Forensic Science Regulator

Overseeing Quality

Report

Report on Sodium Rhodizonate Testing in the 1970s

Mr Andrew Rennison MSc

31 January 2013

FSR-R-623

1. EXECUTIVE SUMMARY

1.1.1 This report sets out the results of a preliminary review of the use of sodium rhodizonate as a test for Firearm Discharge Residue (FDR) in the early 1970s. The issue was referred to me by Lynne Featherstone MP (then Parliamentary Under Secretary of State for Equalities and Criminal Information) as a result of an Adjournment Debate held, in Westminster Hall, about the testing of individuals for FDR in criminal cases in the 1970s. One particular case, that of Mr Cleeland, was highlighted.

1.1.2 The role of the Regulator is to ensure the quality of forensic science and forensic pathology provided to the CJS. The role does not encompass the review or investigation of individual cases to determine whether there may have been a miscarriage of justice. That responsibility lies with the Court of Appeal (Criminal Division) and the Criminal Cases Review Commission. However, the issue having being raised, I have given consideration to the allegations made in the debate, sought out information readily available about the case of Mr Cleeland which was raised in the debate and the sodium rhodizonate test and FDR testing more generally from that period.

1.1.3 A miscarriage of justice could occur if the nature of a test was misrepresented to the court (e.g. it was described as a test for FDR as opposed to lead) or the limitations of the test (e.g. the risk of positive results from lead sources other than FDR) not made clear to the court. In this report I set out the material that I have considered and the scope of the preliminary review within the remit of my role.

1.1.4 The available information does not suggest a pattern of results of this test being misrepresented to the courts. On the contrary, the available information suggests the results were presented as indicative of the presence of lead (a significant component of FDR) as opposed to FDR.

1.1.5 For example, the case of Mr Cleeland was cited in the debate as a clear example of the impact of the suggested problems, however the court was

informed that (a) the results indicated the presence of lead and (b) the risk of positive results from occupational contamination was made clear. The nature of the test and limitations was clearly described in the general scientific literature before it was deployed in the field of FDR examination. There may be cases where this issue has not been handled as well as would be hoped but I found no examples of this when preparing this preliminary report.

1.1.6 It appears that in the early 1970s tests, other than sodium rhodizonate, were available in the research environment and, potentially, available for use in non-routine casework. The fact that there were, either at the same time or at a later time, methods which were more specific than the sodium rhodizonate test does not, by itself, mean that cases where that test was employed resulted in a miscarriage of justice. There are other technologies (e.g. DNA) which have developed significantly and provided the results were not misrepresented to the court and limitations of the test were made clear to the court at the time I do not believe that this in itself poses a risk.

1.1.7 Overall, the available information suggests the following.

a. The sodium rhodizonate was reported as a test for lead and none of the alternative techniques suggest that it was inaccurate or misleading.

b. The results of the sodium rhodizonate test were interpreted correctly.

c. The utilisation of the sodium rhodizonate test was based on testing for lead, reporting the presence of lead, explaining lead was a component of FDR and noting the other potential sources of lead contamination. The subsequent implementation of new/alternative techniques does not show that any of the information provided was misleading.

1.1.8 I would consider commissioning a review where there was evidence that:

a. The results obtained by a method were systematically inaccurate, unreliable or misleading; or

b. The results were generally interpreted or reported in a manner which was capable of misleading the court as to the nature of the results or the evidential value of those results in the context of the case; or

c. The reporting of results generally failed to make clear the limitations of the method; and

d. The consequence is that there is a risk of a significant number of miscarriages of justice.

1.1.9 I do not believe that the above criteria have been met, so in light of my preliminary review, I do not intend commissioning a full review - or investigating this matter any further.

2. PURPOSE

2.1.1 This report sets out the results of a preliminary review, by the Forensic Science Regulator (the Regulator), of the use of sodium rhodizonate as a test for Firearm Discharge Residue (FDR) in the early 1970s. [1]

3. ASSISTANCE

3.1.1 The preliminary review and the production of this report were undertaken with assistance of officials from the Forensic Science Regulation Unit of the Home Office.

4. INTRODUCTION

4.1 The Forensic Science Regulator

4.1.1 The position of the Regulator was proposed in HM Government's response [1] to the report [2] "Forensic Science on Trial" [2]. The creation of the position was announced by Meg Hillier MP (then Parliamentary Under-Secretary of State at the Home Department) on 12 July 2007.

4.1.2 The role of the Regulator was described, in a Written Ministerial Statement [3], as follows:

> "... will be to advise Government and the Criminal Justice System on quality standards in the provision of forensic science. This will involve identifying the requirement for new or improved quality standards; leading on the development of new standards where necessary; providing advice and guidance so that providers will be able to demonstrate compliance with common standards, for example, in procurement and in courts; ensuring that satisfactory arrangements exist to provide assurance and monitoring of the standards and reporting on quality standards generally."

4.1.3 Clearly the role focuses on quality standards within forensic science. It does not deal with market or economic regulation nor does it deal with what could be considered service delivery standards. In performing this role I am supported by the Forensic Science Advisory Council (FSAC).

---

1 The terms Firearm Discharge Residue, Gun Shot Residue and Cartridge Discharge Residue are all used in this field. In this report the term FDR will be employed.

2 By the House of Commons Select Committee on Science and Technology.

4.1.4 Although my remit does not extend to Scotland or Northern Ireland, their respective authorities have agreed to join my work, and the FSAC, as full partners and, accordingly, to implement the resulting standards in their own jurisdictions. This will beneficially ensure the existence of UK-wide standards in forensic science.

4.1.5 It is a feature of the role that I am expected to investigate complaints or concerns raised as to the quality of forensic science supplied to the Criminal Justice Systems (CJS) in the UK.

4.2 Firearm Discharge Residue

4.2.1 When a firearm is discharged there are two separate events. The first is the detonation of a primer (generally a small amount of inorganic explosive) caused by the firing pin striking the cartridge. The primer detonation causes the detonation of the larger propellant charge (generally an organic explosive). It is the detonation of the propellant charge which propels the bullet from the firearm [4].

4.2.2 The two detonations cause material to be expelled from the firearm. These include the following.

a. The material produced by the detonation of the primer (including microscopic metal particles).
b. The material produced by the detonation of the propellant.
c. Non-combusted components of the propellant.

4.2.3 The primer generally comprises materials containing lead, antimony and barium compounds and, as a result, the particles produced contain these elements in varying proportions [4-6].

4.2.4 The person who fired the weapon, and people in the immediate vicinity, will be contaminated with this material to varying degrees.

4.2.5 Forensic science laboratories examine items for the presence of the inorganic or organic residues. [3]

5. BACKGROUND

5.1 The Adjournment Debate

5.1.1 On 20th December 2011 an Adjournment Debate [7] was held, in Westminster Hall, about the testing of individuals for FDR in criminal cases. The debate was initiated by Damian Collins MP who set out his concerns in relation to such testing in the 1970s; these can be summarised as follows.

a. Forensic science laboratories employed a test which gave a positive result for lead (a significant component of FDR) rather than one specific to FDR.
b. The test was used even when there were alternative, more specific, tests available.
c. The CJS was misled as to the nature and value of the results of such testing (in particular that it was specific to FDR).
d. There have, as a result, been a number of miscarriages of justice.

5.1.2 Mr Collins also raised concerns about the conviction (partly based on FDR analysis) of his constituent Mr Paul Cleeland. [4] [5] Indeed, this case was put forward as an example of the above issues.

5.1.3 In responding Lynne Featherstone MP (then Parliamentary Under Secretary of State for Equalities and Criminal Information) stated [8]:

> "I can ask the forensic science regulator … to consider this type of evidence. I cannot give an answer on whether there will be a review, but I will ask his opinion of whether there should be a review."

5.1.4 Following the debate the issue was raised with me.

---

[3] Some laboratories refer to the residue produced from the detonation of the primer as percussion primer FDR. For the purposes of this report that level of specificity is not required.

[4] Mr Cleeland was convicted, on 25 June 1973, of the murder of Mr Terrence Clarke. The offence occurred on 5 November 1972.

[5] This case was previously debated in Parliament in 1982 [9] and 1988 [10]. The 1982 debate contained no reference to the sodium rhodizonate test. The 1988 test mentions the test but only to note that it does not differentiate lead from FDR or other sources.

5.2 The Review

5.2.1 The issue having being raised with me I considered the concerns raised, information readily available about the case of Mr Cleeland, the sodium rhodizonate test and FDR testing more generally.

5.2.2 I determined that the appropriate approach was to undertake a preliminary review to determine whether there was evidence of a significant problem. This would cover the following issues.

a. The nature and purpose of the test employed.
b. Whether it has been represented, particularly to the CJS, as a specific test for FDR.
c. Whether other more specific tests were available and in general use.
d. Whether material available to the CJS made clear the nature of the test.
e. Whether the use of the test gave rise to a risk of miscarriages of justice.

5.2.3 The intention being that a full review of the use of the test would be commissioned only if evidence of a significant problem was found.

5.2.4 The Secretary of State for the Home Department and Mr Collins were advised of the approach adopted.

5.3 Reservations

5.3.1 Although this report, perhaps inevitably, includes discussion of the evidence presented in a particular case it is not my role to comment on the safety of the verdict returned, or overall outcome, of any particular criminal case. Nothing in this report should be interpreted as doing so.

5.3.2 In this report the nature and limitations of certain analytical techniques are discussed. This report relates to the use of these techniques in the 1970s and the limitations etc. discussed relate to the techniques as employed at that time. The discussion may not represent the capabilities of the modern implementation of such techniques.

6. THE REVIEW

6.1 Nature of the Review

6.1.1 As discussed above the review was a preliminary review of the available information to determine whether there was evidence which suggested there was a risk that a significant number of miscarriages of justice may have occurred.

6.2 Process

6.2.1 The approach adopted was as follows.

6.2.2 Advice was sought from Forensic Science Northern Ireland (FSNI) on the following issues.

a. The nature and purpose of the sodium rhodizonate test.
b. Whether the sodium rhodizonate test had been represented, particularly to the CJS, as a test specific for FDR.
c. Whether other, more specific tests, were available and in general use in the early 1970s.
d. Whether material available to the CJS made clear the nature of the sodium rhodizonate test.
e. Whether the use of the test gave rise to a risk of a miscarriage of justice.

6.2.3 Having obtained advice from FSNI in relation to the use of the test in the 1970s steps were taken to confirm this information by contacting scientists who had operated in the field of FDR in the 1970s in the following organisations.

a. The Metropolitan Police Forensic Science Laboratory (MPFSL).
b. The Forensic Science Service. [6]
c. The laboratories in Scotland which became part of the Scottish Police Services Authority.

[6] I was not able to contact a scientist from the Forensic Science Service who worked in the field in the 1970s.

6.2.4 As the case of Mr Cleeland was put forward as an example of a miscarriage resulting from the use of the sodium rhodizonate test information was considered in relation to that case.

a. The court judgments related to the case.
b. Information held by the Metropolitan Police Service in relation to the scientific work in the case.
c. The report of the investigation undertaken by Assistant Chief Constable Boothby into allegations made by Mr Cleeland.
d. The "Humphries Report" into allegations made by Mr Cleeland.
e. Information provided by Mr Collins on behalf of Mr Cleeland.

6.2.5 To determine whether there was evidence of established miscarriages of justice, or a pattern of allegations of miscarriage, based on the use of the sodium rhodizonate test the following steps were taken.

a. Legal research databases [7] were checked for any judgment using the term "rhodizonate". [8]
b. Legal research databases were searched for any UK appellate court [9] judgment including the term "discharge residue".
c. There was a possibility that the matter would arise in court but not as part of a direct appeal. It is possible the matter would be considered before the courts as a judicial review application in relation to a CCRC decision not to refer a case to the Court of Appeal. A search of the legal research databases for judgments of the "Administrative Court" which included the terms "rhodizonate" or "discharge residue" was therefore performed.

6.2.6 To determine if there was evidence of a number of claims of miscarriage of justice having occurred as a result of the use of the sodium rhodizonate test the

---

7 This included a commercially available legal research service and the Internet site of the British and Irish Legal Information Institute (BAILII).

8 An additional search was performed using the term "rhodisonate" to account for any variability in spelling.

9 This included the Court of Appeal (Criminal Division), the House of Lords, the Supreme Court of the United Kingdom, the Court of Appeal for Northern Ireland and the High Court of Justiciary.

CCRC [10] was asked whether a number of applications had been made on that basis.

6.2.7 Inquiries were made with the Metropolitan Police Service and the Forensic Science Service Archive about the availability of records, particularly statements, from other cases involving FDR evidence in the early 1970s. In both cases the response was that it would not be possible to search for cases on the basis of evidence type.

6.2.8 The evidence presented to the "Bloody Sunday Inquiry" [11] was reviewed as it considered the use of FDR evidence in the early 1970s.

7. CONSIDERATION

7.1 Miscarriage of Justice

7.1.1 The risk of a miscarriage of justice can arise, in relation to the use of scientific evidence, as a result of a number of factors. It is not necessary to provide an exhaustive list of these factors but those which are clearly relevant to the matter under consideration are as follows.

a. The scientific method employed is flawed.
b. The nature of the evidence is not properly assessed or reported by the scientist.
c. The nature and value of the evidence is not properly understood by the CJS participants.
d. The evidential value, in the context of the case, is not properly assessed or reported by the scientist.
e. The evidential value, in the context of the case, is not properly understood by the CJS participants.
f. The limitations of the evidence are not properly reported by the scientist or understood by the CJS participants.

---

10 The CCRC does not cover Scotland but it appears logical that, if there were a significant issue, it would have seen more evidence than the Scottish Criminal Cases Review Commission.

11 The inquiry chaired by Lord Saville of Newdigate established under the provisions of the Tribunals of Inquiry (Evidence) Act 1921, to inquire into the events of 30 January 1972 which led to the loss of life in connection with the procession in Londonderry on that day.

7.1.2 Steps have been taken to prevent these factors having an adverse affect on the CJS. The Court of Appeal (Criminal Division) in *R v. Harris & Ors* [2005] EWCA Crim 1980 and *R v. Bowman* [2006] EWCA Crim 417 has stressed the need to address key issues in the expert's report (see the discussion in the paper on legal obligations [11]). The provisions of Part 33 of the Criminal Procedure Rules [12] codify and build on the principles established by the Court (see the discussion in the paper on legal obligations [11]).

7.1.3 An aspect of scientific evidence which does not, by itself, create the risk of a miscarriage of justice is the development of new or improved techniques.

7.1.4 This can be illustrated by the recent history of forensic DNA analysis. The initial STR based analysis employed a system which examined 4 loci within the DNA molecules. This was replaced by systems which examined 6 and then 10 loci and were, as a result, more discriminating. There are now systems available, although not yet routinely employed in this jurisdiction, which examine 15, or more, loci. There is no rational suggestion that the cases involving the earlier technologies resulted in miscarriages of justice as a result of the subsequent introduction of more discriminating systems. Further, there is no suggestion that the current availability of more discriminating systems, which are not employed, is causing miscarriages of justice.

7.1.5 In *R v. Bates* [2006] EWCA Crim 1395 the Court of Appeal (Criminal Division) made clear that the inability to obtain all possible results from existing DNA analysis chemistries did not undermine the safety of the conviction.

7.1.6 The implementation of a new, or improved, technique may indicate possible miscarriages of justice arising from the use of the earlier technology. Situations which would lead to this conclusion include the following.

a. The new technique demonstrates that the results obtained by the earlier technique could be inaccurate, unreliable or misleading. [13]

---

12 The Criminal Procedure Rules S.I. 1269 of 2012.

13 The term misleading relates to the information produced by the earlier technique. The fact that the new technique reaches a different result does not mean the results obtained by the earlier technique were misleading.

b. The interpretation model employed with the earlier technique led to results which were inaccurate, unreliable or misleading.

c. The new technique demonstrates that some aspect of the utilisation of the earlier technique was not properly understood and, as a result, the CJS was provided with information which was inaccurate, unreliable or misleading.

7.1.7 A similar, but related issue, is the availability of further analytical methods which could be employed in any given case. In a many of areas of forensic science routine casework employs a number of, but not every potentially applicable, analytical techniques. Again this does not, by itself, mean the analytical process adopted is inappropriate or creates a risk of a miscarriage of justice.

7.1.8 It is important, to minimise the risk, that the scientist reports the nature of the examination undertaken and (a) the evidential value of that analysis in the context of the case and (b) any limitations about the approach adopted. See the discussion in the paper on legal obligations [11].

7.2 Terminology

7.2.1 Questions have been raised as to whether the sodium rhodizonate test was represented as being specific to FDR as opposed to a test for lead. The use of terms such as “search for FDR” has been highlighted as evidence scientists employing the test believed it was specific to FDR.

7.2.2 In a number of areas of forensic science it is common for scientists to refer to searching an item for some target (e.g. blood or semen). This is true even when the approach employed (e.g. Kastle-Meyer Reagent) is not specific to that target. This does not prove the scientist does not appreciate the nature, and limitations, of the test being used. It is merely a statement of what they are looking for.

7.2.3 It follows that such statements do not offer a significant insight into the views of the scientist. These can only really be assessed by what the scientist reports to the CJS. Further, as what is reported is the information available to the CJS on the scientist’s views this is the important information.

7.3 Sodium Rhodizonate Test

7.3.1 Sodium rhodizonate [14] [15] reacts with a number of metal ions in solution to produce a coloured precipitate. The ions include titanium, mercury, antimony, cadmium, barium, cobalt, manganese and lead [12]. The colour of the precipitate depends on the metal involved and the acidity of the solution.[16]

7.3.2 The nature of this reaction has been known for some time and its use discussed in a number of sources [13-18].

7.3.3 These references generally discuss the sodium rhodizonate test as one for certain metal ions including lead.

7.3.4 Given that lead is a component of FDR the test could be employed to detect possible FDR. It is clear that it is not specific to FDR.

7.3.5 The introduction of the sodium rhodizonate for the detection of FDR is generally credited [19-25] to Harrison and Gilroy in 1959 [26]. An adaption of the procedure was proposed by Price in 1965 [25].

7.3.6 The Harrison and Gilroy paper [26] gives a clear description of the operation of the sodium rhodizonate test. It is clear that it is a test for lead and other metal ions. It also notes the possibility of positive reactions from persons in occupations which involve exposure to lead.

7.3.7 The Price paper [25] also makes clear that the sodium rhodizonate test is for lead.

7.3.8 The test was introduced into forensic science in the UK prior to 1969 [19] but the exact date has not been determined. It continues to be used for the identification of bullet holes and for analysis of the range of distribution of FDR.

7.3.9 The use of the test for detection of possible FDR residues was abandoned in the mid-1970s with the implementation of more specific methods [19].

---

[14] CAS Number 523-21-7.

[15] Referred to under other names including 1,2-dihydroxy-3,4,5,6-tetraoxo-1-cyclohexene disodium salt.

[16] Given that the consideration in this report deals with the question of whether the test was for lead or FDR the discussion shall only consider these options. The fact that it may provide a positive result for other metal ions shall not be considered.

7.4 Sodium Rhodizonate Test – Information

Risk

7.4.1 The risk of a miscarriage of justice occurring as a result of a court being mislead as to the nature of the test or the meaning of the results depends on (a) whether the results were being misrepresented and (b) the ability of such misrepresentation being successful. The latter is dependent on the information which was available to the CJS.

Information

General Information

7.4.2 The information available to the CJS would come from two sources.

a. The general scientific, or other, literature.
b. The statements provided in the case.

7.4.3 With regard to the scientific literature it is relevant to note the following.

a. The test was described in the general scientific literature [12, 27] as a test for lead as opposed to FDR.
b. The test was described in the forensic science literature (including the papers credited with introducing the test to this area of forensic science [25, 26]) as a test for lead.

7.4.4 It follows that minimal research by the court or any party should have identified the true nature of the results. It is difficult to see how an attempt to misrepresent the results would be successful.

Case Information

7.4.5 As noted above it proved difficult to obtain access to records of cases involving the use of the test from the period of interest.

7.4.6 The information which could be located was as follows.

a. Advice from FSNI as to its practices in that period.
b. Information from scientists who worked in the FDR area in that period.
c. Information in relation to the case of Mr Cleeland.

d. Evidence of forensic scientists in the investigation of events surrounding the "Bloody Sunday" incidents. [17]

7.4.7 This is not as much information as would ideally be checked but it does allow for as assessment. This is particularly true as the case of Mr Cleeland was described, in the Adjournment Debate [7], as an example of a miscarriage on this basis of the issues noted above. Indeed it was the only case cited as evidence of the problem.

7.4.8 The advice from the FSNI [19] was based on examination of statements generated in the period 1969 to 1973. The advice was that the results were described as evidence of the presence of lead. Examples of wording from statements from 1971 and 1973 were provided.

7.4.9 The first example was worded as follows.

> "Hand swabs were tested for the presence of lead. Particles of lead, distributed in a manner consistent with them having been deposited by discharge gases from a firearm, were found on the swabs from the right hand".

7.4.10 The second example was worded as follows.

> "Lead residues were detected on the hand swabs of [X]. This was a smeared staining and though to have originated from contact with a lead object rather than from firearms discharge residues. There was also "a considerable amount" of lead residues on the jacket thought to "indicate close proximity to a discharged weapon"".

7.4.11 In relation to the case of Mr Cleeland the following information was available.

a. The judgment of the Court of Appeal (Criminal Division) which dealt with the appeal in 2002. [18]

b. The judgment of the High Court, in 2007, when it dealt with an application for judicial review of the CCRC decision not to refer the case to the Court of Appeal. [19]

---

17 The "Bloody Sunday" incidents occurred on 30 January 1972 and are therefore of a similar time period to the case used as evidence of problems with FDR testing.

18 *R v. Paul Alexander Cleeland* [2002] EWCA Crim 293.

19 *Paul Alexander Cleeland v. Criminal Cases Review Commission* [2007] EWHC 3360 (Admin).

c. The judgment of the High Court, in 2009, when it dealt with an application for judicial review of the CCRC decision not to refer the case to the Court of Appeal. [20]

d. A case report in relation to a challenge to the actions of civil servants considering the case on behalf of the Secretary of State for the Home Department. [21]

e. A case report related to disclosure issue related to the case. [22]

f. A letter from Dr Sheard (then Director of the Metropolitan Police Forensic Science Laboratory (MPFSL)) to C3 Division of the Home Office [23] dated 16 July 1992 [28].

g. Case notes (assumed not to be comprehensive) from the original MPFSL case file.

h. Statements prepared by Mr McCafferty (the MPFSL scientist who was responsible for the use of the sodium rhodizonate test in the case) as follows.

   i. A typed statement, dated December 1972, without the day being specified, which appears to be the original statement in the case.
   ii. A handwritten draft of the statement noted at i.
   iii. A typed statement dated December 1972, without the day being given, identified as being supplementary to a statement dated 5 December 1972.
   iv. A handwritten draft of the statement noted at iii.
   v. A typed statement dated June 1973, without the day being specified, identified as being supplementary to a statement dated 5 December 1972.
   vi. A handwritten draft of the statement noted at v.
   vii. A handwritten statement on Northamptonshire Police headed paper which appears to be dated November 1978. The exact date is not

---

20 *Paul Alexander Cleeland v. Criminal Cases Review Commission* [2009] EWHC 474 (Admin).
21 *R v. Horseferry Road Magistrates Court ex parte Cleeland* [1992] C.O.D. 110.
22 *R v. Secretary of State for the Home Department ex parte Cleeland* [1996] C.L.Y. 1366.
23 C3 Division of the Home Office advised the Secretary of State for the Home Department on whether a case should be referred to the Court of Appeal (Criminal Division) before the creation of the CCRC.

clear. [24] This statement is not particularly easy to read due to the nature of the handwriting.

i. Report by Assistant Chief Constable EJ Boothby into allegations made against Hertfordshire Police by Mr Cleeland.

7.4.12 The "Humphries Report" was not available but the Metropolitan Police Service reviewed a copy of the Report and advised it did not address issues related to the use of the sodium rhodizonate test.

7.4.13 The judgments from the various cases noted above indicate that the evidence available at the trial of Mr Cleeland was clear that the test produced positive results for lead as opposed to FDR. In particular the statements about, and text quoted from, the initial trial make the following clear.

a. The evidence referred to a test for lead.

i. At paragraph 40 of the 2002 judgment there is a description of the test as a test for lead and reference to statements by Mr McCafferty about lead contamination. It appears, but is not clearly stated, that this was evidence before the initial trial.

ii. At paragraph 108 of the 2002 judgment there is a discussion of "the evidence before the jury as to lead contamination". This is the description of Potter LJ in 2002 but does suggest the jury was aware of the nature of the test.

iii. At paragraph 17 of the 2009 judgment there is a statement that Mr McCafferty "examined various items for the presence of lead, since lead contamination can occur as a result of both the use and handling of a discharged firearm". This is the view expressed by Scott Baker LJ in 2009 as opposed to a clear statement of what was before the jury.

iv. At paragraph 19 of the 2009 judgment Scott Baker LJ quotes from the summing up of the trial judge, Lane J (as he was then), discussing the evidence of Mr McCafferty.

---

[24] Although the date is not clear on the versions available Mr Cleeland provided a copy of this statement which he states was taken during the Boothby Inquiry and is dated 27 November 1978.

> "He said there was lead – lead salts which mainly come from the primer – and the technical scientific constituent, he said, was lead azide … He tested all of those clothes chemically for the presence of lead deposits".

v. In paragraph 25 of the 2009 judgment Scott Baker LJ stated:

> "… in the pretrial statements of Mr McCafferty, there is nothing to suggest that the witness was asserting that the lead which he found was firearms discharge residue. He did not say in those statements that the deposits of lead came from the firing of a gun; still less that they must have come from the firing of a gun."

b. The risk of positive results from other lead sources was considered.

i. At paragraph 40 of the 2002 judgment there is discussion of the fact that the positive reaction obtained from certain items may have been the result of contamination with lead as a result of Mr Cleeland's work as a painter and decorator. Other potential sources of lead contamination were discussed. It appears, but is not clearly stated, that this was evidence before the initial trial.

ii. At paragraph 19 of the 2009 judgment Scott Baker LJ quoted the summing of the trial judge, Lane J (as he then was), as follows.

> "the defendant, who, as we know is a painter and decorator, would come into contact with lead based paints and if he did and if they left a residue, his clothing would of course give a positive reaction for lead."

iii. At paragraph 20 of the 2009 judgment Scott Baker LJ quoted from the summing up of the trial judge, discussing the evidence of the defence expert witness Mr Lyne, as follows.

> "He, you will recollect, went on to say that you can get clothing contaminated from ordinary environmental reasons. He mentioned petrol fumes from petrol which contains lead".

iv. Further - at paragraph 20.

> "The other possibility which was mooted as a reason for lead contamination was the sanding off of lead based paints".

v. At paragraph 25 of the 2009 judgment there is a discussion of the evidence of Mr McCafferty – see paragraph a.v above.

vi. At paragraph 27 of the 2009 judgment there is a quote from the cross examination of Mr McCafferty at an earlier trial of the charges. [25]

"The reaction I got from that coat could have been got from a gun. It could have been got from a number of other sources".

vii. At paragraph 28 of the 2009 judgment the court expressed the view that Mr McCafferty was not asserting that positive results proved the presence of FDR.

c. Positive results were noted as potentially being from legitimate contamination with lead.

i. At paragraph 40 of the 2002 judgment the court noted that, at the original trial, Mr McCafferty agreed that a number of the positive results obtained could have arisen from contamination with lead as a result of Mr Cleeland's occupation.

ii. At paragraph 32 of the 2009 judgment Scott Baker LJ refers to the report of the CCRC which states the defence expert gave evidence as to the potential for occupational contamination with lead.

7.4.14 The statements issued by Mr McCafferty refer to a test for lead and for testing for FDR.

a. The statement of December 1972 issued as supplementary to the statement of 5 December 1972 contains the following text.

"I obtained a positive reaction for lead".

"I examined and tested the clothing [references to specific exhibits] for the presence of lead".

b. The statement of November 1978 contains the following text.

"All items of Cleeland's clothing for examination principally for firearms residues"

[25] There appears to be no available transcript of the relevant evidence at the subsequent trial.

> "On the completion of my examination of all … items received including the items of CLEELANDS clothing I made a … statement which covered my chemical tests for the presence of possible firearms residue" [26]

7.4.15 The letter from Dr Sheard [28] refers to the MPFSL being in possession of an undated statement by Mr McCafferty which reported "positive reactions for lead". It further noted that the possibility of sources of lead other than FDR was not discussed in that statement but that this was covered at the trial.

7.4.16 The case notes contain handwritten records of the examination of a number of items. In relation to the items associated with Mr Cleeland they contain comments such as "RHOD – NEG" and "RHOD.FRONT-+". In other areas, particularly those dealing with hand swabs, the notes have records such as "NEG".

7.4.17 Where the notes deal with control samples it contains records such as "No Lead", "No REACTION" and "NEG FOR LEAD".

7.4.18 Advice from scientists who worked for the MPFSL in the early 1970s is that the results of the sodium rhodizonate test were reported as an indication of lead. It was then explained that one source of lead was FDR but that there were other sources. This position was supported by the views obtained from Scotland.

7.4.19 In relation to the investigations surrounding the "Bloody Sunday" incidents the evidence provided by forensic scientists was reviewed, and quoted, by Dr Lloyd OBE [29]. The evidence of Dr Martin (who undertook scientific tests in the original inquiry) was quoted and often referred to lead as the basis of the result.

7.4.20 The evidence of Dr Martin before the Bloody Sunday Inquiry also makes clear his position that the sodium rhodizonate test was for lead as opposed to FDR.

7.4.21 The report by ACC Boothby deals with issues surrounding the examination of weapons within the forensic science laboratory but not issues surrounding FDR.

---

[26] The handwriting is difficult to read so some text is not quoted.

7.5 Sodium Rhodizonate Test – Evidential Value

7.5.1 The sodium rhodizonate test is, as discussed above, a test for lead as opposed to FDR.

7.5.2 In cases involving examination for FDR the presence of lead was used as an indication of the possible presence of FDR. The level of confidence which such an inference could justify depended on the circumstances of the case and the level at which lead would be found in similar examinations where the source was not the discharge of a firearm.

7.5.3 The work of Home Office Central Research Establishment (HOCRE) [27] [21] showed that, in that period, hand swabs taken from the general public showed a significant level of lead contamination. [28] The level of contamination appeared to be linked to the occupation of the individual.

7.6 Alternative Techniques

Risk

7.6.1 In the Adjournment Debate [32] it was suggested that a miscarriage could have occurred as a result of the sodium rhodizonate test being employed at a time when other, more specific, techniques were available. Reference was made to Atomic Absorption Spectrometry (AAS) and Neutron Activation Analysis (NAA).

Neutron Activation Analysis

Availability

7.6.2 There are reports [20, 25] which indicate the development of NAA for FDR analysis purposes began in the early 1960s. The paper by Price [25] indicates work was being undertaken by the Home Office and the Atomic Weapons Research Establishment.

7.6.3 Advice from FSNI [19] indicates NAA was not routinely employed in forensic science laboratories in the UK in the 1970s for the analysis of FDR and, due to the introduction of Scanning Electron Microscopy (SEM) with Energy Dispersive

---

[27] HOCRE was a part of the Forensic Science Service.

[28] It must be borne in mind that lead may have been more prevalent in the environment in the 1970s.

X-Ray Analysis (EDX) has never been routinely used. This view is supported by the following.

a. There were papers published in the 1970s which indicate the technique was still a matter of research [20, 21].
b. The letter from Dr Sheard [28] included advice that NAA had not been adopted in the UK. This was supported by staff from the MPFSL.
c. The evidence of Dr Martin [30] to the Bloody Sunday Inquiry noted his approach to the HOCRE [29] to seek NAA analysis and indicated it was the only forensic science facility in the UK which was performing such analysis.

7.6.4 The lack of uptake has been discussed and possible reasons suggested include the following.

a. Inability to analyse for lead [5, 20, 21, 28].
b. Irradiation requirements and need for access to a nuclear reactor [5, 21, 24, 28].
c. Training requirements for personnel [5].
d. Analysis time [5, 21, 24].
e. Cost [5, 21].

Specificity

7.6.5 NAA operates as a bulk analysis method and provides total quantities of the elements present but does not determine the proportion which originated from a common source (e.g. FDR particles) as opposed to various environmental sources [19].

7.6.6 It follows that NAA was not capable of identification of FDR as the source of the elements. Given the ability to identify FDR constituents other than lead it may be expected to have been more specific than the sodium rhodizonate test.

[29] This establishment was located on the site of the Atomic Weapons Research Establishment and, as a result, had access to nuclear reactor facilities.

Atomic Absorption Spectrometry

Availability

7.6.7 Advice from FSNI [19] indicates AAS was introduced into forensic science for FDR analysis in the mid-1970s. It was in use in the HOCRE by 1972 [19] and was being employed for research. It appears the technique was available for casework by 1974 [19]. It was in use in the Northern Ireland Forensic Science Laboratory [30] from the mid-1970s. This view is supported by a number of points.

a. The HOCRE was involved in research in the application of AAS to FDR in 1972/73 [21, 24].
b. The letter from Dr Sheard [28] indicates the technique was developed in 1973/74 but that there were issues with contamination and interpretation. Due to the development of SEM/EDX methods it was not routinely employed in casework in the MPFSL. [31] [32]

Specificity

7.6.8 AAS operates as a bulk analysis method and provided total quantities of the elements present but does not determine the proportion which originated from a common source (e.g. FDR particles) as opposed to various environmental sources [19].

7.6.9 The work of the HOCRE [21] concluded that positive results, by AAS analysis, for lead and antimony were not definite proof of contamination with FDR. It might be expected to be more specific than the sodium rhodizonate test on the basis that it would detect elemental components of FDR other than lead. The work of the HOCRE provides support to this position but without further research it is impossible to state conclusively that this is the case.

7.6.10 There has been criticism of the technique due to the number of false positives reported [5].

---

30 The forensic science laboratory in Northern Ireland has been referred to be a number of names over the period of its existence. FSNI is a relatively recent name.

31 The fact the MPFSL appears not to have employed AAS where it appears to have been used in Northern Ireland may be a result of differing distribution of case types.

32 This position was confirmed by advice from scientists who worked in the MPFSL at that time.

Scanning Electron Microscopy

Availability

7.6.11 Advice from FSNI [19] indicates this method was the subject of research and development over the period 1974-1977. Its use in the field of forensic FDR analysis was popularised by a 1976 paper [9]. It was in use in the Northern Ireland Forensic Science Laboratory from the late 1970s. FSNI also noted information from the MPFSL which suggested this method was implemented in that laboratory from about 1978/79. This position is supported by the following points.

a. The letter from Dr Sheard [28] notes that SEM/EDX was only available in the MPFSL after the transfer to the site in Lambeth in 1974. No date of introduction is given but it is said to have seen subject to development and available in casework only from the mid-1970s. This has been supported by scientists working in the FDR field in that period.
b. Material published in the period [22] makes reference to a number of papers published in the period 1974-1976.
c. There are suggestions [6] that a report published in 1977 was important in the adoption of SEM/EDX in this field.

Specificity

7.6.12 SEM with EDX has distinct advantages as a method for the identification of FDR. It offers the ability to examine individual particles, their morphology and determine their elemental composition. The scientist can therefore determine whether the morphology and composition are consistent with it being FDR [6]. It has therefore become one of the standard methods for identification of inorganic FDR [6]. It is not considered to be specific to FDR.

Other Techniques

7.6.13 The advice from FSNI [19] and information from elsewhere [5] refer to a number of other analytical methods but these do not appear to have been in routine use within forensic science laboratories in the UK in the 1970s.

7.7 Evidence of Miscarriages of Justice

Appeals Related to Sodium Rhodizonate

7.7.1 No appellate court judgments were located where the term “rhodizonate”, or “rhodisonate”, was employed.

7.7.2 It is difficult to envisage circumstances where an attack could be made on the quality of the sodium rhodizonate test without a mention of the test, by name, in the judgment. However, it is notable that the search did not identify the 2002 appeal by Mr Cleeland. [33]

7.7.3 Examination of the judgment [34] shows that there was no attack on the quality of the sodium rhodizonate test itself. One of the grounds of appeal related to the failure to use more specific tests. [35]

Appeals Related to Discharge Residue

7.7.4 The search of the legal databases provided a number of cases where an appeal court judgment had included the text “discharge residue” - or otherwise met the search criteria. [36] These were the following.

a. *Murry v. DPP* [1993] 97 Cr. App. R. 151.
b. *R v. Campbell* [1998] 1 Cr. App. R. (S) 264.
c. *R v. Martin* [2001] EWCA Crim 2245.
d. *R v. Tozer* [2002] EWCA Crim 966.
e. *R v. Luck* [2002] EWCA Crim 1345.
f. *R v. Bristow & Anor.* [2002] EWCA Crim 1571.
g. *R v. George* [2002] EWCA Crim 1923.
h. *R v. Bamber* [2002] EWCA Crim 2912.
i. *R v. Crook* [2003] EWCA Crim 1272.
j. *R v. Higginson* [2003] EWCA Crim 3319.
k. *R v. Konopek* [2005] EWCA Crim 22.

---

33 *R v. Paul Alexander Cleeland* [2002] EWCA Crim 293.
34 *R v. Paul Alexander Cleeland* [2002] EWCA Crim 293.
35 See paragraph 67 of the judgment.
36 The nature of database search protocols is that some results will be returned where the components of the terms appear rather than the specific term.

l. *Re Attorney General's Reference (No. 89 of 2005)* [2005] EWCA Crim 3031.
m. *R v. Russell* [2006] EWCA Crim 470.
n. *R v. Davis* [2006] EWCA Crim 1155.
o. *R v. Khan* [2006] EWCA Crim 2602.
p. *R v. Abnett* [2006] EWCA Crim 3320.
q. *R v. George* [2007] EWCA Crim 2722.
r. *R v. Labastide & Anor.* [2008] EWCA Crim 2564.
s. *R v. Johnson* [2008] EWCA Crim 3272.
t. *R v. Keeling* [2009] EWCA Crim 861.
u. *R v. Campbell* [2009] EWCA Crim 1076.
v. *Re Attorney General's Reference (No. 16 of 2009)* [2009] EWCA Crim 2439.
w. *Re Attorney General's Reference (No. 84 of 2009)* [2010] EWCA Crim 1879.
x. *R v. T* [2010] EWCA Crim 2439.
y. *R v. Joseph* [2010] EWCA Crim 2580.
z. *R v. Sannoh* [2010] EWCA Crim 3117.
aa. *R v. Martin* [2011] EWCA Crim 2245.
bb. *R v. Chattoo & Ors.* [2012] EWCA Crim 190.
cc. *R v. Williams* [2012] EWCA Crim 264.
dd. *R v. Caracher & McGinn* [2000] NICA 35.
ee. *Gage v. HM Advocate* [2006] HCJAC 7.
ff. *McBride v. HM Advocate* [2009] HCJAC 2.
gg. *McDonald v. HM Advocate* [2010] HCJAC 45.
hh. *Gage v. HM Advocate* [2011] HCJAC 40.
ii. *Gage v. HM Advocate* [2012] HCJAC 14.

7.7.5 None of these cases involved an attack on the sodium rhodizonate test.

7.7.6 It was noted that the 2002 Court of Appeal judgment in relation to the case of Mr Cleeland did not appear in the above list. Examination of the judgment showed that the term "discharge residue" was not employed but the terms "powder residue", "lead residue" and "firearms residue" were employed.

7.7.7 Further searches were performed for appellate court judgments using these terms. This provided the following, additional, judgments.

a. *R v. Cleeland* [2002] EWCA Crim 293.
b. *R v. Nolan* [2002] EWCA Crim 464.
c. *R v. Ozer & Ors.* [2002] EWCA Crim 925.
d. *Re Attorney General's Reference (No. 3 of 2004)* [2004] EWCA Crim 1532.
e. *R v. Edwards* [2004] EWCA Crim 2102.
f. *R v. Enninful* [2004] EWCA Crim 2582.
g. *R v. Singh* [2005] EWCA Crim 1448.
h. *R v. Khan* [2005] EWCA Crim 1492.
i. *R v. Melville* [2005] EWCA Crim 1668.
j. *R v. Gibney* [2005] EWCA Crim 1887.
k. *R v. Russell* [2006] EWCA Crim 470.
l. *R v. Kelly & Anor.* [2007] EWCA Crim 1715.
m. *Re Attorney General's Reference (No. 96 of 2007)* [2007] EWCA Crim 3488.
n. *R v. Barnes* [2008] EWCA Crim 529.
o. *R v. Smith & Anor.* [2008] EWCA Crim 1342.
p. *R v. Preston* [2008] EWCA Crim 2024.
q. *R v. Langage* [2008] EWCA Crim 2398.
r. *R v. Welford* [2008] EWCA Crim 2845.
s. *R v. Oyebanjo* [2008] EWCA Crim 3259.
t. *R v. Nelson* [2009] EWCA Crim 1600.
u. *R v. Tate* [2009] EWCA Crim 2438.
v. *R v. Sabi* [2010] EWCA Crim 180.
w. *R v. Biddulph* [2010] EWCA Crim 567.
x. *R v. Okwa* [2010] EWCA Crim 832.
y. *R v. McLean* [2010] EWCA Crim 2398.
z. *R v. Russell* [2011] EWCA Crim 49.
aa. *R v. Bucknor* [2010] EWCA Crim 1152.
bb. *R v. Evans* [2011] EWCA Crim 938.

cc. *Hemphill v. HM Advocate* [2001] HCJAC 21.

7.7.8 As might be expected from the search terms a number of these cases were related to matters other than FDR (e.g. traces of drugs or fingerprint powder).

7.7.9 These judgments were examined and, apart from the case of *R v. Cleeland*, none involved questions about the application of the sodium rhodizonate test.

7.7.10 A search of the legal databases for "Administrative Court" judgments including the term "rhodizonate" produced no records. A similar search for "discharge residue" produced only one case - which was a judicial review application by Mr Cleeland. [37]

Challenges to the Criminal Cases Review Commission

7.7.11 The only cases where a challenge has been made to a decision of the CCRC which appears relevant to this review are those brought by Mr Cleeland.

Criminal Cases Review Commission

7.7.12 The CCRC reported that it had only received one application which included a challenge to the sodium rhodizonate test. It also reported that it had not, as at the date of response, referred any case to the Court of Appeal (Criminal Division) on the basis of a concern over the nature or application of the sodium rhodizonate test.

8. CONCLUSIONS

8.1 The Nature of the Sodium Rhodizonate Test

8.1.1 It is clear that the test, as employed in the field of FDR analysis, is a test for the presence of lead – not a test specifically for FDR.

8.1.2 As discussed, in section 7.1, this could give rise to a risk of a miscarriage of justice if the nature of the test was misrepresented to the court (e.g. it was described as a test for FDR as opposed to lead) or the limitations of the test (e.g. the risk of positive results from lead sources other than FDR) not made clear to the court.

---

[37] *Paul Alexander Cleeland v. Criminal Cases Review Commission* [2009] EWHC 474 (Admin).

8.1.3 The available information does not suggest a pattern of results of this test being misrepresented to the courts. On the contrary, the available information suggests the results were presented as indicative of the presence of lead as opposed to FDR. In the case of Mr Cleeland, cited as a clear example of the impact of the suggested problems, the court was informed that (a) the results indicated the presence of lead and (b) the risk of positive results from occupational contamination was made clear.

8.1.4 Even if there had been pattern of misrepresenting the nature of the test to the CJS (which is not supported by the evidence) it appears unlikely it would have been successful. The nature of the test was clearly described in the general scientific literature before it was deployed in the field of FDR examination. The forensic science literature, including the papers credited with promoting its use in FDR analysis, were clear as to its nature and limitations.

8.2 The Evidential Value of the Sodium Rhodizonate Test

8.2.1 As discussed above the sodium rhodizonate test identifies the presence of lead as opposed to FDR. The evidential value of a positive result depends on the circumstances of the case and the level of lead likely to be found in equivalent tests performed on the general public.

8.2.2 The level of positive results in the general public [21], not associated with the discharge of firearms, indicates that positive results would have to be carefully interpreted and reported – particularly in light of the apparent link of occupation to lead contamination.

8.2.3 In the case of Mr Cleeland the court was advised of the potential for non-FDR related lead contamination and the impact of his occupation on the probability.

8.2.4 There may be cases where this issue has not been handled as well as would be hoped. However, this will almost certainly be the result of case specific factors as opposed to a systemic issue.

8.3 The Availability of Other Techniques

8.3.1 Research on the potential use of other techniques (including NAA and AAS) was underway from the 1960s until 1973/74 when the use of AAS became available as a routine technique in the UK. The utilisation of AAS appears not to have been universal. The use of SEM/EDX was introduced into forensic science in the UK around 1976-1978.

8.3.2 It appears that in the early 1970s tests, other than sodium rhodizonate, were available in the research environment and, potentially, available for use in non-routine casework. The suggestion that the sodium rhodizonate tests results were provided to the CJS while other techniques were being routinely employed in forensic science laboratories appears misconceived.

8.3.3 It appears clear that in the early 1970s there were tests for FDR in development (and perhaps available for non-routine casework) which were more specific than the sodium rhodizonate test. Further, by about 1978 the implementation of the SEM/EDX method provided a far more specific test

8.3.4 The fact that there were, either at the same time or at a later time, methods which were more specific than the sodium rhodizonate test does not, by itself, mean that cases employing the sodium rhodizonate test resulted in a miscarriage of justice.

8.3.5 The discussion at 7.1 sets out some circumstances where the introduction of a new technique may indicate an earlier technique gave rise to a risk of miscarriages of justice. The available information does not suggest any of these criteria apply in this area.

a. The sodium rhodizonate is a test for lead and none of the alternative techniques suggest that it was inaccurate or misleading.
b. The results of the sodium rhodizonate test did not require an interpretation model.
c. The utilisation of the sodium rhodizonate test was based on testing for lead, reporting the presence of lead, explaining lead was a component of FDR and noting the other potential sources of lead contamination. The

implementation of the new/alternative techniques does not show that any of this information was misleading.

8.4 A Full Review

The Grounds for a Review

8.4.1 The role of the Regulator is to ensure the quality of forensic science and forensic pathology provided to the CJS. The role does not encompass the review or investigation of individual cases to determine whether there may have been a miscarriage of justice. That responsibility lies with the Court of Appeal (Criminal Division) and the CCRC. [38]

8.4.2 I would consider commissioning a review where there was evidence that: [39]

a. The results obtained by a method were systematically inaccurate, unreliable or misleading; or
b. The results were generally interpreted or reported in a manner which was capable of misleading the court as to the nature of the results or the evidential value of those results in the context of the case; or
c. The reporting of results generally failed to make clear the limitations of the method; and
d. The consequence is that there is a risk of a significant number of miscarriages of justice.

8.4.3 The existence of one, or more, of these criteria would inform my consideration but would not determine my decision.

8.4.4 The above criteria are clearly applicable to a situation where there is a question as to the reliability of a technique. In this case the issue of the availability of more specific techniques was also raised. In light of the discussion at 7.1.6 I believe the same criteria can be employed in relation to that issue.

---

38 In Scotland the Scottish Criminal Cases Review Commission.

39 The list provided deals with matters relevant to the issue under consideration and is not comprehensive.

Are there Grounds for a Review?

8.4.5 In relation to the criteria noted at 8.4.2 the following is clear.

a. The sodium rhodizonate test is a test for lead and there is no evidence that the results obtained were inaccurate, unreliable or misleading.
b. The interpretation and reporting of the results made clear, on the available evidence, the test was for lead - a fact which was clear in the literature. This was not misleading.
c. The reporting of the results appear, on the available evidence, to have made clear that it identified lead as opposed to FDR and the potential for occupational contamination was both reported and discussed in the literature.
d. There is no evidence that there have been a number of miscarriages, or allegations of miscarriage, of justice.

8.4.6 In light of the above there is no evidence that the use of the sodium rhodizonate test has caused a number of miscarriages of justice. Further, there is no evidence that the availability of more specific techniques caused a number of miscarriages of justice.

Should there be a Review?

8.4.7 I have decided not to commission a full review of the use of this technique.

9. ACKNOWLEDGEMENTS

9.1.1 I would like to thank the following for their assistance.

a. Home Office Ministers for raising this matter with me.
b. Mr Collins MP and Mr Cleeland for the provision of information.
c. Forensic Science Northern Ireland and Dr Griffin OBE, of that establishment, for the provision of advice.
d. The Metropolitan Police Service for the provision of information.
e. The Criminal Cases Review Commission for provision of information.
f. The following forensic scientists for assisting with the review.

i. Mr D Pryor - previously of the Metropolitan Police Forensic Science Laboratory.

ii. Mr G Warman – previously of the Metropolitan Police Forensic Science Laboratory.

iii. Dr J Lloyd OBE – previously of the Forensic Science Service.

iv. Mr D Hall of the Scottish Police Services Authority.

g. Dr J Adams and Mr S Iveson of the Home Office for assistance with the review and preparation of the report.

10. REFERENCES

1 Forensic Science on Trial: Government Response to the Committee's Seventh Report of Session 2004–05, 2005.

2 Forensic Science on Trial, Report of the House of Commons Select Committee on Science and Technology, 2005.

3 House of Commons Hansard, 12 July 2007, Column 67WS.

4 Wardlow T, Firearms, the Law, and Forensic Ballistics, 2nd Edition, CRC Press, 2005.

5 Dalby O, Butler D and Birkett JW, Analysis of Gunshot Residues and Associated Materials – A Review, J Forensic Sci, 2010, 55(4), 924-943.

6 Schwoeble AJ and Exline DL, Current Methods in Forensic Gunshot Residue Analysis, CRC, 2000.

7 House of Commons, Hansard, 20 December 2011, Column 438WH.

8 House of Commons, Hansard, 20 December 2011, Column 444WH.

9 House of Commons, Hansard, 29 April 1982, Column 1060.

10 House of Commons, Hansard, 18 July 1988, Column, 922.

11 Forensic Science Regulator, Legal Obligations, FSR-I-400.

12 Feigl F, Spot Tests: Inorganic Applications, Elsevier 1954.

13 Glater RAB and Hernandez Jr L, Lead Detection in Living Plant Tissue Using a new Histochemical Method, J Air Pollution Control Assoc, 1972, 22(6) 463-7.

14 Chandra R, Detection of Barium, Strontium and Calcium with Sodium Rhodizonate, J Chem Ed (1962), 39(8), 397.

15 Ch'en NK, Chu CH and Ch'in HH, Sodium Rhodizonate as a Specific Reagent for Lead, Shangyi Xuebao, 1958, 153-4.

16 Mukherji AK and Dey AK, Rhodizonic Acid, Reagent for Inorganic Analysis. I. Colour Reactions of Sodium Rhodizonate with Metal Ions, Chimie Analytique, 1957, 39, 148-9.

17 Feigl F and Suter HA, Analytical Uses of Sodium Rhodizonate, Industrial and Engineering Chemistry , Analytical Edition, 1942, 14, 840-2.

18 Kolthoff IM, The Use of Sodium Rhodizonate as a Reagent for Barium, Strontium and Lead, Pharmaceutisch Weekblad, 1925, 62, 1017-20.

19 Advice provided to the Forensic Science Regulator by Forensic Science Northern Ireland.

20 Cornelis R and Timperman J, Gunfiring, Detection Method Based on Sb, Ba, Pb and Hg Deposits on Hands, Evaluation of the Credibility of the Test, Medicine Sci Law, 1974, 14(2), 98-116.

21 Renshaw GD, Private Communication.

22 Andrasako J and Maehly AC, Detection of Gunshot Residues on Hands by Scanning Electron Microscopy, J Forensic Sci, 1977, 22(2), 279-287.

23 Coleman RF, The Application of Neutron Activation Analysis to Forensic Science, J Forensic Sci Soc, 1966, 6(1), 19-27.

24 Renshaw DG, Pounds CA and Pearson EF, The Quantitative Estimation of Lead, Antimony and Barium in Gunshot Residues by Non-Flame Atomic Absorption Spectrophotometry, Atomic Absorption Newsletter, 1973, 12(2), 55-56.

25 Price G, Firearm Discharge Residues on Hands, J Forensic Science Soc, 1965, 5, 199-200.

26 Harrison HC and Gilroy R, Firearm Discharge Residues, J Forensic Sci (1959), 4, 184-199.

27 Feigl F, Laboratory Manual of Spot Tests, Academic Press, 1943.

28 Sheard B, Letter to C3 Division of the Home Office dated 16 July 1992.

29 Lloyd JBF, Initial Report: Firearms & Explosives Residues, Evidence for the Bloody Sunday Inquiry, 1999.

30 Martin J, Evidence for the Bloody Sunday Inquiry.

31 Nesbitt RS, Wessell JE and Jones RF, Detection of Cartridge Discharge Residue by use of the Scanning Electron Microscope, J Forensic Sci, 1976, 21, 595-610.

32 House of Commons, Hansard, 20 December 2011, Column 440WH.

11. ABBREVIATIONS

Abbreviation	Meaning
ACC	Assistant Chief Constable
Admin	In conjunction with EWHC indicates the Administrative Court
Anor.	Another
BAILII	British and Irish Legal Information Institute
CAS	Chemical Abstract System
CCRC	Criminal Cases Review Commission
CJS	Criminal Justice System
C.L.Y.	Current Law Year Book
C.O.D.	Crown Office Digest
Cr. App. R.	Criminal Appeal Reports
DNA	Deoxyribonucleic acid

DPP	Director of Public Prosecutions
EDX	Energy Dispersive X-ray Analysis
EWCA Crim	England and Wales Court of Appeal Criminal Division
EWHC	England and Wales High Court
FDR	Firearm Discharge Residue
FSAC	Forensic Science Advisory Committee
FSNI	Forensic Science Northern Ireland
HCJAC	High Court of Justiciary – Appeal Court
HM	Her Majesty's
HOCRE	Home Office Central Research Establishment
LJ	Lord Justice of Appeal
J	Justice of the High Court
MP	Member of Parliament
MPFSL	Metropolitan Police Forensic Science Laboratory
MSc	Master of Science
NICA	Northern Ireland Court of Appeal
Ors.	Others
SEM	Scanning Electron Microscopy
STR	Short Tandem Repeat
UK	United Kingdom