Introduction

One of the goals of the ENFSI DNA working group is to establish forensic DNA analysis quality assurance guidelines. Contamination prevention is an important issue for every forensic DNA laboratory. The recommendations described below are in addition to the Quality Assurance Programme.

The scope of this document provides recommendations for the minimum requirements for the laboratory layout and analysis (test) design to prevent the occurrence of contamination.
The Forensic Science Regulator's document FSR-G-208 '*The control and avoidance of contamination in laboratory activities involving DNA evidence recovery and analysis*' and the SWGDAM '*Contamination Prevention and Detection Guidelines for Forensic DNA Laboratories*' are good sources of information.

General Recommendations

- An organisation's facilities are required to meet the ENFSI QA assurance programme requirements in terms of separation of working areas for reference and crime samples.
- Separation of casework and reference material during processing.
- Separation of crime samples/exhibits from suspects and victims during examination.
- Dedicated changing rooms/areas close to the laboratories is recommended.
- Laboratory should be easy to clean (i. e. smooth walls, floors).
- Every laboratory shall have its own dedicated equipment / reagents.
- Protective clothing such as lab coats, (two layers of) gloves, face mask, hair cover, and snoods (in case of facial hair) should be worn and changed frequently.
- A gowning/disrobing procedure should be in place.
- Each laboratory should have its own dedicated lab coats or use different disposable coats.
- Molecular biology grade reagents and consumables should be used if available.
- Sterile and/or disposable consumables should be used.
- Human DNA free/forensic DNA grade reagents and (disposable) consumables should be used if available. They should be ordered from suppliers of consumables and reagent that work according the ISO18385:2016.
- Equipment transferred between laboratories shall be decontaminated before transfer and before use in the new location.
- Pre PCR rooms should be geographically separated from the rest of the laboratory areas (post PCR). Consider provision of positive air pressure or an airlock space between pre-PCR and other laboratories.
- Movement of a sample, material or person from a post-PCR area to a pre-PCR area should be minimised and only be allowed after thorough decontamination of material or change of protective clothing by the person.
- Restricted access to laboratories shall be enforced with warning signs.

- Human contact with the samples should be minimized as much as possible (e.g. make the best use of robotic handling devices; minimize the reopening of a crime sample, etc.).
- Contamination prevention should be discussed with other departments if crime samples have to be examined there before coming to the DNA laboratory.
- Validation tests should incorporate the evaluation of the risk of contamination where necessary. For example, for robots verify that the liquid handling procedures do not lead to any cross-contamination events.
- There shall be written procedures for cleaning and decontaminating facilities and equipment with attention to robotic systems including accessories.
- Every laboratory shall have its own cleaning equipment for benches. Pre and post PCR cleaning of the floor shall be done with dedicated equipment.
- Cleaning personnel shall be trained to work in laboratory conditions.
- Where possible, separated areas should be set up for the examination of “heavily” and “lightly” loaded stained crime samples.
- Environmental monitoring procedures should be documented. Test results shall be recorded and reviewed.
- In case of a contamination event, the lab should implement corrective/preventive actions as necessary.
- As a minimum the laboratories should keep the following information concerning traceability of contaminations:
  1. Contamination count vs. total number of samples processed;
     a. Number of contaminations in reference samples;
     b. Number of contaminations in case work samples
  2. Contamination analysis;
     a. Number of sample to sample contaminations;
     b. Number of person to sample contaminations.
  3. Determination of the analytical step where the contamination has likely occurred (Crime Scene, Sampling, Extraction (separate automatic from manual), Amplification, Electrophoresis).
  4. Specific activity that led to the contamination (human factor, machine, procedure).

Recommendations for automated systems

- The time that samples are held in open receptacles should be minimised and/or the robot shall have a protective screen.
- The robot programs should be designed to prevent contamination risks during sample transfer, mixing and re-sampling.
- The preparation of the reaction mix shall be conducted in a separate area/location to the robotic device.
- DNA devices with integrated extraction, pre/post PCR processing and genetic analysis shall be placed in a pre-PCR room.

Staff Recommendations

- Training of staff shall include contamination prevention techniques / rules
- Competency testing should include contamination checks
- Staff elimination database and preferably of visitors, "external" equipment technicians, QC samples shall be in place

Recommendations for Analytical (Test) design /set up

- Where possible, upon submission and before the DNA extraction stage, articles for examination and sampling should be separated into high yielding (e.g. semen, tissue, blood) and low yielding DNA categories (e.g. articles contacting the skin, handled articles). Low yielding categories should be sampled first from those yielding high quantities of DNA, which should be sampled last.
- Blank and negative controls shall be used for every series of analysis (tests).
- Reference and crime samples shall be analyzed as separate batches.
- Intra and inter-batch contamination checks should be done
- Sample results should be tested against the elimination database
- Where possible, reagents should be divided and stored in as small an aliquot as possible.

References

- ISO 18385:2016 *Minimising the risk of human DNA contamination in products used to collect, store and analyse biological material for forensic purposes*.
- ENFSI DNA Working Group: Quality Assurance Programme for DNA Laboratories.
- ENFSI DNA Working Group: Concept Training Document.
- ENFSI DNA Working Group: Recommended Minimum Criteria for the Validation of Various Aspects of the DNA Profiling Process.
- SWGDAM Contamination Prevention and Detection Guidelines for Forensic DNA Laboratories – APPROVED 01/12/2017. Available at: https://media.wix.com/ugd/4344b0_c4d4dbba84f1400a98eaa2e48f2bf291.pdf
- 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.