Forensic Science Regulator
Overseeing Quality

Guidance

The Control and Avoidance of Contamination In Crime Scene Examination involving DNA Evidence Recovery

FSR-G-206

ISSUE 1

1. INTRODUCTION

1.1.1 For the purposes of this guidance, contamination is defined as 'the introduction of DNA, or biological material containing DNA, to an exhibit at or after the point when a controlled forensic process starts'. This is distinct from the adventitious transfer of biological material to an exhibit that can also occur, usually prior to the exhibit or sample being recovered[1] and before investigative agencies have intervened.

1.1.2 These guidelines for good practice are necessary because DNA techniques in routine use can readily generate profiles from DNA found in minute saliva aerosols or in skin cells deposited on handled items.

1.1.3 From a forensic science perspective, crime investigation activities can be considered as two distinct phases:

a. crime scene investigation (scene/victim/suspect), during which investigative agencies are involved in locating, recording, recovering, packaging, storing and transporting exhibits; and
b. the analytical phase in which the recovered exhibit is processed within a laboratory.

1.1.4 Contamination can occur at any point in these investigation phases. The principal sources of DNA contamination are:

a. from personnel to the exhibit/DNA sample;
b. from contaminated consumables (for example, swabs, tubes, personal protective equipment [PPE]/ barrier clothing) to the exhibit/DNA sample; and
c. from exhibit to exhibit or DNA sample to DNA sample;
d. from contaminated equipment not properly cleaned from previous scenes (for example, cameras, tripods, step plates).

1.1.5 Contamination may occur as follows:

[1] Often referred to as 'background DNA'.

a. directly[2] (for example, saliva or dandruff from an examiner ending up on an exhibit); or

~~b.~~ indirectly[3] (for example, biological material present on a drawer handle is transferred on to the gloves of an examiner who opens the drawer, fails to change their outer pair of gloves and then handles a significant item, resulting in the indirect transfer of biological material from the handle of the drawer to the item).

1.1.6 Contamination may be:

a. sporadic, that is resulting from an incident affecting just one DNA sample from a number in a batch; or

b. systemic, resulting from an event that affects a whole batch or series of DNA samples at the same time.

1.1.7 Anti-contamination measures fall into two core areas of activity.

a. Prevention of contamination as far as is practicable, for example, by:

i. minimising the chance of contamination occurring by, for example, staff using barrier clothing;

ii. restricting access to areas containing exhibits;

iii. cleaning scene examination equipment and surfaces before and after use;

iv. rendering consumables free from detectable levels of DNA;

v. ensuring that equipment used at crime scenes is adequately decontaminated between scenes based on risk assessment; and

vi. separation of exhibits during transport and in storage.

b. Detection of contamination primarily involves:

i. comparison of DNA profiles generated from items against a database of reference DNA profiles from personnel from whom there is a significant risk of contamination;

[2] Also described as ‘primary transfer’.
[3] Also described as ‘secondary transfer’.

ii. comparison of DNA profiles generated from items to results detected from quality assurance (QA) testing of reagents and consumables and from laboratory controls;

iii. cross-checking of profiles within the same batch of samples and from different batches of samples processed within the same laboratory;

iv. investigation of unexpected results; and

v. the incorporation of appropriate controls into the forensic process.

1.1.8 It is recognised that DNA contamination incidents cannot be eliminated completely, given the prevalence of human DNA within the living and working environment. This issue is exacerbated by the increasing sensitivity of DNA analytical techniques.

1.1.9 Nothing can be done to reduce background DNA at crime scenes, but it is essential that everyone in the investigative process is:

a. aware of the importance of maintaining the integrity of evidence; and

b. takes appropriate steps to minimise the risks posed by the inadvertent addition or the transfer of DNA during crime scene examination or other stages of the forensic analysis process.

1.1.10 Therefore, an effective DNA anti-contamination process requires a combination of approaches both to minimise the opportunity and therefore the risk of occurrence and maximise the ability to detect contamination when it does occur. One study where 46 crime scene worker profiles matched 58 criminal cases out of 327 (14%) (Lapointe *et al.*, 2015) demonstrates the level of inadvertent transfer of DNA by staff during crime scene recovery.

1.1.11 The purpose of this document is to provide guidance on how to control and avoid the incidence of DNA contamination during crime scene examination, including the searching for, recording and recovery of items, their packaging, transportation and storage prior to submission for forensic examination.

1.1.12 This guidance should be read in conjunction with FSR-P-302 (Forensic Science Regulator), BS ISO 18385:2016 *Minimizing the risk of human DNA contamination in products used to collect, store and analyse biological material*

for forensic purposes (British Standards, 2016) and sections 8.8.3 to 8.8.5 in FSR-G-208 (Forensic Science Regulator)

1.1.13 The interaction of the Forensic Science Regulator's (FSR's) anti-contamination guides together with the DNA consumable standard BS ISO 18385:2016 is shown in Figure 1.

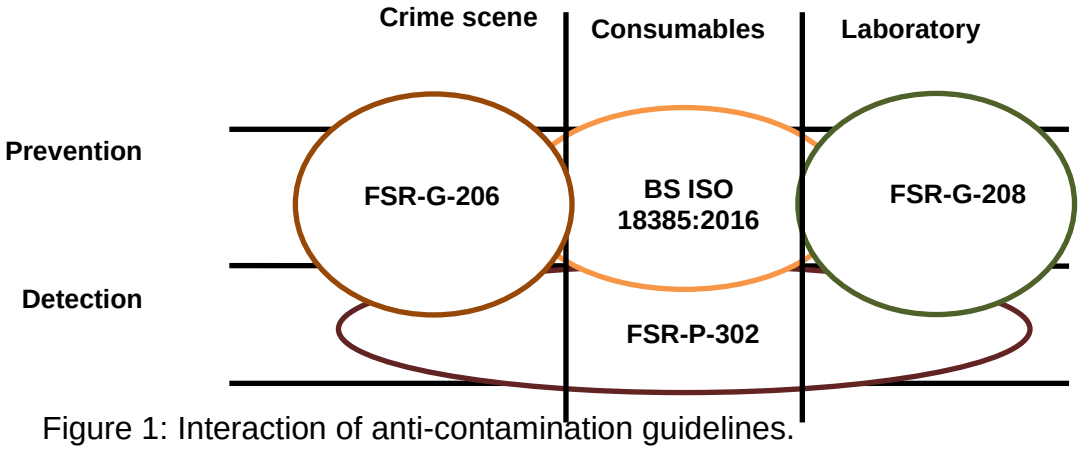

Figure 1: Interaction of anti-contamination guidelines.

2. SCOPE

2.1.1 The scope of the *Codes of Practice and Conduct for Forensic Science for Providers and Practitioners in the Criminal Justice System* (the Codes) (Forensic Science Regulator), encompasses initial forensic science activity at crime scenes, which includes the following:[4]

a. the scene examination strategy;
b. the searching for, recording, recovery, preservation, transport and storage of exhibits; and
c. screening tests for use in the field.

It is widely acknowledged that ISO/IEC 17020:2012 *Conformity assessment – Requirements for the operation of various types of bodies performing inspection* (British Standards, 2012a) is the international quality standard most appropriate to crime scene work.

[4] This guidance does not apply to targeted forensic evidence recovery in proactive investigations, where safety or security requirements may preclude the use of anti-contamination measures. Such activity should be the subject of a separate protocol, including the communication of contamination issues that need to be considered when analysing DNA results.

2.1.2 Guidance on the application of this standard to scene examination is provided by both the UK Accreditation Service (UKAS) in the documents RG201 (UKAS, 2015) and the International Laboratory Accreditation Cooperation (ILAC) G19:08 (ILAC, 2014). These provide high level requirements with regard to anti-contamination measures including:

a. demonstrating that reagents and kits used at scenes are fit for purpose;
b. a risk assessment of issues surrounding the potential for cross-contamination between samples; and
c. an assessment of each individual scene to ensure that suitable anti-contamination measures are in place.

2.1.3 Whilst there is considerable guidance available on crime scene operating policies and procedures, relatively few publications specifically address DNA contamination issues and the most informative of these are included in the Bibliography (section 16). This guidance collates the latest thinking on DNA anti-contamination measures and correlates this against the relevant sections of the ISO/IEC 17020 standard to assist in accreditation assessment of crime scene investigator (CSI) activities against this standard.

2.1.4 This guide provides requirements and guidance regarding anti-contamination measures to be taken at crime scenes. These include:

a. anti-contamination strategy;
b. personnel;
c. equipment and consumables;
d. crime scene activities and procedures;
e. drying cabinets and temporary storage of items; and
f. contamination detection measures.

2.1.5 Within the scope of this document is the use of drying cabinets, given that these may be used as an interim processing stage prior to the submission of items to a laboratory for assessment and analysis. Outside of the scope is the recovery of evidence and taking of reference samples from either victims or arrestees; these will be covered in a separate guidance document.

2.1.6 This appendix applies to England and Wales. Scotland and Northern Ireland should also institute parallel arrangements for their jurisdictions.

3. IMPLEMENTATION

3.1.1 This guidance is available for incorporation into an organisation's standard operating procedures and quality management system from the date of publication. The requirements set out in this guidance come into effect from October 2018.

4. MODIFICATION

4.1.1 This is the first issue of this document.

5. TERMS AND DEFINITIONS

5.1.1 The terms and definitions set out in the following documents also apply to this guidance.

a. *Codes of Practice and Conduct for Forensic Science Providers and Practitioners in the Criminal Justice System* (the Codes) (Forensic Science Regulator).
b. *DNA Analysis,* FSR-C-108 (Forensic Science Regulator.
c. *DNA contamination detection: The management and use of staff elimination DNA databases,* FSR-P-302 (Forensic Science Regulator.

5.1.2 The word 'shall' has been used in this document where there is a corresponding requirement in ISO/IEC 17020 or the Forensic Science Regulator's Codes; the word 'should' has been used to indicate generally accepted practice and the word 'may' has been used for recommendations. Recommendations have been used to indicate what ideal practice is when it is practicable.

5.1.3 Although this document is presented as guidance, it is written using the language of a standard; this is because from 1 October 2020 the requirements set out in this guidance will be mandatory as codes of practice.

6. ANTI-CONTAMINATION STRATEGY (ISO/IEC 17020 Clause 7.1.2, 7.1.6[5])

6.1 Crime Scene Anti-Contamination Strategy

6.1.1 At crime scenes the risk of contamination shall be minimised as far as is practically possible. A key element of this, especially for serious and major crimes, i.e. where a crime scene manager (CSM) or equivalent is deployed, is to manage activities both within and outside the scene and at other relevant locations in a strategic and coherent fashion to ensure that contamination risks are understood and mitigated as far as practically possible.

6.1.2 This applies not just to a particular scene or secondary scene, but across a case or linked cases, addresses and vehicles.

NOTE: The anti-contamination strategy should not be seen to cover health and safety risk assessments in a scene; these are separate issues.

6.1.3 For each serious and major crime scene an overall and fully documented forensic strategy is required. The anti-contamination strategy is a component of this and shall:

a. be tailored around the known circumstances of the investigation;
b. commence at the earliest practicable opportunity following the first receipt of case-specific information;
c. be subject to continual review and modification as the investigation develops;
d. be properly documented and effectively communicated to all relevant staff.

6.1.4 Factors that shall be considered and written into the anti-contamination strategy include the following:

[5] RG201 (UKAS, 2015, sections 7.1.2 and 7.1.6) stipulates that the organisation shall have collated data to demonstrate the suitability of the whole process of scene examination including: scene evaluation; strategy setting; search; sequential process; and recording. An appropriate scene strategy needs to be documented, in some instances this may be generic that can be referenced in the scene attendance records. However, even in these circumstances a review of the appropriateness of a generic strategy should be made. Where the scene does not meet the requirements of this generic strategy a more detailed specific strategy should be recorded. Any changes to this should be indicated in the records.

a. prior to scene attendance;
b. environmental factors;
c. staff deployment;
d. cordons and scene protection;
e. scene assessment;
f. contamination risks between different parts of the same scene;
g. use of dogs;
h. handovers;
i. release of a scene.

Prior to scene attendance

6.1.5 This shall apply to all individuals including investigators, witnesses, suspects or other members of the public. Any PPE / barrier clothing worn by the above shall be recorded. The physical proximity of the scene to a suspect or victim's address or vehicle, once this is known shall also be recorded.

6.1.6 The strategy should provide a record of previous entry to the scene and their activities, for example, where did they go, what did they touch, move or leave behind before control was established?

Environmental factors

6.1.7 Environmental factors include the following.

a. Hot conditions that introduce a higher risk of contamination (for example, scenes where extreme heat introduces the risk of contamination due to perspiration whilst undertaking searching, recording and recovery activities). In this example the strategy could include the provision of lighter more breathable scene suits and regular breaks arranged at the beginning of the crime scene attendance.
b. The linking of environments, for example, through communal corridors, waterways or streets. In this example the strategy could include identifying a route(s) to minimise contaminating the primary scene or appropriate protective clothing changes required.

Staff deployment

6.1.7 Avoidance of utilising the same personnel, vehicles or equipment that have:

a. attended a scene related to the same offence;
b. attended a linked scene or incident; or
c. been involved in the laboratory examination of items recovered from the same case.

6.1.8 Where operational imperatives dictate that utilising the same staff cannot be avoided, due consideration before deployment shall be given to:

a. the risks and possible transfer mechanisms for material to pass from one scene to another and how these can be mitigated (such as the use of different vehicles and equipment) to provide support to examination at different scenes associated with the same crime or a linked crime; and
b. showering and change of clothes for practitioners, and ensuring adherence to strict cleaning and decontamination measures for equipment between scenes.

6.1.9 Due consideration should also be given to the closeness of scenes with interrelated cross-contamination risks, such as nearby properties where there is a risk that staff may attend the wrong scene or area by mistake. In addition, consideration should be given to the risks associated with investigators returning to the same scene or sharing pool vehicles between scenes.

Cordons and scene protection

6.1.10 Cordons shall be sufficient and positioned appropriately as soon as it is safe to do so and should include all known or possible routes to and from the location of the incident by all individuals involved as a key anti-contamination measure.

6.1.11 Control and maintenance of the cordon and attendee record, i.e. a scene log, shall be undertaken by persons who are trained and competent in this role.

6.1.12 The scene cordon and scene log shall be assessed by the first attending crime scene investigator (CSI)/scene of crime officer (SOCO) and amended if

evidence or forensic opportunities are in imminent risk of loss or contamination. Appropriateness shall also be checked by the CSM or equivalent.

6.1.13 Access to the scene should be controlled as a single point of entry. Wherever possible a route from the cordon boundary to the location of the incident should not knowingly be used by any individuals involved in the incident, i.e. a common approach path is established. Exceptionally, two entry points may be more appropriate if this enables staff to avoid passing from one delineated zone to another.

6.1.14 Personnel required to attend the scene subsequently to assist in the examination should be directed to park their vehicles in a suitable designated area (rendezvous point) outside the cordon but as near to the head of the common approach path as possible. This will minimise potential contamination risks during the transport of items to and from scene.

6.1.15 Utilising scene entry tents is an example of good scene management. These can be separated into different areas for putting PPE / barrier clothing on and taking it off, and for packaging and disposing of used PPE/ barrier clothing.

6.1.16 It is the responsibility of the CSM to ensure that the minimum number of people required to undertake the effective examination of the scene are admitted.

Scene assessment

6.1.17 In the initial assessment of the scene appropriate precautions shall be taken to preserve evidence on floors, for example, by using cleaned stepping plates or identifying, clearing and marking a common approach path through the scene.

6.1.18 This shall identify what parts of the scene are under protection and the anti-contamination measures required within these including:

a. parts where PPE / barrier clothing shall be worn;
b. parts where PPE/ barrier clothing shall not be worn (for example, where overshoes must be removed);
c. protection of ground surfaces including where stepping plates are to be deployed;

d. designated areas for disposal of waste such as used PPE/ barrier clothing.

6.1.19 Where an exhibit is assessed to be too great a biohazard to be handled, transported and/or stored, relevant professionals should be deployed to deal with it in accordance with health and safety regulations.

Contamination risks between different parts of the same scene

6.1.20 Inadvertent movement of material from one part of a scene to another constitutes a contamination risk. For example, communal living areas or shared/public areas within scenes or where rooms within a scene have been ascribed particular significance by witnesses. Under these circumstances, additional measures to avoid cross-contamination shall be considered:

a. to control entry to and exit from specific areas within the scene;
b. early examination, recording and recovery of DNA (visible and non-visible) from frequently handled items for example, door handles;
c. examination of different rooms on different days or by different personnel;
d. change of barrier clothing and/or other equipment between different parts of the same scene;
e. PPE/ barrier clothing should be disposed of or retained if suspected of being a potential source of contamination as appropriate (see also 11.1.2).

Use of dogs

6.1.21 Where the use of dogs for locating body fluids within a crime scene is being considered, the risks of contamination shall be assessed along with the feasibility of utilising less contamination-prone alternatives.

6.1.22 Dogs may introduce DNA from outside the scene including:

a. from individuals who have handled the dogs;
b. transferring material from one part of a scene to another;
c. transferring material out of the scene; and
d. potentially compromising the capability of obtaining DNA results by contaminating items with their own oral mucus, which strongly inhibits the DNA amplification polymerase chain reaction (PCR).

6.1.23 It is recognised, however, that for certain scenarios such as searching large woodland areas, there may be no viable alternative to canine searches. Where this is the case the sequence of activities should be included in the case strategy and notes taken regarding where and when the dogs were used together with a note of the contamination risks.

Handovers

6.1.24 During the handover of responsibilities to new staff, briefing shall be provided on the anti-contamination strategy and anti-contamination measures, and a record should be made prior to the release of the scene.

6.2 Contamination Strategy Across a Case

6.2.1 Throughout the duration of an investigation specific notes should be made of each scene including:

a. dates and times of examinations;
b. all the anti-contamination measures implemented and reasons for these, including measures to minimise the risk of specific identified contamination risks;
c. the personnel deployed and for what purpose;
d. for extended or complex investigations, consideration should be given to the completion of a 'contamination matrix' to assist in identifying any potential contamination incident(s).

These provide the basis on which to assess contamination risk and to formulate and manage the case anti-contamination strategy.

7. PERSONNEL (ISO/IEC 17020 Clause 6.1.3)

7.1.1 Crime scene management goes through two phases: stabilisation followed by control. During the stabilisation phase the primary objectives are to make the location safe and to preserve life.

7.1.2 All emergency service personnel who attend crime scenes should have forensic awareness. They should be trained and fully competent with regard to DNA anti-contamination measures that should be applied without impacting on their

primary roles for scene attendance. This includes paramedics and fire service staff who may attend during the stabilisation phase. Once the crime scene is controlled this may include, for example, forensic scientists, exhibits officers, CID officer, forensic pathologists, police search advisers, licensed search officers and staff from forensic science providers (FSPs).

7.1.3 The first attending officer shall also be trained, competent and equipped to undertake the role of the initial CSM prior to attendance of a professional forensic practitioner who will take over as CSM or equivalent.

7.1.4 When control of the scene has been achieved, the CSM shall record the known and stated activity of individuals involved pre and post incident, emergency service personnel, members of the public and possible suspects known to have been within the cordoned off area. This information shall include where they have been, what they have touched, moved, taken away and left behind. These activities shall be taken in to account for the anti-contamination strategy.

7.1.5 The CSM shall also consider, record and request for seizure relevant samples, clothing and footwear and control samples (fingerprints and DNA) from emergency service personnel, members of the public and possible suspects.

7.1.6 Key for all personnel attending the crime scene is being trained in and demonstrating knowledge through assessment of:

a. contamination issues including contamination theory and understanding the mechanics of contamination, the rationale behind anti-contamination measures, and practical knowledge of any anti-contamination-related standard operating procedures (SOPs) employed at scenes to avoid contamination;
b. issues relating to contamination risks and their avoidance in specific processes and methods shall be an integral part of staff training documentation, and the relevant issues shall be included within training plans and manuals.

7.1.7 This guidance appendix to the Codes (Forensic Science Regulator) shall be introduced to all scene-going investigators.

7.1.8 All staff attending a scene once it is controlled shall be made fully aware of the risks specific to the scene and how they are to be mitigated. It is the responsibility of the CSM or equivalent to ensure that all individuals attending the scene are aware of, and conform to, the anti-contamination measures specific to the crime scene in question as defined in the scene anti-contamination strategy.

7.1.9 Anyone suffering from a short-term medical condition that causes the shedding of body fluids or particles (for example, colds, coughs, influenza, elevated temperature promoting sweating or hay fever) should be actively discouraged from attending the scene. There is also an increased risk of contamination from individuals who are naturally heavy shedders or have certain skin conditions. This increased risk may be acceptable provided that it is effectively managed by the use of appropriate personal protection equipment (PPE) /barrier clothing and adherence to anti-contamination procedures, and that the DNA profile of the affected individual is available for searching against on the relevant elimination database (see 7.1.12; 11.1.5).

7.1.10 All staff called to a scene specifically for examination purposes (searching, recording and recovery) shall ensure that they have sufficient equipment to undertake their duties. This includes equipment needed for taking effective anti-contamination measures and for health and safety requirements. This equipment includes:

a. sufficient PPE/ barrier clothing;
b. sufficient consumables including recovery and packaging equipment;
c. sufficient cleaning materials ;
d. equipment that has been effectively cleaned since the last deployment to a scene.

7.1.11 In addition, police staff who may attend the crime scene first should have access to:

a. sufficient PPE/ barrier clothing (for example, gloves and mask);
b. sufficient consumables including recovery and packaging equipment (for example, swabs and bags).

7.1.12 All staff working in the forensic process shall, where practicable, have had a DNA sample taken from them for submission to the relevant staff elimination database. With some organisations this will be a mandatory requirement, for others the absence of such a sample should be recorded (see section 11).

8. EQUIPMENT AND CONSUMABLES

8.1 Receipt, Handling and Storage

8.1.1 Steps shall be taken to ensure that appropriate precautions are taken to minimise the contamination of consumables prior to use.

8.1.2 As a minimum this includes secure storage, restricted access, steps to minimise the chance that the handler (Fonneløp *et al.*, 2016)[6] causes inadvertent DNA contamination and the risk of DNA being transferred from adjacent items or the storage environment.

8.1.3 Any sample packaging and/or collection kits[7] used shall be fit for purpose.

8.1.4 Areas used for the storage and handling of consumables, samples and exhibits shall be secure and access restricted to authorised personnel only (the Codes 23.3).

8.2 Personal Protective Equipment/Barrier Clothing

8.2.1 Personal protection equipment (PPE)/ barrier clothing serves a double purpose:

a. to protect the wearer from contact with hazardous materials; and
b. to protect exhibits from contamination by the wearer.

For serious crimes PPE/ barrier clothing for entering the crime scene shall consist of the following.

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[6] **Fonneløp, A. E., Johannessen, H., Egeland, T. and Gill, P.** (2016) 'Contamination during criminal investigation: Detecting police contamination and secondary DNA transfer from evidence bags'*, Forensic Science International: Genetics*, vol. 23, pp 121–129.

[7] This can be demonstrated by consumable manufacturers and kit assemblers meeting the requirements set out for DNA consumables in BS ISO 18385:2016 (British Standards, 2016) and for other non-DNA consumables, set out in the publicly available specification (PAS) 377:2012 (British Standards, 2012b).

a. Face mask: This shall be a pinch-nose barrier type mask that is effective at preventing DNA transfer.[8] The wearer shall keep talking to a minimum whilst sampling, or when recovering samples, or when in close proximity to possible sources of DNA evidence. The wearer shall also avoid having to adjust or otherwise manipulate the face mask (or glasses if worn) whilst at the scene. Where this cannot be avoided, the outer gloves should be replaced immediately.

b. Mob cap/hairnet: A mob cap or hairnet, or the hood of the scene suit shall be worn at all times in the scene to prevent shed hair or skin flake contamination by the examiner.

c. Gloves: Two pairs shall be worn at all times when handling exhibits. These shall be disposable and powder free[9] nitrile gloves. Exposure of skin or clothing shall be avoided by for example:

   i. taping the inner pair to the scene suit; or
   ii. inserting the thumb through a hole in the cuff to prevent the suit sleeve from rucking up and always wearing gloves over the top;
   iii. wearing 'long cuff' gloves as the 'inner' pair so that the cuff can be stretched over the sleeves of the scene suit.

d. Over-suit: This shall be worn at all times, including the hood or mob cap, at the scene. It shall not be modified by making holes or openings in the suit that expose skin or clothing (see exception c.ii above), or be otherwise handled unnecessarily at the scene.

e. Overshoes: These should be worn at all times within the scene unless otherwise directed by the CSM or equivalent. Exposure of skin or clothing between the scene suit and overshoes should be avoided, if necessary by taping them together.

f. The outer gloves shall be changed regularly, ideally at a designated place away from the area being examined, both before and after handling individual items that may be submitted for DNA analysis.

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[8] Other masks may need to be used for other purposes (for example, health and safety). This should be recorded.

[9] The powder in many types of gloves has been found to inhibit subsequent DNA analysis and can potentially contaminate items being handled, therefore powdered gloves should be avoided.

g. If any of the PPE / barrier clothing becomes visibly stained they shall be changed.

h. If any item(s) of PPE/ barrier clothing is believed to have become a potential source of contamination this possibility shall be recorded in the examination notes and the specific item(s) of PPE / barrier clothing seized as exhibits.

8.2.2 The order of putting on PPE /barrier clothing shall be as follows:

a. face masks should be put on before any other protective clothing to avoid the latter from being contaminated with saliva aerosols; followed by
b. mob cap/helmet (if required);
c. first pair of gloves;
d. over-suit;
e. overshoes; and finally
f. second pair of gloves.

8.2.3 For volume crimes the following PPE / barrier clothing shall be worn as a minimum during examination and handling of items:

a. face mask;
b. gloves, a second pair is required when recovering potential DNA from scene.

8.2.4 The wearing of gloves and face masks when searching and recovering evidence at all scenes of crime regardless of their seriousness is essential, as most contamination occurs by:

a. handling items without gloves or where the gloves are torn; or
b. talking, sneezing or coughing over the items.

8.2.5 Due consideration should also be given to wearing additional or alternative PPE / barrier clothing depending on the specific health and safety requirements of each scene.

8.2.6 All PPE / barrier clothing including overshoes should be removed at the designated exit point when exiting a scene. This shall be sealed either for appropriate disposal or retention (see 11.1.2).

8.3 Consumables Including Disposable Equipment (ISO/IEC 17020 Equipment 6.2.2/6.2.3 or Process Requirement 7.1.1/7.1.2)

8.3.1 Consumables are single-use commodities used in the collection, preservation and processing of material for forensic analysis, and are bought and used up recurrently. These include PPE/ barrier clothing, tamper evident containers, swabs and packaging that come into direct contact with the material for forensic analysis. A consumable can also be equipment used in the collection, processing and safe handling of the material, for example, disposable tweezers and scissors.

8.3.2 Wherever possible consumables including disposable equipment that will come into direct contact with the evidential material intended for DNA analysis shall be quality assured to be free from detectable human DNA or forensic DNA grade

8.3.3 Assurance can be provided by the consumables being independently certified as compliant with ISO 18385:2015[10] or through quality control (QC) testing of batches of reagents and consumables, verified by the generation and documentation of data, as being fit for purpose when using the most sensitive DNA tests.[11] Further detail on QC requirements can be found in FSR-G-208 (Forensic Science Regulator, sections 8.8.4 and 8.8.5).

8.3.4 Ideally consumables/items should be individually sealed or provided as a self-contained kit comprising a set of all the required items for a specific activity. Where these are not available all reasonable efforts should be made in the storage, transport and handling of multiple packs of consumables to minimise the risk of cross-contamination post-receipt from the supplier. For example, a box of disposable nitrile gloves should be dedicated solely for use as outer

[10] Publication of BS ISO 18385 (British Standards, 2016) will replace sections 3.2.2, 3.2.3, 3.3.2 and Annex A in PAS 377:2012 (British Standards, 2012b).

[11] FSR-G-208 (Forensic Science Regulator, 2016, section 8.8.4) defines this for short tandem repeat (STR) profiling as a single increased polymerase chain reaction (PCR) amplification cycle number to the recommended manufacturer's protocol, combined with the most sensitive DNA detection method (for example, post-PCR clean up).

gloves and should be kept in a re-sealable bag that is only opened when wearing a pair of under-gloves.

8.4 Packaging

8.4.1 The packaging of collected material shall preserve the integrity of the potential material for forensic examination and minimise the risk of loss, degradation or contamination.

8.4.2 As a minimum this should include:

a. separate packaging of items where the packaging of items together is likely to compromise them;
b. the appropriate packaging for the size, condition and forensic analysis requirements of the material recovered; and
c. secure sealing.

8.5 Non-Disposable Equipment

8.5.1 Equipment that is to be re-used at different scenes and that do not come into direct contact with items being recovered for subsequent DNA analysis shall be effectively cleaned prior to re-use. This might include, for example:

a. equipment and kits to undertake examination of the scene;
b. fingerprint brushes/powders;[12]
c. imaging equipment to record the scene;
d. lighting equipment;
e. stepping plates for the preservation of surfaces.

8.5.2 Equipment shall be cleaned using documented standard operating procedures (SOPs) demonstrated to be effective at removing DNA. A cleaning log should also be kept.

8.5.3 The processes adopted by the end-user shall be verified, by the generation and documentation of data, to be fit for purpose in their hands, as it is the

[12] For major crime scenes ideally a new fingerprint brush/powder is used if DNA recovery has not been completed prior to use. For volume crime, sequential processing should be undertaken to minimise cross-contamination, together with periodic replacement in particular when there is any possibility that a contaminated surface may have been brushed

combination of cleaning agent and how it is physically used that determines its effectiveness. This can be evidenced by the same process as environmental monitoring. See FSR-G-208 (Forensic Science Regulator, section 8.7).

Cellular contamination monitoring

8.5.4 One method of monitoring the effectiveness of cleaning is the use of Adenosine Triphosphate- (ATP)-based[13] luminometry methods.[14] This may be used as means of assessing the degree of cellular contamination on a surface in real time, by swabbing the surface and measuring the ATP activity using a handheld device.

8.5.5 Any ATP luminescence methods shall be 'calibrated' for the handheld model used against the absence and low levels of detectable DNA (Donnelly *et al.*, 2015).

8.5.6 The monitoring of ATP activity would not be a direct replacement for all monitoring activities, but can indicate ineffective cleaning and can be used in combination with DNA profiling to allow for efficient and effective monitoring.

9. CRIME SCENE ACTIVITIES AND PROCEDURES

9.1.1 All activities within the crime scene should be controlled by a suitably trained individual who has gained competence in the understanding of the mechanisms of contamination, assessment of risk and minimising risk whilst promoting detection. Typically this is by a CSM or equivalent for major incidents, whilst for less serious crimes compliance with anti-contamination procedures may be the responsibility of another nominated individual such as a forensic practitioner or the crime scene investigator (CSI) in attendance.

[13] ATP is a molecule found in all living cells, including plants, animals and humans as well as bacteria, yeasts, etc. The use of ATP-based luminometry methods has been routinely used in hospitals and the food and beverage processing industry for many years as a means of assessing the degree of cellular contamination on a surface in real time.

[14] Method has to be validated for the intended use as no off-the-shelf DNA standard to assess the outputs from the various illuminometers is available.

9.1.2 Where the controlling individual requires additional input from suitably qualified sources in relation to anti-contamination measures this input shall be documented.

a. Access to the crime scene should be restricted as far as is practicable to those personnel who need access for a specific reason.
b. Movement within the crime scene should be kept to the minimum possible for the work that has to be undertaken.
c. Verbal communication whilst within the crime scene should be kept to a minimum despite the fact that masks are being worn.
d. The touching of spectacles, face, telephones, door handles, light switches, pens, paper, rulers, etc., without subsequently changing the outer pair of gloves should be avoided.
e. The use of mobile phones and radios should be minimised within the scene and, if used, appropriate anti-contamination procedures carried out.
f. Items from which samples are taken should be handled carefully and as little as possible, and packaged at the earliest opportunity.
g. All items seized shall be packaged, sealed and labelled at the time they are taken, and wherever possible the packaging should be taken to the item and not the item to the packaging.
h. Measures should be put in place to prevent/minimise contamination of equipment and consumables brought into the crime scene.
i. Packaging and other containers should be of an appropriate size for the items being packaged so that the item does not become damaged, and the packaging does not become compromised during transportation and storage.
j. Due care and consideration should be made when deciding whether to package items separately or whether to combine them (for example, cigarettes).

10. DRYING CABINETS AND TEMPORARY STORAGE OF ITEMS

10.1 Introduction

10.1.1 Consideration shall be given to preserving DNA from degradation for items recovered that are wet; should freezing not be a suitable option (for example, wet clothing) then items shall be dried in a controlled environment.

10.1.2 If practicable, recovered items for DNA laboratory examination should be transported to the laboratory without delay. Where this is not practicable, for example, where exhibits' reviews are required or items are not required for immediate submission, the risk of degradation of evidence should be assessed. Actions should be taken to minimise the loss of evidence, for example, drying or prioritisation of the examination of higher risk items.

10.1.3 All items shall be stored in such a manner so that they cannot be cross-contaminated, tampered with or stolen, and so that only authorised personnel have access to them. This is essential in order to ensure that the integrity of the evidence cannot be compromised and that the chain of custody can be demonstrated and therefore does not provide the basis for any subsequent challenge.

10.1.4 Samples that are obviously stained with body fluids such as blood should be dried separately from less obviously stained items to prevent contamination by transfer of dried flakes, etc. Items considered for sensitive DNA tests should be dried separately, unless recovered co- mingled from the same owner and separation would compromise other material of interest.

10.1.5 Short-term storage conditions should be in accord with police force/organisational standard operational procedures (SOPs), which specify best practice for each type of evidence. Where the circumstances of the case dictate, wet or damp items should ideally be dried to preserve DNA prior to forensic examination. Where it is not possible to commence drying the item immediately on receipt, it shall be adequately packaged to preserve the distribution evidence, for example, by folding it into a piece of brown paper then immediately freezing it in a polythene bag to minimise degradation.

10.1.6 Regardless of where they are located, drying rooms or cabinets used to dry recovered items should conform to the same general requirements as any other room or equipment used for accreditation to ISO/IEC17025 for body fluid searching and examination, as outlined in FSR-G-208 (Forensic Science Regulator, section 8). This requirement has been stipulated by the Forensic Science Regulator because drying necessitates opening the packaging[15] and therefore should only be undertaken in a controlled environment.

10.2 General Operational Principles

10.2.1 Sufficient drying space capacity should be made available to ensure that the drying of submitted items can commence without delay during typical daily casework demand levels. As a contingency for exceptional peaks in demand, sufficient freezer space should be kept free for storage of items until drying space becomes available. Under no circumstances should the drying processes be accelerated by using heat or with fans.

10.2.2 Items between which a link may be of evidential significance should not be dried in the same space, for example, by sequentially drying one after the other in the same cabinet or room. Current (as at December 2014) best practice operated by some police forces is to dry potentially linked items from the same case at different physical locations.

10.2.3 The drying cabinet should ideally have the following characteristics:

a. temperature controlled between 15.5^{o}C and 24^{o}C;
b. humidity controlled, relative humidity not to exceed 60 per cent;
c. under negative air pressure with 12 to 15 air changes per hour;
d. air re-circulated through an activated high efficiency particulate air (HEPA) filter;
e. drying area not in direct sunlight;
f. walls, ceiling and floor shall have surfaces that readily allow decontamination; and

[15] An exception to this rule is where a wet item has been packaged in a breathable polymer bag that has been demonstrated to enable the item to dry out in situ without leakage of DNA from the sealed bag.

g. a locking mechanism on the door to prevent access except by the assigned personnel.

10.2.4 Ideally a dedicated room(s) should be utilised, which is accessed by a lobby area for putting on/removing personal protective equipment (PPE) / barrier clothing and is equipped with commercially manufactured drying cabinets. These cabinets are specifically designed to meet the above specification and therefore will be easier to decontaminate than drying facilities that have been modified from other applications. Both the room and the drying cabinets within shall be subject to regular and effective cleaning regimes, and environmental monitoring.[16]

10.3 Decontamination of Re-Usable Equipment Between Exhibits

10.3.1 The following are examples of how equipment may be decontaminated. However, it is essential that the processes adopted are documented and their effectiveness verified in the hands of the end-user. In all instances due consideration should be given to the health and safety implications of using these cleaning regimes. They shall be risk assessed and safe systems of work established prior to use.

a. Items that are not suitable for emersion in fluid without damaging them should be thoroughly cleaned using a disposable cleaning roll or wipes liberally wetted with a chemical that inactivates and removes DNA. If direct contact with sources of DNA will occur, then the removal of the cleaning agent is necessary. Where equipment or items are susceptible to corrosion, then an appropriate cleaning agent that does not corrode[17] shall be used.

b. Small items thought to be contaminated that are suitable for emersion in fluid without damaging them should be submerged in a cleaning agent, scrubbed/wiped down to remove material. They should be rinsed in sterile

[16] Further details on environmental monitoring can be found in FSR-G-208 (Forensic Science Regulator, 2016, section 8.7).

[17] Activ8™ contains no oxidising or corrosive ingredients and can therefore be used with confidence on all surfaces including fabrics and carpets (King's College London and Metropolitan Police Service, 2015).

distilled water should direct contact with sources of DNA for recovery occur.

c. An example of cleaning surfaces (including drying cabinets) is as follows:

i. spray the entire surface with a chemical at the concentration that is effective (for example, 1% solution of sodium hypochlorite destroys DNA);

ii. leave for 5 minutes;

iii. wipe the entire surface thoroughly using disposable cleaning roll (or similar);

iv. if direct contact with items for DNA recovery will occur, it may be necessary to clean with (distilled/purified/sterile) water or ethanol[18,] to remove cleaning agent residue.

10.4 Handling Procedure For Drying

10.4.1 Between each use, the drying cabinet shall be decontaminated as detailed in 10.3.

10.4.2 Only one item should be handled at a time.

10.4.3 The packaging should be opened at the opposite end to the original seal so that the integrity of the original seal is verifiable if necessary. This shall be undertaken outside of, but very close to, the drying cabinet.

10.4.4 Paper should be placed under the item to capture any trace evidence that might fall off while it dries. This paper should be packaged separately and submitted with the item.

10.4.5 Segregation of items and the handling of items potentially in the same case should be observed at all times, for example, scene and suspect, victim and suspect, different suspects, different locations within a scene, and multiple scenes.

[18] Safety testing has revealed that cleaning with a solution of hypochlorite and ethanol can produce levels of gaseous chlorine at or above the recommended exposure limits (Ballantyne, *et al.*, 2015, pp 428–439. See also Bright *et al.*, 2011.

10.4.6 Once the items have dried they should be re-packaged and re-sealed using adhesive tape. Ideally the original packaging should be re-used, but where this is not possible, the item should be re-packaged and sealed in appropriate replacement packaging, and the original packaging should be retained for continuity purposes.

10.4.7 The location of the drying cabinet and the time and date of the drying (as well as any other samples in the batch) should be recorded in the event of quality assurance (QA) investigations, etc.

10.5 Record Keeping

10.5.1 The following anti-contamination records shall be kept.

a. Cabinet logs shall be maintained for each cabinet. These shall detail the following:

   i. the exhibit number and crime reference number of each item;
   ii. the person who placed the item in the cabinet including time and date, plus confirmation that the cabinet was decontaminated beforehand;
   iii. the person who removed the item from the cabinet including time and date, plus confirmation that the cabinet was decontaminated afterwards.

b. Room access logs.
c. Competency records of staff accessing the drying facilities.
d. Cleaning logs.
e. Environmental monitoring records.
f. Case notes shall record where applicable:

   i. that the item has been dried in-force; and
   ii. all instances where contamination is suspected in the handling and drying of the item, giving details of the incident.

10.6 Personnel Considerations

10.6.1 Prior to being granted access to the drying cabinet facilities each member of staff shall have demonstrated competency in operating the cabinets. Key to this is being trained in and demonstrating knowledge through assessment of:

a. contamination issues;
b. the rationale behind anti-contamination measures; and
c. practical knowledge of the anti-contamination-related SOPs employed in the handling of items and operation of the drying facilities to avoid contamination.

10.6.2 Issues relating to contamination risks and their avoidance in specific processes and methods shall be an integral part of staff training documentation and the relevant issues shall be included within the training plans and manuals.

10.6.3 This guidance appendix to the Codes (Forensic Science Regulator) shall be introduced to all new users of the drying facilities as part of their training.

10.6.4 Where a member of staff has a cold or other medical condition that risks compromising forensic casework, such as persistent coughing or sneezing, consideration should be given to excluding them from the drying area as per section 7.

10.7 Personal Protective Equipment / Barrier Clothing

10.7.1 Outdoor clothing, for example, coats, gloves, scarves, and other personal belongings are not permitted within the drying facility.

10.7.2 The following protective clothing shall be worn by all individuals including staff, visitors and service engineers when entering the drying area, and all of whom should provide an elimination sample.

Laboratory coats

10.7.3 Dedicated disposable laboratory coats that fully cover the neck, arms and wrist areas shall be worn and properly fastened. Alternatively a scene suit may be worn, fully fastened.

10.7.4 Coats/suits shall be changed before handling items from a different case, individual, location and where other circumstances dictate, for example, after handling a heavily stained exhibit.

a. It is acceptable not to change laboratory coats when handling different items of clothes that have been worn at the same time by the same individual.
b. For handling volume crime samples, it is acceptable to use a lower cost alternative of wearing disposable paper aprons and sleeve covers over the laboratory coat and changing the apron and sleeve covers between items, rather than the laboratory coat.

10.7.5 Dedicated coats shall not be worn outside the drying area to which they have been assigned.

Gloves

10.7.6 Disposable gloves shall be worn at all times in the drying area, and removed when leaving the area. Two layers of gloves shall be worn; ideally powder-free nitrile or other suitable alternative (8.2.1c), and shall not be removed within the drying area.

10.7.7 The wrist of the glove should cover the wrist of the laboratory coat. Where this is not possible, disposable cuffs shall be used to cover the gap.

10.7.8 The outer set of gloves shall either be changed or thoroughly cleaned using a validated method for the effective removal of DNA, whenever they come into contact with a potentially contaminated surface, for example, a door handle, chair, stationery, or when retrieving items from the floor.

10.7.9 Outer gloves shall be changed between the handling of different items.

Face masks

10.7.10 When examining exhibits, pinch-nose face masks shall be worn that are properly tied and adjusted to cover the nose and mouth.

10.7.11 Touching the mask with gloved hands shall be avoided. If it is necessary to adjust the mask then the outer gloves shall be changed or wiped with a cleaning product validated to remove DNA.

Hair cover

10.7.12 Disposable mob caps or similar hair cover shall be worn entirely covering the head hair within the drying facility.

10.7.13 Where necessary, for example with bearded individuals, additional hair cover (snoods) shall be used to ensure that all facial hair is covered when used in conjunction with the face mask.

10.8 Gowning Procedure

10.8.1 Ideally the gowning/disrobing procedure shall be undertaken in a lobby area or designated area proximal to the entrance/exit of the drying facility.

10.8.2 Gowning-up should be undertaken in an appropriate sequence, in line with the anti-contamination strategy an example of which is the following:

a. on entering lobby/room/designated area, immediately put a face mask;[19]
b. then put on a mob cap and ensure that all hair is secure within the cap;
c. then put on the first pair of gloves;
d. then put on overshoes;
e. next put on goggles or other eye protection where necessary[20];
f. then put on disposable laboratory coat or scene suit; and finally
g. put on the second pair of gloves.

11. CONTAMINATION DETECTION MEASURES

11.1.1 It is recognised that even when all practicable precautions are taken to minimise the risk of contamination, incidents will still inevitably occur. The primary vectors for contamination transfer are personnel, equipment and consumables.

[19] Do not talk at all until the mask is securely fitted.
[20] Change gloves if necessary

11.1.2 Due consideration should be given to the retention of personal protection equipment (PPE) / barrier clothing to allow for subsequent sampling and analysis where transfer of contamination on the protective clothing of scene attendees is suspected. This is not seen as a default requirement in every case and the decision on how appropriate this is should form part of the anti-contamination strategy where there is a higher risk identified in relation to the movement of personnel between distinctly separate scenes within a single examination site, or a series of geographically separate sites.

11.1.3 The use of consumables that have been manufactured specifically to minimise the presence of DNA contamination should be used (see 8.3); manufacturers who are compliant with PAS 377:2012 /ISO 18385:2015 are required to generate and retain DNA profiles from manufacturing and assembly staff who are at risk of contaminating products so that comparisons may be performed against these profiles to check for potential contamination.

11.1.4 The provision of DNA profiles from staff whose role poses a high risk of contamination for routine screening of crime stain profiles is described in FSR-P-302 (Forensic Science Regulator).

11.1.5 All individuals entering the scene of crime shall be recorded in the scene log. From a contamination perspective, these fall into the following two categories.

a. All law enforcement staff whose roles routinely entail scene attendance and are therefore categorised as at high risk of contaminating crime stains with their own DNA. The routine screening of these personnel is described in FSR-P-302 (*ibid.*). This requires profiles from these individuals to be held on a police elimination database (PED) or central elimination database (CED), and these are routinely screened against each crime stain profile relevant to their police force or area prior to the crime profile being loaded on to the National DNA Database® or reported in a particular case. All police personnel whose roles are categorised as a high contamination risk shall be included on the CED.

b. Other individuals whose roles do not include routine attendance at scenes, ,(for example, first officer attending) and non-police personnel (for example, personnel from other emergency services and pathologists) are

not included on the CED and therefore not routinely screened against crime profiles for potential contamination events. These individuals may pose an even higher risk of contamination at a particular scene than the previous category. A first officer attending will not be wearing PPE/ barrier clothing, may have only basic forensic awareness training and their first priority is to deal with the immediate situation rather than contamination avoidance. Where contamination is suspected, then these individuals may be required to provide a sample for profiling and comparison for elimination purposes as a one-off exercise.

11.1.6 No individual should be permitted to enter the controlled scene of a serious crime unless they consent to being compared against crime stain profiles for potential contamination, where this is deemed necessary.

12. MANAGEMENT OVERSIGHT AND CONTINUOUS IMPROVEMENT

12.1.1 There shall be governance and oversight by the senior management of police, and other agencies undertaking crime scene recovery of DNA evidence, with regard to contamination avoidance, monitoring and detection, as described in this guidance, including the drying and temporary storage of items. This shall include a manager with appropriate technical knowledge having responsibility for:

a. assessment and review of contamination, including responsibility for undertaking investigations into contamination events to identify the root cause, and for escalating contamination issues to senior management where required;
b. maintaining a log of contamination events and periodically reviewing these to identify trends and potential for further anti-contamination measures as part of an overall continuous improvement process;
c. reviewing environmental monitoring results of non-disposable equipment to determine the ongoing efficacy of decontamination procedures;
d. ensuring that the competence of staff is maintained and demonstrated through a formalised and effective competence management system.

12.1.2 Reviews assessing contamination trends shall be made available to the Forensic Science Regulator/the Forensic Science Regulation Unit, the UK Accreditation Service and the National DNA Database® Delivery Unit to enable overall trends within the industry to be monitored.

12.1.3 There should be good communication with staff and staff ownership of contamination issues. Improvement at the team/unit level should also be encouraged with regular feedback on performance, including notification of contamination events, plus trends in contamination incidents, with a view to continuous improvement in performance.

13. ACKNOWLEDGEMENTS

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14. REVIEW

14.1.1 The published guidance will form part of the review cycle as determined by the Forensic Science Regulator.

14.1.2 The Forensic Science Regulator welcomes views on this guidance. Please send any comments to the address as set out on the Internet site at: www.gov.uk/government/organisations/forensic-science-regulator or email: FSREnquiries@homeoffice.gsi.gov.uk

15. REFERENCES

Ballantyne, K., Salemi, R., Guarino, F., Pearson, J., Garlepp, D., Fowler, S. and van Oorschot, R. (2015) 'DNA contamination minimisation – finding an effective cleaning method', *Australian Journal of Forensic Sciences*, vol. 47, issue 4, pp 428–439.

Boyd, N., Goodwin, D., Tumelty, B., Donnelly, P., McClelland, A. and Brown, S. (2014) *Use of ATP testing to supplement DNA Environmental Monitoring,* Forensic Science Northern Ireland. Personal communication to the Forensic Science Regulator DNA specialist group meeting. 11 December 2014.

Bright, J. A., Cockerton, S., Harbison, S., Russell, A., Samson, O. and Stevenson, K. (2011) 'The effect of cleaning agents on the ability to obtain DNA profiles using the Identifiler™ and PowerPlex® Y multiplex kits', *Journal of Forensic Sciences* vol. 56 (1), pp 181–185.

British Standards (2005) *BS EN ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories*.

British Standards (2012a) *BS EN ISO/IEC 17020:2012 Conformity assessment – Requirements for the operation of various types of bodies performing inspection* .

British Standards (2012b) *PAS 377:2012 Specification for consumables used in the collection, preservation and processing of material for forensic analysis: Requirements for product, manufacturing and forensic kit assembly*.

British Standards (2016) *BS ISO 18385:2016 Minimising the risk of human DNA contamination in products used to collect, store and analyse biological material for forensic purposes.*

Donnelly, P., Boyd, N., Goodwin, D. and Tumelty, B. (2015) *ATP Based Monitoring of High Care DNA Recovery Areas in a Forensic Environment*. Forensic Science Northern Ireland. Personal communication to the Forensic Science Advisory Council meeting. 29 April 2016.

Fonneløp, A. E., Johannessen, H., Egeland, T. and Gill, P. (2016) 'Contamination during criminal investigation: Detecting police contamination and secondary DNA transfer from evidence bags', *Forensic Science International: Genetics*, 23, pp 121–129.

Forensic Science Regulator *Codes of Practice and Conduct for Forensic Science Providers and Practitioners in the Criminal Justice System*. Birmingham: Forensic Science Regulator. Available at: https://www.gov.uk/government/collections/forensic-science-providers-codes-of-practice-and-conduct [Accessed 04/07/2016].

Forensic Science Regulator *DNA contamination detection: The management and use of staff elimination DNA databases,* FSR-P-302*.* Birmingham: Forensic Science Regulator. Available at**:** https://www.gov.uk/government/publications/dna-contamination-detection [Accessed 04/07/2016].

Forensic Science Regulator *The control and avoidance of contamination in laboratory activities, involving DNA evidence recovery and analysis*, FSR-G-208. Birmingham: Forensic Science Regulator. Available at: https://www.gov.uk/government/publications/laboratory-dna-anti-contamination-guidance [Accessed 04/07/2016].

Forster, L., Thomson, J. and Kutranov, S. (2008) 'Direct comparison of post-28-cycle PCR purification and modified capillary electrophoresis methods with the 34-cycle "low copy number" (LCN) method for analysis of trace forensic DNA samples', *Forensic Science International: Genetics*, 2 (4), pp 318–328.

ILAC (2014) *ILAC G19:08/2014 Modules in a Forensic Science Process*. International Laboratory Accreditation Cooperation. Available at: http://ilac.org/news/ilac-g19082014-published/ [Accessed 04/07/2016].

King's College London and Metropolitan Police Service (2015) *Cleaning project.* Personal communication to the Forensic Science Regulator DNA specialist group meeting. 10 July 2015.

Lapointe, M., Rogic, A., Bourgoin, S., Jolicoeur, C. and Séguin, D. (2015) 'Leading-edge forensic DNA analyses and the necessity of including crime scene investigators, police officers and technicians in a DNA elimination database', *Forensic Science International: Genetics*, vol.19, pp 50–55.

UKAS (2015) *RG201:2015 Accreditation of Bodies Carrying out Scene of Crime Examination,* edition 2*.* UK Accreditation Service. Available at: https://www.ukas.com/download/publications/RG%20201.pdf [Accessed 04/07/ 2016].

16. BIBLIOGRAPHY

ACPO (2007) *DNA Good Practice Manual*, third edition. Association of Chief Police Officers.

ENFSI (2012) *Scenes of Crime Examination Best Practice Manual*, v1.0. European Network of Forensic Science Institutes.

Forensic Science Service Ltd (2009) *The Scenes of Crime Handbook* v.2.

Home Office (2013) *Drying Exhibits: Guidance for Forces*, v1.0. London: Home Office.

National Policing Improvement Agency (2009) *Guidelines for the Avoidance of Contamination in the Recovery, Packaging and Submission of Material for DNA Analysis*, CUSTP-GP-031.

NISTIR (2013) *The Biological Evidence Handbook: Best Practices for Evidence Handlers*, NISTIR 7928. National Institute of Standards and Technology Internal or Interagency Reports.

17. FUTHER READING

Arena, A. (2010) **'**Dna Exitus plus™ versus standard bleach solution for the removal of DNA contaminants on work surfaces and tools'*, Investigative Sciences Journal*, vol. 2, pp 20–27.

Bolivar, P. A., Tracey, M., McCord, B. (2016) 'Assessing the Risk of Secondary Transfer via Fingerprint Brush Contamination Using Enhanced Sensitivity DNA Analysis Methods', *Journal of Forensic Sciences*, vol. 61 (1), pp 204–211.

Cale, C. M., Earll, M. E., Latham, K. E. and Bush, G. L. (2016) 'Could Secondary DNA Transfer Falsely Place Someone at the Scene of a Crime?', *Journal of Forensic Sciences*, vol. 61 (1), pp 196–203.

Davies, C., Thomson, J. and Kennedy, F. (2015), 'Assessing primary, secondary and tertiary DNA transfer using the Promega ESI-17 Fast PCR chemistry', *Forensic Science International: Genetics*, Supplement Series 5, pp e55–e57.

Farash, K., O'Brien, H., Hanson, E., Petraco, N. and Ballantyne, J. (2015) *Combined Genetic and Micro-Chemical Analysis of Household Dust as Definitive Trace Identifier of a Room and Its Occupants.* Available at: http://www.aafs.org/sites/default/files/2015/abstracts/B90.pdf [Accessed 04/07/ 2016]. Poster available at: http://f1000research.com/posters/1097111 [Accessed 04/07/ 2016].

Fonneløp, A. E., Egeland, T. and Gill, P. (2015) **'**Secondary and subsequent DNA transfer during criminal investigation'*, Forensic Science International: Genetics*, vol. 17, pp 155–162.

Goray, M., Fowler, S., Szkuta, B. and van Oorschot, R.A.H. (2016) 'Shedder status—An analysis of self and non-self DNA in multiple handprints deposited by the same individuals over time', *Forensic Science International: Genetics,* vol. 23, pp 190–196.

IFSA (2014) 'Minimum Requirements for Crime Scene Investigation - A document for emerging laboratories'. Available at: http://www.wff2014korea.org/bbs/skin/notice/download.php?code=2013_notice&number=100 [Accessed 04/07/2016].

IFSA (2104) 'Minimum Requirements for DNA Collection, Analysis and Interpretation - A document for emerging laboratories'. Available at: http://www.wff2014korea.org/bbs/skin/notice/download.php?code=2013_notice&number=101 [Accessed 04/07/2016].

Lehmann, V. J., Mitchell, R. J., Ballantyne, K. N. and van Oorschot, R. A. H. (2015) 'Following the transfer of DNA: How does the presence of background DNA affect the transfer and detection of a target source of DNA?', *Forensic Science International: Genetics*, vol. 19, pp 68–75.

Liebers, V., Bachman, D., Franke, G., Freundt, S., Stubel, H., Duser, M., Kendzia, B., Bockler, M., Brunning, T. and Raulf, M. (2015) 'Determination of ATP Activity as a Useful Tool for Monitoring Microbial Load in Aqueous Humidifier Samples', *International Journal of Hygiene and Environmental Health*, vol. 218, issue 2, pp 246–253.

Manoli, P., Antoniou, A., Bashiardes, E., Xenophontos, S., Photiades, M., Stribley, V., Mylona, M., Demetriou, C. and Cariolou, M. A. (2016) 'Sex-specific age association with primary DNA transfer'*, International Journal of Legal Medicine*, vol.130 (1), pp 103–112.

Meakin, G. and Jamieson, A. (2013) 'DNA transfer: Review and implications for casework'*, Forensic Science International: Genetics*, vol. 7, issue 4, pp 434–443.

Moore, G., Smyth, D., Singleton, J. and Wilson, P. (2010) 'The Use of Andenosine Triphosphate Bioluminescence to Assess the Efficacy of a Modified Cleaning Program Implemented Within an Intensive Care Setting'*, American Journal of Infection Control*, vol. 38, issue 8, pp 617–622.

Mound, S., Smith, P. A., Brown, N., Leonard, R., Lovell, C., Horrocks, E. and Bennett, S. (2016 in press) 'Empirical Approaches to Improving the Contemporary use of DNA in Crime Scene Investigative Practice', submitted to the *International Journal of Police Science and Management*; to request a copy contact: paul1.smith@port.ac.uk).

National Institute of Justice Forensic Technology Center of Excellence (2011) *Comparison Study of Disinfectants for Decontamination*, Award No. 2010-DN-BX-K210.

National Institute of Justice Forensic Technologies Center of Excellence (2012) *Swab Collection Study*, Award No. 2010-DN-BX-K210.

Petraco, N., Ballantyne, J., Hanson, E. and Farash, K. (2015) *A Study of the Formation, Collection, and Microscopic Trace Material and Genetic Makeup of Household Dust Specimens.* Available at: http://www.aafs.org/sites/default/files/2015/abstracts/B89.pdf [Accessed 04/07/2016].

Quinones, I. and Daniel, B. (2012) 'Cell free DNA as a component of forensic evidence recovered from touched surfaces', *Forensic Science International: Genetics*, vol. 6 (1), pp 26–30.

Raymond, J. J., van Oorschot, R. A. H., Gunn, P. R., Simon, J., Walsh, S. J. and Claude Roux, C. (2010) 'Trace evidence characteristics of DNA: A preliminary investigation of the persistence of DNA at crime scenes', *Forensic Science International: Genetics*, vol. 4, issue 1, pp 26–33.

Shama, G. and Malik, D. J. (2013) 'The Uses and Abuses of Rapid Bioluminescence-Based ATP Assays', *International Journal of Hygiene and Environmental Health*, vol. 216, issue 2, pp 115–125.

Sherlock, O., O'Connell, N. O., Creamer, E. and Humphreys, H. (2009) 'Is it really clean? An evaluation of the efficacy of four methods for determining hospital cleanliness', *Journal of Hospital Infection*, vol. 72, issue 2, pp 140–146.

Skalleberg, A. G. and Bouzga, M. M. (2016) 'Detecting and collecting traces of semen and blood from outdoor crime scenes using crime scene dogs and presumptive tests', *Forensic Science International*, vol. 264, pp 146–152.

Sweet, D., Lorente, M., Lorente, J. A., Valenzuela, A. and Villanueva, E. (1997) 'An improved method to recover saliva from human skin: The double swab technique', *Journal of Forensic Sciences*, 42 (2), pp 320–322.

Szkuta, B., Harvey, M. L., Ballantyne, K. N. and van Oorschot, R. A. H. (2015) 'DNA transfer by examination tools – a risk for forensic casework?', *Forensic Science International: Genetics*, vol. 16, pp 246–254.

Toothman, M. H., Kester, K. M., Champagne, J., Cruz, D. T. W., Street, S. and Brown, B. L. (2008) 'Characterization of human DNA in environmental samples', *Forensic Science International: Genetics*, vol. 178, issue 1, pp 7–15.

UNODC (2009*) Crime Scene and physical evidence awareness for non-forensic personnel*, ST/NAR/39, ISBN 978-92-1-130273-8. Available at: http://www.unodc.org/unodc/en/scientists/crime-scene-and-physical-evidence-awareness-for-non-forensic-personnel.html [Accessed 04/07/2016]

Vandewoestyne, M., Van Hoofstat, D., Franssen, A., Van Nieuwerburgh, F. and Deforce, D. (2013) 'Presence and potential of cell free DNA in different types of forensic samples'*, Forensic Science International: Genetics*, vol. 7, issue 2, pp 316–320.

Van Oorschot, R. A. H., Ballantyne, K. N. and Mitchell, R. J. (2010) 'Forensic trace DNA: a review', *Investigative Genetics.* 1:14. Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3012025/ [Accessed 04/07/2016]

Van Oorschot, R. A. H., Glavich, G. and Mitchell, R. J. (2014) 'Persistence of DNA deposited by the original user on objects after subsequent use by a second person', *Forensic Science International: Genetics*, vol. 8, issue 1, pp 219–225.

18. ABBREVIATIONS

Abbreviation	Meaning
ACPO	Association of Chief Police Officers of England, Wales and Northern Ireland
ATP	Adenosine Triphosphate
BS	British Standard
CED	central elimination database

CSI	crime scene investigator
CSM	crime scene manager
DNA	Deoxyribonucleic Acid
EN	European Standards
ENFSI	European Network of Forensic Science Institutes
FSP	forensic science provider
FSR	Forensic Science Regulator
FSRU	Forensic Science Regulation Unit
HEPA	high efficiency particulate air
HSE	Health and Safety Executive
IEC	International Electrotechnical Commission
IFSA	International Forensic Strategic Alliance
ILAC	International Laboratory Accreditation Cooperation
ISO	International Organisation for Standardization
NDNAD	National DNA Database®
NDU	National DNA Database® Delivery Unit
PAS	publicly available specification
PCR	polymerase chain reaction
PED	police elimination database
PPE	personal protective equipment
QA	quality assurance
QC	quality control
SOCO	scene of crime officer
SOP	standard operating procedure
STR	short tandem repeat
UKAS	UK Accreditation Service
UNODC	United Nations Office on Drugs and Crime

19. GLOSSARY

Consumables: Single-use commodities used in the collection, preservation and processing of material for forensic analysis, which are bought and used up recurrently. These include personal protective equipment, tamper evident containers, swabs, and packaging that come into direct contact with the material for forensic analysis. A consumable can also be equipment used in the collection, processing and safe handling of the material, for example, disposable tweezers and scissors.

DNA contamination: The unintended presence of DNA, i.e. the introduction of DNA, or biological material containing DNA, to an item after a crime has been committed, either before, during or after its recovery from the scene of crime (or from a person).

Elimination database: Collection of DNA profiles held in a searchable format from staff whose access/role/activities are deemed to be a potential **DNA contamination** risk. The profiles are used solely for the purposes of detecting potential contamination events.

Forensic DNA grade: Consumables certified to having met the requirements in ISO 18385:2015.

Forensic science provider: Organisation that undertakes any part of the DNA sample recovery and analytical process on behalf of the police or other criminal justice system customers; police evidence recovery laboratories are also included.

Investigator: A person, however named, trained to perform crime scene examinations and/or investigations. Other names used for this function are scene of crime officer (SOCO), crime scene investigator (CSI), crime scene examiner (CSE).

Un-sourced contaminant: A DNA profile identified as a contaminant for which the source has not been identified; historically most have been found to come from manufacturing staff. Unsourced contaminants are usually observed in no DNA template (negative) controls and quality control batch tests, or if the DNA profiling result appears at odds with pre-expectations.

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