the same person.

**ITEM<sup>3</sup>:** a general term used to describe all physical material that can potentially be removed from a crime scene for treatment in a laboratory (e.g. plastic bags, knives, documents), as opposed to non-removable parts of the scene (e.g. walls, ceilings).

**LATENT (FINGER)MARK<sup>2</sup>:** Friction ridge impression/detail not generally visible to the eye and must be enhanced either by development powders or by physical and/or chemical treatments.

**LIKELIHOOD RATIO:** The likelihood ratio is the ratio of two probabilities under two mutual excluding hypotheses (i.e. the prosecution hypothesis and the defence hypothesis):

1. the probability that those observations would have been made if the prosecution proposition were true;
2. the probability of those observations if the defence proposition were true.

A likelihood ratio of one is neutral; a likelihood ratio  $>1$  means that the observations support the prosecution proposition; conversely, a likelihood ratio  $<1$  means that the observations support the defence proposition.

**MARK<sup>1</sup>:** The term used to refer to an area of friction ridge detail from an unknown donor. Usually recovered, enhanced or imaged from a crime-related item, or directly retrieved from a crime scene.

**MEASUREMENT OF UNCERTAINTY<sup>1</sup>:** The estimation of the uncertainty of measurement is an ISO/IEC 17025:2005 requirement and is based upon the principle that all measurements are subject to uncertainty and that a value is incomplete without a statement of accuracy. Sources of uncertainty can include unrepresentative samples, rounding errors, approximations and inadequate knowledge of the effect of external factors.

**MINUTIAE<sup>2</sup>:** Minutiae are small details. They can be events along a friction ridge path, including bifurcations and ending ridges.

**OBJECTIVE<sup>1</sup>:** Undistorted by emotion or personal bias; based on impartial, transparent, observable phenomena.

**OPINION<sup>1</sup>:** The matter of an opinion is the conclusion of the practitioner, who by study or experience has specialist knowledge and would be able to form a sound judgement on that subject matter to render an opinion of value.

The opinion forms part of a body of knowledge or experience that is sufficiently organised or recognised to be accepted as a reliable body of knowledge or experience.

The opinion is the conclusion of the practitioner established at the evaluation stage of the ACE process. If necessary the opinion will be supported and evidenced by demonstrating their decision making process by the use of working notes.

**OPTICAL PROCESS<sup>3</sup>:** a process where the principal interaction resulting in the visualisation of the fingermark is influenced by the optical properties of the mark and surface. This description also includes processes operating outside the visible region of the electromagnetic spectrum.

**PALM MARK<sup>2</sup>:** An impression from the palm left under non-controlled conditions.

**PALM PRINT<sup>2</sup>:** An impression of the friction ridges of all or any part of the palmar surface of the hand, taken under controlled conditions.

**PATTERN:** The arrangement of friction ridges formed during foetal growth. Patterns are classified into different categories.

**PHYSICAL PROCESS<sup>3</sup>:** a process where the principal interaction resulting in the visualisation of the fingermark is physical in nature, e.g. the adhesive properties influencing powder adhesion during powdering, nucleation and growth of metal films during Vacuum Metal Deposition.

**PORES<sup>2</sup>:** Small openings on friction ridges through which sweat is released.

**PRACTITIONER<sup>3</sup>:** a person competent in a particular forensic area involved in the practical application of processes relevant to that area.

**PRINT:** An impression of the friction ridge skin recorded under controlled conditions.

**PROFICIENCY TEST (PT)<sup>1</sup>:** The determination of the testing performance of a laboratory by means of inter-laboratory comparison, i.e. tests to evaluate the competence of analysts and the quality performance of a laboratory.

These tests can vary:

- a. **external proficiency test:** a test conducted by an agency independent of the analysts or laboratory being tested;
- b. **blind or undeclared proficiency test:** a test in which the analysts are not aware that they are being tested;
- c. **open or declared proficiency test:** a test in which the analysts are aware that they are being tested.

**QUALITY<sup>2</sup>:** For fingerprint examination this applies to the clarity of information contained within an area of friction ridge detail.

**QUANTITY<sup>2</sup>:** The amount of information contained within an area of friction ridge detail.

**REFERENCE PRINT:** The print of a person, associated with a known or claimed identity, and recorded either electronically, by ink, or by another medium under controlled conditions.

**REPEATABILITY<sup>2</sup>:** The ability to obtain consistent reporting outcomes when repeatedly undertaking the same task. This repeatability is required in order to validate a process. It should be possible for a process to be repeated with the same reporting outcome achieved each time.

**RIDGE DETAIL<sup>2</sup>:** An area comprising the combination of friction ridge flow, friction ridge characteristics, and friction ridge structure to include creases.

**SCAR<sup>2</sup>:** A scar is an area of fibrous tissue that replaces normal skin after injury.

**SEARCH<sup>1</sup>:** A comparison of friction ridge detail against other friction ridge detail held in files or databases. Searches can be manual or automated.

**SEQUENTIAL PROCESSING<sup>3</sup>:** the application of a sequence of visualisation processes to an item or surface with the objective of maximising fingermark recovery. Sequential processing involves the selection of the processes in a logical sequence, beginning with non-destructive processes and then utilising processes with a progressively increasing impact on the fingermark and substrate.

**SUBJECTIVE<sup>1</sup>:** The opposite of objective – activity taking place within the mind that is modified by an individual's personal experiences and bias.

**SUBSTRATE<sup>2</sup>:** The surface upon which friction ridge detail is deposited.

**SUFFICIENT/SUFFICIENCY<sup>2</sup>:** The quantity and quality of characteristics and/or detail present in an area of friction ridge detail reaches the practitioner's threshold and a conclusion/outcome can be made.

**SURFACE<sup>3</sup>:** (1) a general term used to describe the non-removable parts of the scene such as walls and ceilings; (2) a term used to refer specifically to the surface layer of a substrate, particularly where it differs from the bulk properties or where a particular property of it (e.g. texture) is important.

**TENPRINT<sup>2</sup>:** A generic reference to a controlled recording of an individual's fingers and palms using ink, electronic imaging, or other medium.

**TOLERANCE<sup>2</sup>:** The acceptance of dissimilarity caused by distortion, usually involving an identification; it is generally expressed as 'within tolerance' or 'out of tolerance' for the level of clarity that is present in both impressions.

**VALIDATION<sup>1</sup>:** The process of providing objective evidence that a method, process or device is fit for the specific purpose intended. It is a method to check the reliability of a process and the outcomes of that process. The validation should demonstrate that the same result should be obtained to show that the process works.

**VERIFICATION<sup>1</sup>:** In fingerprint examination it is the final step of the ACE-Verification process. It can be defined as the independent application of the ACE process, utilised by a subsequent examiner to either support or refute the conclusions of the original examiner. This independent examination by another examiner or examiners, using the ACE process provides a cross-check to ensure that the outcome decision is not based on a subjective judgement of one individual but acceptance as the consensus conclusion of more than one examiner.

**VISUALISATION<sup>3</sup>:** the conversion of a latent fingermark into a readily visible one, independent of the means by which this is achieved.

**VISUALISATION PROCESS<sup>3</sup>:** a process applied to a fingermark on a substrate to make it either readily visible to a human observer, or readily detectable by an imaging system being used to examine the substrate.

Some of the information contained within this glossary is extracted from the following references and are Crown copyright:

<sup>1</sup>Forensic Science Regulator, Codes of Practice and Conduct: Fingerprint Comparison, FSR-C-128

<sup>2</sup>Forensic Science Regulator, Fingerprint Examination – Terminology, Definitions and Acronyms, FSR-I-402, Issue 1, 2015

<sup>3</sup>Fingermark Visualisation Manual, First Edition, 2014, Home Office Centre for Applied Science and Technology, Editor: Dr H Bandey, ISBN: 978-1-78246-234-7



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