

Forensic Science Regulator

Codes of Practice and

Conduct

Development of Evaluative Opinions

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Issue 1

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1. Foreword

1.1.1 This appendix to the Codes of Practice and Conduct has been prepared in order to:

- a. Promote improvement and standardisation in the development of evaluative opinions;
- b. Improve alignment between disciplines;
- c. Encourage development of better data sets to inform interpretation;
- d. Encourage better design and use of proficiency trials to calibrate expert performance; and
- e. Enhance the transparency and understanding of opinion evidence in the courts.

1.1.2 For some, it goes too far in requiring calibration and transparency about paucity of data, but for others it does not go far enough. Some believe there is too long a period prior to requiring compliance and yet others think the time frame too challenging. Some disciplines see a huge mountain to climb while others believe they are already ahead of what is laid down here. For those already ahead, there is no need to go backwards, but there is a need for pragmatism in where the bar is set to begin with. Much depends on the current status of each discipline and, for that reason, there will be further discussion within each discipline, so that a realistic timetable for adoption can be set.

1.1.3 It contains more guidance than would be usual in a standard, but that is to facilitate understanding at this early stage. It is inevitable that there will be updates, perhaps even before initial implementation, but this issue points the way and signals what needs to be done.

1.1.4 There will be a separate guidance document developed in due course, to provide more detail on the means by which both expert performance and knowledge bases can be calibrated. There may also be specific guidance developed for some disciplines, for which this type of approach is new.

1.1.5 Development of the appendix has involved consultation with many experts in statistics, forensic science and the law. It has involved numerous compromises,

as it is an attempt to embed a logically correct and transparent approach to interpretation of evidence whilst maintaining comprehensibility to lay court participants, most particularly jurors, many of whom are not extensively schooled in the finer points of statistical thought or philosophical nuance.

- 1.1.6 I encourage all forensic scientists to give real thought and effort to seeing how the provisions in this document could produce the greatest improvement for their discipline, rather than being daunted by changes that will be required.



Dr Gillian Tully CBE
Forensic Science Regulator

2. Introduction

- 2.1.1 The role of an expert witness is to provide independent assistance to the court by providing expert evidence within their area of expertise. In this role an expert can, contrary to the general prohibition, provide evidence of opinion. Part of the role of expert witnesses (see 9.1.18) is to assess the probative value of their observations (see 9.1.37) and to present their evidence (see 9.1.11) in a way that conveys its strengths and limitations in a clear, complete, correct and consistent manner.
- 2.1.2 Different disciplines have evolved their own ways of assessing that probative value and use their own terminology. These include unqualified statements of an individual's view 'as an expert' and a variety of statistical approaches.
- 2.1.3 This document sets out a scientific approach to evaluating observations, based on a wealth of published research. It aims to reduce variability in approaches, address the concerns of the courts, increase transparency and adopt a common terminology, which is applicable across the spectrum of forensic science disciplines.
- 2.1.4 The way experts in the field of forensic science evaluate the observations from their work, report that work to the Criminal Justice System (CJS) and explain

the relevance of the observations, has been the subject of much research, development and discussion over the last 30 years. In the UK this led to the general acceptance of the Case Assessment and Interpretation (CAI) model through which practitioners are guided to consider a hierarchy of questions [1]. A detailed guide for judges, lawyers and expert witnesses has been published by the Science and Law Section of the Royal Statistical Society [2]. That guide, which includes worked examples, is essential reading alongside this appendix.

- 2.1.5 The CAI model also assists in mitigating the potential influence of bias on the expert. The model requires that the expert assesses, based on the relevant case-specific information, what question(s) they should seek to answer. This enables appropriate propositions (see 9.1.48) to be formulated, which address the issues in the case at the appropriate level (e.g. activity level (see 9.1.28) or source level (see 9.1.31)). The expert assesses the potential outcomes of an examination or analysis (see 9.1.12), again based on the information prior to the examination or analysis taking place. Further information on bias and how to mitigate against its effects is given in [3]. It is important to note that the expert setting the case strategy will need more case-specific information than will a DNA analyst interpreting a profile; each requires only what is relevant to their task.
- 2.1.6 The assessment (see 9.1.4) addresses potential outcomes under the conditions of the prosecution and the defence propositions being true. As a result, the expert can advise the commissioning party whether scientific analysis can be of assistance in answering questions of relevance to the case and, if so, enable the appropriate tests to be carried out.
- 2.1.7 Examinations and analyses result in observations, which are evaluated within the framework of these initial assessments and reported accordingly.
- 2.1.8 Using this framework, experts can operate in different ways within criminal justice proceedings:
- a. In investigative mode, experts generate possible explanations (see 9.1.16) to account for their scientific observations. If investigative opinion (see 9.1.26) is presented in a report, it should be clearly declared that a range of alternative explanations for the data might also be possible, but have

not been presented, and that if a specific explanation is later proposed to the expert it should be considered as a separate exercise.

- b. In the evaluative mode, the expert focuses on disputed issues and evaluates their observations.

- 2.1.9 The evaluative mode is the subject of this document; whilst investigative mode is referred to on several occasions throughout this document where the difference between the two modes may require clarification, this document does not set standards for the investigative mode. Further types of evidence may be given by experts and practitioners (see 9.1.46) including factual information and, for a restricted set of analytical methods, categorical opinions. Categorical opinions based on analytical results will be dealt with in a later annex to this document.
- 2.1.10 The CAI model was adopted by the Association of Forensic Science Providers (AFSP) [4]. Subsequently, the European Network of Forensic Science Institutes (ENFSI) published a guideline [5] for evaluative reporting that expanded on the previous work. The Australia New Zealand Police Advisory Authority has adopted a similar approach, with its National Institute of Forensic Science publishing an introductory guide to evaluative reporting [6].
- 2.1.11 There remains a philosophical debate between scientists who advocate an approach where probability ought to be quantified precisely and its uncertainties established (e.g. [7] [8]) and those who take the approach that probability is personal and incorporates uncertainty (e.g. [9] [10]). This standard takes no philosophical position. It is the Regulator's view that there ought to be an ongoing effort to produce more and better data sets to improve evaluation of evidence but that even where data are limited, it is by far preferable to use a logically correct approach, being transparent about any limitations arising from a paucity of data, rather than to persist with unstructured and often unscientific approaches.
- 2.1.12 This document aims to reduce variability in approaches, address the concerns of the courts, increase transparency and adopt a common terminology, which is applicable across the spectrum of forensic science disciplines. As an appendix to the Forensic Science Regulator's Codes of Practice and Conduct [11] it sets

standards for development of evaluative expert evidence against which compliance will be assessed. As such, it will enable greater consistency between different experts and different disciplines.

- 2.1.13 It will not be quick or easy to migrate to this single approach; for some disciplines, the route to implementation will be relatively straightforward but for others, it will be a longer process and hence implementation will be expected closer to the end of the prescribed period. The Regulator's specialist groups for DNA, fingerprints, and digital forensics will advise on implementation stages in those disciplines and, where necessary, working groups will be established for other disciplines.
- 2.1.14 To ensure common understanding, drafting conventions covering the precise meaning of terms as used in this document have been adopted and are included in the glossary at section 9. At the first use of each term, a cross-reference is provided to the relevant section of the glossary. As far as possible, the terms are in alignment with 'The use of statistics in legal proceedings: primer for the courts' [12].

3. Scope

3.1 Scope

- 3.1.1 This document sets standards and provides guidance on the development of expert evaluative opinion in the field of forensic science (see 9.1.41) for use in the CJS in England and Wales
- 3.1.2 The model can apply equally in other jurisdictions but the legal context in which the model is implemented may differ. This may lead to a need to modify some aspects of the standards/guidance.
- 3.1.3 This document covers the generation of evaluative opinion that is subsequently included in a report and, on the basis of the report, in oral testimony. It is recognised that adherence to these standards during oral testimony can be difficult but, as a minimum, the principles must be maintained.

Codes of Practice and Conduct

3.1.4 This document is based on there being an appropriate framework in place to guide the handling of a case from initial receipt of a request through to the provision of evidence in court. Stages of that framework include: ¹

- a. Reviewing the nature of the expert evidence being requested;
- b. Establishing the key issue(s) to be addressed;
- c. Determining what examinations and analyses are required;
- d. Commissioning those examinations and analyses;
- e. Interpreting the observations;
- f. Writing a report; and
- g. Appearing in court.

This document therefore covers that span of work.

3.1.5 This document discusses legal issues related to the provision of expert evidence when relevant to the issues being addressed but does not attempt to provide comprehensive guidance on this matter. That can be found elsewhere [13].

3.1.6 This document does not attempt to provide a comprehensive list of issues to be addressed in an expert's report but does deal with interpretation-related content. The content which is required because of legal provisions is discussed elsewhere [13] [14] [15].

3.1.7 For the avoidance of doubt the approach set out in this document applies to evaluative opinions produced within the forensic science areas (other than as excluded in section 3.2) set out below.

- a. Authorship analysis.
- b. Blood pattern analysis.
- c. Collision investigation.
- d. Interpretation of damage.
- e. Digital forensics, including:
 - i. Cell site analysis; and
 - ii. Multi-media evidence analysis

¹ The sequence as set out here is simplified as there may be a series of reports, notification of a variation of opinion (as required by the Criminal Procedure Rules), and multiple appearances in court.

- f. DNA and body fluid examination and analysis.
- g. Document examination and analysis.
- h. Drugs examination and analysis (other than excluded below).
- i. Explosives examination and analysis (other than excluded below).
- j. The investigation of explosives related crime.
- k. Fingerprint comparison.
- l. Fire investigation.
- m. Firearms discharge examination and analysis.
- n. Firearms examination.
- o. Gait analysis.
- p. Marks examination and analysis.
- q. Physical fit.
- r. Speech science.
- s. Toxicology.²
- t. Trace evidence examination and analysis.
- u. Vehicle examination.

3.1.8 This document does not attempt to address issues related to the production of investigative opinions (see 9.1.43) or reporting of factual or technical issues (see 9.1.44).

3.2 Exclusions

Evidence Types

3.2.1 This document sets standards, and provides guidance, applicable to evaluative opinion across all of the main forensic science disciplines. It does not apply to the comparison of analytical results to a legal limit, such as, but not limited to, the following.

- a. The analysis of blood/urine for alleged drink driving limit offences (s5 Road Traffic Act 1988).
- b. The analysis of blood for alleged drug driving limit offences (s5A Road Traffic Act 1988).

² Forensic toxicology includes any chemical analysis and interpretation from body tissue.

- c. The determination of whether or not an air weapon is especially dangerous, based on whether or not the kinetic energy of a discharged missile is greater than the specified limits (Firearms (Dangerous Air Weapons) Rules 1969).

3.2.2 This document does not apply to forensic pathology. ³

3.2.3 Reporting of analytical results such as opinion on the identification of drugs or their metabolites which do not involve evaluation of the observations in the context of the case will be dealt with by way of an annex to this document at a later date. Reporting of this type of opinion is therefore excluded from the scope of the current document. The areas excluded are as follows.

- a. The identification of substances and determination if they are controlled drugs.
- b. The identification of the metabolites of drugs.
- c. The identification of explosive substances (as defined by the 1875 Explosives Act).

3.2.4 'Match Reports' from intelligence databases, with no further contextual assessment, are excluded as these are not evaluative opinions. Examples include the automated reporting of matches between suspect samples and crime scene samples from the National DNA Database[®] (NDNAD) and the investigative reporting of corresponding features between a fingerprint and one from a respondent list generated by an Automated Fingerprint Identification System (AFIS). ⁴

Reporting Methods

3.2.5 The CJS in England and Wales utilises 'Streamlined Forensic Reports' (SFR) to provide a summary of an expert's conclusions in accordance with the provisions of the Criminal Procedure Rules (CrimPR). ⁵ The provisions of this document

³ This document does not apply to forensic pathology because the Codes of Practice and Conduct do not apply to that area.

⁴ Producing an investigative report of a putative fingerprint 'match' against an AFIS respondent list involves opinion but does not involve consideration of propositions in the context of a case. Any putative 'matches' that are disputed (for example via the SFR process) and all activity level reporting of fingerprints are subject to the provisions of this standard.

⁵ See Part 19 CrimPR.

with regard to the development of an evaluative opinion apply regardless of whether that opinion is reported using the SFR process or in a full report. Provisions related to the requirements of reports (i.e. the content required by Part 19.4 CrimPR [13] [14]) do not apply to SFR1 as they cannot be used as evidence other than as agreed fact. These requirements do apply to SFR2 as these may be used in evidence other than as agreed fact.

- 3.2.6 In the event that certificates are used as evidence, the content of the certificate will be determined by the relevant legislation.

4. Implementation

- 4.1.1 Issue 1 of this document is published on 16 February 2021.
- 4.1.2 A staged approach will be taken to requiring compliance, which will be published by a Regulatory Notice and/or in the Regulator's Codes of Practice and Conduct [11]. The aim, however, will be for all work within the scope of this document to be compliant by October 2026.

5. Modification

- 5.1.1 This is the first issue of this document.
- 5.1.2 The document has been drafted to ensure compliance with The Public Sector Bodies (Websites and Mobile Applications) (No. 2) Accessibility Regulations 2018.
- 5.1.3 The Regulator uses an identification system for all documents. In the normal sequence of documents this identifier is of the form 'FSR-#-####' where (a) the '#' indicates a letter to describe the type or document and (b) '####' indicates a numerical, or alphanumerical, code to identify the document. Combined with the issue number this ensures each document is uniquely identified.
- 5.1.4 In some cases, it may be necessary to publish a modified version of a document (e.g. a version in a different language). In such cases the modified version will have an additional letter at the end of the unique identifier. The identifier thus becoming FSR-#-####.
- 5.1.5 In all cases the normal document, bearing the identifier FSR-#-####, is to be taken as the definitive version of the document. In the event of any discrepancy

between the normal version and a modified version the text of the normal version shall prevail.

6. General Issues

6.1 Role of the Expert Witness

6.1.1 The role of the expert witness is to provide independent assistance to the court by providing expert evidence within their area of expertise. In this role an expert can, contrary to the general prohibition, provide evidence of opinion. Part 19 of the CrimPR contains rules relating to the use of expert evidence in criminal proceedings. Related guidance is contained in Part 19 of the Criminal Practice Directions (CrimPD). Further guidance on the application of these provisions is contained in guidance issued by the Regulator [13].

6.1.2 CrimPR 19.4(h) requires an expert report to “include such information as the court may need to decide whether the expert’s opinion is sufficiently reliable to be admissible as evidence”. CrimPR 19.3(3)(c) requires a party serving an expert’s report to

“serve with the report notice of anything of which the party serving it is aware which might reasonably be thought capable of — (i) undermining the reliability of the expert’s opinion, or (ii) detracting from the credibility or impartiality of the expert”.

Additional guidance is provided by CrimPD 19A.

6.1.3 In *Davie v. Edinburgh Magistrates* [1953] SC 34; 1953 S.L.T. 54 the court made clear that:

“... Expert witnesses, however skilled or eminent, can give no more than evidence. They cannot usurp the functions of the jury or Judge sitting as a jury ... Their duty is to furnish the Judge or jury with the necessary scientific criteria for testing the accuracy of their conclusions, so as to enable the Judge or jury to form their own independent judgment by the application of these criteria to the facts proved in evidence.”

6.1.4 Although a Scottish case, this has been quoted with approval in the Court of Appeal (Criminal Division) – see *R v. Gilfoyle* [2000] EWCA Crim 81.

6.1.5 In *R v. Smith* [2011] EWCA Crim 1296 the Court of Appeal stated:

“The presentation to the jury must be done in such a way that enables the jury to determine the disputed issues.”

It is clear that part of the role of the expert witness is to present the evidence in a way which transparently demonstrates its validity such that it can be deemed admissible to assist the court. The expert:

- a. Presents observations to the court;
- b. Provides information to assist the court in assessing the validity of those observations; and
- c. Provides evaluative opinion to help the court address disputed issues, with a clear account of the basis on which that opinion has been reached.

Requirements and Restrictions: Standards

6.1.6 Any approach to interpretation of observations to develop an evaluative opinion must recognise that there are certain requirements and restrictions on what an expert may do [13].

- a. An expert shall only provide opinion evidence within their area of expertise.
- b. An expert shall not provide evidence of opinion in areas where such opinion is not required by the court. Put simply the expert shall not give evidence when members of the jury are capable of dealing with the issue without assistance.
- c. An expert shall not comment on whether the accused is guilty or not guilty.

6.2 Effective Case Management

6.2.1 Effective case management ensures early identification of real issues in the case. Each party has a duty to actively assist the court in fulfilling its case management obligations (CrimPR 3.3), which includes communication to establish, at CrimPR 3.3 (2) (c),

(ii) what is agreed and what is likely to be disputed,

(iii) what information, or other material, is required by one party of another, and why.

6.2.2 These provisions assist the expert ⁶ in ensuring they have sufficient information to determine:

⁶ An expert will generally need to work with those instructing them to ensure they have the information required and that the strategy set is appropriate to the case.

- a. The questions they seek to answer to give the most effective assistance to the court; and
- b. The propositions in relation to which they evaluate their observations.

6.2.3 Where there is a disagreement between experts instructed by opposing parties regarding interpretation, it is recommended that a pre-trial meeting of experts should be sought, to clarify and narrow down areas of disagreement (in accordance with CrimPR 19.6). The transparent approach laid out in this document aims to assist with identifying areas of agreement and disagreement.

6.2.4 CrimPR 19.2(b) makes clear that an expert's duty to the court includes "actively assisting the court in fulfilling its duty of case management under rule 3.2, in particular by - (i) complying with directions made by the court, and (ii) at once informing the court of any significant failure (by the expert or another) to take any step required by such a direction."

7. Approach to Assessment and Interpretation

7.1 Scientific Quality

7.1.1 The general precepts applying to methods for the development of evaluative opinion are as follows.

- a. That they are founded on a sound scientific basis and validated (as set out in [11]) such that any limitations (for example in the extent or quality of data available [12]) are known and transparently reported.
- b. That they comply with the following principles in relation to evaluation in forensic science [16] [17] [18].
 - i. Evaluation of scientific observations is carried out within a framework of circumstances (see 9.1.24). The evaluation depends on the content of the framework.
 - ii. Evaluation is only meaningful when two competing, mutually exclusive propositions are considered. More than one pair of propositions may be considered in the same case, depending on the issues which need to be addressed.
 - iii. The role of the expert is to consider the probability of the observations given the propositions that are addressed, and not the

probability of the propositions (see 9.1.47) in light of the observations.

- c. That they are based upon the four precepts originally set out in the paper published by the AFSP [4]: balance, logic, robustness and transparency.

7.1.2 The standards set out in this document describe the mechanism by which this framework shall be applied in formulating evaluative opinions.

Balance

7.1.3 It is incumbent on the expert witness to offer impartial and even-handed advice to the CJS.

7.1.4 To achieve this balance the expert needs to develop their opinion based on consideration of both the positions of the prosecution and defence. Expressing a view as to the probability of the observations given one proposition without considering the probability of the observations given the other proposition is highly likely to be misleading and biased.⁷

This matter is dealt with in more detail in 8.2.8 - 8.2.10.

Logic

7.1.5 A trial is founded on the notion of reasoning in the face of uncertainty. Where scientific evidence is concerned, much has been done to establish a logical framework for that reasoning which is founded in the notion of probability. Courts are accustomed to hearing uncertainties expressed in various ways but the class of statements that are logically justified for the expert are different from those that the court will consider. Thus, the jury may consider questions of the kind “what is the probability that the prosecution proposition is true” whereas the expert considers questions of the kind “what is the probability that I would have obtained these observations if the prosecution proposition were true?”.

7.1.6 The logical error of confusing (‘transposing’) the conditioning statement (see 9.1.6), is commonly known as ‘the prosecutor’s fallacy’, but more correctly referred to as ‘illegitimately transposing the conditional’ [19]. This can be illustrated as follows (from [19]), in which the conditional statement is within

⁷ The use of at least two alternative propositions is required by ILAC G19 section 4.8.1 [25].

parenthesis. In assigning the denominator of the likelihood ratio (see 9.1.35), the expert should consider a question of the type: ‘what would be the probability of finding this trace evidence on the accused {if he had nothing to do with the incident}?’ Misinterpreting or misrepresenting the question as ‘what is the probability that the accused had nothing to do with the incident {if this trace evidence has been found on him}?’ would be an illegitimate transposition of the conditional.

Robustness

7.1.7 The expert:

- a. Communicates the scientific validity of the methods employed;
- b. Bases their opinion on sound knowledge and understanding of the types(s) of evidence and uses, wherever possible, data sets of appropriate quality and taking account of their relevance to the case (see the provisions with regard to databases in 8.4.5 - 8.4.8);
- c. Uses mathematical/statistical models which are valid and appropriate or, in the absence of such models, explains the limitations of their approach; and
- d. Ensures that the observations from the examinations and analyses, upon which they base their opinion, are themselves scientifically valid.

Transparency

7.1.8 The expert:

- a. Provides opinion that includes sufficient information, including limitations, to enable scrutiny by other experts and effective cross-examination;
- b. Communicates the reasoning and how they reached their conclusion in a manner that is comprehensible to legal professionals and juries; and
- c. Sets out in the report, or any other input into the CJS, the basis of their opinion as described in section 8.5.4.⁸

7.1.9 By achieving the required transparency, the expert will deliver some of the requirements of Part 19 CrimPR and Part 19 CrimPD.

⁸ Guidance on the content of reports has been provided [13] [14].

7.2 Evaluative Framework

Likelihood Ratio

7.2.1 The Likelihood Ratio (LR) is the ratio of the probabilities of obtaining the scientific observations, given the truth of each of the two stated propositions. This can be represented, in its simplest form, by the following equation.

$$LR = \frac{p(O|H_p, I)}{p(O|H_d, I)}$$

7.2.2 The numerator is the probability (p) of the scientific observations (O) if the prosecution proposition (H_p) were true and given the conditioning information (I) (see 9.1.6). The denominator is the probability (p) of the scientific observations if the defence proposition (H_d) is true and given the conditioning information.

7.2.3 A LR approximating to 1 arises when there is no discernible difference between the probability of the scientific observations given either proposition. This evidence provides no assistance to the court in addressing the given propositions: the court is in the same position as if no scientific examination had been carried out. A LR larger than 1 indicates evidence that supports proposition H_p, and all the more so the further the LR departs from 1. Conversely, a LR smaller than 1 indicates evidence that supports proposition H_d, all the more so the further the LR departs from 1. In practice, rather than reporting a LR smaller than 1, which can be difficult to understand, the numerator and denominator are often inverted, so that support for proposition H_d is expressed. A review of the role of likelihood ratios in the interpretation and evaluation of evidence is provided by Aitken et al [20].

7.2.4 When reporting the outcomes of DNA comparisons given source and sub-source levels, the LR is 'capped' at 1 billion (1,000 million). Reporting the LR at this level reduces the variability in results reported by different statistical models and, in doing so, avoids unnecessary disagreements about orders of magnitude greater than 1 billion (1,000 million) which, in reality, are likely to make little difference, when the facts in issue in the case are more often at activity level.

Knowledge, Judgement and Data

- 7.2.5 Determination of the LR requires the expert to assign probabilities informed by knowledge and judgement, any relevant available data and, where appropriate, observations from experience (see 9.1.38). Differences in the data available to different experts may affect the breadth of the opinion that might be expected from a range of experts, so transparency regarding the data used in assigning probabilities is a critical part of this standard.
- 7.2.6 The judgement of the expert is an essential component of the evaluation. Questions like “How relevant are the data?”; “How appropriate is the model in this particular case?”; “What limitations are presented by the size of the dataset?” are all highly relevant and all dependent on expert judgement. CrimPD V contains, at 19A, advice on some of the factors which the court will look at when determining the reliability of expert opinion evidence. In particular 19A.6 directs it to be astute to check for flaws which might detract from reliability, such as flawed data or reliance on an inference/conclusion not properly reached.
- 7.2.7 In an ideal situation, the scientist would have access to relevant, high quality data sets to inform their evaluation. However, the nature of forensic science, where every case has different circumstances, means that large and directly relevant data sets are very rarely available. A LR determined by the expert using experience alone can be no more wrong than the expert’s opinion on which it is based and that opinion is admissible evidence. However, it is less easily tested than a LR based on relevant data, quantitative measurements, and statistical models.
- 7.2.8 The LR, when applied in the manner set out in this document, allows structured, logically correct assessment of the value of the observations irrespective of the size of the data set. It requires the basis of an expert’s opinion to be transparently provided to the court. It facilitates understanding of the reasons for differences in opinion between experts, such as differences in the quality and relevance of data and/or experience or differences in assumptions.
- 7.2.9 Communication of the outcomes of evaluation needs to take account of the fact that lay jurors and other court participants may equate a numerical value of a

LR with a level of precision that was not intended by the scientist. For this reason, where the LR is based on a data set that is not adequately representative of the case circumstances or not of sufficient quality or size to enable a precise numerical assessment, it cannot be reported as a single figure; instead, results will be reported at an order of magnitude level, alongside a verbal equivalent (see 8.5.11 - 8.5.12).

7.2.10 In cases where the expert has relied solely on observations from expertise which are not available for scrutiny by another expert, quoting any numerical value is not justified and a qualitative evaluation is appropriate (see 8.5.13 - 8.5.15).

7.2.11 In some cases, the reported LR is determined by combination of multiple elements related to individual pieces of evidence; this may be the case, for example, when considering activity level issues or when combining observations on the pattern, size, and wear characteristics of a footwear mark. Conditional probabilities (see 9.1.6) can be assigned for each piece of evidence in the numerator and similarly in the denominator. The conditional probabilities in the numerator are multiplied together and those in the denominator multiplied together to result in a single LR. In these circumstances, it is necessary to consider whether the component LRs are sufficiently independent to allow this approach. If not, then the individual LRs should be provided with an explanation that the overall value of the observations cannot be obtained by simple multiplication. A general approach to consideration of multiple elements is that of Bayesian networks. A review of the role of Bayesian networks in evidence evaluation is provided by Taroni et al [21].

8. Standards and Guidance

8.1 Conditions Precedent

Standards

8.1.1 A forensic unit providing evaluative opinion evidence shall meet the following requirements.

- a. The policies and procedure for case assessment and interpretation shall be part of the quality management system.
- b. The policies and procedures for making reports of evaluative opinion shall be part of the quality management system.⁹
- c. The method for evaluation shall be validated according to the Codes of Practice and Conduct [11].
- d. The policies and procedures shall ensure there is clarity in any report as to the source(s) of data used in forming the evaluative opinion.^{10 11}
- e. The experts providing evaluative opinion shall be demonstrably competent to do so (see also 8.1.2 - 8.1.3).¹²
- f. Any statistical models and assumptions involved in the evaluation shall be clear to the CJS and shall be valid.^{13 14}
- g. Processes for the peer review of evaluation shall be part of the quality management system.¹⁵

8.1.2 Expertise cannot be simply measured in years, number of cases examined, educational achievements, post-nominals or seniority, nor is it equivalent to credibility or eloquence although all these elements may contribute. The broad range of case circumstances encountered in any discipline of forensic science means that a particular expert will have more relevant experience and expertise in some cases than in others.

- a. The competence of each expert in each discipline in which they claim expertise shall be assessed, both initially and thereafter at appropriate intervals. Continuing Professional Development (CPD) is an important element of ensuring ongoing competence, as is ensuring that experts remain up to date with their knowledge of the scientific literature relevant to their field. This enables them to comply with their obligations under CrimPR 19.4 (b) and (f).

⁹ This is a requirement of LAB 13 section 6.4 [26].

¹⁰ This is a requirement of LAB 13 section 6.21 [26].

¹¹ This is a requirement of Part 19 CrimPR [13].

¹² This is a requirement of LAB 13 sections 6.6, 6.13 and 6.14 [26]. It is also a requirement of ILAC G19 4.8.3 [25].

¹³ This is a requirement of LAB13 section 6.10 [26].

¹⁴ The validity of the model employed should be addressed as part of the validation of the method [11] [27].

¹⁵ This is a requirement of ILAC G19 section 4.8.2 [25].

- b. Experts should participate in regular calibration of their expertise [22] [23] through, for example, blind proficiency tests that are representative of the complexity encountered in casework.

8.1.3 It is recognised that blind trials are imperfect, in as much as they are difficult to set up in a realistic manner and the number of relevant trials that any one expert will have engaged in will, at first, be low. Nonetheless, they are important in providing a method by which the expert's expertise may be measured using ground truth data and calibrated against the expertise of others. In instances where an expert is unable to demonstrate any such calibration of their expertise, the commissioning party and the court shall be made aware that their opinion is uncalibrated.

8.2 **Assessment - Identification of Questions and Propositions**

Standards

8.2.1 The expert needs sufficient case-specific information to determine appropriate propositions, select appropriate analyses and to interpret the observations. Other than that information, the expert does not need, and should not see, any more case-specific information (such as information on previous convictions, reasons unrelated to the scientific analysis why investigators have identified a suspect and any other extraneous information not relevant to the scientist's task) [3].

8.2.2 The expert shall:

- a. Consider the questions being asked by the submitting party in the case and identify the issue(s) their analysis can address;
- b. Consider all available, relevant case-specific information and, where necessary, request additional information; and
- c. Discuss the issues to be addressed and potential propositions with the relevant instructing party (e.g. police, defence, prosecuting authority ¹⁶) and where possible the other party. ¹⁷

¹⁶ Normally the prosecuting authority will be the Crown Prosecution Service (CPS), The Crown Office and Procurator Fiscal Service (COPFS) or the Public Prosecution Service (PPS)

¹⁷ It is recognised that this may not be routinely possible in volume crime case work.

Codes of Practice and Conduct

8.2.3 On the basis of the case circumstances and any agreed key issue(s), the following shall be identified.

- a. The prosecution proposition(s).
- b. The defence proposition(s).

8.2.4 There may be more than two propositions, but the assessment will, in general, consider the propositions in pairs; each pair shall be mutually exclusive.

Addressing the Appropriate Level of Issue

8.2.5 An expert should assist the court by addressing propositions at the level which will provide the most effective assistance with resolving the issues facing the decision-makers in the CJS. This will often involve the expert addressing propositions at the activity level.

8.2.6 The expert shall consider, firstly, whether the relevant case circumstances allow them to specify the fact in issue (see 9.1.23) at activity level and, secondly, whether they then have the expertise and resources to provide opinion to help address that fact in issue. If not, the expert shall inform the submitting party that they are only able to consider propositions at source, or sub-source level (see 9.1.33) and are not able to comment on any activity. The limitations shall be explicit, such that the commissioning party could not reasonably make the assumption that any LR that may be provided would relate to an activity. For example, if DNA from the handle of a weapon is considered in a robbery case given sub-source level propositions, then any LR provided would not relate to the handling or use of that weapon during the robbery. This example illustrates that sub-source propositions do not provide the most effective assistance with resolving the issues facing the court in this case.

8.2.7 If possible, and in the interest of a balanced approach, the expert shall seek the other party's version of events from the investigator, prosecution team, or defence team (see section 6.2).

Cases where the suspect makes "No comment"

8.2.8 Where a defendant makes no positive case, there may well be no alternative proposition deriving from them. Normally the real issue should be identified by

the defence and that should assist the expert with formulating an alternative proposition. They may however decline to do so.

- 8.2.9 When no defence proposition has been offered, the expert should generally adopt, on behalf of the defendant, one or more alternative propositions, which should be relevant to the facts in issue. The propositions shall be clearly stated in the report. An alternative proposition may be a form of negation of the prosecution proposition, which may be qualified (e.g. the DNA is not from the suspect but from an unknown person) and may take into account the case circumstances, i.e. the defendant (who was arrested at his home) has had no involvement in the events. The limitation of this approach is that a simple negation of the prosecution proposition may tend to maximise the value of the LR. As a result, this limitation should be stated clearly within the expert's report, with an explicit offer to re-evaluate should an alternative proposition be provided.
- 8.2.10 The expert shall avoid an approach which could lead to unintentional bias. In the absence of a defence proposition, a report shall not state that the observations are what would be expected if the proposition were true, even if such a statement were qualified by an explanation that meaningful evaluation is not possible in the absence of a defence proposition. On occasion, it may be appropriate to decline to offer an opinion.
- 8.2.11 What is clear is the need for all relevant participants in the CJS to be engaged in deciding the most appropriate approach in any particular case or case type.
- 8.2.12 The expert shall set out clearly what propositions have been addressed so that the defence, or the court, can determine if the report addresses issues of relevance to the case.

8.3 Assessment - Nature of Examination

Standards

- 8.3.1 Following identification of the issues and specifying the propositions, the expert shall establish if the examination and/or analysis of items submitted can assist by carrying out an assessment following the CAI model [1] [2]. This involves the

following, although the process may be abbreviated for 'standard' submissions such as DNA swabs in volume crime cases.

- a. Identifying the potential examinations and/or analyses which might be undertaken.
- b. Considering where sampling for one type of trace may preclude, or impact on, sampling for another (e.g. sampling for latent fingerprints and/or DNA).
- c. Identifying what the potential outcomes of examinations/analyses might be. These potential outcomes may be grouped into broader categories where appropriate.
- d. Assigning probabilities to each potential outcome given the propositions set and relevant case-specific information; this assignment is not expected to be precise.
- e. Producing likelihood ratios for each potential outcome and using them to inform the examination strategy (see 9.1.14) to be carried out, bearing in mind that the observations from multiple tests may not be independent of each other.
- f. Considering, in light of the probabilities and LR's determined as above, whether any scientific examinations or analyses will progress the case or assist the CJS. Consideration should be given to situations where:
 - i. The assigned probabilities are of the same order of magnitude for each proposition; and
 - ii. The assigned probabilities are different but very low for both propositions.

8.3.2 Examinations and analyses commissioned should be those that most effectively help to progress the issues in the case - whether the outcome would support the prosecution or defence.

8.3.3 If, as a result of the probability assignments and likelihood ratio derivations, scientific examinations or analyses are unlikely to progress the consideration of either prosecution or defence, i.e. the LR approximates to 1, the instructing party shall be advised accordingly. Such advice (whether followed or not) shall be documented on the case record.

- 8.3.4 If the assigned probabilities are different but are very low for both propositions, the expert shall reconsider whether the issues in the case can be usefully addressed using the identified propositions and advise the instructing party accordingly. This advice shall be documented on the case record. For example, if a window were broken by someone throwing an object from some distance away, then there would be only a very low expectation of glass from that window transferring to their clothing. If a suspect claimed not to have been near the window at the relevant time, then there would again be only a low expectation of finding glass in their clothing of the same type as that broken in the window. Therefore, the assigned probabilities would be very low for both propositions and it would be unlikely that the issues in the case could be usefully addressed using the identified propositions.
- 8.3.5 If an instructing party dictates an examination strategy that, in the opinion of the expert, is unlikely to assist with addressing the issues in the case or does not enable the expert to take a balanced approach, then the party shall be advised, preferably in writing, accordingly and the advice and conversations shall be recorded on the case record. Any resulting limitations on the interpretation(s) shall be described in the report.^{18 19}
- 8.3.6 If access to relevant items, or funds for additional examinations as identified through the assessment, is denied, then the instructing party shall be advised as to the limits of any resulting interpretation. Reference to any limitations on the opinion shall be recorded in the case notes and also be made in the report.
- 8.3.7 Wherever possible, probabilities should be assigned numerically. Great care should be taken to ensure that the assignment does not imply a level of precision that cannot be justified. Unless there is a data set which is sufficiently relevant, high quality and of sufficient size on which to base the assignment, probabilities should be assigned at an order of magnitude level.
- 8.3.8 There will be examples, such as probabilistic evaluation software for DNA or fingerprint comparison, which may assign probabilities on the basis of

¹⁸ Part 19.4 of the Criminal Procedure Rules requires that reports set out any limitations on the opinions being expressed. There is a more general requirement to disclose any information which may undermine the views expressed [13].

¹⁹ There may also be a requirement to address the issue in the report [13].

probability density functions, resulting in many significant figures. In such circumstances the LR, when determined, should in general be reduced to one significant figure.

8.3.9 All probability assignments require judgement by the expert and whilst data can assist in informing those assignments, it is not a straightforward issue of selecting the 'correct' number from a dataset that is fully representative of every issue in the case. Datasets do not need to be fully representative to provide useful information, for example on the trends that can be expected. Judgement on the part of the expert is required in relation to, for example:

- a. What data to use;
- b. The relevance of the data to the case; and
- c. The quality, validity and availability of data.

8.3.10 Published data of appropriate quality should be used wherever possible as a basis for these assignments. If relevant published data are not available, or to supplement published data, data from unpublished sources may be used as long as the provenance and quality of the data have been reviewed and deemed suitable by the expert and the source of the data is documented on file. Unpublished datasets shall be made available for inspection by an expert instructed by the other party if probability assignments based thereon are a fact in issue in the case.

8.3.11 The validity of a structured data set (including any local data set) from previous casework, a 'knowledge base' (see 9.1.27), shall be calibrated regularly by conducting studies using ground truth data as described by Evett [22].

8.3.12 In cases where the specific material or evidence type within a class for which the expert is competent as an expert is not known to the expert then assignments of the probabilities should be based on technical knowledge and/or case specific experiments. This would cover situations where, for example, an expert in particulate trace evidence had little experience of an unusual form of building debris but did have extensive knowledge of transfer and persistence of similar particles. It is not a justification for claiming expertise in areas which are not actually within the scope of the expert's domain specific knowledge.

- 8.3.13 Where the expert does not have relevant and robust experimental data to inform probabilities, they may have sufficient personal experience and knowledge to enable them to compare the relative frequencies of their observations given that each of the propositions were true. The manner in which an expert should justify the use of observations from experience is by regular calibration of their expertise (see section 8.1.2 - 8.1.3). Based on these relative frequencies, the expert may believe that the probability of their observations is greater if one of the propositions, rather than the other, were true. They are unable to say precisely how much larger but believe the LR is sufficiently different from a value of 1 to have probative value. This is, essentially, 'qualitative' in nature. In such an instance, the expert shall record their recollected experience in a manner that enables another expert and the court to understand its basis.
- 8.3.14 For example, if their qualitative assessment of the probability of the observations is based on how many times they have observed a similar occurrence (e.g. a type of damage) in other relevant cases, they may wish to categorise that experience using a scale such as that given below:
- a. No or almost no equivalent instances from their remembered experience;
 - b. Few equivalent instances from their remembered experience;
 - c. About half of equivalent instances from their remembered experience;
 - d. Many equivalent instances from their remembered experience; or
 - e. All, or almost all instances from their remembered experience.
- 8.3.15 If the qualitative assessment of the probability of the observations is based on the number, clarity and distinctiveness of different features in a comparison case, then that assessment should be clearly set out.

8.4 Examinations, Analyses and Evaluation

Standards

- 8.4.1 All examinations and analyses shall be performed in accordance with the Codes of Practice and Conduct [11].
- 8.4.2 Propositions set, and any probabilities assigned shall not be changed at any stage unless:

Codes of Practice and Conduct

- a. The key issue in the case changes; and/or
- b. The conditioning information changes e.g. changes to alleged timings or to the specifics of an alleged activity, such as distance or force.

8.4.3 Such reassessments shall be documented, robust and justifiable and shall be peer reviewed.

8.4.4 The LR shall be determined.

- a. For cases where probabilities have been assigned on the basis of a data set of sufficient relevance, quality and size, the LR shall be determined to one significant figure.
- b. For cases where probabilities have been assigned on the basis of structured data set(s) which are limited in their relevance, quality and/or size but are available for inspection by another expert, the LR shall be determined at an order of magnitude level.
- c. For cases where probabilities have been assigned on the basis of unstructured observations from experience, which are not available for inspection by another expert, a qualitative LR shall be assigned (see 8.5.13 - 8.5.15).

Guidance

Data Collections

8.4.5 In some areas, the evaluation will employ data collections. Examples include:

- a. Collections of data concerning the frequency of occurrence of fibres, glass, footwear undersole patterns and DNA alleles; and
- b. Experimental data on transfer and persistence of traces.

8.4.6 The relevance of the data set, its quality and how representative the data are, can be affected by issues such as the population covered, the territorial extent of the data, whether the data are up to date and how closely the experimental conditions replicate the case circumstances. The size of the data set may also have an impact.

8.4.7 Data tend to be most relevant where they closely relate to the propositions of interest. For example, if the expert is assigning a probability to their

observations if there has been secondary transfer of DNA onto a plastic knife handle, data relating to transfer between individuals and similar non-porous substrates will be more relevant than data on transfer between individuals and worn clothing. Or if the expert is trying to assign a probability for obtaining a match of a footwear mark at the scene of a burglary with the shoes of a suspect, it may well be reasonable for an expert to state their assumption that the range of footwear worn by people who may be suspected of a crime differs from the range of footwear worn by a sample of the general public (on the basis that impressions from, for example, high heeled shoes and flip-flops which are alien to the premises are rarely encountered at crime scenes). A database consisting of sole patterns of shoes from people suspected of involvement in crime may therefore be a more relevant footwear database to consult in this case than a database consisting of sole patterns from the general population. It is important that the assumptions of the expert and the reasons for those assumptions always be explicitly stated. Other information may assist the expert in determining the appropriate database to consult. For example, if the offender in a violent assault was described by witnesses as being of Caucasian origin, then the most relevant allele frequency database to consult may be a database of Caucasian allele counts. Again, it is important that the expert is transparent about their assumptions and the reasons for choosing specific data sets.

8.4.8 Forensic science case records contain a wealth of data, some of which would be useful in evaluation if it were maintained in a searchable 'knowledge base' and regularly calibrated [22].

8.4.9 Calibration involves regular review of sections of the content by conducting experimentation using ground truth data under controlled conditions and comparing to relevant sections of the knowledge base. Such ground truth experimentation enables the knowledge base to be updated and expert opinions to be checked against a snapshot of known-source data.

8.5 Reports

General

8.5.1 This section does not apply to SFR1 or certificates.

Standards

- 8.5.2 The legal provisions with regard to evidence of fact and evidence of opinion are different. The forensic unit shall ensure all staff who provide reports to instructing parties understand the difference between evidence of (a) fact and (b) opinion. The forensic unit shall also ensure all staff are aware of the legal requirements and obligations which apply to the type(s) of evidence they provide.
- 8.5.3 It is not the aim of this document to state all information which must be included in a report but to note those issues related to interpretation which need to be addressed. Where it would aid clarity in the body of the report, some of the required information may be separated into appendices. Separate guidance sets out what must be included in reports [13] [14] [15].
- 8.5.4 Reports shall include the following.
- a. A declaration of the expertise being claimed by the expert.²⁰
 - b. The training, qualification and experience which gives the expert the ability to assist the court.
 - c. Information to allow the court to establish whether the claim to expertise is justified.²¹
 - d. The question(s) being asked of, and answered by, the expert.
 - e. The relevant circumstances of the case i.e. those aspects of the circumstances that identify the issue, specify the propositions, and condition probabilities for potential observations (all known as ‘task-relevant’ information).²²
 - f. Relevant items received.
 - g. The propositions considered. The level at which propositions are considered shall be clear in the report.²³
 - h. The examination strategy, including the following.

²⁰ This is a requirement of Part 19 CrimPR [13].

²¹ The information provided must provide a balanced picture of the expert's experience [13].

²² This, in part, reflects the requirements of CrimPR 19.4(c) [13].

²³ There is danger in an expert considering propositions at one level in their report and at different levels in oral testimony. Doing so relies on an “on the spot” evaluation, without the opportunity to reflect, consider, consult data and ensure that the outcomes are peer reviewed. For these reasons, it is strongly discouraged and if undertaken, the limitations must be made clear to the court.

- i. The items examined.
 - ii. The examinations and analyses performed.
 - iii. A record of any advice given if certain examinations and/or analyses would not progress the case or assist the CJS (see sections 8.3.3 - 8.3.5).
- i. The observations obtained from each examination/analysis undertaken in the sense of the overall conclusion as opposed to each observation.
 - j. A record of any observations, or any other information known to the expert, which would tend to undermine the conclusions being drawn from these data.
 - k. The model for assessment and evaluation employed.
 - l. Background scientific or expert information used in the assessment and evaluation. This shall include, but not be limited to, the following.
 - i. Any work (e.g. text books, scientific papers) specifically relied on in the development of the opinion.
 - ii. Any representations of fact or opinion relied on by the expert in forming the opinion.
 - iii. The expert's experience in the evidence type under consideration.
 - m. Where relevant, the probabilities assigned to the observations given the truth of each proposition.
 - n. The evaluation of the observations. The report shall make clear both the strengths and limitations of the evaluation, including the following.
 - i. The level of complexity of the case (evidence type, observations, case circumstances).
 - ii. The quality and provenance of the data, knowledge and experience used in the assessment.
 - iii. Any assumptions made.
 - iv. Any omission of evidence or any information that may influence the conclusions.
 - v. Areas where experts may differ in their evaluation (see 8.5.7-8.5.8).
 - o. Conclusion(s).

- i. The conclusions shall be expressed in a manner which assists the court. This requires that the conclusion be placed into context within the case, bearing in mind that in most cases, a statement is read to the court without the scientist being present.
- ii. Limitations on the conclusions shall be made clear (e.g. if source level propositions have been evaluated, it must be explicitly clear that the conclusion does not address any activity level issues that may be relevant in the case).
- iii. Where applicable, any limitations should be discussed in relation to the range of opinions in the profession. In this regard the profession must be considered to be the persons regarded as competent experts in the relevant field. 'Outliers' need not be accommodated.
- p. If further work is likely to have a significant impact on the opinion, then this should be made clear in the report.
- q. A glossary of technical terms used in the report.

8.5.5 The evaluation and conclusion(s) in the report shall relate to the issue(s) and pair(s) of propositions as identified during case assessment and as described in the 'Purpose' section of the report.

8.5.6 There shall be, in the report, a sentence saying that if the information (particularly that on which propositions are based) changes, then the interpretation will need to be reconsidered. A potential sentence is:

"My approach to the examination strategy and interpretation of the observations in this case is crucially dependent on the information made available to me. If any of this information is incorrect or if further information is made known to me, it will be necessary for me to reconsider my interpretation."

8.5.7 In accordance with the requirement to set out the range of opinion in the profession, arising from the provisions of CrimPR 19.3 and CrimPR 19.4(f), the expert shall assess the likely breadth of opinion anticipated, based on the general level of acceptance (and any published criticism) of the approach taken, the availability of data and expertise, and any key assumptions.

8.5.8 In a report which is to be used as evidence, that is a report other than an SFR1, the expert shall set out clearly their assessment of the likely breadth of opinion. A suitable format for this assessment is given below:

Source of potential variation in opinion	Reference	Assessment
Published data relied on in assigning probabilities	Any papers relied upon in the case should be referenced. It is not possible to list all papers an expert's knowledge is based on, but any that are specifically relevant to the case should be listed.	Size, relevance and quality of data set should be described.
Level of acceptance and/or criticism	Any key peer reviewed papers supporting or criticising the approach taken.	Is there general acceptance of the scientific basis of the approach taken?
Unpublished structured data relied on in assigning probabilities	Provenance of the data should be described. Is it available to other experts in the case?	Size, relevance and quality of data set should be described.
Casework experience relied upon in assigning probabilities	Describe relevant experience.	Brief appraisal of the size and relevance of the personal data and its limitations (e.g. ground truth is unknown). Is it presented in a searchable and calibrated 'knowledge base'

Source of potential variation in opinion	Reference	Assessment
		(see 9.1.27) or is there no calibration of the data?
Expertise	Reference participation in activities such as blind proficiency testing to calibrate expert performance.	Brief appraisal of relevance and limitations of the calibration activities and the expert's performance.
Assumptions	<p>Refer to any published paper(s) describing the assumptions underlying any model used (e.g. DNA degradation model), published or unpublished validation studies.</p> <p>There may be case specific assumptions, for example, that the source of the DNA is not contested.</p>	Brief assessment of the impact of these assumptions on the LR and whether they are widely accepted or controversial in the field.
Overall assessment	Overall assessment of the likely breadth of expert opinion on the matter should be assessed (narrow/medium/broad). If there is little relevant, published data and the assumptions are controversial, the overall assessment would be that there is likely to be a broad range of expert opinion. If there is sufficient relevant, published data to enable a statistically robust evaluation and there is little or no controversy regarding the	

Source of potential variation in opinion	Reference	Assessment
	assumptions, then a narrow range of opinion would be expected.	

8.5.9 When there is significant disagreement between experts, a pre-trial meeting should be sought to clarify and narrow areas of disagreement (see section 6.2.3 and Part 19 of the CrimPR [13]).

Conclusions for LRs Determined With Adequate Data

8.5.10 Where the LR has been determined quantitatively using data sets of adequate size and relevance, the value of the observations shall be expressed numerically, in the manner illustrated below. “In my opinion, the observations are no more probable under one proposition than the other. Therefore, the observations do not assist in this matter.”

Or

“In my opinion, the observations are approximately [numerical value of LR, to one significant figure ²⁴] times more probable if [proposition] rather than [proposition] were true.”

Conclusions for LRs Determined with Limited Data

8.5.11 Because of the potential for lay jurors and other court participants to equate a numerical value with a level of precision that the expert has not intended, conclusions based on LRs determined by a combination of expert judgement and some limited but structured data set(s) should be presented at an order of magnitude level, alongside a verbal expression, in a way that enables the court to see where on a scale the conclusion in the particular case lies.

²⁴ For DNA source or sub-source LRs reported at the 1 billion LR, the wording should be

“The observations are approximately 1 billion (1,000 million) times more probable if [proposition] were true rather than if [proposition] were true.

8.5.12 There is always a danger that words are not understood in the manner they were intended. It is therefore important to give as much context as possible with the conclusion, including by presenting the full scale and the placing of the conclusion within that scale. The verbal scale is given below.

LR Order of Magnitude	Verbal Scale
c. 1 - 3	In my opinion the observations are no more probable if [proposition A] rather than [proposition B] were true. Therefore, the observations do not assist in addressing which of the two propositions is true.
c. 4 - 10	In my opinion the observations are slightly more probable if [proposition A] rather than [proposition B] were true.
c. 10 – 100 (tens)	In my opinion the observations are more probable if [proposition A] rather than [proposition B] were true.
c. 100 – 1000 (hundreds)	In my opinion the observations are much more probable if [proposition A] rather than [proposition B] were true.

Notes:

1. Where the LR is close to one of the boundaries, e.g. around 1 - 3 or around 900 – 1100, the expert will need to use their judgement in assigning a verbal conclusion.
2. The expert would be anticipated to consider their observations and evaluation in the ‘Interpretation’ section of their report, using wording such as “Overall, it is my view that my observations are between ten and one hundred times more probable if A were true rather than B”. In the ‘Conclusion’ section of their report, the verbal equivalent would be used: “In my opinion, my observations are more probable if ...”.

3. It seems unlikely that, in the absence of a relevant, high quality data set, a LR of >1000 would be obtained for a single observation.
4. Multiple observations in combination, such as the sole pattern, size, and wear represented in a footwear mark may give rise to higher LR values, as may multiple fingerprint features. Where multiple independent observations combine such that in the expert's opinion, the probability of the observations under proposition A is high (1 or close to 1) and the probability of the observations under proposition B is extremely small, wording such as "In my opinion it would be extremely unlikely to observe the combination of x,y and z if proposition B were true" may be used.
5. It is likely that in some instances, a combination of features would give rise to LRs in the order of 1000 or less. In such instances, the appropriate order of magnitude and verbal equivalent would be reported.

Conclusions for Qualitative Assessment without Data

- 8.5.13 Where no (published or unpublished) structured data are available, a qualitative evaluation shall be reported, based on the expert's qualitative evaluation of the probability of the observations under each proposition as laid out in 8.3.13 - 8.3.15.
- 8.5.14 The verbal scale in section 8.5.12 may be used to express the expert's conclusion. The expert shall be explicit that their conclusion is based solely on experience and as such is likely to differ from that of other experts. Where the expert's knowledge has not been meaningfully calibrated, this limitation shall also be explicit in the report.
- 8.5.15 The full verbal description scale used and the expert's recollected experience of the occurrence of the observations under each proposition shall be provided in the report for reference.

Disclosure

- 8.5.16 The requirement to set out observations, or any other information, which would undermine the conclusions is a legal obligation placed on an expert witness and discussed in detail elsewhere [13].

8.6 Presentation of Evidence in Court

- 8.6.1 It is not the aim of this document to provide comprehensive standards or guidance in relation to all aspects of presentation of evidence in court but to address those relating to interpretation.

Standards

- 8.6.2 The expert should not, subject to the points below, give evidence on matters that were not addressed in their report(s). There may be cases where matters are raised in cross examination, which are developed as a result of issues that have occurred during the trial, and which may need to be considered by the expert. Where there has been good case management, these should not be common.
- 8.6.3 The expert shall ensure that limitations affecting their interpretation are made clear within their oral evidence.
- 8.6.4 If the questions addressed in their interpretation were at source (or sub-source) level, the expert shall ensure that the limitations of that interpretation are known to the court and that the LR provided cannot be assumed to relate to any activity.
- 8.6.5 If the expert has addressed source or sub-source level questions but is asked about activity level questions in court, they shall state that the evaluation they have carried out has not addressed questions of activity and that a different evaluation is required.
- 8.6.6 If the expert is pressed to consider activity level questions that were not addressed in their report, they shall first consider whether or not they have the skills, knowledge and information to do so. If they do not, they shall make the court aware that to proceed would be beyond the scope of their expertise. If they do, then they should ask for time to consider their interpretation. The court

shall be made aware of the limitations, including lack of peer review of this opinion and the fact that the expert is unable to consult sources of data such as publications. It is always preferable for activity level questions to have been addressed in the report if it is thought likely that these are the questions of relevance to the court. If necessary, the expert shall request sufficient time to return to their place of work to consider the issues, consult data and seek peer review.

8.6.7 The expert shall ensure that they do not illegitimately transpose the conditional and that they make reasonable efforts to correct such a transposition if it is made by any court participant.

8.6.8 The expert shall be as well prepared as possible to present their evidence clearly, using visual aids, for example diagrams or charts, where this is likely to assist with clarity. Visual aids shall not be used in such a way that they could result in unintended biases or could disguise the limitations of the evidence.

8.6.9 If there is a limitation to their evidence, which has not been stated in evidence in chief or brought out through cross-examination, then the expert shall address the judge and request permission to add a caveat to their evidence.

9. Glossary

Activity Level Issue

9.1.1 See Level of Issue.

Analysis

9.1.2 See Examination and Analysis

Assessment and Interpretation

9.1.3 In this document the convention has been adopted that assessment and interpretation are separate activities, defined as follows.

Assessment

9.1.4 The application of expert judgement to devise an examination strategy, based upon a framework of circumstances in the form of written submission details,

photographs, 'preview' examinations of items, discussions with submitting officers etc, that addresses in an effective way the identified key issues in the case. At this stage, potential outcomes are documented and probabilities are assigned, given the truth of each of the competing propositions

Interpretation

9.1.5 The consideration of the observations from the work implementing the examination strategy. Interpretation may be investigative, evaluative or in certain circumstances, categorical. Only evaluative interpretation, which is also referred to as evaluation, is covered by this document.

Conditioning Information and Conditional Probabilities

9.1.6 Probabilities are assigned on the basis of certain conditions (that is, they are conditional probabilities) although this is not always explicitly stated. These can be represented as $p(O|I)$ which means the probability of the observations 'O' given (represented by the vertical line '|') the conditioning information 'I', For example, the probability of throwing a 6 with a die is often given on the conditioning information (conditioning statement) that it is a 'fair die' – $p(6| \text{fair die})$. Or, within the forensic context, "what is the probability of observing this DNA genotype if it had come from an unknown Caucasian individual?".

9.1.7 In forensic science, interpretation of observations normally involves the assignment of the probability of the observations given:

- a. The proposition:
- b. Relevant aspects of the case circumstances; and
- c. Whatever data and knowledge the expert has used to inform the probability of obtaining their observations [22].

Conditional Probabilities

9.1.8 See Conditioning Information and Conditional Probabilities

Data

9.1.9 Data may include published or unpublished structured sets of observations from analytical experimentation on samples of known source. It may also include

one-off experiments.²⁵ See also Observations from Experience and Knowledge Base.

Evaluative Opinion

9.1.10 See Opinion Types.

Evidence

9.1.11 In this document the convention has been adopted that the 'evidence' will be used to describe the reporting of the facts and opinions related to observations to the CJS.

Examination and Analysis

9.1.12 In this document the convention has been adopted that the term 'examination' refers to the investigation of an item with the intention of locating, identifying and recovering material of interest. The term 'analysis' refers to any form of test, comparison or analytical method performed on an item or relevant material recovered from an item.

9.1.13 The information produced by examination and analysis shall be collectively referred to as 'observations'.

Examination Strategy

9.1.14 A documented plan of examinations and analyses that are designed to meet the needs identified through Case Assessment.

9.1.15 Although the terms examination and analysis have been defined to mean different things in this document the term 'examination strategy' has been used for some time to cover all work planned in the case and will be used in that sense in this document.

Explanation

9.1.16 A hypothesis (theory) that can account for scientific observations. It is formulated after the scientific observations have been obtained and may be useful in generating investigative opinions.

²⁵ The provenance, nature and quality of these types of data differ, resulting in a need for transparency.

- 9.1.17 For any set of observations there may be many different explanations which need not be mutually exclusive.

Expert

- 9.1.18 In this document, the term 'expert' refers to the person producing the evaluative opinion evidence and acting as an expert witness. The term is not used to define any criteria for claiming expert status.

Fact and Opinion

- 9.1.19 There are a number of sections of this document that discuss facts and opinions. Further, there are sections that discuss the different provisions which apply to each. It is therefore necessary to have a clear understanding of the difference between fact and opinion.
- 9.1.20 It is not the intention of this document to engage in a philosophical debate about the difference between fact and opinion but to consider, in the context of forensic science employed within the CJS in England and Wales, how these terms should be used.
- 9.1.21 Fact could be defined as 'a truth known by actual experience or observation; something known to be true'.
- 9.1.22 Opinion could be defined as 'an inference drawn from perceived facts' (based on views from a legal standpoint [24]).

The provision of definitions is a relatively simple step. The manner in which those definitions work in practice is more complex and requires consideration. This further consideration is provided in Annex B.

Fact in Issue

- 9.1.23 The facts in issue are those facts that the prosecution is required to prove or disprove in order to establish the guilt of the accused and those facts the defence asserts or seeks to put in play.

Framework of Circumstances

- 9.1.24 A summary of all of the case-specific information known to the expert about the alleged offence and suspect(s) that is relevant to the assessment and

interpretation of the observations. This framework must always be regarded as provisional because it depends on the evidence of others (police, crime scene managers or crime scene investigators, pathologists, eye witnesses, victim, suspect etc).

Interpretation

9.1.25 See Assessment and Interpretation.

Investigative Opinion

9.1.26 See Opinion Types.

Knowledge Base

9.1.27 A structured database of information and assigned probabilities, ordered according to casework conditions. The knowledge base is calibrated through regular review of its content through experimentation under controlled conditions [22].

Level of Issue

Offence Level

9.1.28 An offence level issue is one which relates to the commission of a criminal offence (e.g. the accused raped the complainant).

Activity Level

9.1.29 An activity level issue is one which concerns conduct (chiefly an act and/or omission, which is a fact in issue [2]).

9.1.30 In a case involving an alleged sexual offence the activity level issues might be whether or not the suspect had sexual intercourse with the complainant.

Source Level

9.1.31 A source level issue is one that asks whether an item (e.g. a footwear mark or blood) of unknown origin originates from a particular specified source (e.g. a suspect's shoe or a named person). There is no consideration of what activity led to the existence of the item.

Codes of Practice and Conduct

9.1.32 Continuing the example of an alleged sexual offence case a source level issue may be whether or not semen found on the complainant originated from the suspect.

Sub-Source Level

9.1.33 A sub-source level issue is considered in situations where the analytical observation cannot be attributed to a particular material, for example when a DNA profile cannot be attributed to a particular type of cellular material or body fluid. In these situations, the expert will instead address an issue of, for example, whether the DNA profile (not the blood, semen, saliva etc) originated from the named person.

9.1.34 Continuing the example of an alleged sexual offence case a sub-source level question may be whether or not DNA (from an unspecified source) found on the complainant originated from the suspect.

Likelihood Ratio (LR)

9.1.35 The ratio of two probabilities; the probability that the observations would have been obtained if the prosecution proposition were true divided by the probability that the observations would have been obtained if the defence proposition were true.

Match

9.1.36 Saying that two items match means that they correspond completely, given the conditions under which they were observed and/or the analytical methods used. It does not necessarily mean that they will completely correspond under other conditions, or by other analytical methods, or that they are from the same source.

Observations

9.1.37 The results of the examination and analyses carried out according to the documented examination strategy. The observations in a glass case may include, for example, the number of glass fragments, their refractive index and their elemental composition.

Observations from Experience

- 9.1.38 Observations from previous cases, which are unstructured and cannot be produced for scrutiny by another expert.

Opinion

- 9.1.39 See Facts and Opinion

Opinion Types (For Examples see Annex A)

Categorical Opinion

- 9.1.40 An assertion that, in the view of the expert, a particular proposition is definitely true (or definitely false).

Evaluative Opinion

- 9.1.41 An opinion on the value of the observations, based upon a pair of case specific propositions and clear conditioning information (framework of circumstances) that is provided for use as evidence in court (other than as agreed facts).
- 9.1.42 In this document the term refers only to opinions based on propositions at the activity, source and sub-source level as defined.

Investigative Opinion

- 9.1.43 An opinion that arises in casework and in which explanations are generated to account for observations. The provision of an explanation for an observation is termed an investigative opinion. Some experts may provide probabilities for explanations.

Technical (Factual) Reporting

- 9.1.44 This is the reporting of observations based solely on the technical competence of the individual. No inferences/explanations (opinion) are drawn from the observations. An example would be where a digital forensics practitioner has used a specified software tool to extract data from a mobile phone. A factual report explains what the practitioner has done and the observations obtained, such as a list of the files of a certain type that were retrieved. It offers no opinion

on how the files came to be on the device or whether any of their content is relevant to a fact in issue in the case.

Offence Level Issue

9.1.45 See Level of Issue.

Practitioner

9.1.46 A scientist or technician involved in generation of observations and/or factual reports, but who is not qualified to give expert evidence.

Probability of a Proposition

9.1.47 At the evaluative stage, it is logically incorrect to express an opinion in the form of a probability that a particular proposition is true (i.e. to provide a posterior probability). The expert should consider the probability of the observations given each of the propositions.

Proposition

9.1.48 A statement that is either true or false and is generated, in part, from the background information but may also depend upon the observations that have been made at the alleged crime scene (or other information obtained before the consideration by the expert).

9.1.49 In the context of a criminal trial there will most often be a pair of propositions - one representing the prosecution's position, the other representing the defence's position in relation to a particular issue.

9.1.50 Propositions shall be mutually exclusive (i.e. if one is true then the other must be false) and will often, but not always, be exhaustive (i.e. they cover all possibilities within the framework of circumstances of the case).

Report

9.1.51 Any written document setting out the expert's conclusions. A statement admissible under s9 Criminal Justice Act 1967 is one form of report.

Source Level Issue

9.1.52 See Level of Issue.

Sub-Source Level Issue

9.1.53 See Level of Issue.

Technical (Factual) Reporting

9.1.54 See Opinion Types.

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- o. Members of the Forensic Science Regulator's Quality Standards Specialist Group.
- p. Members of the Forensic Science Advisory Council.

11. Review

- 11.1.1 This document is subject to review at regular intervals.
- 11.1.2 If you have any comments please send them to the address or e-mail set out on the Internet at URL: www.gov.uk/government/organisations/forensic-science-regulator.

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13. Abbreviations and Acronyms

Abbreviation	Meaning
AFIS	Automated Fingerprint Identification System
AFSP	Association of Forensic Science Providers
CAI	Case Assessment and Interpretation
CJS	Criminal Justice System
COPFS	Crown Office and Procurator Fiscal Service
CPD	Continuing Professional Development
CrimPD	Criminal Practice Directions
CrimPR	Criminal Procedure Rules
CPS	Crown Prosecution Service

Codes of Practice and Conduct

DNA	Deoxyribonucleic Acid
ENFSI	European Network of Forensic Science Institutes
EWCA Crim	England and Wales Court of Appeal Criminal Division
Exif	Exchangeable Image File
ILAC	International Laboratory Accreditation Cooperation
LR	Likelihood Ratio
NDNAD	National DNA Database
PPS	Public Prosecution Service
SFR	Streamlined Forensic Report
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
URL	Uniform Resource Locator

14. Annex A - Examples

14.1.1 Examples of technical/factual, investigative and evaluative interpretation.

Technical/factual Interpretation

14.1.2 The database reports a match to the profile recorded for Mr X.

14.1.3 The gun is subject to control by firearms legislation.

14.1.4 A partial fingerprint searched against the national fingerprint database returned a list of possible candidates including Mr X.

Investigative Interpretation

14.1.5 The fire was probably started deliberately.

14.1.6 In my opinion the pattern and distribution of the blood spots suggest that the assault began in the living room and continued into the kitchen.

14.1.7 The tyre probably deflated as a result of the impact.

Evaluative Interpretation

14.1.8 My observations are 100 times more likely if the amphetamine came from the suspect's stock than if they had come from some other stock.

14.1.9 My glass observations are more probable if the suspect broke the window rather than if he thrust his head through the broken pane afterwards.

14.1.10 My observations are as likely if Ms. X's or Mr. V's versions of events were true.

14.1.11 In my opinion it would be extremely unlikely to observe the concordance between the many features within the partial fingerprint from the knife and the fingerprint from Mr A if the mark had come from someone other than Mr A.

14.1.12 The pattern and distribution of the blood spots are in the order of ten to one hundred times more probable if Mr. X had assaulted Mr. Y than if he had been standing close to the assault when someone else assaulted Mr. Y.

15. Annex B – Fact/Opinion Further Consideration

15.1.1 Whether a statement is one of fact or opinion depends on a number of issues. In many cases these factors are clear and the determination is simple. However, that is not always the case.

15.2 Fact, Inference and Opinion

15.2.1 To be a statement of fact the text must contain no inference.

15.2.2 'I searched the hard disk with tool X and the tool found no files containing text Y' is a statement of fact as there is no inference.

15.2.3 'I searched the hard disk with tool X and determined that it contains no files containing text Y' is opinion. The assertion that no files are present requires the expert to consider issues related to the effectiveness of the tool employed to determine a conclusion.

15.2.4 Similarly, a statement which includes a comparison, e.g. against a legal limit, is likely to be opinion as it includes an evaluation of issues such as uncertainty of measurement.

15.3 Obscured Inference

15.3.1 As the example above illustrates, it is, in some cases, possible to reduce a statement of opinion to one of fact.

15.3.2 In some cases, such as that above, this is acceptable as the statement of fact properly reflects the work done and the conclusions which can be properly drawn from that work.

15.3.3 In other cases, this approach is more questionable.

15.3.4 For example, in relation to a mobile phone examination, it would be possible to make a statement along the lines "I have performed data extraction using the tools set out in table A and obtained the observations in table B. There were no communications between Mr A and Mr B.

15.3.5 At first consideration this text appears to be a series of statements of fact. However, the following points need to be considered.

- a. The reduction of the manner in which an inference is drawn to a set of rules does not change the fact an inference is drawn.
- b. The assertion being made in the text is that there were no communications between Mr A and Mr B. The person making the assertion knows only that their extraction and analysis procedures did not find any communications between Mr A and Mr B, so the assertion that there were none does not come within the definition of fact.

15.4 Flawed Logic

15.4.1 There are cases where logic of the following form has been used.

- a. I am an expert in the relevant field.
- b. I have declared that these two items 'match'.
- c. These items therefore 'match'.
- d. A statement that they match is therefore a statement of fact.

15.4.2 This logic is flawed but the flaws do not need to be considered to establish this is a statement of opinion. The person making the statement does not know whether the items have the same source so this must be an opinion.

15.4.3 A specific example of flawed logic concerned treating as fact the geolocation data obtained from an evidential mobile device.

- a. I am an expert in forensic analysis of mobile devices.
- b. Using a validated tool, I have extracted geolocation data from the evidential mobile device.
- c. The geolocation information was generated on the mobile device.
- d. A statement that the device was at that location at the given time is therefore a statement of fact.

Note: Some forensic practitioners make the further leap when the evidential mobile device is assumed to belong to the defendant: A statement that the defendant was at that location at the given time is therefore presented as a statement of fact.

15.4.4 False logic of a digital photograph being taken using an evidential mobile device.

- a. I am an expert in forensic analysis of mobile devices.
- b. Using a validated tool, I have extracted a digital photograph and associated metadata from the evidential mobile device.
- c. The metadata is compatible with the mobile device.
- d. A statement that the photo was taken using the mobile device is therefore a statement of fact.

Note: The method can influence the interpretation. For instance, exchangeable image file format (Exif) metadata is less distinguishing, photo response non-uniformity is more distinguishing, and the photo contents containing a 'selfie' is even more distinguishing.

15.5 Facts are Personal

- 15.5.1 The above discussion makes clear that whether a statement is a fact depends on who is making the statement.
- 15.5.2 In the field of drugs examination, someone (perhaps the manufacturer) can presumably make a statement of fact as to the nature of the drug.
- 15.5.3 The expert who has analysed the material does not actually know the nature of the material. All they can do is draw an inference from the analytical observations obtained. While, depending on the nature of the analyses performed, the risk of the identification being incorrect is remarkably low, that does not change the fact the identification is an opinion.
- 15.5.4 This approach has the advantage that it respects the rules of evidence (e.g. hearsay) on what people can give evidence about.

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