

Neutral Citation Number: [2009] EWCA Crim 2698

Case Nos: 2007/04708/B3
2007/04710/B3
2007/04800/D4

IN THE HIGH COURT OF JUSTICE
COURT OF APPEAL (CRIMINAL DIVISION)
ON APPEAL FROM THE CROWN COURTS AT TEESSIDE AND STAFFORD
THE HON MR JUSTICE KEITH
MR RECORDER PATRICK THOMAS QC

Royal Courts of Justice
Strand, London, WC2A 2LL

Date: 21/12/2009

Before :

LORD JUSTICE THOMAS
MR JUSTICE KITCHIN
and
MR JUSTICE HOLROYDE

Between :

Regina
- and -
David Reed and Terence Reed

Respondent

Appellants

Regina
and
Neil Garmson

Respondent

Appellant

James M Hill QC & Tom Mitchell for the Appellant (David Reed)
Eric A Elliott QC & John Gillette for the Appellant (Terence Reed)
Nicholas C Campbell QC & Tina Dempster for the Respondent

M Burrows QC & A Baker for the Appellant (Garmson)
S Linehan QC & D J Desmond for the Respondent

Hearing dates: 20, 21, 22 and 23 October 2009

Judgment

Lord Justice Thomas:

1. This is the judgment of the court to which each of us has contributed.

I:THE ISSUES IN THE APPEAL

(1)Low Template DNA

2. The appellants in both appeals were convicted in August 2007 on the basis of an analysis of DNA profiles as well as other evidence.
3. DNA evidence has played a significant part in criminal trials since its application to forensic science was appreciated; it has been employed as a routine technique in the United Kingdom since 1987. The process as first used was described by Lord Taylor CJ in *R v Deen* (21 December 1993). In *R v Doheny* [1997] 1 Cr App Rep 369, Phillips LJ (as he then was) gave some general guidance about its interpretation, the role of experts and directions given to juries. In *R v Bates* [2006] EWCA Crim 1395, Moore-Bick LJ gave a more detailed description of DNA evidence at its then stage of development as used in a trial in 2005.
4. As the science of DNA developed, techniques of analysing minute quantities of DNA, Low Template DNA, were developed from 1999 onwards. One of the processes of analysis and interpretation of Low Template DNA is called Low Copy Number (LCN) DNA. It is employed by the Forensic Science Service (FSS). Evidence of DNA profiles using this process was adduced in August 2007 at the trials of the appellants in these appeals.
5. During 2007, following a recommendation of an earlier review of the LCN process, the Forensic Science Regulator (the holder of a post established by the Home Secretary in July 2007 to advise the Executive on the quality standards of suppliers of forensic science services) asked Professor Brian Caddy to lead an independent review of the standards of science used in the analysis of all Low Template DNA, including the LCN process. Professor Caddy was Emeritus Professor of Forensic Science at Strathclyde University with extensive experience in conducting independent reviews.
6. Before this review had been completed, a challenge was made in the Northern Irish case of *R v Sean Hoey* [2007] NICC 49 to the reliability of DNA evidence using the FSS's LCN process. The defendant was charged with offences of murder, conspiracy to murder and other offences in relation to the Omagh Bombing which had occurred on 15 August 1998. The case against Hoey was based substantially on DNA evidence using the LCN process. As the judge, Weir J, was not satisfied as to the integrity of any of the items relied on prior to their examination, the prosecution case failed. However, extensive evidence was given in the course of the trial as to the reliability of the LCN process for the purpose of obtaining data of sufficient evidential quality. Weir J summarised in his judgment what he described as, "the attack made on the evidential value and reliability of the system" by Dr Daniel Krane, a professor at Wright State University, Dayton, Ohio and Professor Allan Jamieson, a Director of the Forensic Institute. We set out at paragraphs 104 and following the relevant experience of Professor Jamieson when he gave that evidence. It appears that Weir J drew attention to the attack of Dr Krane and Professor Jamieson because of his stated concern about "the present state of the validation of the science and methodology

associated with the LCN process and in consequence its reliability as an evidential tool”.

7. Professor Caddy reported in April 2008 that the processes were valid, as we explain below at paragraph 72, but set out caveats in relation to the interpretation of the results where the quantity of DNA analysed was below a certain amount.
8. In the grounds of appeal in each appeal, as they developed, the appellants raised, among other grounds, the general reliability of DNA evidence using the LCN process including its lack of validation, the limited research, the absence of protocols, disputes over interpretation and the scope of evaluation. Leave to appeal was given in each case on this and other grounds. In each appeal, leave was also sought to adduce fresh evidence under s.23 of the Criminal Appeal Act 1968; that evidence was contained in expert reports provided by Professor Jamieson who had not given evidence at either trial. In other cases where DNA evidence obtained by the Low Template DNA has been relied upon, criticisms similar to those made in *R v Hoey* have been made, often by Professor Jamieson.
9. These two appeals were therefore listed together for hearing on the basis that the Court would hear *de bene esse* evidence as to the reliability and evidential value of Low Template DNA evidence, primarily that which had been obtained using the LCN process and then determine whether to admit that evidence. Directions were given by the court at a directions hearing for the service of evidence in relation to that general issue. The court was told at a hearing in July 2009 that the appellants would rely on a *pro bono* opinion provided by Dr Krane, in addition to calling Professor Jamieson. This was not provided. Instead the appellants provided a report in September from Dr Bruce Budowle, a professor at the Department of Forensic and Investigative Genetics at the University of North Texas; he had been a senior scientist in the FBI’s Laboratory Division and had been involved in the development and validation of DNA processes. The appellants sought leave to call Dr Budowle and that legal aid be extended to cover his attendance, as it still appeared that there was a general challenge to the use in evidence of profiles obtained from Low Template DNA. The Crown sought leave to call Dr Adrian Linacre, a senior lecturer in forensic science at Strathclyde University who had been a member of Professor Caddy’s review, Mr Andrew Rennison, the Forensic Science Regulator, and others experienced in Low Template DNA. Witness Statements were served containing extensive materials in relation to the general reliability of Low Template DNA analysis and in particular the LCN process.
10. However, very shortly before the hearing of the appeals, both appellants abandoned, in circumstances we explain at paragraphs 62 and following, their general attack on the reliability of Low Template DNA evidence using the LCN process. Although, therefore, in the event, the reliability of DNA profiles obtained from Low Template DNA through the LCN process in general was not directly before us, it became clear that the circumstances in which the reliability of Low Template DNA profiles obtained through the LCN process can be called into question can be described within the narrow compass which we set out at paragraphs 71 and following. We nonetheless heard evidence *de bene esse* from Professor Jamieson, Dr Budowle, Dr Linacre and Valerie Tomlinson (an officer of the Forensic Science Service) in relation to this issue as well as the other issues on the appeal which we must summarise along

with an outline of the evidence before turning to the detail of DNA profiling and the analysis of Low Template DNA.

11. The course these appeals took required a great deal of work from counsel and those assisting them. We would like at the outset to pay tribute to the skill and diligence with which these appeals were conducted.

(2) An outline of the evidence and issues in each appeal

(i) Reed & Reed

12. David Reed and Terence Reed were convicted at the Crown Court at Teesside before Keith J and a jury on 7 August 2007 of the murder of Peter Hoe. Peter Hoe lived alone at a house in Eston; on the evening of 12 October 2006 he was dropped off by a friend at about 2100; his body was found at 1300 on 13 October 2006. He had been stabbed many times.
13. Two pieces of plastic which the Crown contended were parts of two separate knife handles were found near Peter Hoe's body. One (AC/3) had revealed cellular material which matched the DNA profile of Terence Reed and the other (AC/4) cellular material which matched the DNA profile of David Reed and Peter Hoe. The match probabilities were such that it was accepted to be their DNA. AC/4 fitted the blade of a knife which was found in a drain at Peter Hoe's address. In addition to that evidence, the Crown contended, primarily on the basis of a message left on a mobile telephone, that the murder was at or shortly after 2100 on 12 October. Observations of the appellants in the vicinity of Peter Hoe's house and cell site evidence showed that both appellants had had the opportunity to kill Peter Hoe at about that time; there was also evidence of motivation. The Crown also relied on the purchase by Terence Reed of an Adidas tracksuit top on the day following the killing, the purchased item being identical to the top that he had been wearing on the night of the killing. It was their case that he had had to dispose of the one he was wearing because it had become bloodstained.
14. The defence case was one of alibi. A challenge was made to the weight which could be attached to the message on the mobile telephone and to the reliability of the evidence of the movements of Peter Hoe. We consider at paragraphs 144-176 below the matters raised on the appeals that relate to the issues of alibi and other matters not relating to DNA.
15. Although there had been no dispute that the DNA profiles on the pieces of plastic AC/3 and AC/4 matched the DNA profiles of Terence Reed and David Reed respectively, a significant challenge was made to the value of that evidence, though neither put forward any positive case as to how their DNA came to be on the pieces of plastic. The evidence for the Crown given by Valerie Tomlinson, an officer of the FSS based at Wetherby, was that the profiles which had been recovered from AC/3 and AC/4 had been obtained using the LCN process. They were not from blood or other identifiable biological material, but simply cellular material that had been transferred to the pieces of plastic.
16. It was common ground that cellular material could be transferred by direct contact with the plastic (primary transfer) by the person whose DNA had been so transferred

or by secondary transfer to the plastic by another person transferring the cellular material of the person whose DNA had been found (or even tertiary transfer) – an issue we explain in more detail at paragraphs 59 and following. Although all of these were accepted by Valerie Tomlinson to be possibilities, she expressed views that it was highly unlikely that the appellants had innocently touched the knives at some stage and that someone else had brought the knives to Peter Hoe's address. She also considered that it was unrealistic that each appellant had passed their DNA to someone else who then transferred it to the pieces of plastic which were found at Peter Hoe's address. No challenge was made to the admissibility of her evidence.

17. On the hearing of the appeal, the focus of the challenge to the evidence of Valerie Tomlinson was in relation to the evidence she had given of primary and secondary transfer and the propriety of an expert expressing the views which she had expressed about the evaluation of the possibilities. It was contended that the only admissible evidence that Valerie Tomlinson could have given was evidence of match probability and as to the general mechanisms of primary and secondary transfer, without any evaluation of its significance to the case. It was further contended that, as she was not on this basis entitled to give evidence as to when and how the DNA material was transferred to AC/3 and AC/4, the evidence of match probability would have led to speculation and so should have been excluded under s.78 of the Police and Criminal Evidence Act 1984. We consider these issues at paragraphs 77 below after we have set out the general scientific background to DNA evidence and the analysis of Low Template DNA.

(b) *Garmson*

18. Garmson was convicted at the Crown Court at Stafford on 20 August 2007 before Mr Recorder Patrick Thomas QC (as he then was) of various offences of kidnapping, rape and sexual assault which related to incidents that had occurred in April 2005 and March 2006. It was the incident in April 2005 which raised the issue of DNA evidence and was the subject of the appeal.

19. The incident in 2006 was not subject to appeal, but as it was highly material as similar fact evidence to the 2005 incident, it is convenient to describe that incident first. In March 2006 Garmson forced himself into the back of a car in which a young woman, AO, was sitting. In the front passenger seat was another woman. The driver was a man. He threatened them with a knife, demanded money and directed the man where to drive. He then assaulted AO in the back seat, kissing her on the lips, putting her hand on his genitals and asking her to give him oral sex. She grabbed the knife and asked the driver to stop. When he did so, she and the other lady escaped. Garmson compelled the man to continue driving, following the directions given by Garmson. Garmson was subsequently identified. DNA was taken from the lip of AO.

20. Three months later Garmson was arrested for a series of offences that had occurred in 2005.

21. On that occasion KM, the complainant, and her partner, JB, had gone by car to a country park to have oral sex, as she was having her period. Whilst they were doing this, a man tapped on the window and asked them how to get to Newport. He got into the car and demanded that KM drive him and JB to Newport.

22. Along the way he ordered JB out of the car and then directed KM to drive to a small lane with a layby. There he ordered her to stop the car, kissed her and then made her give him oral sex and he then raped her *per vaginam*. He also put his finger into her vagina. After that he asked her to drive him to Newport, telling her to stop; where he stopped was 400 metres from the house where he lived at weekends with his mother.
23. Garmson was not visually identified by either KM or JB. Both said he had long hair. A photograph taken three weeks before the incident showed Garmson with short hair (so short that it could not have grown to the length suggested by the time of the attack on KM). It was the Crown's case that he had been wearing a wig. Garmson was identified by the DNA profile taken in the 2006 incident. The Crown's case against him relied not only on the DNA evidence to which we refer at paragraphs 179 to 187 below, but also on:
 - i) The similarity of the attack to that which had occurred in 2006.
 - ii) The finding of green fibres in the car which matched green fibres found on a pullover in his house.
 - iii) His knowledge of the roads and the fact that he had been dropped off so close to his mother's home.
 - iv) The fact that he had said on his arrest and before he had been given details of what it was alleged had happened, "there's a difference between asking for a blow job and raping someone".
24. The DNA evidence relating to the 2005 series of offences was found on four items – the tampon string of KM, the lip swab of KM, the front of KM's knickers and the outside of KM's trousers. All of these were analysed using the LCN process. The Crown relied upon the DNA result of the tampon string and the lip swab; Mr Harrington, the forensic scientist called by the Crown, gave evidence which showed match probabilities with the appellant.
25. The appellant's experts at trial were Dr Short and Professor Balding; Mr Harrington was cross examined by Garmson's counsel on the basis of their reports, but when they were called, Garmson was acting in person. Their evidence primarily related to match probabilities.
26. On the appeal, the focus of the expert evidence was on a re-examination of the match probabilities, but based on evidence not challenged at trial in relation to discounting the presence of other DNA found on the items analysed. It was contended that the judge should not have admitted the DNA evidence given the match probabilities obtained from the profiling and the nature of the profiles obtained; it was also contended that the judge misdirected the jury.
27. Having explained the context in which the appeals arose and the issues, it is necessary next to explain in more detail the science of the analysis of DNA and in particular Low Template DNA.

II: THE SCIENCE OF THE ANALYSIS OF DNA AND LOW TEMPLATE DNA

28. At a directions hearing prior to the hearing of the full appeal, we directed the parties to provide us with what is known in other jurisdictions as a “primer” or guide to the basic science of DNA profiling and in particular Low Template DNA profiling, using the LCN process. The document was produced to us by the Crown. Save for one part, it was not in dispute. It therefore formed a clear statement of that part of the expert evidence which was not in issue.

29. It is not necessary for us to set out a full explanation of DNA profiling; we do so only to make the scientific evidence to which we must refer readily understandable.

(1) The basis of the technique

30. DNA is found in the mitochondria and nucleus of each cell. The analysis with which forensic science is mainly concerned is the analysis of nuclear DNA and the issue relating to Low Template DNA analysis entirely relates to nuclear DNA. In the nucleus the DNA is arranged into 23 pairs of chromosomes; half of the nuclear DNA is inherited from the father and half from the mother. Except in the case of identical twins, different combinations of DNA are inherited and therefore each person’s DNA is unique.

31. Current technology does not allow each difference to be examined. Forensic analysis of nuclear DNA is therefore obtained through profiling of specific areas (loci) of DNA which are known to be widely different. These variable areas are found in those parts of the DNA strand (or sentence) known as the “non-coding” regions.

32. The technique depends on analysing the difference in the number of what are known as “Short Tandem Repeats” (STRs) in the non-coding region at the particular loci. The difference in number causes a variation in length between the DNA of each person.

(2) The SGM+ standard profile used to determine to whom the DNA belongs

33. The use of STRs was introduced in 1994 when 4 loci were analysed; it was extended then to 6 loci and in 1999 a standard profiling test, known as “the Second Generation Multiplex test” (SGM+), was introduced. That is the test described in *R v Bates* and remains the current standard test as described below at paragraph 38.

34. This test simultaneously analyses 10 STR loci, known as D3, VWA, D16, D2, D8, D21, D18, D19, THO1, and FGA. It is also significant that the DNA at the different loci will have different molecular weights, the importance of which is illustrated in the appeal of Garmson – see paragraphs 194 and following below.

35. As there are two STRs at each locus, (the one inherited from the mother and the other from the father) a complete analysis will produce two results for each of the 10 loci, each of which is a numerical value representing the number of STR repeats. The particular numerical type observed is referred to as an allele. The test also identifies the sex of the individual from which the DNA has originated based on the analysis of a marker called Amelogenin situated on the sex chromosomes. The result is expressed as XY for males and XX for females. Another, and related, technique

involves the analysis of particular variable regions on the Y chromosome (the “Y-STR analysis”).

36. At a crime scene, the forensic scientist will seek to obtain body fluids or other cellular materials from which DNA can be extracted – blood, semen, body tissue, hair, teeth or bone. The recovery of the sample is made by different methods – swabbing, scraping, cutting out or lifting.
37. The DNA is then extracted from the cells by chemical treatment and can be measured. The process of measurement is known as quantification (or quantitation), but the process of quantification consumes part of the amount of the available DNA. For that reason, it was not at the time of the trials of the appellants the practice of the FSS for that reason to quantify the amount of DNA. Professor Caddy recommended in his review that quantification should take place. It now is standard practice in the FSS to quantify, as it can be helpful to take into account the quantity in determining the subsequent process and the interpretation of the result. The DNA obtained is generally divided into three parts (aliquots). Two are used in the tests carried out immediately and one retained for use in a further test or by the defence.
38. A chemical technique known as “DNA amplification” or “PCR” (polymerase chain reaction) is used to copy the informative STR regions of the DNA many times so as to enhance their concentration relative to the other DNA. During the process these STR regions are targeted by synthetic pieces of DNA called primers which seek out the STR regions. Each primer is labelled with a fluorescent dye so that the newly generated STR copies are tagged and can be visualised and measured in the laboratory. There then follows a further part of the process known as gel or (more recently) capillary electrophoresis. In essence this process involves the newly synthesised DNA fragments being introduced onto a matrix or gel and being separated according to size by the application of an electric current which causes the DNA fragments to move through the matrix. The longer fragments containing more STR repeats are impeded by the matrix and pass the point of reference later than shorter and therefore faster fragments.
39. The standard profiling test involves copying using 28 cycles. Originally 2 nanograms of DNA were required. In 1999, the SGM+ test permitted 1 nanogram (one billionth of a gram (10^{-9})) of DNA to be used as the standard starting template. The standard kit used is designed optimally to produce a full profile on 1 nanogram which is the approximate equivalent of 160 human somatic cells which typically can be visualised in a tiny blood spot.
40. Two runs of the test are carried out; the runs are often conducted simultaneously in crime investigations as there is normally urgency to obtain the result. Sequential runs have the advantage of enabling the scientist to consider and evaluate the results of the first run to see whether any adjustments to the process are needed.
41. The results of each test run are produced in graphical form known as an electrophoretogram. The electrophoretogram requires expert interpretation, as, for example, the different loci can react differently on amplification. The process can generate results, known as “artefacts”, which are the consequence of the process and which are not an analysis of the DNA itself. Two of the most common are “pull up” which is a consequence of the detection software and results from saturation of the

various electronic detectors of the fluorescent dyes resulting in over exposure of the STR profile image and “stutter” which is a miscopying of the DNA during the amplification process and typically seen as a peak one repeat unit less in size than the true allele.

42. If the amount of DNA is of good quality and of sufficient amount, then a full or complete profile with two alleles at each of the 10 loci will be produced. A typical example is:

STR site examined	Sex Test	D3	VWA	D16	D2	D8	D21	D18	D19	THO1	FGA
Sample 1	XY	14	15	12	24	11	30	13	13	7	20
	(male)	16	17	12	25	12	32	14	16	9	23

43. If the DNA is degraded or present in very small amounts, some alleles may not be detected and there will be a partial profile with alleles only being shown for some sites. The less information that the profile contains, the weaker the ability to assess the match of the profile to that of the individual whose DNA is under comparison.

(3) Low Template DNA and the LCN process used

44. As set out at paragraph 39, the standard SGM+ test is designed to produce a full profile with 1 nanogram of DNA. It can be employed for smaller quantities.
45. However, particularly where no identifiable body fluid is present, the amount of DNA present may be as low as the equivalent of that contained in one body cell. Where a sample is measured to be less than what is required to generate a profile using the standard SGM+ test, then Low Template DNA analysis is often undertaken. Professor Caddy defined this as:

“An ultra sensitive technique that has the potential to yield a DNA profile from sub-optimal biological samples e.g. LCN DNA analysis”

46. With the opening up of the provision of forensic scientific services, the various providers, including the FSS, Orchid Cellmark Ltd and LGC Forensics, offered different processes. Although Professor Caddy considered all these, the LCN process used by the FSS was the specific process under consideration in these appeals. It is important to note, as we have mentioned at paragraph 37 above, that the FSS at the time of the testing did not quantify the DNA, but acted on the judgment of the forensic science officer as to whether it was appropriate to use the LCN process based on that officer’s judgment of the quantity of DNA.
47. In the LCN process, the DNA is copied using 34 cycles in the PCR process as opposed to the 28 cycles used in the standard SGM+ test referred to in paragraph 39 above. The objective is to produce increased sensitivity and a stronger result from Low Template DNA samples. The results require expert interpretation.
48. It is known that statistically random or stochastic effects can be produced. These include allelic “drop out” (an allele that should be present but is not detected, giving a false negative for that allele), allelic “drop-in” (an apparently spurious allele seen in

electrophoresis, potentially giving a false positive for that allele) and an increase in stutter. As we explain at paragraph 74.ii) the threshold below which stochastic effects can be produced is at present accepted to be between 100 and 200 picograms – a picogram is one million millionths of a gram (10^{-12}) roughly equivalent to a ten millionth of a grain of salt. Above that threshold (often called the stochastic threshold), the stochastic effect should not affect the reliability of the DNA profile obtained. Below that stochastic threshold the electrophoretograms may be capable of producing a reliable profile, if for example there is reproducibility between the two runs.

49. However, the stochastic effects may be such that no reliable profile can be generated. The FSS had found that in a very high proportion of profiles obtained using the LCN process the profiles were not capable of robust and reliable interpretation because of stochastic variations. An example of this is what was found on the bolt holder on the door of Peter Hoe's house in the appeal in Reed and Reed. The stochastic variations were such that no reliable profile interpretation could be made.

(4) DNA mixtures

50. A sample may contain DNA from more than one person. This may be identified by there being more than two alleles at one or more of the loci tested. Where there is DNA from more than one person, it is often the case that one person will have contributed more of the DNA than another. That profile is referred to as the major profile and that person is referred to as the major contributor; the profile of the other or others is referred to as the minor profile and the provider of that profile as the minor contributor.
51. If there are two contributors and four alleles at a locus, this will be because each of the persons has two different alleles at that locus. However, if the individuals have common alleles at a given locus, then they will overlap each other and not be shown separately. This is referred to as masking.

(5) Match probability

52. The forensic scientist compares the DNA profile of the sample taken from the crime scene (analysed in the manner set out) with the profile of an individual connected or suspected of being connected with the scene known as the "reference profile".
53. The scientist expresses the relationship of that profile to the DNA of the individual suspect in terms of probabilities, known as the "match probability". This is the probability of obtaining the match if in fact the DNA did not originate from the suspect but came from an unknown person who is unrelated to the suspect but has the same profile. If the profile is full, it is possible to express the match probability as a billion to one. If the unknown person is a close relative or the profile is incomplete, then the match probability will be higher, for example 1 in 10,000. Where there is a mixture, then this has to be taken into account in the evaluation of the match probability.
54. It is well established that the jury need careful direction in respect of issues of expert evidence concerning DNA. This is particularly important in the case of partial profile

DNA evidence. As this court explained in *R v Bates* at paragraph 30, in relation to the evidence of a partial profile which had been admitted, the jury must be:

“made aware of its inherent limitations and are given a sufficient explanation to enable them to evaluate it. There may be cases where the match probability in relation to all the samples tested is so great that the judge would consider its probative value to be minimal and decide to exclude the evidence in the exercise of his discretion, but this gives rise to no new question of principle and can be left for decision on a case by case basis. However, the fact that there exists in the case of all partial profile evidence the possibility that a “missing” allele might exculpate the accused altogether does not provide sufficient grounds for rejecting such evidence. In many cases there is a possibility (at least in theory) that evidence exists which would assist the accused and perhaps even exculpate him altogether, but that does not provide grounds for excluding relevant evidence that is available and otherwise admissible, though it does make it important to ensure that the jury are given sufficient information to enable them to evaluate that evidence properly. Moreover, as the court observed in *Doheny and Adams* at page 373D, the significance of DNA evidence depends to a large extent upon the other evidence in the case. By itself such evidence, particularly if based on a partial profile, may not take the matter far, but in conjunction with other evidence it may be of considerable significance.”

55. The probative value of evidence relating to match probabilities will depend upon all the circumstances. For example, the mere possibility that a missing allele might not match the profile of the accused is not of itself a sufficient ground for excluding the evidence. However, where it is not accepted that the DNA is that of the defendant, then if evidence as to match probability is to be placed before the jury so they can evaluate the probabilities in the context of all the other evidence in the case, then the judge must explain its relevance, the other evidence which provides the context which gives the match probability its significance and must draw attention to any evidence which might exculpate the defendant.

(6) The type of biological material from which the DNA sample originated

56. There are broadly two types of biological material – particulate items of material (such as bone, hair, vomit, faeces, skin flakes) and “stains” of biological fluids. Some stains of biological fluids are detectable by visual examination or presumptive tests (blood, semen or saliva), but some are not – sweat, skin cells or vaginal secretions. It is relatively straight forward to determine the precise nature of the material if it is particulate or if it is a stain of a biological material that can be detected by visual examination or by a presumptive test.
57. In the case where it is not detectable by visual examination or a presumptive test, it is not possible to know the precise nature of the biological material from which the

DNA originated. The material often originates from skin cells; hence the expression “touch DNA” has come into use, but we do not consider it a helpful expression.

58. The forensic scientist may well be able to form an opinion as to the nature of the material, but the extent to which an opinion can properly be expressed on this and the manner and time of transfer which we describe in the following paragraphs was in dispute.

(7) The manner and time of the transfer of cellular material

59. DNA can be transferred in many ways, of which the following are of particular significance:

- i) Primary transfer by a person directly to the object from which the sample was taken.
- ii) Secondary transfer by a person to another person and by that other person to the object from which the sample was taken
- iii) Tertiary transfer by a person to an object and from that object to another person and by that person to the object from which the sample was taken.

60. Some research has been carried out on this, but much remains to be done. We were referred to studies carried out by the FSS and a number of published papers including:

- i) The study undertaken by Alex Lowe and others at the FSS: *The propensity of individuals to deposit DNA and secondary transfer of DNA from individuals to inert surfaces* (2002). The study was directed at transferability in Low Template DNA cases where it was not possible to identify the cellular material transferred. It showed that in tests under controlled conditions there was a difference between individuals in their tendency to deposit or shed DNA, but it was not known why this was so. Secondary transfer which resulted in only the cellular material of the original transferor being found (and not that of the intermediary) could occur under certain ideal conditions where clean objects and washed hands were used; the tests had shown that this happened where all the contact occurred without delay. In all other cases where the delay in the different contacts was either 30 minutes or an hour, a profile of the transferor and the intermediary was found. It would therefore be expected that unless the contacts had occurred within a very short time period, a mixed profile would be found. The paper made clear that it was necessary for further work to be done.
- ii) The study by Phipps and Petricevic undertaken in New Zealand: *The tendency of individuals to transfer DNA to handled items* (2006). It was shown in experiments with volunteers who held tubes under controlled conditions that many conditions influenced shedding; an individual could not be relied upon to shed a consistent amount of cellular material over time. It also showed that secondary transfer observed was low and confirmed earlier work by RA Wickenheiser (*Trace DNA: A review, discussion of theory, and application of the transfer of trace quantities of DNA through Skin contact* (2002)) that

secondary transfer of cellular material is possible, but not likely. The authors concluded:

“The study of DNA shedding has shown that the trace transfer of DNA from an individual to an inert surface is a more complex subject than has been realised. The results indicate that the success rate of obtaining a trace DNA profile on forensic casework items will depend both on the characteristics of the DNA contributor and the specific activities performed by the contributor before touching the item. Despite this the results gained in this study have shed some light on the variables that affect the transfer of trace DNA, factors that have been shown to include the time since a person last washed their hands and which of the two hands an item is touched with. Although further research is required, the work presented here goes some way towards advancing understanding of the transfer of trace levels of DNA, and in doing so may allow forensic analysts to be able to evaluate better the meaning of this type of evidence.”

61. The scope of the evidence that can properly be given by an expert about the cellular material and the circumstances of its transfer was the central issue in the appeal of Reed and Reed; we set out our conclusions at paragraphs 111 and following.

III: THE NATURE OF THE DISPUTE ON THE APPEALS

62. No challenge at either trial was made as to the admissibility of the DNA evidence, though the DNA evidence had been carefully reviewed by experts instructed on behalf of the defence, as we explain at paragraphs 86 and 191.
63. The initial challenge on the appeal by the appellants Reed and Reed appears to have been directed as a challenge to the admissibility of the evidence given by Valerie Tomlinson as to the manner and timing of the transfer of the appellants' DNA. However, as we have set out at paragraph 7, an appeal based on a general challenge to a number of aspects of evidence obtained from Low Template DNA was developed. Extensive information was provided by the FSS in this appeal and in a trial at the Central Criminal Court, *R v Stretch and Puttock*, in which Professor Jamieson had been engaged; with leave, the information provided in *Stretch and Puttock* was made available for use in these appeals. The detail of the general challenge was set out in reports by Professor Jamieson and Dr Budowle served in August and September 2009. It was deployed to contest specific aspects of the case against the Reeds, apart from the issues relating to transfer. These aspects included (1) the inadmissibility of the profiles as they were based on the science of Low Template DNA which was uncertain and unreliable and (2) the inadmissibility of the profile on AC/4, the mixed profile, as there were special difficulties with the interpretation of mixed profiles
64. The general challenge mounted by the Reeds also formed one of the grounds of Garmson's appeal; no separate details were provided. Counsel for Garmson very

responsibly relied on those conducting the appeal by the Reeds to advance that part of the appeals.

65. It appears never to have been in issue in the appeal in Reed and Reed that the DNA found on AC/3 and AC/4 matched their DNA. The Crown maintained that the profiles from AC/3 and AC/4 were interpretable and had none of the stochastic effects that made them uninterpretable for the reasons set out in paragraph 48. It was also accepted by Professor Jamieson that no credible challenge could be made to the profiles. It appears, however, to have been assumed by those advising them and the Crown that the quantity of the DNA was such that it was only possible to obtain a profile by using the LCN process.
66. The practice of dividing the DNA recovered into three aliquots (as explained at paragraph 37 above) was followed in the case of the Reeds. The defence expert instructed at trial did not seek an analysis of it and it remained retained by the FSS. In the light of the general challenge made to the LCN process in the reports served in August and September 2009 and no doubt in the light of the recommendation by Professor Caddy that the amounts of DNA should be quantified, the FSS were asked, with the agreement of the appellants, to quantify the third aliquot.
67. It was then discovered that there were 2.5 nanograms of DNA present on AC/4 and 1 nanogram on AC/3. There was then a disagreement between the experts as to the tests to be performed.
68. On 13 October 2009, Dr Budowle asked that the standard SGM+ test for DNA described at paragraphs 33 and following be run because it would help clarify whether the profiles obtained by the LCN process were of high quality. It was run on 15 October 2009, four days before the hearing of the appeal; on the following day a profile was produced that was similar to that obtained using the LCN process. It was accepted that the appeal could no longer be pursued on the basis it was a Low Template DNA case involving the use of the LCN process.
69. The appeal by the Reeds therefore was pursued on the basis that, as the cellular material could not be identified, no opinion evaluating the method of transfer of the DNA on to AC/3 and AC/4, let alone its timing, should have been admitted as evidence at the trial.
70. At the outset of the appeal in Garmson, the appellant abandoned the ground of appeal relating to the reliability of the evidence of the DNA obtained from Low Template DNA using the LCN process.

IV: THE RELIABILITY OF LOW TEMPLATE DNA EVIDENCE

71. It followed that the issue of the reliability of the analysis of Low Template DNA using the LCN process did not directly arise in the appeals. However there was a considerable measure of agreement as to the circumstances in which a challenge could properly be made to the use of Low Template DNA evidence.
72. Professor Caddy's review reported on the validity of the techniques of Low Template DNA where the amount was less than 200 picograms. He considered that the processes used, including the LCN process, were valid for amounts less than 200

picograms. He made clear that for those amounts the identifiable stochastic effects to which we have referred impacted on the profiles. He recommended that the Regulator should develop a consensus on standards for the interpretation of such profiles and monitor the implementation of the standards; the limitations had to be made clear.

73. The Forensic Science Regulator broadly accepted the conclusions of the Report in his response dated 7 May 2008, but, as he believed that a single set of caveats was unlikely to be effective, he would ask a specialist group to consider whether the issues that had to be considered by an expert should be identified and where appropriate included in a report. He also made clear that he did not consider validation a necessary pre-condition for the admission of scientific evidence, provided the obligations under Rule 33.3(1) of the Criminal Procedure Rules were followed. In the light of the issues that emerged in these appeals and considerations set out in the next paragraph and paragraphs 111 and following, we see much force in that view; we consider the importance of Rule 33.3(1) at paragraph 129 below.
74. On the evidence before us, we consider we can express our opinion that it is clear that, on the present state of scientific development:
- i) Low Template DNA can be used to obtain profiles capable of reliable interpretation if the quantity of DNA that can be analysed is above the stochastic threshold – that is to say where the profile is unlikely to suffer from stochastic effects (such as allelic drop out mentioned at paragraph 48) which prevent proper interpretation of the alleles.
 - ii) There is no agreement among scientists as to the precise line where the stochastic threshold should be drawn, but it is between 100 and 200 picograms.
 - iii) Above that range, the LCN process used by the FSS can produce electrophoretograms which are capable of reliable interpretation. There may, of course, be differences between the experts on the interpretation, for example as to whether the greater number of amplifications used in this process has in the particular circumstances produced artefacts and the effect of such artefacts on the interpretation. Care may also be needed in interpretation where the LCN process is used on larger quantities than that for which it is normally used. However a challenge to the validity of the method of analysing Low Template DNA by the LCN process should no longer be permitted at trials where the quantity of DNA analysed is above the stochastic threshold of 100-200 picograms in the absence of new scientific evidence. A challenge should only be permitted where new scientific evidence is properly put before the trial court at a Plea and Case Management Hearing (PCMH) or other pre-trial hearing for detailed consideration by the judge in the way described at paragraphs 129 and following below.
 - iv) As we have mentioned, it is now the practice of the FSS to quantify the amount of DNA before testing. There should be no difficulty therefore in ascertaining the quantity and thus whether it is above the range where it is accepted that stochastic effects should not prevent proper interpretation of a profile.

- v) There may be cases where reliance is placed on a profile obtained where the quantity of DNA analysed is within the range of 100-200 picograms where there is disagreement on the stochastic threshold on the present state of the science. We would anticipate that such cases would be rare and that, in any event, the scientific disagreement will be resolved as the science of DNA profiling develops. If such a case arises, expert evidence must be given as to whether in the particular case, a reliable interpretation can be made. We would anticipate that such evidence would be given by persons who are expert in the science of DNA and supported by the latest research on the subject. We would not anticipate there being any attack on the good faith of those who sought to adduce such evidence.
75. In reaching this view we have taken account of the evidence of Dr Budowle. In his report, he set out his view that LCN was not a robust technology; for example samples not susceptible to SGM+ analysis contain too little DNA and yield inherently non-reproducible results. At one stage of his evidence he appeared to accept the conclusions we have set out; he then appeared to go back on this. It might therefore have appeared that he had contradicted himself. If that had been the case, it would have cast grave doubts about the value of his evidence. We think, however, from a detailed consideration of the transcript that he did not, in the result, resile from his acceptance of the conclusions we have set out, but was rightly seeking to draw attention to the need for careful interpretation and to the need for an expert to take considerable care in the conclusions expressed. We have also considered his comments about the protocols and guidelines for the interpretation of LCN DNA with which he had been provided, but the materials before us did not support the observations he made.
76. Professor Caddy's review also considered the question as to the extent to which an expert could express a view on the way in which Low Template DNA had been transferred and the timing of the transfer. As that issue arose specifically on the appeal in Reed and Reed, we will consider that after setting out the circumstances in which it arose and the evidence given at trial.

V: THE APPEAL IN REED AND REED

(1) The issue on the DNA evidence

77. As we have set out in our summary of the issues, there was no challenge to the fact that the matches of the profiles found on the pieces of the knife handles (AC/3 and AC/4) to the profiles of the appellants were such that it was clearly their DNA. The issue was whether any evidence could be admitted which enumerated the possibilities of how the DNA came to be on the knife handles and, if so, whether those possibilities could be evaluated. If such evidence could not be admitted, then the issue arose as to whether any of the evidence of finding the DNA on the handles should have been admitted.
78. It was common ground that in cases where a reliable DNA profile has been obtained (as was the case here), but the type of cellular material from which it has been obtained is unknown (as was the case here) an expert can in many cases, in addition to giving evidence of the profile match and match probability, give evidence

enumerating the possibilities as to how the DNA has been transferred to the object from which the DNA profile has been obtained.

79. In the present case, however, it was submitted on behalf of the appellants that it was simply not possible to say how the material had been transferred. It could not be assumed that the material was skin cells as there was a real possibility of epithelial cells being transferred from saliva, whether by primary or secondary transfer. It was not possible to tell whether they had been transferred by primary, secondary or tertiary transfer or when this had happened. In the circumstances the possibilities through which the material came to be transferred to AC/3 and AC/4 should not have been enumerated as there were too many variables; it certainly was not possible to go any further and evaluate them.
80. Before setting out the detail of the argument as applied to the admissibility of the evidence given by Valerie Tomlinson, it is necessary to set out in more detail that part of the evidence of Valerie Tomlinson relating to her attendance at the crime scene and the analysis of the DNA (which was largely unchallenged) and then her evidence in relation to the manner and time of the transfer of the DNA.

(2) The evidence of Valerie Tomlinson

(i) The examination of the scene of the crime

81. Valerie Tomlinson is a chartered biologist who has been employed by the FSS since 1982; since 1988 she has been engaged in DNA profiling for criminal investigations and paternity testing, after undergoing a three month intensive course in DNA profiling at the FSS laboratory and then a period of apprenticeship. She has since then undergone periodical assessment of her competencies. Her predominant work has been in cases involving offences against the person, predominantly in the laboratory, but also in visiting scenes of crime since 1985. During the period of the existence of the Council for the Registration of Forensic Practitioners, she was one of the assessors employed to conduct peer review of those accredited by the Council.
82. After the discovery of Peter Hoe's body she visited Peter Hoe's house and spent 3 days at the crime scene. The two pieces of plastic were near Peter Hoe's body – AC/4 near his right leg and AC/3 a little further away from his outstretched left hand. She considered these incongruous as, apart from the disturbance caused by the killing, the house was very tidy; she formed the view that these came from two different knife handles and it was possible that they related to weapons used in the attack on Peter Hoe. As we have set out at paragraph 13 above, a blade was found in the drain and AC/4 fitted that blade. Although it was not formally admitted, either at the trial or on the appeal, that the pieces of plastic came from the handles of two knives, there can be little doubt that they did. It was the evidence of Dr Mark Egan, the pathologist called by the Crown, that the blade found in the drain could have been used to inflict four of the wounds inflicted on Peter Hoe.

(ii) The analysis of the DNA by the FSS

83. AC/3 and AC/4 were received by Valerie Tomlinson at the laboratory at Wetherby and examined by her assistant under her direction. AC/4 had traces of blood on it as it was on part of the carpet that was blood stained. AC/3 was examined under the

microscope and had no traces of blood. She was of the opinion that, if there was any DNA on the plastic, other than and additional to the blood on AC/4, it was most likely to be DNA which had been transferred through touch; it was therefore likely that the amount would be low and therefore it should be tested by the LCN process which she considered reliable. She did not quantify the DNA recovered from each piece, as quantification would have consumed some of the DNA, as explained at paragraph 37. This was in line with FSS policy. The recovered DNA from both AC/3 and AC/4 was each divided into three parts and test runs using the LCN process were then conducted simultaneously on two of the parts recovered from each piece; simultaneous testing was in accordance with FSS operating procedures for police investigations.

84. She then considered the electrophoretograms for each test on each piece.
- i) Blood is a relatively good source of DNA compared to cellular material (such as skin cells) transferred through touch. She was therefore surprised that on AC/4 the DNA profile from the cells other than the blood of Peter Hoe was of the same order of contribution as the DNA profile from the blood. Two runs produced in her opinion, which was not disputed, a very high degree of consistency. She was satisfied they could be interpreted to give a reliable profile of the other contributor of the DNA on AC/4.
 - ii) The two runs on the material obtained from AC/3 produced results that were of sufficient quality to enable her to generate a reliable profile of the contributor of the DNA.
 - iii) She had never had results of that quality before from the LCN process. It was common for DNA transferred through touch to have results that could not be interpreted at all or showed such complex mixtures that they were difficult to interpret.
 - iv) There was no other identifiable DNA profile on either AC/3 or AC/4.
85. In the light of her opinion on the two runs, she did not conduct a test on the third part. It was retained for use by the defence. This was the part that was used for the test carried out using the SGM+ analysis on 15 October 2009, as explained at paragraph 68.
86. Her results, including her opinion on the match probabilities, were examined prior to the trial by Ms Sue Woodroffe on behalf of the appellants. She was an expert trained at the FSS in 1988 who had left for independent practice, but who had considerable experience of the LCN process. No report from her or from another expert in DNA instructed on behalf of the appellants at trial, Ms Elaine King, was disclosed on behalf of the appellants. No expert evidence was called on DNA on behalf of the appellants.
- (iii) *Her evidence at trial on the manner and timing of the transfer of the DNA*
87. Valerie Tomlinson's evidence at trial was that she had examined all the possible scenarios as to how the DNA of both appellants had been found on both pieces of plastic. She regarded as significant:

- i) The fact there was no identifiable DNA profile from any other person (save Peter Hoe in the case of AC/4).
 - ii) The DNA profiles obtained were of a quality much higher than she would ordinarily have expected from the LCN process; it was possible therefore to give some clearer guidance as to an evaluation of the possibilities of transfer.
 - iii) The fact that there were two knife handles fragments each with the profile of one of the appellants.
 - iv) The knives were foreign to the scene (as the handles did not match any in Peter Hoe's kitchen).
88. In her view cellular material would be transferred through primary transfer to an object if there was contact for a sufficient period of time. If that object was then handed to another, then if there was sustained contact within a relatively short period of time of it being handed to that other (10 and 20 minutes), then sufficient detectable quantities of the original holder's DNA could be transferred. If a longer period of time elapsed, then it was likely that other activities would remove the DNA of the original holder from that other's hands so that it was not available for transfer.
89. Even though there was no explanation from either of the appellants, she considered it her duty to look at all the explanations that were possible, including secondary and tertiary transfer. It was not necessary for her to consider the possibility that the appellants had touched knives that Peter Hoe had in the house as both denied ever visiting the house. The possible explanations she outlined were:
- i) There could have been a primary transfer when the knives were brought by David and Terence Reed to Peter Hoe's house and when they broke they were handling them. The DNA observed was what she would have expected to see under those circumstances.
 - ii) There could have been primary transfer when David and Terence Reed both touched different knives innocently and someone had brought them to Peter Hoe's house. Her evidence was that that was highly unlikely, as it would require too much of a coincidence; that, although there was DNA from others, that was at a very low level when compared with the profiles of David and Terence Reed.
 - iii) There could have been secondary transfer by David and Terence Reed transferring their DNA to other people and those other persons had transferred the DNA of the Reeds onto the knives which had then been taken to Peter Hoe's house. She regarded the possibility of secondary transfer as "unrealistic". There would have had to have been "substantial contact" between David and Terence Reed and those other persons and those other persons would have had to have been in contact with the knives "pretty quickly" for the cellular material from David and Terence Reed to have got onto the knives. The profiles were so dominant that the cellular material could not have been on the knives for months.

- iv) As to the defence suggestion that David Reed might have transferred his DNA to Peter Hoe when they shook hands on an occasion covered in the evidence of two prosecution witnesses and Peter Hoe had then transferred that DNA to one of the knives, there were considerable difficulties. There would have had to have been a coincidence that Peter Hoe had touched the knife used in the attack shortly after shaking hands with David Reed. This did not explain the transfer of Terence Reed's DNA.
- v) Although she could not say how long the DNA had been on the handles, the fact that there were full profiles would tend to preclude the DNA having been there for any length of time as it would have degraded far more than it had, as some degradation is always to be expected where unidentified cellular material is deposited.
- vi) In all the circumstances, the most likely explanation for the DNA of the appellants being on AC/3 and AC/4 was that they were brought to Peter Hoe's house by the appellants and that they were handling them when they broke.

90. Her evidence to us was much the same.

- i) She made clear that she could not eliminate the possibility of primary or secondary transfer, but in her experience it was much more likely in the case of secondary or tertiary transfer that there would be a mixed profile indicating DNA being present from more than one and often several persons. Furthermore, this was a case where the DNA of one of the appellants was present on one knife handle and the DNA of the other was present on the other knife handle.
- ii) In the case of the knife handles she considered that the most likely logical means of DNA being transferred was through touching. She had considered saliva which could have been transferred. It was possible that the knife handles had been sneezed on or spat on or lain on saliva on the floor, but that would have required the fortuity of saliva from two individuals landing on separate knife handles.
- iii) Although the cellular material from which the DNA had been derived could not be identified, the likelihood was, given it was on a piece of plastic from a knife handle, that it was cellular material from the hands. She would always expect a degree of degradation, but in these profiles there was not the degree of degradation that precluded interpretation of the profiles
- iv) She had not evaluated the possibility that one man brought both the knives to the scene and not the other. As to the possibility of a person wearing gloves and bringing the knives to the scene, she would have expected the DNA on the knife handle to have been rubbed off or to have found the DNA of another person as gloves can retain and deposit DNA.
- v) The knives were examined for fingerprints, but as far as she was aware none that were useful were found; it was not unusual to find DNA on plastic and no fingerprints.

(iv) *The appellants' criticism of her evidence*

91. It was submitted on behalf of the appellants that Valerie Tomlinson had gone far beyond giving admissible evidence, when she gave evidence that the most likely explanation was that DNA had been transferred when they brought the knives to Peter Hoe's house and they were handling them when they broke; this was in effect a direction from an expert to convict. It was simply not possible to say how the unidentifiable cellular material had got there and it followed it was impossible to say that the DNA had been transferred by handling when they broke.
92. Her evidence that secondary transfer was "unrealistic" was also inadmissible. If it could not be stated whether primary transfer had taken place, secondary transfer could not be excluded. At trial, her evidence could only have been understood by a jury as effectively excluding secondary transfer.
93. Her conclusion that the transfer must have been primary was simply not justified by her assertion that the profile was of high quality; there was no research to sustain that opinion and it was, for that further reason, inadmissible.
94. She was also wrong to have claimed that the cellular material could not have persisted for a long time by asserting that there was no evidence of any significant degree of degradation. There was no way of establishing how long the cellular material had been present on AC/3 and AC/4.
95. Valerie Tomlinson had failed to take account of the fact that the material was only found on a fragment of each handle; she did not take into account the possibility that there might have been cellular material from others on the rest of the handle or on the blade.
96. Her opinion displaced the other expert evidence in the case – (a) the pathology evidence given by Dr Mark Egan, called by the Crown, and Dr Carl Gray, called by the defence, that the knives had not broken through contact with a bone or been bent, (b) the evidence of the metallurgist, Professor Gibson (called by the defence), as to the force required to break knives and (c) the evidence of the unidentified finger prints. The strength of her views would have meant that the jury did not properly consider the alibi defence.
97. In essence she had moved outside the proper province of an expert by becoming an advocate for the prosecution. The only evidence that was admissible was evidence of the match probability. As she could not give admissible evidence on the possibilities as to how or when the cellular material had transferred, it would have been unfair to admit the evidence of the match probabilities, as it would have led to speculation. The trial judge should therefore have excluded it under s.78(4) of the Police and Criminal Evidence Act 1984.
98. Although it was accepted on behalf of the appellants that they had not objected to the admissibility of Valerie Tomlinson giving such evidence, they would have objected if they had had available to them the report of Professor Caddy's Review and the evidence of Professor Jamieson and Dr Budowle, to which we now turn.

(2) The evidence of Professor Jamieson and Dr Budowle

99. We consider the evidence of Dr Budowle first, as there was no dispute about his expertise.

(i) *The evidence of Dr Budowle*

100. Dr Budowle's evidence on transferability was:

- i) It was not possible given the state of development of science to know how unidentifiable cellular material, whatever its quantity, had been transferred – whether by primary, secondary or tertiary transfer.
- ii) The research to which we have referred at paragraph 60 demonstrated that no firm view could be expressed as to the time for which an object had to be held for primary transfer to take place or the period of time that could elapse between primary and secondary transfer. More research was needed before it was permissible for a forensic scientist to express an opinion on the method and timing of transfer.
- iii) If cellular material was found on a knife handle, then it could not be assumed these were skin cells as the material could have been deposited by saliva which might contain epithelial cells; such transfer could occur by placing the object in the mouth or spitting. He had shown in research he had conducted on cigarette butts that sufficient DNA was deposited when smoking which could be analysed using the standard test.
- iv) The profiles originally obtained by the LCN process were not of high quality. The electrophoretograms showed degradation and split peaks and pull ups; these demonstrated that the profiles were not of good quality, though they were interpretable. He attributed the interpretability to the “luck of the draw” as opposed to robust technology. However, he accepted that those obtained in October 2009 by the standard test were of high quality.
- v) Valerie Tomlinson should not therefore have expressed the views she did about the circumstances of the transfer of the cellular material. Although it was possible for views to be given enumerating possibilities in certain circumstances, she should not in the circumstances of this case have evaluated the possibilities or expressed views as to the time for which a person had to hold the object or the time that could elapse between primary and secondary transfer.

101. Dr Budowle had undoubted and extensive experience of DNA; he had held a senior position within the FBI. He was punctilious in underlining the danger of a scientist expressing views beyond that expert's competence. He rightly emphasised the dangers that can arise when a scientist expresses views beyond the narrow scientific point on which the expert is asked to opine. There is, we accept, always a danger that if an expert expresses one part of his scientific evidence with confidence, and also expresses other views, those other views can, unless care is taken, be given a verisimilitude of certainty by association.

102. We cannot, however, accept his evidence that a properly qualified expert cannot evaluate the enumerated possibilities of the circumstance of transfer. We reject it

primarily because it does not stand the test of analysis as set out in our conclusion at paragraphs 120 and following. It is significant to note that he accepted that an expert could in other circumstances give evaluative evidence. When he declined to evaluate the possibilities that had been enumerated in this case, he claimed he did not have sufficient information or that there were other possibilities. He never identified those other possibilities. Nor could he explain why he could not do so, save to say that a DNA scientist should not do so, as the scientist did not have the requisite knowledge and that the possibilities should be evaluated by others by reference to other evidence.

103. We have also taken into account the fact that his experience is of a different jurisdiction where the scientist who gives evidence may have a narrower type of expertise and the scope of evidence an expert can give may not be the same as the scope in this jurisdiction. It is also important to note that his experience was not based on the work of a forensic scientist in this jurisdiction who attends both the scene of the crime and supervises the laboratory work. As he made clear, his experience was limited to the examination of DNA both in the laboratory and from case work. His expertise did not extend to examining the scene of a crime and relating that examination to the evaluation of the circumstances of transfer of unidentified cellular material.

(ii) *The experience and evidence of Professor Jamieson*

104. It is necessary to set out in some detail the qualifications of Professor Jamieson as the Crown contended that he was not qualified to give expert evidence. Professor Jamieson has a degree in Biology and Genetics and a PhD from the Forensic Science Unit at Strathclyde University. He then engaged in post doctoral research until 1993 when he was appointed the manager for laboratory medicine at a hospital in Glasgow; in 1995 he became head of Lothian & Borders Police Forensic Science Laboratory until 2002.
105. In 2002 he established an organisation in Glasgow with the name “The Forensic Institute”; it is not an institute in the normal sense of the word, but a private commercial organisation. It is not accredited by United Kingdom Accreditation Service or any other body in England and Wales or any Scottish Body. He has written some peer reviewed papers and carried out academic work in areas of forensic science.
106. His experience in the interpretation of DNA profiles is limited. He took a one day training course in the use of the relevant software and had no training in interpretation. He bases much of his knowledge of DNA and the analysis of Low Template DNA on papers and discussion with other scientists; he does not conduct laboratory research. The Omagh Bombing case, *R v Hoey* (in which the attack we have described was launched on the LCN process) was the first case in which he had provided an expert opinion on Low Template DNA; he had known of LCN as a process, but that case was the first opportunity he had to study it. He told us that he was unaware that other scientists had been approached to give evidence for the defence in *R v Hoey*.
107. He gives evidence with a degree of gravitas and fluency that is impressive and is able to explain concepts clearly. However his expertise on the interpretation of DNA

profiles is limited, without any relevant first hand laboratory or research experience. He is not qualified to make a scene of crime investigation.

108. We are satisfied that he was invited to contribute to the review by Professor Caddy, but did not do so for reasons which did not seem to us to be at all convincing. When the review was published, the Forensic Institute published a press release which stated that the review had not consulted anyone who had expressed a contrary opinion on the FSS's LCN process and "spoke only to the organisations selling the technique" and to the police as "customers". A similar passage appears in a paper entitled *Fit for Purpose: The Review of Low Template DNA* written by Professor Jamieson and Dr Rhonda Wheate and published in *Barrister Magazine* in 2008. These were, in our judgement, not only inaccurate statements, but statements that appeared to call into question the integrity of both the review by Professor Caddy and the providers of processes of Low Template DNA analysis. There is no foundation for these statements. We are satisfied that the review was carried out with complete integrity. There is no evidence whatsoever to call into question the good faith or integrity of the suppliers of processes for analysing Low Template DNA. The fact that Professor Jamieson, in the light of all the material he has now seen, no longer calls into question the validity of the process where the quantity is above the stochastic threshold, provides considerable mitigation for statements that in our view should never have been made and which, we were told, have now been withdrawn.
109. His evidence in relation to the ability of an expert to give evidence on the circumstances of transferability was in most respects similar to that of Dr Budowle. His basic premise was that, where the nature of the cellular material was unknown, there was insufficient research to evaluate whether it was transferred to the surface where it was found by primary or secondary transfer. Furthermore the research to date did not provide sufficient information about the persistence of such cellular material and how long it could remain on a surface. There was therefore no reliable basis on which to put forward an evaluation of the probabilities of the mechanisms and circumstances of transfer in any given case.
110. Whilst it is impossible to understand how he had sufficient expertise to be able to give evidence in *R v Hoey*, let alone to assist in the attack made in that case on the LCN process, he has given evidence in so many Low Template DNA cases since then on the strength of the observations in *R v Hoey* that he has acquired a degree of experience from these cases, his discussion with others and his reading of papers. We retain clear reservations about the extent of his expertise in relation to DNA profiles; it is, for example, not comparable to that of Valerie Tomlinson. However, it is not necessary for us to go further, as our grounds for not accepting his evidence in relation to the capability of an expert to give evidence on the circumstances of transfer are the same as the primary reasons we have set out in respect of Dr Budowle at paragraph 102 above.

(3) Conclusion on the admissibility of the evidence of Valerie Tomlinson

(i) The relevant principles

111. It is important to distinguish the issue of the admissibility of expert evidence from the assessment of that evidence by the jury. In the present appeal, the issue related to admissibility. There are three relevant principles relating to the admissibility of the

evidence given by Valerie Tomlinson. First, expert evidence of a scientific nature is not admissible where the scientific basis on which it is advanced is insufficiently reliable for it to be put before the jury. There is, however, no enhanced test of admissibility for such evidence. If the reliability of the scientific basis for the evidence is challenged, the court will consider whether there is a sufficiently reliable scientific basis for that evidence to be admitted, but, if satisfied that there is a sufficiently reliable scientific basis for the evidence to be admitted, then it will leave the opposing views to be tested in the trial.

- i) As was set out by the Supreme Court of South Australia in *Bonython* (1984) 38 SAAR 45, the subject matter of the evidence must be part of “a body of knowledge or experience which is sufficiently organised or recognised to be accepted as a reliable body of knowledge or experience”. However, there is no closed category where evidence cannot be placed before a jury; as was observed by Steyn LJ in *R v Clarke* [1995] 2 Cr App R 425 at 429, “it would be wrong to deny to the law of evidence the advances to be gained from new techniques and new advances in science.” This is exemplified in the DNA cases.
- ii) In *R v Dallagher* [2002] EWCA Crim 1903 (where the expert evidence was that of ear prints), the court, after considering what was believed to be the test in the United States in *Frye v US* 293 F 1013 (1923) and the consideration of it by this Court in *R v Gilfoyle (no2)*[2001] 2 Cr App R 57, referred to at paragraph 29 with approval to a passage set out in *Cross and Tapper: The Law of Evidence* now to be found at page 580-1 of the 11th edition:

“The better and now more widely accepted view is that so long as the field is sufficiently well established to pass the ordinary tests of reliability and relevance, then no enhanced test of admissibility should be applied, but the weight of the evidence should be established by the same adversarial forensic techniques applicable elsewhere.”
- iii) In *R v Luttrell* [2004] EWCA Crim 1344 (where the expert evidence was that of lip reading), the court observed at paragraph 37 that “although at one time a more conservative approach had been adopted, the policy of the English courts has been to be flexible in admitting expert evidence and to enjoy the advantages to be gained from new techniques and new advances in science”. It again cited the passage in *Cross and Tapper* to which we have referred.
- iv) With the establishment of the Forensic Science Advisory Council and the Forensic Science Regulator, there may be very much more assistance available to the court, as there was in this case on appeal for us, to help it in its assessment of whether the evidence is sufficiently reliable for it to be admitted, but the ultimate decision remains that of the court on the principles we have set out.

It should be noted that the Law Commission Consultation Paper on the Admissibility of Expert Evidence in Criminal Proceedings in England and Wales

(2009) at Parts 3 and 4 contains a valuable discussion of the case law and the enhanced test for admissibility used in the United States as set out in the decision of the US Supreme Court in *Daubert v Merrell Dow Pharmaceuticals* 509 US 579 (1993). We set out at paragraphs 128 and following the procedure under the Criminal Procedure Rules through which the courts in England and Wales control the admissibility of expert evidence on the principles of admissibility which we have summarised.

112. Second, even if the scientific basis is sufficiently reliable, the evidence is not admissible unless it is within the scope of evidence an expert can properly give. In *R v Atkins and Atkins* [2009] EWCA Crim 1876, an appeal concerned with experts giving evidence about what is commonly called “facial mapping”, the court had to consider the extent to which an expert could express a view on the significance of what he had observed without there being a statistical basis for comparison purposes. Hughes LJ in giving the judgment of the court, after emphasising that the jury had to be told that the opinion was not based on a statistical database, said at paragraph 23:

“An expert who spends years studying this kind of comparison can properly form a judgment as to the significance of what he has found in any particular case. It is a judgment based on his experience. A jury is entitled to be informed of his assessment. The alternative, of simply leaving the jury to make up its own mind about the similarities and dissimilarities, with no assistance at all about their significance, would be to give the jury raw material with no means of evaluating it. It would be as likely to result in over-valuation of the evidence as under-valuation. It would be more, not less, likely to result in an unsafe conclusion than providing the jury with the expert's opinion, properly debated through cross-examination and, if not shared by another expert, countered by contrary evidence.”

113. Third, unless the admissibility is challenged, the judge will admit that evidence. That is the only pragmatic way in which it is possible to conduct trials, as sufficient safeguards are provided by Part 3 and Part 33 of the Criminal Procedure Rules to which we refer at paragraph 129 below. However, if objection to the admissibility is made, then it is for the party proffering the evidence to prove its admissibility: see *Atkin and Atkin*, at paragraph 9:

“This case therefore does not raise any question as to the judge's power at common law to exclude evidence tendered as expert, if it be argued that the expert is insufficiently qualified or that his evidence is insufficiently based upon expertise. We say no more about that than that there can be no doubt that such a power exists. That is because he who asserts admissibility must demonstrate it. Evidence of opinion is not ordinarily admissible. Opinion based upon identifiable expertise outside the experience of the jury is one exception. If objection be taken to admissibility (though not otherwise) it must be determined by the judge. It is for him who tenders such evidence to establish the exception, viz the expertise and that it

is the foundation of the opinion. The power to rule on admissibility applies equally to Crown and defence.”

114. As regards this appeal,

- i) It is now established that the underlying science for Low Template DNA analysis is sufficiently reliable to produce profiles, where the amount analysed is above the stochastic threshold of between 100 and 200 picograms.
- ii) It has been long established that an expert can give evidence as to match probabilities and it must follow that such evidence can now be given where the LCN process is used for quantities above the stochastic threshold.
- iii) The admissibility of evaluative evidence of the possible ways in which the DNA was transferred is challenged on the basis that the scientific basis is insufficiently reliable.

The issue for us is whether, given the state of scientific knowledge on transferability of unidentified cellular material, Valerie Tomlinson could give admissible evidence setting out the possible explanations for the presence of DNA on the plastic from the knife handles and evaluating those possibilities, where the biological material from which the DNA has been taken was not identifiable, even though the amount was more than 200 picograms. The question of admissibility depends on the reliability of the underlying science and the scope of evidence it is proper for an expert to give. As objection has been taken, then it is for the Crown to prove that the evidence was admissible. If it was correctly admitted, it was for the jury to determine whether they accepted it.

(ii) *An opinion enumerating the possible mechanisms of transfer and the time of transfer*

115. Professor Caddy recommended that there should be national agreement on how Low Template DNA profiles were to be interpreted:

“7.4 It is our opinion that any Low Template DNA profile should always be reported to the jury with the caveats: that the nature of the original starting material is unknown; that the time at which the DNA was transferred cannot be inferred; and that the opportunity for secondary transfer is increased in comparison to standard DNA profiling. There may perhaps be some exceptions (see section 4.2 above).

7.5 It is our opinion that when DNA profiles match as a result of LCN DNA profiling, the significance of the match should be reported on the probability that the two DNA profiles match only [6]. As the results were obtained from LCN it is inappropriate to comment upon the cellular material from which the DNA arose or the activity by which the DNA was transferred.”

116. As we have already stated, the Forensic Science Regulator broadly accepted the conclusions of the Report in his response dated 7 May 2008.
 117. However, as is clear from Professor Caddy's Report and from the evidence of Dr Linacre to us, the report was dealing with Low Template DNA where the quantity was less than 200 picograms.
 118. The evidence of Dr Linacre was that it is permissible to express an opinion on the possible mechanisms by which the cellular material came to be transferred where the profile is derived from a quantity which is above 200 picograms. It may be that an opinion can also be expressed on profiles where quantities are below 200 picograms, but that question was not before us and we express no view.
 119. We accept the evidence of Dr Linacre, as it is logically cogent. It is common ground that it is permissible for the expert to enumerate the possibilities in most circumstances. Even though the scientific knowledge on transferability (which we summarised at paragraphs 59 and 60 above) is plainly incomplete, we consider that the underlying science is sufficiently reliable for a range of possibilities to be enumerated as to the circumstances of transfer, including the mechanisms and timing, provided the limitations are made clear. Whether a forensic scientist can do so in any given case will depend on the circumstances, but in the present appeal the circumstances (including the quality of profile) were such that the possibilities could be enumerated.
- (iii) *An opinion evaluating the possible mechanisms of transfer and the time of transfer*
120. It is also, in our view, clear that, as a witness can express an opinion on the possibilities with suitable caveats, then logic dictates that it will not only be possible to give some evaluation of each of the possibilities of the circumstances of transfer, but essential to do so when there is sufficient undisputed other evidence that enables this to be done. It seems to us that it is not logical, as was the essence of the evidence of Professor Jamieson and Dr Budowle, to say that an expert could never give such evidence, once it is accepted that the possibilities can be enumerated. Indeed, as we have mentioned, Dr Budowle accepted that a forensic scientist could do this in relation to other areas of science. His reservation concerned unidentified cellular material, whatever the quantity.
 121. However, in our view, a forensic science officer with scenes of crime experience such as Valerie Tomlinson can properly use knowledge of the scene of the crime and the other agreed circumstances to evaluate those possibilities by reference to her experience and the scientific research that has been undertaken. However care must be taken to guard against the dangers of that evaluation being tainted with the verisimilitude of scientific certainty to which we referred at paragraph 101.
 122. As Valerie Tomlinson told us, it may well at the present time be uncommon for a forensic science expert to be able to give evidence which enumerates and evaluates the possibilities. However, we consider that the science is sufficiently reliable for it to be within the competence of a forensic science expert to give admissible evidence evaluating the possibilities of transfer in DNA cases where the amount is over 200 picograms and when there is a sufficient evidential basis from the profiles and other material, as there was in this appeal, for it to be done. As Valerie Tomlinson rightly

pointed out, it is difficult to envisage the circumstances being set out in a protocol or defined by a set of rules (as suggested by Dr Budowle and referred to in *R v Hoey*), because the circumstances in which such evidence can properly be given are likely to be so variable. It is therefore essential, as we emphasise at paragraphs 128 and following below, that the court exercise a firm degree of control over the admissibility of this type of evidence by reference to the principles to which we have referred. The evidence on the possibilities and the evaluation must be clearly set out in full in the terms in which it is to be given. Where there is a challenge to its admissibility, the court must rule on the issue of admissibility in advance, or at the outset of the trial, in the way we describe below.

123. One of the points raised by Dr Budowle was to suggest that there were other possibilities that might affect the position. He posited the possibility that one of the Reeds had brought both knives to the scene. If that possibility had been raised in cross examination of Valerie Tomlinson at the trial, we consider that it was capable of evaluation. However such an evaluation would have made no difference, as that possibility did not affect the essential matter which she had evaluated – handling of the knives by the appellants when bringing them to the deceased’s house.
124. Another possibility raised by Dr Budowle further demonstrates the illogicality of the position taken. It is common ground that the cellular material cannot be identified. However there are, based on reliable science, only two real possibilities - from skin cells transferred on handling or by secondary transfer, as Valerie Tomlinson suggested or, as Dr Budowle suggested, deposit from epithelial cells through spit. It is easy to envisage ways in which spit might have been transferred – putting the knife handles into the mouth (as Dr Budowle opined in relation to a pen), spitting on the hands (as Dr Budowle opined in relation to a base ball bat) or spitting or sneezing. Given the information that Valerie Tomlinson observed at the scene of the killing and the other agreed facts, it is difficult to see why the jury could not have been given Valerie Tomlinson’s evaluation of the possibilities.
125. In the present case, it was clear that an evaluation could and should have been given. The striking fact about the present case is that the DNA of the appellant Terence Reed was present on AC/3 and that of David Reed was present on AC/4; there is sufficient in the scientific research for a view to be expressed on the circumstances in which there can be secondary transfer. An expert could therefore give admissible evidence evaluating the possibilities to which we have referred at paragraph 89 by reference to the known mechanisms of primary and secondary transfer, the observations at the scene of the crime and the other agreed facts.
126. Valerie Tomlinson was an impressive witness. She had no preconceptions as to what she would find at the scene. She made a very careful evaluation of the electrophoretograms; they were in fact of high quality, as the test conducted in October 2009 proved. She was entitled to use her undoubted and extensive experience and the research set out in the papers to which we referred in paragraph 60 to evaluate the possibilities. We are satisfied that Valerie Tomlinson’s evidence was put forward in such a way to make clear that she was expressing her evaluation of probabilities and that this part of her evidence was to be viewed in marked contradistinction to her evidence in relation to the match probability, where there was no issue as to the scientific certainty of her conclusion. In short, the evaluative

evidence was not given the verisimilitude of scientific certainty in the way her evidence was given. Her evidence was admissible.

127. We would add one qualification. Although we accept that Valerie Tomlinson could properly give admissible evidence evaluating the alternative mechanisms of primary and secondary transfer, we do not consider that she could give admissible evidence that expressed an opinion that the appellants were handling the knives when they broke. This was not one of the possibilities which could properly be enumerated, as there was no reliable scientific basis for her to be able to express a view on the use the appellants made of the knives as opposed to the circumstances of transfer of their DNA. Her opinion on this had no underlying scientific basis and therefore went beyond the scope of the evidence an expert could be permitted to give. However, as we have made clear, she was entitled to express the view that the most likely explanation for the DNA of the appellants being on AC/3 and AC/4 was that they had brought them to the scene. That view was the logical conclusion from her evaluation of the other possibilities - secondary transfer was unrealistic and primary transfer to each of the knives which had then been brought by another to the scene was highly unlikely. As the bringing of the knives to the scene was the vital part of her evidence, we do not consider that the impermissible gloss she added would have affected the jury's conclusion. Furthermore, no objection was made to that gloss, as, in accordance with the principles we have set out, it should have been. There is a clear procedure to identify such evidence and exclude it as inadmissible, as we set out in the following paragraphs.

(iv) *Pre-trial procedure and the exclusion of inadmissible evidence in the context of DNA cases.*

128. In his judgment in *R v Doheny Phillips* LJ emphasised at page 373 the importance of the court exploring the issues prior to the trial:

“We would add that it is important that any issue of expert evidence should be identified and, if possible, resolved before trial and this area should be explored by the court in the pre-trial review.”

129. Part 33 of the Criminal Procedure Rules has, since its making and bringing into force on 8 November 2006, set out the procedure through which the court controls expert evidence in the developing science of DNA. First, we agree with the views of Professor Caddy (to which we referred at paragraph 73) as to the importance of Rule 33.3(1) in providing a very important safeguard. This requires at sub-paragraphs (f) and (g) each expert to identify where there is a range of opinion on the matters dealt with in his report. In such a case, the expert must summarise the scope of opinion and give reasons for his own opinion. If the expert cannot give his opinion without qualification, he must state the qualification. Compliance with this obligation will identify for the other party an area where there is a range of opinion; it is particularly important that this rule is followed in the expert report obtained by the Crown.

130. Second, the Rule enables clear identification of what is in issue before the trial begins. Under Rule 33.6(2) the court has power to direct experts to discuss expert issues in the proceedings and prepare a statement for the court of the matters on which they agree and disagree giving their reasons. If an expert does not comply with this, that

party may not call the expert to give evidence without the permission of the court (Rule 33.6(4)). The court has further extensive power under Part 3 to which recourse can be had as necessary.

131. In cases involving DNA evidence,
 - i) It is particularly important to ensure that the obligation under Rule 33.3(1)(f) and (g) is followed and also that, where propositions are to be advanced as part of an evaluative opinion (of the type given by Valerie Tomlinson in the present case), that each proposition is spelt out with precision in the expert report.
 - ii) Expert reports must, after each has been served, be carefully analysed by the parties. Where a disagreement is identified, this must be brought to the attention of the court.
 - iii) If the reports are available before the PCMH, this should be done at the PCMH; but if the reports have not been served by all parties at the time of the PCMH (as may often be the case), it is the duty of the Crown and the defence to ensure that the necessary steps are taken to bring the matter back before the judge where a disagreement is identified.
 - iv) It will then in the ordinary case be necessary for the judge to exercise his powers under Rule 33.6 and make an order for the provision of a statement.
 - v) We would anticipate, even in such a case, that, as was eventually the position in the present appeal, much of the science relating to DNA will be common ground. The experts should be able to set out in the statement under Rule 33.6 in clear terms for use at the trial the basic science that is agreed, in so far as it is not contained in one of the reports. The experts must then identify with precision what is in dispute – for example, the match probability, the interpretation of the electrophoretograms or the evaluative opinion that is to be given.
 - vi) If the order as to the provision of the statement under Rule 33.6 is not observed and in the absence of a good reason, then the trial judge should consider carefully whether to exercise the power to refuse permission to the party whose expert is in default to call that expert to give evidence. In many cases, the judge may well exercise that power. A failure to find time for a meeting because of commitments to other matters, a common problem with many experts as was evident in this appeal, is not to be treated as a good reason.
132. This procedure will also identify whether the issue in dispute raises a question of admissibility to be determined by the judge or whether the issue is one where the dispute is simply one for determination by the jury.
133. This appeal illustrates the way in which disputed issues should have been addressed (if the opinions expressed by Dr Budowle and Professor Jamieson had then been available to the appellants) and the importance of the care needed in relation to expert evidence of this kind through the use of the procedure under Rule 33.6.

- i) We have set out at paragraph 127 our conclusion that a small part of Valerie Tomlinson's evidence should, if the opinions expressed by Dr Budowle and Professor Jamieson had been available, have been the subject of an objection as to its admissibility. As we have set out, it was, in our view, inadmissible because it had no reliable scientific basis and was therefore not evidence which an expert could give. The inadmissibility of that part is to be distinguished from the remainder of her evidence where, even though she was giving evidence in an area where scientific knowledge is incomplete, the science is sufficiently certain for that evidence to be admissible in all the circumstances of this case.
- ii) The Crown would have set out all the evidence that Valerie Tomlinson sought to adduce in her report. The defence expert would, on the assumption we have made as to the availability of the opinions of Dr Budowle and Professor Jamieson, have challenged at least that part relating to her view that the appellants were holding the knives when they broke.
- iii) This would have been identified as an area of disagreement by the experts in the document produced for the court under Rule 33.6 and was an issue of admissibility. The defence would then have taken that objection in accordance with the general duty under Part 3. The court could then have ruled on its admissibility prior to or at the outset of the trial. That evidence would then not have been given.
- iv) The other parts of the evaluation of Valerie Tomlinson (which the court would have ruled was properly admissible evidence) which were in issue would have similarly been identified as an issue for the jury. It would have been for the defence to challenge that before the jury by way of cross examination alone or by also calling their expert to give evidence.

134. As we have not accepted the evidence of Professor Jamieson and Dr Budowle on enumerating and evaluating the possible mechanisms of transfer which formed the basis for the objection to the admissibility of Valerie Tomlinson's evidence, it follows that her evidence was admissible and, as was accepted at the outset of the appeal, the appeal on that ground must fail. For reasons we explain at paragraphs 140-143 below, we decline to admit their evidence under s.23 of the Criminal Appeal Act 1968. If we had accepted their evidence and admitted it, then the logical consequence would have been that Valerie Tomlinson's evidence on evaluation of the possibilities was inadmissible. As Mr Hill QC accepted on behalf of David Reed, if there was to be a challenge to the evidence of Valerie Tomlinson on the basis that some of her evidence went beyond that which an expert could properly give, then the proper course would have been to apply to exclude that part of the evidence of Valerie Tomlinson. As that did not happen and as we have declined to admit the evidence of Dr Budowle and Professor Jamieson, the issue raised by the appellants under s.78(4) of the Police and Criminal Evidence Act 1984 (as summarised at paragraph 97 above) does not arise.

(5) The expert evidence on metallurgy and pathology

135. The metallurgist, Professor Gibson had conducted experiments that showed that the stress required to break new knives of the type that resembled the broken knife was in the order of 11.8 Newton metres, whereas the maximum force an individual could

exert in the circumstances was likely to be 10 Newton metres. He considered that it probable that neither of the knives used had fractured in the course of the attack and that they were probably not even used in the attack, because in order to fracture they had to bend and the pathology evidence was that there was nothing about the wounds that suggested that they had bent. He did accept that the knives could have been broken at the scene after Peter Hoe had been attacked, as it was not known what the knives used actually were or how old they were.

136. Valerie Tomlinson had considered that evidence, but it was contrary to her own observations and those of her colleagues. She had seen knives which had broken in the course of a stabbing without the need for bending. Professor Gibson had experimented on new knives and it was right to take into account that older knives might break more easily.
137. Both pathologists had agreed that there was no evidence on the body of Peter Hoe to show that the knives had broken through contact with a bone or other hard tissue or been bent; there was no sign of twisting in the wounds. She had taken that into account, but she had not expressed a view as to how they were broken. She told us that she had examined many knives and observed what had happened during stabbing incidents; it was very difficult to recreate the force needed to break a knife.
138. There was agreed evidence at the trial that there were a very large number of unidentified finger prints at the scene. Her evidence to us was that she would have expected to find them.
139. We reject the contention of the appellants to which we have referred at paragraph 96 that her evidence displaced that of the other experts. She properly took their views into account subject to the qualification elaborated at paragraph 127 and did not in her evidence move beyond her area of expertise. Nor in our judgment did the discovery of unidentified finger prints at the scene undermine her ability to express an evaluation of the probabilities, as the presence of these did not undermine the logical basis on which she expressed her evaluation.

(6) Conclusion on whether to admit the evidence of Professor Jamieson and Dr Budowle under s.23

140. As we have set out, we heard the evidence of Professor Jamieson and Dr Budowle *de bene esse*. In deciding whether that evidence is admissible the court has to exercise its discretion taking into account the factors set out in s.23 of the Criminal Appeal Act 1968.
141. We decline to admit that evidence for two entirely independent reasons.
142. First, in the result, there was nothing in the evidence given that was not available at the time of the trial. As the appeal developed, the aspects relating to Low Template DNA fell away and the issue was one relating to the scope of evidence that could be given about transferability. The scientific literature to which we referred at paragraph 60 was available at the time of the trial and the issues well understood. The fact that the profile was obtained by the LCN process was irrelevant to this issue, as was the report of Professor Caddy which dealt with quantities less than 200 picograms. The evidence of Professor Jamieson and Dr Budowle was not dependent on the quantity of

the cellular material, but on the fact that it was not identifiable. That fact was always known. There was no reason for the failure to adduce it, save for the obvious inference that those experts instructed at the time on behalf of the appellants rightly considered that no challenge could be made to the essential part of the evaluative evidence being given.

143. Secondly the challenge in this appeal was to the admissibility of the evidence of Valerie Tomlinson. We have determined that her evidence was admissible. A decision was made at trial not to call the experts who were then advising the appellants to challenge the evidence put forward by Valerie Tomlinson. As the challenge to the admissibility of her evidence has failed, the decision not to call that evidence cannot be revisited, as was implicitly accepted by Mr Hill QC for both appellants. It is not therefore in the interests of justice now to admit evidence of Dr Budowle and Professor Jamieson simply on the basis that, if it had been called, it might have affected the decision of the jury.

4. The grounds of the appeal other than those relating to DNA

144. We turn now to grounds of appeal which relate to what have conveniently been referred to as “the non-DNA points”. We are able to deal with these comparatively briefly.

145. Both Terence Reed and David Reed were given leave by the single judge to argue grounds relating to the summing up in respect of their defence of alibi. Although their grounds are expressed in differing terms, both appellants raise similar points and there is no distinction to be drawn between them. Terence Reed was in addition given leave to argue other grounds. It was therefore his counsel who took the lead in arguing the non-DNA points, and it is convenient to focus on his submissions.

(1) The evidence relevant to the other grounds

146. It is appropriate, before considering the various grounds of appeal, to summarise in more detail some features of the evidence in relation to these grounds. As we have set out Peter Hoe lived at Jubilee Road, Eston. His body was found in his home at about 1300 on the 13 October 2006. The evidence as to the previous day, the 12 October, included the following:

- i) Between about 1730 and 1800 the two appellants, together with their friend Paul Cairns, were in Eston. They went to Peter Hoe’s house, where they were seen by a witness standing in the front garden and looking up at the window. They visited local public houses, giving every appearance of looking for someone whom they could not find. The appellants admitted this part of the evidence, but said they were looking for David Reed’s girlfriend, and not for Peter Hoe.
- ii) After about 1800 the appellants returned by car to the house where their parents lived, which was also the home of Terence Reed. By car, it would take only 4 or 5 minutes to drive from Peter Hoe’s house to Terence Reed’s home.

- iii) The appellants later returned to Eston, and were seen between about 2030 and 2045 near Peter Hoe's home. Terence Reed was seen knocking on the door. This evidence was in broad terms accepted by the appellants, their case being that they were again looking for David Reed's girlfriend and not for Peter Hoe.
 - iv) At 2047 Terence Reed was captured on CCTV film at the Talbot public house, which is about 2 to 3 minutes' walk from Peter Hoe's home.
 - v) Terence Reed admitted that sighting, and asserted that he and his brother had then left Eston and returned to his own home, arriving there at about 2100. He said that his parents, and a family friend Judith Hunt, were there. David Reed only stayed for a short time before leaving.
 - vi) A prosecution witness Lance Gray said he had dropped Peter Hoe off at his home between 2055 and 2110. This was the last time that Peter Hoe was seen alive by anyone other than his murderers.
 - vii) At 21.00.28 Peter Hoe's mobile phone made contact with the mobile phone of a friend of his called Atkinson. Mr Atkinson did not answer his phone, and so a voicemail was left. The voicemail lasted for 4 minutes 27 seconds. During that period there was music playing which was later identified as a Mike Oldfield DVD found in the player at Peter Hoe's house. There was also a noise which the Crown alleged was the sound of Peter Hoe moaning and groaning, but no actual speech. It was the Crown's case that Peter Hoe had either tried to call his friend for help, or had chanced to press keys on his phone which resulted in that call being made, at a time very soon after he had been fatally wounded.
 - viii) At 2114 Terence Reed's mobile phone made a call which was transmitted through a mast situate near to his own home.
147. It was the defence case that the appellants were at their parents' home at around 2100, which was alleged by the Crown to have been the time of the fatal attack upon Peter Hoe. Terence Reed gave evidence to that effect. He called as witnesses his parents, both of whom supported his account. He did not call as a witness either Judith Hunt or Paul Cairns.
148. Neither of those persons was called as a prosecution witness. However, the prosecution had taken (and disclosed to the defence) a witness statement from Judith Hunt, in which she confirmed that she had visited the Reeds on the 12 October but put that visit at a significantly earlier time.
149. In cross-examination of Terence Reed, leading counsel for the Crown asked whether it was intended to call Judith Hunt as a defence witness. Terence Reed replied to the effect that she would probably not give evidence because she was frightened of the Hoe family. In his closing speech, prosecuting counsel commented on the fact that Judith Hunt had not been called as a defence witness. In their closing speeches, counsel for the appellants pointed out that the Crown could have called Judith Hunt as a prosecution witness.

150. David Reed did not give evidence. His case was the same as his brother's in all respects relevant to these grounds of appeal.

(2) The summing up

151. At an early stage of his summing up the judge gave the conventional direction as to the burden and standard of proof. Later, having referred to the defence of alibi put forward by both appellants, the judge directed the jury in clear terms that

“it is for the prosecution to disprove the alibi and even if you conclude that their alibi was false, that by itself could not entitle you to convict them of murder. It is a matter which you may take into account, of course, but you should bear in mind that an alibi is sometimes invented to bolster a genuine defence”.

He went on to say, again in clear terms, that if the jury thought that the appellants could have been elsewhere at the time of the killing, they must return verdicts of not guilty. Terence Reed initially sought to argue that the judge had failed adequately to direct the jury as to the effect of their finding that the alibi might be true. Leave was refused by the single judge, and the appellant has wisely not renewed that application.

152. Even before the jury had retired to consider their verdicts they had sent a note to the judge asking why Judith Hunt and Paul Cairns had not given evidence. At an early stage of his summing up the judge entirely properly directed the jury not to speculate as to why a witness had not been called. The relevant passage included the following:

“It is sometimes said that there is no property in a witness, which means that anyone can be called by either side, but you must not speculate about why you have not heard from Paul Cairns or Judith Hunt and you must not speculate about what their evidence would have been if you had heard from them. The bottom line is that you must not try to fill any gaps which you think there are in the evidence by speculating about them.”

It is acknowledged that this initial direction was impeccable.

The specific issues raised

(i) The summing up: Judith Hunt

153. However, criticism is made of what the judge said at a later stage in his summing up, when he was reminding the jury of the evidence relating to the appellants' alibi. The first ground of appeal relates to what the judge said about Judith Hunt.

154. It is submitted first of all that the judge himself invited speculation as to the possible reason why Judith Hunt had not given evidence, and did so in terms which could have caused the jury to think that the burden of proof had shifted onto the defence. We reject that criticism: the judge in the relevant passage was in our view doing no more than reminding the jury of the rival contentions of the prosecution and the defence, and again telling the jury not to speculate.

155. It is submitted secondly that the judge inadvertently misled the jury by saying that the prosecution could have called Judith Hunt,

“but it is prudent to call someone from whom you have a witness statement and it may be that Judith Hunt, like George and Linda Reed [the parents], had not been prepared to give a witness statement to the police, but all this is speculation and it is not something that you should indulge in”.

The judge did not then know that Judith Hunt had made a statement to the police, the contents of which had caused those representing Terence Reed to advise on tactical grounds that she should not be called. Nor did he know that the prosecution had actually arranged for Judith Hunt to be at court, but had decided not to call her.

156. In the absence of the jury, the judge was apprised of those facts. That was done on a Friday afternoon, and counsel wished to consider over the weekend what should be done about that and other points which had been raised. On the Monday morning the judge indicated to counsel that he intended to tell the jury that Judith Hunt had made a statement, but to do so in the context of showing the jury how dangerous it is to speculate. No counsel raised any objection. The jury then came into court, and the judge told them that he had something to say which illustrated the danger of speculating about why someone had not been called not to give evidence. He said that he had been told that the police had taken a statement from Judith Hunt, and continued:

“It means that the prosecution could have called Judith Hunt if her statement contradicted David and Terry Reed’s alibi; the defence could have called Judith Hunt if it supported their alibi. You do not know what the statement said. You do not know whether Judith Hunt would have stuck by her statement had she given evidence. I therefore repeat what I said to you on Friday. You must accept the position for what it is and you must leave it at that.”

157. That passage is criticised on 3 broad grounds.

- i) It is said that the judge in trying to rectify his earlier error inadvertently misled the jury into thinking that Judith Hunt’s witness statement to the police did not contradict the appellant’s alibi, when in fact it did: that, it is submitted, would be likely to cause the jury to speculate in terms unfavourable to the defence case.
- ii) It is submitted that the judge failed to make clear to the jury that it was for the prosecution to make the jury sure that the alibi was false, and that the appellant must be acquitted if the alibi might be true.
- iii) It is submitted that the judge wrongly introduced evidence after the jury had retired, namely the fact that the witness statement had been made. It should be noted that the third of those grounds did not feature in any document, and was raised for the first time in the course of oral submissions before us.

158. We reject those submissions. It was in our view incumbent on the judge to direct the jury about persons not called as witnesses, particularly bearing in mind that the jury had asked a specific question on that topic. In relation to Judith Hunt he initially did so in terms which are accepted to be impeccable, and which in our judgment were in no way undermined by what followed later. We do not accept that anything he said could be said to invite speculation adverse to the defence case. It is unfortunate that the judge's later remarks were based on a mistaken understanding as to whether Judith Hunt had given a statement to the police. However, the judge corrected the error in an appropriate manner, and we see no basis for thinking that the jury ignored his direction not to speculate. It was not in the circumstances of this case necessary for the judge to repeat what he had already said about the burden of proof, or to spell out again what must already have been abundantly plain to the jury in this regard. The criticism of the judge for adding to the evidence is unsustainable when counsel did not at the time object to his stated intention to tell the jury that the police had taken a statement from Judith Hunt: their silence can only be taken as assent to the course which the judge had indicated, and in the circumstances of this case there was no irregularity in correcting, by agreement, what was agreed to have been an error.

159. We do not think it necessary to refer to the cases which were cited to us in support of the defence submissions. The legal principles to be applied are not in dispute, and the application of those principles must inevitably depend upon the precise facts and circumstances of individual cases. We think it sufficient to say that in our judgment the jury in this case can have been in no doubt as to the burden of proof, and in no doubt that they were required to decide the case on the evidence before them without speculating as to why other potential witnesses had not been called by either side, or as to what those persons would have said if they had been called.

(ii) *The summing up: Paul Cairns*

160. Similar considerations apply to the second ground of appeal, which relates to the summing up in respect of the absence from the witness box of Paul Cairns. It is submitted that he was a man who did support the appellant's account of the early visit to Eston, and had indeed done so in interview under caution when he himself had been arrested, but who had not been called for tactical reasons. Initially the judge simply said that since Cairns had not been called as a witness "you don't know whether he would have supported Terry's version of events up to then but you also do not know why he has not been called to give evidence and therefore you have simply got to leave it at that". In the absence of the jury, counsel submitted that the judge should add to that direction (which was not otherwise criticised) words to the effect, "You don't know whether he would have supported or contradicted the prosecution case". He submitted that it was a question of balance. The judge responded that he did not think there was any lack of balance in what he had said, and declined to say any more on the topic.

161. In our judgment the judge, having already given the directions to which we have referred, was correct to deal with the objection in the way he did. It was not necessary for him to say any more. We see no merit in this ground of appeal.

(iii) *The Crown's expert evidence on the mobile phone recording*

162. The third of these grounds of appeal related to the expert evidence of a prosecution witness, Mr Philip Harrison, a forensic audio consultant who had given detailed consideration to the recording on Atkinson's mobile phone of the voicemail from Peter Hoe's mobile phone. In relation to a single syllable utterance nine seconds into the tape, Mr Harrison gave evidence that he was as sure as he could be that it was a product of the human vocal cords, though he could not say what it might be. In relation to certain noises on the recording which sounded like breathing, Mr Harrison said in terms that they were electronic interference and not a human voice. In relation to different noises heard about 2 minutes 30 seconds into the recording, however, his preferred interpretation was that it was a human voice moaning and groaning, although he could not rule out either an electronic noise or a human humming along with the music or breathing heavily on exertion. Mr Harrison summarised his opinion in this way: "My preferred interpretation is the moaning, groaning but due to the quality I can't discount the others".

163. In relation to this part of the expert evidence, the judge said:

"The defence absolutely correctly point out that Mr Harrison was unable to exclude other possibilities and you must give that the weight that you think it deserves, but the fact that Mr Harrison could not exclude other possibilities does not mean that you cannot be sure that his preferred view was the right one".

164. The submission made on behalf of Terence Reed is that that was a misdirection: if the expert witness could not be sure, how could the jury be sure? The significance of the misdirection, it was submitted, was that the prosecution relied heavily on this noise being the sound of Peter Hoe moaning and groaning as the basis for asserting that he had been fatally wounded at a time before the appellant was shown (in particular by the cell sited of his 2114 phone call) to be at his own home.

165. We do not accept that there was any misdirection. As with most expert witnesses in criminal cases, Mr Harrison was expressing his opinion in relation to one specific aspect of the evidence. It is always for the jury to decide the facts in the light of the evidence as a whole. Whilst they must of course pay due regard to the expertise of an expert witness, they are neither obliged to agree with him, nor obliged to share doubts or reservations expressed by him. The judge rightly directed the jury to that effect. In the circumstances of this case the jury were entitled to be sure that the fatal attack was carried out by the appellants between the 2047 sighting at the Talbot public house and the 2100 voicemail to Atkinson's phone. A particular feature of the evidence which was highly relevant in this regard, bearing in mind that the body of Peter Hoe was not found until the following day, was that Peter Hoe's 2 mobile phones were not used to make or answer any call after the voicemail left on Atkinson's phone at 2100.

(iv) *The timing of the voice mail*

166. The fourth ground of appeal is based upon an allied point also relating to that voicemail. As we have indicated, the voicemail left on Atkinson's mobile phone began at 21.00.28. It was established that the music which can be heard at the start of the voicemail comes 4 minutes and 6 seconds into the Mike Oldfield DVD. On that basis, counsel submitted that the DVD must already have been playing for 4 minutes

6 seconds before the voicemail began, and that it must therefore have been put on at 20.56.22. From that premise, counsel went on to make submissions about the probable time of the fatal attack and the appellant's alibi.

167. The judge in summing up referred to that submission, and observed that it was not correct to say that the DVD must have been started at 20.56.22, because it may have been paused at some point into the recording, and subsequently restarted from that point. He continued -

“I am not of course saying that that is what happened. It is just that you should treat [counsel's] point with caution though it is undoubtedly the case that ... we don't hear any sounds of fighting or any sounds of the killers leaving on the voicemail, and that suggests that the voicemail probably started after they left”.

168. It is submitted that there was no evidential basis for any suggestion that the DVD had been paused, and so the judge was inviting improper speculation. We reject this criticism, for two reasons. Firstly, Mr Harrison himself had referred in his evidence to the possibility that the DVD had been paused and then restarted, so the judge was doing no more than reminding the jury accurately of that part of the evidence and making clear that he was not suggesting that such pausing had in fact occurred. Secondly, it seems to us that the judge was entitled if not bound to point out to the jury that the premise of counsel's submission to them was indeed mistaken.

(v) *The summing up in relation to the phone call at 2114*

169. The fifth ground of appeal relates to the terms in which the judge summed up a part of the evidence relating to Terence Reed's phone call at 2114. As we have said, the cell siting of that call showed that it was transmitted through a mast near to his home: the evidence to that effect came from a prosecution expert witness employed by Forensic Telecommunications Services (“FTS”). The defence case was that the jury should accept the cell siting of that call as supporting the appellant's evidence that he was at his home by that time. That was a fair point. However, the defence sought to push the point a stage further by contending that Terence Reed had put forward his alibi at a time when he did not know that cell siting of his phone call would provide support for what he said.

170. A careful note taken by junior counsel records that in his evidence in chief the appellant, with reference to the time when his defence statement was served, said “At that time I was aware police could interrogate phone”. In cross-examination the note records that the appellant said

“This FTS thing is new to me. I didn't know they could do that, when I got it, it proved I wasn't lying. ... At the time I didn't know police can prove movements from phone”.

171. The judge in summing up initially referred to defence counsel's submissions on that point and said that his own note of the appellant's evidence was different. It was subsequently submitted, in the absence of the jury, that he had been in error to summarise the evidence in the way he did, in particular because of possible ambiguity

in the use of the word “interrogate”, and reference was made to junior counsel’s note. The judge accepted the submission, and went on to say to the jury that “there could be a difference between Terry Reed knowing that the police could interrogate his mobile to find out where it was at a particular time, which Terry Reed did admit knowing they could do at the time when his defence case statement was made, and whether Terry Reed knew that the police could find out just from having his mobile number rather than having his mobile phone where his mobile was at a particular time, and that was not something which he was asked about”.

172. It is submitted to this court that that passage was at best ambiguous, and did not adequately remedy the deficiency of the earlier passage. The effect, it is submitted, was that a good defence point was lost. We disagree. If there was any ambiguity in the passage just referred to, it seems to us it came about because the point had not been fully developed when the appellant was giving his evidence. In any event, it seems to us at best a peripheral point which added nothing to the defence case, and cannot affect the safety of the conviction. If the evidence as a whole made the jury sure of guilt (as it plainly did), evidence that the appellant was at or near his own home by 2114 could not help him. The geography and timescale were such that there was in truth sufficient time for the appellant and his brother to have committed the murder and then returned to, or near to, their family home by 2114.

(vi) *The red Adidas top*

173. The sixth ground of appeal is that the judge failed adequately to sum up the evidence relating to a red Adidas top recovered from the appellant’s home. In the CCTV footage from the Talbot public house on the evening of the murder, the appellant could be seen wearing a red Adidas hooded top. There was evidence that on the following evening he purchased a new red Adidas hooded top from a sportswear shop. The prosecution case was that the top he had been wearing at the time of the murder would have become stained with the blood of Peter Hoe, and that he had therefore disposed of it but had quickly bought an identical replacement so that he would not have to explain what had become of the first one. The defence case was that the appellant was not involved in the murder and therefore had no need to dispose of the first top, and that he often bought sportswear similar to items which he already owned.

174. It was submitted on behalf of the appellant that the prosecution could not prove that the top recovered from the appellant’s home was the one he had bought on the day after the murder. Nor could they prove that it was not the one he had been wearing on the evening of the murder. Since it had no blood on it, the jury could not be sure of guilt if this was or might have been the top worn at the time of the murder.

175. The submission on appeal was that the judge failed adequately to put the defence case before the jury in his summing up. We are quite unable to accept that submission. The judge in our view accurately reminded the jury of the evidence in this regard, and specifically pointed out the inability of the prosecution to prove whether the red top seized from the appellant’s home was the only one then in his possession. We do not accept that anything he said was unfairly detrimental to the defence.

5. The cumulative effect of all the grounds

176. It was submitted finally that each of the grounds of appeal related in one way or another to the way in which the defence case was put to the jury in the summing up, and that the combined effect of the suggested misdirections was to render the conviction unsafe. We have indicated above our reasons for rejecting the individual grounds. We reject also the submission as to their cumulative effect. There was in truth a strong prosecution case against Terence Reed. His defence was fully and fairly put before the jury in the summing up, and nothing the judge said to the jury was wrong in law, or unfairly prejudicial to the defence, or otherwise undermined the safety of the conviction. The same is true of the case against David Reed, and the summing up in relation to his defence.
177. We have again brought into account the DNA evidence with the other grounds. There was, in all, a strong case against these appellants and ample evidence on which the jury was entitled to convict them. We are satisfied that this was a safe conviction and the appeal is dismissed.

VI GARMSON

(1) The DNA Evidence

178. It is convenient first to give a brief explanation of the DNA profile results obtained from the four samples of biological material recovered from KM and their comparison to reference profiles obtained from KM (the victim), JB (her partner) and Garmson.

(i) Trace of semen on the tampon string

179. At the time of the offences, KM was wearing a tampon. Upon examination this was found to be heavily bloodstained. More significantly, a trace of semen was found on the tampon string, but not in an amount such as would be expected from full ejaculation. This semen sample was submitted for standard SGM+ DNA analysis which revealed a mixed DNA profile. The major component matched the KM reference profile, a result entirely to be expected given she had been using the tampon.

180. The minor profile was incomplete but revealed it had originated from one or more males and comprised four distinct alleles which differed from those of KM, one at each of four different loci, namely 13 at D16; 18 at D2; 13 at D18 and 21 at FGA. All four of these “foreign” alleles matched the corresponding alleles present in Garmson’s reference profile. On the assumption all these foreign alleles came from one person, the match probability of that person being unrelated to Garmson was said by Mr Harrington, the forensic expert for the Crown, to be 1 in 120. But we should also note that two of the alleles (those at loci D2 and FGA) also matched the reference sample of JB. If these alleles are discounted (on the basis they may have been contributed by JB) then it was accepted by Mr Linehan QC, who appeared on this appeal on behalf of the Crown, that the match probability of the remaining two alleles coming from a person unrelated to Garmson increases to 1 in 9, a matter to which we must return.

(ii) The lower lip swab

181. KM said that the offender kissed her so a swab was taken from her lower lip. The DNA extracted from this sample was subjected to both standard SGM+ and LCN 34 cycle process. Once again the major profile was a perfect match with that of KM, as would be expected. But the analyses also revealed a minor profile indicating the presence of DNA from one or more males.

182. A total of six alleles differing from those of KM were found, namely 15 at VWA; 18 at D2; 13 and 14 at D18; 15 at D19 and 21 at FGA. All of these foreign alleles matched the corresponding alleles present in Garmson's profile. On the assumption that all these foreign alleles came from one person, the match probability of that person being unrelated to Garmson was said by Mr Harrington to be 1 in 2,500. But again, three of these foreign alleles (18 at D2; 15 at D19 and 21 at FGA) also matched the reference sample of JB. If these alleles are discounted (on the basis they may have been contributed by JB) then the match probability of the remaining three alleles originating from a person unrelated to Garmson was accepted by the Crown to increase to 1 in 77, so raising a similar issue to that in relation to the tampon.

(iii) *Saliva on the inside front of KM's knickers*

183. A saliva stain was found on the inside front of KM's knickers. DNA was extracted and subjected to LCN 34 cycle analysis, yielding a mixed profile again containing the DNA of at least two people. The major profile matched that of KM but the minor profile was in this case more complex. It revealed the DNA came from one or more males with a total of five alleles which did not match those of KM, namely 18 at VWA; 18 at D2; 14 at D19 and 6 and 7 at Tho1. Three of these matched the profile of JB but not Garmson (18 at VWA, 14 at D19 and 7 at Tho1), one matched the profile of Garmson but not JB (7 at Tho1); and one matched the profile of both JB and Garmson (18 at D2).

184. In summary, all the foreign alleles matched the profiles of at least one or other of Garmson and JB. So it is possible they were both contributors. If, on the other hand, all the foreign alleles were derived from only one person, then that person cannot have been either Garmson or JB. He must have been a third and, as yet, unidentified male.

(iv) *Trouser waistband*

185. A swab was also taken of an area on the outside of the waistband of KM's black trousers. DNA was extracted and subjected to LCN 34 cycle analysis. The major profile again matched that of KM. What remained was a partial profile of six foreign alleles, namely 18 at D2; 8 at D8; 13 at D18; 6 and 7 at Tho1 and 21 at FGA. Two of these matched Garmson's profile but not that of JB (13 at D18 and 6 at Tho1); one matched JB's profile but not that of Garmson (7 at Tho1); two matched both the profiles of JB and Garmson (18 at D2 and 21 at FGA); and one matched neither the profile of JB nor that of Garmson (8 at D8).

186. So in this case it is clear that at least one of the foreign alleles was contributed by a third unidentified male. It also follows that if all the foreign alleles were derived from one person then that person cannot have been Garmson or JB. If, on the other hand, they were not, then the results do not rule out Garmson as a possible contributor.

(v) *Y String analysis*

187. A further and different set of analyses carried out on DNA samples from the lip swab taken from AO, and the tampon string and lip swab from KM were conducted using what is commonly referred to as a “Y-STR” analysis of the Y chromosome (to which we referred at paragraph 35). The results obtained were not and have never been in dispute. Specifically it was accepted by Dr Short on behalf of the defence that if the 2005 (KM) and 2006 (AO) DNA had come from two different people, she would have expected it to show up in the Y-STR results and it did not; the tests failed to demonstrate any difference between the two.

(v) *The expert evidence at trial concerning the four KM samples*

188. It is necessary to summarise the expert evidence given at trial, as the application under s.23 to adduce further evidence from Professor Jamieson on this appeal must be considered in that context.

189. Mr Harrington who was called by the Crown explained the results we have summarised; he was cross examined by Mr Grey, who at that time still appeared on behalf of Garmson.

- i) *The sample from the tampon string.* He referred to the four foreign alleles in the minor profile, explained that these matched the reference profile of Garmson and expressed his view that the probability of this DNA coming from an unknown person who was unrelated to Garmson was 1 in 120. We do not understand that opinion to have been challenged on the ground that two of the four foreign alleles were also common to the reference profile of JB.
- ii) *The lip swab.* He explained that the combination of SGM+ and LCN tests revealed a total of six foreign alleles, that no DNA was detected that must have originated from someone other than KM or Garmson and that assuming all the foreign alleles originated from one person, the match probability of that person being unrelated to Garmson was 1 in 2,500. As in the case of the tampon string, he was not asked to give a match probability on the alternative basis that some of the foreign alleles should be discounted as being common to the reference profile of JB.
- iii) *The saliva stain on the knickers.* Mr Harrington correctly identified five foreign alleles, two of which were present in the reference profile of Garmson and the remaining three of which were present in the reference profile of JB. Under cross examination he also accepted, fairly, that one of the alleles (18 at D2) matched both.
- iv) *The trouser waistband.* Mr Harrington explained this yielded a DNA profile indicating the presence of DNA from at least two people. Of the six foreign alleles comprising the minor profile, four matched the reference profile of Garmson, one of the others matched the reference profile of JB and one (which must have been 8 at D8) did not originate from KM, Garmson or JB. It was his view that Garmson could therefore be a contributor of some of the DNA found in the sample but that one component (8 at D8) must have come from an unknown source. This, he thought, was to be expected given the

location of the DNA on the outside of the trousers, the sensitivity of the LCN process and the potential for secondary transfer. He again accepted under cross examination that, as was the case, there was a degree of overlap between the foreign alleles found in the profiles of Garmson and JB.

190. Dr Short and Professor Balding gave expert evidence on behalf of Garmson. Both are highly qualified. Dr Short has a First Class Honours degree in Biology and a PhD in Forensic Biology. She has been a forensic scientist for 20 years, initially with the Forensic Science Service and more recently on a freelance basis. Professor Balding is Professor of Statistical Genetics at Imperial College, London and has a particular expertise in the statistical interpretation of DNA evidence, probabilities, how they are calculated and the assumptions on which they are based. However, it is important to note that when they gave their evidence on, respectively, 14 and 16 August 2007, Garmson was acting in person, as he had withdrawn instructions from Mr Grey on 13 August 2007.
191. The evidence of Dr Short and Professor Balding can be summarised. They expressed concerns about whether match probabilities derived from minor profiles can be relied upon at all. It was also Professor Balding's opinion that it is not safe simply to ignore missing alleles and that these may have a significant effect on match probabilities. Dr Short was concerned the evidence did not establish the DNA came from Garmson, nor the number of sources from which it had come. She expressed particular concern as to the source of the DNA derived from KM's tampon string and considered it possible that it was not derived from the offender but rather from an old semen stain found on the car seat and that it diffused up and onto the tampon string, as she drove the car whilst naked from the waist down. This stain yielded a DNA profile which matched that of JB. Importantly, Dr Short did, however, accept the DNA evidence showed that Garmson was one of the men who might have committed the offences. Subject always to her general concerns, she also accepted the calculation of the 1 in 120 match probability in relation to KM's tampon string and the 1 in 2,500 match probability in relation to her lower lip swab.

(2) The application to adduce fresh evidence from Professor Jamieson

192. As we have set out at paragraph 70, Garmson abandoned the ground of appeal relating to the reliability of the LCN DNA process. Nevertheless he maintained his application to admit the evidence of Professor Jamieson under s.23. We agreed to hear his evidence *de bene esse*. His evidence in this appeal was directed primarily in relation to the samples of biological material recovered from KM. He raised two principal concerns which we will address in turn.

(i) *Should the foreign alleles have been discounted in calculating the match probabilities?*

193. Both in relation to the DNA recovered from the tampon string and that recovered from KM's lower lip swab, Professor Jamieson's evidence in chief was that Mr Harrington had erred in calculating the match probabilities because he had wrongly failed to discount the foreign alleles common to the reference profile of JB. As we have set out at paragraphs 180 and 182, if these are discounted then the match probability in relation to the DNA derived from the tampon string increases from 1 in

120 to 1 in 9, and the match probability in relation to the DNA derived from the lower lip swab increases from 1 in 2,500 to 1 in 77.

194. This was not an issue upon which Mr Harrington was challenged in cross examination. Indeed Dr Short agreed with his calculations, subject of course to her general concerns to which we have referred at paragraph 191. The likely reason became apparent as Professor Jamieson was cross examined and can be illustrated by his evidence in relation to the sample derived from the tampon string. As set out at paragraph 180 above, the three foreign alleles common to the reference profile of JB were 18 at D2, 13 at D18 and 21 at FGA. Each of these is of a relatively high molecular weight and hence particularly susceptible to degradation. If an allele has degraded then it will not be revealed in the DNA profile. So, as Professor Jamieson accepted, the alleles of relatively high molecular weight tend to be lost first.
 195. The significance of this becomes clear by consideration of the low molecular weight alleles such as those at loci D3, VWA, D8 and D19. On the assumption that JB contributed the high molecular weight foreign alleles to the minor profile derived from the tampon string, then it may reasonably be supposed that he also contributed low molecular weight foreign alleles, these being less likely to have degraded. The profile of JB reveals the presence of some alleles at loci D3, VWA, D8 and D19 which are different from any of those seen in the profiles of KM and Garmson. Yet none of these is apparent in the mixed profile derived from the tampon string. The natural inference is that the DNA in the minor profile is not derived from JB at all. As Professor Jamieson accepted in cross examination, the obvious conclusion is that the minor profile is derived from one single source – and, if so, that source cannot have been JB.
 196. The same point emerged in relation to the mixed profile from KM's lower lip swab. The profile of JB has a low molecular weight allele 18 at VWA. Yet this cannot be seen in the mixed profile. It is therefore reasonable to suppose JB was not a contributor to this mixed profile, a proposition we again understood Professor Jamieson to accept.
- (ii) *To whom did the foreign alleles belong?*
197. Professor Jamieson's second concern was that in relation to all four samples, there was nothing to indicate the foreign alleles were derived from more than one person (indeed he thought that was the most obvious explanation) and, if so, that person cannot have been Garmson. He elaborated this primarily by reference to the mixed profiles derived from the outside waistband of KM's trousers and the saliva stain on the inside front of her knickers. He emphasised that the former required an explanation for the presence of foreign allele 8 at D8, and that since this cannot have come from Garmson or JB, it was necessary to postulate yet another person, who is unknown. As for the latter, neither Garmson nor JB could have provided *all* the foreign alleles.
 198. In our judgement this was evidence which both Dr Short and Professor Balding could have given at trial. Indeed, in her statement of 26 September 2006, Dr Short expressly noted in relation to the sample recovered from KM's trousers that of the six foreign alleles, JB had three in his profile, Garmson had four (they shared two in common) and one of the alleles was not present in either profile and so represented

DNA from someone else. An explanation, she continued, was that all of the foreign DNA had come from one source, that source being someone other than Garmson. She did not give evidence of this particular aspect of her statement when she gave evidence at the trial, but she did explain that such low levels of DNA are very difficult to interpret, that it was very difficult to say how many people might have contributed to the foreign DNA and, indeed, that it was not possible to say whether it had come from more than one person. She did not, however, comment specifically on the evidence Mr Harrington gave in relation to the DNA recovered from the trouser waistband, the presence of the foreign allele 8 at D8 and the potential for DNA found at this location to have come from different sources.

199. We are satisfied, after hearing Professor Jamieson and reviewing the transcripts of the evidence at trial, that the evidence Professor Jamieson gave on this appeal could and should have been given at trial, if Garmson wished to rely upon it. Dr Short was plainly in a position to give this evidence and we do not consider the fact that Garmson had by that time chosen to represent himself is a reasonable explanation for the failure to adduce it. Furthermore, and for reasons we shall explain, we do not believe it affords any ground for allowing the appeal in any event.

200. In our judgement therefore, the grounds for admitting his evidence under s.23 have not been made out and we accordingly do not admit his evidence.

(3) The grounds of appeal relating to the admission of the evidence of match probability and the content of the summing up

201. The remaining grounds of appeal are:

- i) The judge should not have admitted DNA evidence relating to match probabilities of 1 in 120 and 1 in 2,500 or of a match between two DNA components;
- ii) The judge failed properly to direct the jury as to the limitations of the DNA evidence and, in particular, the LCN process.

(i) Should the evidence have been admitted in relation to the match probabilities?

202. We have explained the importance of the judge's direction on match probability at paragraphs 54 and 55 above.

203. We are satisfied that in the summing up the judge properly directed the jury on all the issues relating to DNA. Indeed we would wish to pay tribute to the way in which the complex issues were put before the jury by the judge. After summarising the basic science of DNA, the elements of the process of profiling and the concepts of match probability and partial profiles, he summarised the substance of Mr Harrington's evidence to the jury. He pointed out that the DNA recovered from the lower lip and tampon string were the two items upon which Mr Harrington felt it safe to rely and which provided some assistance by way of match probability. He summarised the concerns of Dr Short as to the source of the DNA derived from the tampon string. He specifically reminded the jury of her evidence that the match probabilities would be rendered invalid if the foreign alleles had not all come from the same person. But on the assumption they did, she agreed with the calculations presented by Mr Harrington.

As for Professor Balding, the judge explained his essential criticism that the prosecution had treated the missing alleles as neutral and this, the Professor considered, was not justifiable, at least not in all cases.

204. As we shall explain in considering the second remaining ground of appeal, he also emphasised the limitations of the DNA evidence in the context of the case as a whole. Nothing said by Professor Jamieson in the course of his evidence on the question of match probability gives us any reason to doubt the safety of the conviction. His only criticism of the match probabilities presented by the prosecution melted away in the course of his cross examination, as we have set out above.

(ii) *Was there a failure properly to direct the jury as to the limitations of the DNA evidence?*

205. This ground of appeal has at its heart two criticisms of the summing up:

i) The judge failed to direct the jury that where there was no match probability given for alleles said to match those of Garmson, that was because the scientists could not begin to assess the significance of the match.

ii) Perhaps more importantly, the judge failed adequately to direct the jury that if *all* of the foreign alleles found in *all* of the samples came from one person, that person cannot have been Garmson.

206. We can address the first criticism quite shortly. It relates to the DNA samples derived from the saliva on the inside front of KM's knickers and the outside of her trousers' waistband. In the case of both, the judge explained to the jury that Mr Harrington did not consider it appropriate to calculate a match probability. In the case of the DNA derived from the knickers, this was hardly surprising since only four foreign alleles were identified and only two of these matched the profile of Garmson. The importance of this result was not that it suggested Garmson *was* the offender but rather that it indicated he could not be *excluded*.

207. Much the same applies to the DNA derived from the waistband. In this case Mr Harrington did not consider it appropriate to attribute a match probability to the common alleles because, as the judge reminded the jury, trace amounts of DNA from unknown sources were to be expected given the location of the DNA on the outside of the trousers and the sensitivity of the LCN process. In these circumstances, the possibility of secondary transfer was clearly a very real one.

208. Accordingly we reject the first criticism. The judge fairly directed the jury as to the significance of the match between Garmson's profile and the foreign alleles found in the DNA profiles derived from KM's knickers and trouser waistband and they were left in no doubt that the reason Mr Harrington had not calculated a match probability was because he could not assess the significance of the match beyond the conclusion that it did not *exclude* Garmson.

209. The second criticism is that the judge failed adequately to direct the jury in relation to an alleged inconsistency in the approach adopted by the prosecution to, on the one hand, the DNA samples derived from the tampon string and the lip swab and, on the other hand, those derived from the knickers and trouser waistband. The submission

was developed as follows. Mr Harrington approached the former on the basis that all the foreign alleles came from one person, and hence his calculation of the match probabilities to which we have referred. By contrast, Mr Harrington approached the latter on the basis that the foreign alleles may have come from more than one person. If he had adopted a consistent approach to both, and accepted there was nothing to indicate *all* the foreign alleles in *all* the samples had not come from one person, then he would have been driven to accept that Garmson cannot have been that person. All these are matters which, it is said, the judge failed to explain to the jury.

210. In considering this submission we have had well in mind the evidence at trial. We have also had regard to the evidence given before us by Professor Jamieson. As we have explained, Mr Harrington was not effectively challenged as to his approach to the foreign alleles identified in the DNA samples derived from KM's tampon string and lower lip swab, nor as to his approach to the foreign alleles identified in the DNA samples derived from KM's knickers and trouser waistband. Moreover his evidence expressly included an explanation as to why the DNA derived from the waistband might have come from multiple sources. Dr Short's concerns were more general and she considered it was not possible to say how many sources any of the samples had come from. But she clearly accepted that all of the foreign alleles might have come from Garmson. There was nothing in any of the results to exclude him.

211. All of this evidence was fairly summarised by the judge in the course of his summing up. He also gave the jury considerable general guidance. At the outset of his consideration of the DNA evidence he said this:

“The important thing is this. No-one suggests that this evidence on its own conclusively proves the guilt of the defendant on any count or goes anywhere near doing that. If all you had was the DNA evidence you could not begin to find Mr Garmson guilty on any of these counts because all the DNA evidence does (at the most) is show that he is one of the men who may have committed these offences and that is perhaps to put it at its highest.”

212. A little later the judge asked the jury to consider whether the evidence showed that all of the DNA in the minor profiles came from one person, this being an assumption the experts had made when talking about match probabilities, and again pointed out that Garmson was one of the persons from whom it could have come. Now it is true to say he did not expressly say that if the jury considered that every foreign allele in every sample came from one source then it cannot have been Garmson. But in context we have no doubt the jury must have understood this aspect of the summing up to be directed to the samples from which the match probabilities were derived.

213. After addressing the concerns of Dr Short and Professor Balding, the judge returned to the overall value of the DNA evidence and explained to the jury that they might consider it fell somewhere in a spectrum. At the bottom end, none of the DNA evidence eliminated Garmson as a suspect. At the other end, there was evidence that he was one of hundreds or thousands of men in the UK who might have committed the offences. The judge then reiterated the approach to be adopted in these terms:

“...if the DNA evidence stood alone, you could not convict on it on any count. But it does not stand alone and you will consider its value carefully and use it as part of the evidence when you consider each count individually in the case as a whole.”

214. Moreover, when the judge came to consider the evidence of Mr Harrington in relation to the minor profile derived from the trouser waistband, he specifically drew the attention of the jury to the foreign allele (8 at D8) which did not originate from KM, Garmson or JB. But he continued, accurately summarising Mr Harrington’s evidence, that this was to be expected given the location of the DNA and the sensitivity of the process.
215. In our judgment the summing up was comprehensive and unimpeachable. We therefore reject this second criticism and with it this ground of appeal.

(4) The overall safety of the conviction

216. We have set out in our summary of the other evidence relied on at paragraph 23 above.
217. We are satisfied that the evidence before the jury was clear and there was more than sufficient evidence on which they could be sure that it was Garmson who committed the sexual assault in 2005 on KM. The conviction is safe and the appeal is dismissed.