PATTEN REPORT RECOMMENDATIONS 69 AND 70 RELATING TO PUBLIC ORDER EQUIPMENT

A RESEARCH PROGRAMME INTO ALTERNATIVE POLICING APPROACHES TOWARDS THE MANAGEMENT OF CONFLICT

This is the Second Report prepared by the Steering Group led by the Northern Ireland Office, in consultation with the Association of Chief Police Officers

December 2001

FOREWORD BY JANE KENNEDY MP,
MINISTER OF STATE AT THE NORTHERN IRELAND OFFICE

In June last year the then Secretary of State for Northern Ireland in close consultation with the Home Secretary established a United Kingdom-wide Steering Group to lead a research programme to:

- establish whether a less potentially lethal alternative to the baton round is available, and
- review the public order equipment which is presently available or could be developed in order to expand the range of tactical options available to operational commanders.

The report of the first phase of the project was published at the beginning of April. This report represents the end of the second phase. The report is being made publicly available; copies will be placed in the library of both Houses of Parliament and the report has been put on both the Northern Ireland Office website and the Home Office website.

As the report demonstrates, the pace of the project has been intensified. I am grateful to the Programme Co-ordinator, to the other members of the Steering Group, to the representatives of the Association of Chief Police Officers in England and Wales (ACPO), and to the Home Office Police Scientific Development Branch who carried out most of the research.

The publication of the report is particularly timely. This month has seen the transition of the RUC to the Police Service of Northern Ireland. It has also seen the creation of the Northern Ireland Policing Board, established on a democratic, cross-community basis. We will be working closely with the Policing Board in taking the work forward.

The title of this report rightly makes the point that the research programme is about alternative policing approaches to the management of conflict. The programme covers an unprecedented breadth of research. It brings home that there are no easy answers, 'no quick fix' solutions. But the report brings out a wide range of factors to be taken to account, including:

- the operational needs of the police in responding to public disorder,
- alternative approaches to managing conflict,
- the Human Rights and legal perspective,
- some ethical and cultural considerations and the approaches adopted elsewhere,
- the background to the use of baton rounds in Northern Ireland and overseas,
- the detailed characteristics of a wide range of alternative technologies,
- medical evaluation criteria.

The report then sets out the suggested prioritisation jointly proposed by the Steering Group and ACPO. It also highlights two systems – personal incapacitant sprays and water cannon - both mentioned in the Patten report. However the report, rightly in my view, makes no absolute recommendations for specific systems. That would be premature at this stage. The Steering Group has invited comments on the report from any interested parties. I welcome that approach. For my part, I will be seeking to hear the views of the Policing Board, the Chief Constable, the Ombudsman, and others with whom I will be in contact. Written comments from all those with an interest in this important subject will be welcome. This consultation will take place alongside the initial stages of the third phase of the research programme.

The Government has declared its intention to publish a further progress report by the end of next summer. If there are decisions or actions that can usefully be taken before then, we will do so. On the other hand, we will not shirk from full medical evaluation of alternative technologies where considered appropriate. It would be irresponsible to exchange a short-term problem for one that potentially raised longer term issues until and unless we were satisfied that the change genuinely constituted a better way of dealing with disorder.

I commend this report and will continue to take a close personal interest in the programme.

C O N T E N T S

CHAPTER 1: INTRODUCTION

A. The Approach to the Second Phase

1. This is the second report of the Steering Group set up to take forward recommendations 69 and 70 of the report of the Independent Commission on Policing for Northern Ireland (the Patten report). It concludes the second phase of the programme and initiates the third phase.

2. Recommendation 69 stated that "An immediate and substantial investment should be made in a research programme to find an acceptable, effective and less potentially lethal alternative to the Plastic Baton Round (PBR)."

3. Recommendation 70 stated that "The police should be equipped with a broader range of public order equipment than the RUC currently possess, so that a commander has a number of options at his/her disposal which might reduce reliance on, or defer resort to, the PBR."

4. In summer 2000, the Secretary of State for Northern Ireland set up a UK-wide Steering Group to lead the research programme. The Group has comprised representatives from Her Majesty's Inspectorate of Constabulary, the Home Office, the Association of Chief Police Officers, the Ministry of Defence, the Police Authority for Northern Ireland, the Police Scientific Development Branch (PSDB) of the Home Office, the RUC*, and was chaired by the Northern Ireland Office. It was given the following Terms of Reference:

> *"Objective*
>
> *To establish whether a less potentially lethal alternative to baton rounds is available; and to review the public order equipment which is presently available or could be developed in order to expand the range of tactical options available to operational commanders.*
>
> *Task*
>
> *In the light of the recommendations in the Patten report for a research programme to find an acceptable, effective and less potentially lethal alternative to the Plastic Baton Round, and for the RUC to be equipped with a broader range of public order equipment, to provide advice to the Secretary of State for Northern Ireland in a report as follows:*
>
> *Phase 1 (defining operational objectives and literature review)*
>
> *Define the operational objective against which less potentially lethal weapons must be tested.*
> - *Prepare a literature review of less potentially lethal weapons available or under research.*
> - *Examine the literature review against the operational objective.*

* This report refers in the main to the RUC rather than PSNI as that was the service's title for the great majority of the period under review.

Phase 2 (evaluating the literature review, preparing business case and directing further research as necessary)

- *Formulate proposals for further research on less potentially lethal weapons which would benefit from further research and which have the potential for successful transfer to the operational field, setting out the timings and the costs of that research.*
- *Prepare business case.*

Phase 3 (research)

- *As directed under Phase 2, conduct further research, evaluate performance and safety, and establish deployment costs.*

Phase 4 (operational objectives and public order equipment)

- *Define operational objectives for public order equipment.*
- *Prepare a report on the tactical deployment of a range of public order equipment in Northern Ireland, covering as wide a range of equipment as possible."*

5. Commander Messinger of the Metropolitan Police was appointed Programme Co-ordinator in April 2001. He was asked in particular to co-ordinate the separate strands of activity. In taking forward the programme since the publication of the phase I report in April 2001, contact has been had with a wide range of interested parties in Northern Ireland, Great Britain and overseas, including:

- the Northern Ireland Human Rights Commission,
- the Committee for the Administration of Justice,
- the University of Surrey,
- Amnesty,
- Liberty,
- the Omega Foundation,
- the National Institute of Justice, in America,
- the Law Enforcement and Corrections Technology Advisory Council,
- Pennsylvania State University,
- the Royal Canadian Mounted Police and the Victoria Police Department, British Columbia,
- Government Departments and police services in Belgium, Holland, Germany, Austria, Canada, Australia and elsewhere.

In addition the Secretary of State for Northern Ireland and the Minister for Security have had discussions on baton rounds, amongst other issues, with a further range of interested bodies in Northern Ireland, including political parties and groups such as British-Irish Rights Watch and Relatives for Justice.

6. The programme both quickened and broadened during 2001. This was partly in response to policing incidents in Britain and to political developments in Northern Ireland. In particular, close liaison was established between the Patten Steering Group and the key ACPO sub-committees. Efforts were made to obtain the views of, and input from, non-governmental organisations and Northern Ireland political parties. This report will be published on the Northern Ireland Office website, be tabled in Parliament, and be distributed to a wider range of interested parties.

Comments on its contents and views on the way forward will be welcomed. Written comments should be sent to:

The Secretary to the Steering Group
Room 4.25, Block B
Castle Buildings
Stormont
BELFAST
BT4 3SG

Or e-mailed to: pateam@nics.gov.uk

B. An Overview of the Report

7. This report essentially covers analysis and developments over a six month period from the beginning of April to the end of October. In line with the stages set out in the phase I report, the main elements in this report are:

- an analysis of the policing needs, not just in Northern Ireland but also in Great Britain, primarily in public order situations,
- an assessment of the human rights and legal context, and of other issues bearing on the acceptability of alternative systems,
- an in-depth review of currently available less lethal technologies and those that are at a development stage.

Operational Needs

8. Traditional causes of disorder include sporting events, industrial disputes, social/political protest or local responses to a specific policing action. In addition, in Northern Ireland, disorder often flows from the deep-seated divisions within the community. In Great Britain, in the summer of 2001, there were disturbances in a number of northern cities. A synopsis of the issues these have raised is set out later in the report.

9. Community-based policing requires a greater sensitivity, in responding to potential public disorder. The management of conflict is a core responsibility of the police service on behalf of wider society. Internationally, and in the United Kingdom, a great deal of effort has gone into the development of tactics, equipment and procedures for dealing with the actual encounter. Increasingly attention is being focussed on the skills and procedures required to defuse critical situations, to negotiate acceptable outcomes and to manage risk. A holistic approach is required if policing is to be developed so as to truly contribute to public safety and enjoy the confidence of the community.

10. The focus of this report is on matters relevant to the two specific recommendations in the Patten report. It was realised that an essential preliminary exercise was a gap analysis. Accordingly a study team was set up in spring 2001 to analyse public disorder situations and, in particular, the views of police officers who had had first-hand experience. These in-depth interviews were examined by a team working to a methodology approved by the University of Surrey who have also reviewed the conclusions. The results of the study are set out in chapter 2. The chapter begins with an overview of policing disorder in the community, and includes accounts of public disorder in parts of the UK during the year. It also contains the

broad operational requirement drawn up by ACPO in consultation with the Patten Steering Group.

The Human Rights and Legal Context

11. The framework document in the phase I report identified several related issues:

- human rights and legal requirements,
- ethical and cultural grounds,
- medical issues.

12. Chapters 3 and 4 cover the first two of these issues. An understanding of the human rights context is essential. In the Northern Ireland context, it is a central tenet of the Patten report. Chapter 3 sets out parts of various international documents and discusses their relevance for public order policing. The text was shared, prior to publication, with both the Northern Ireland Human Rights Commission and Keir Starmer, a well-known legal expert on human rights and author of "European Human Rights Law". The chapter also highlights the new accountability arrangements placed upon the police in Northern Ireland in relation to the Policing Board, the Police Ombudsman and the Oversight Commissioner.

13. Chapter 4 contains an audit framework derived from the previous ACPO human rights policy audit. It summarises, under four critical headings, the individual criteria against which systems should be assessed. The Steering Group and ACPO believe that these questions should be addressed when new options are being considered.

14. Chapter 5 summarises, with some examples, the usage of baton rounds in Northern Ireland (and indeed overseas). It acknowledges that no study of this kind would be complete without an account of their effect in previous years. The chapter also includes a summary of the approaches being taken overseas. It notes the impetus to research as a result of incidents during public disorder at inter-governmental summit meetings earlier this year.

The Review of Less Lethal Technologies

15. The next section in the report has been compiled by the Home Office Police Scientific Development Branch on behalf of the Patten Steering Group and ACPO. It is the Branch's assessment of available technologies, and those under development, that have the potential for use as an option that is less lethal than a lethal firearm. The analysis builds on the literature survey contained in the phase I report published in April this year. It takes account of a range of test firings carried out by PSDB, and also a trial of extended-range, impact munitions, undertaken by the Los Angeles Sheriff's Department – in conjunction with the Applied Research Laboratory of Pennsylvania State University.

16. The following chapter contains an overview of the medical factors relating to the potential technologies. This assessment has been directly prepared at the request of the Steering Group by an independent medical panel drawn from academic and medical institutions in the United Kingdom with input from the United States.

Next Steps

17. Most importantly, the final chapter of the report sets out the suggested priorities for further research. This analysis is in the light of the technical assessment so far completed. The next stage, for systems identified as meriting further evaluation, will be extensive test firings and full medical evaluation. A timetable is set out.

CHAPTER 2: THE MANAGEMENT OF CONFLICT

A. Introduction

1. This chapter looks at the demands on the police and its officers in managing conflict in the community. In managing conflict situations, on behalf of wider society, police officers may need to use a variety of approaches from negotiation through non-injurious physical coercion to physical force. Such force itself can range from physical pushing or causing minor discomfort through injury or temporary incapacitation, even ultimately to the deprivation of life in the most extreme situation.

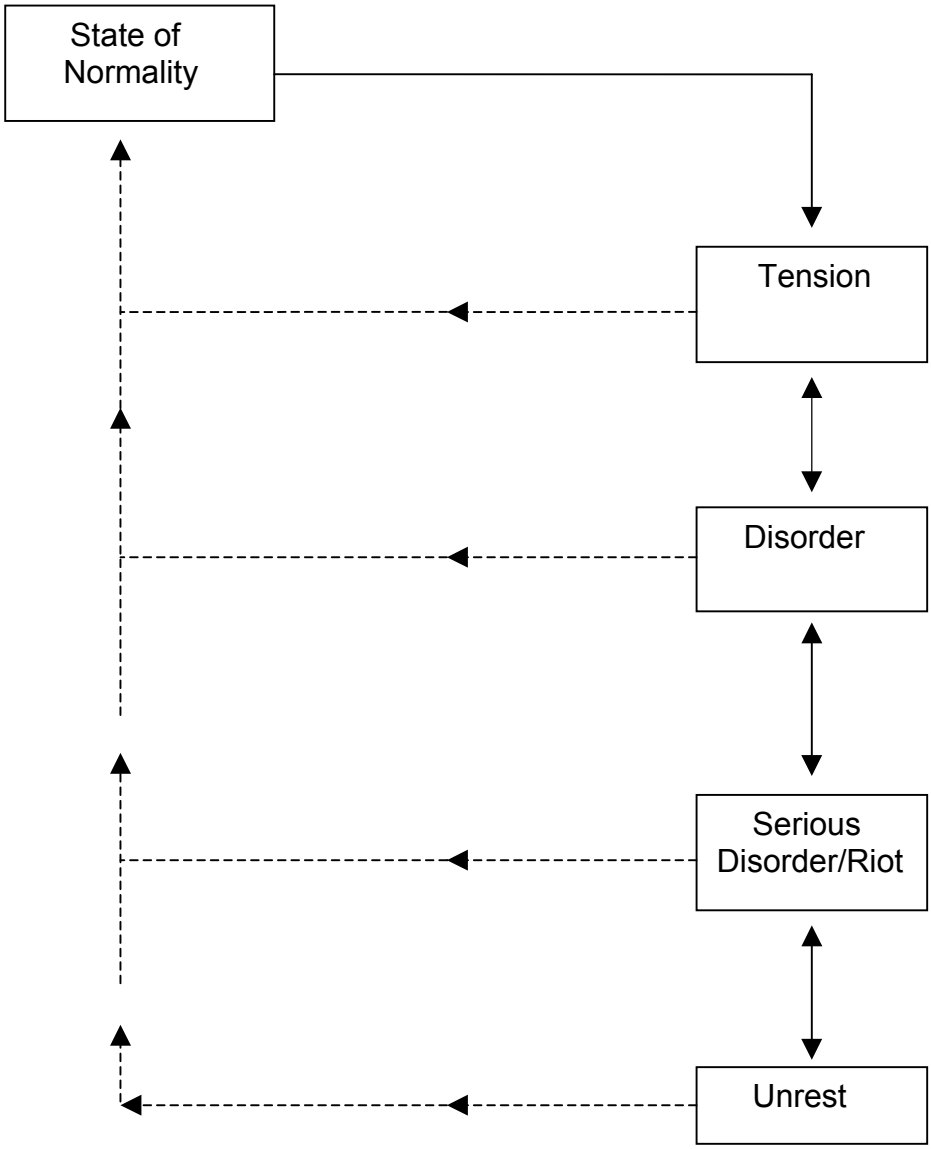
2. This chapter tries to place conflict management in a wider context. It begins with an overview of policing disorder in the community drawing on the experience of the Programme Co-ordinator. It then includes an assessment of public disorder in England earlier this year. The main section is the operational needs analysis. The chapter concludes with the broad operational requirement drawn up by ACPO in consultation with the Patten Steering Group.

B. Policing disorder in the community – an overview

3. Disorder in a community can emerge in a variety of ways. While it is not a continuum, it may appear, at the low end of the scale, as a rowdy person causing annoyance; at the other end, as a full blown riot, involving determined rioters intent on looting, causing serious injury, setting fire to cars etc. Between these two extremes sits a whole range of situations including disputes between individuals, noisy youths, fighting between rival gangs, pub fights, troublesome sporting events, rowdy concerts, illegal raves, firearms incidents, terrorist incidents, violent demonstrations and so on. This list is by no means exhaustive.

4. To most people, the term 'public disorder' probably means 'disorderly demonstration' or 'riot', ie the type of disorder shown at the upper end of the scale. This is particularly so in Northern Ireland, which has seen more than its fair share of such disorder over the years and to help understand some of the issues involved at this level, the following model may be used:

Disorder Model



An explanation of the various stages of the model is shown below:

State of normality: The day-to-day state of order and provision of policing services within a community. This can vary widely from one area to another and even by time of day. Communities are varied entities and may be permanent or transient in nature.

Tension: A level of increased concern or feelings in a community. A trigger incident can result in movement from a state of heightening tension to disorder; such incidents can be instigated by the police, the community or a third party.

Disorder: This represents the stage at which mood is supplemented by action, whether isolated or sustained. It manifests itself in disruption, damage or violence. Such disorder may occur following a single or series of trigger incidents. At this level, unchecked or uncontrolled activity may encourage serious disorder.

Serious disorder/riot: Escalation into violent or disruptive behaviour. This stage may be typified by extreme conflict. This could take the form of violent protest, the act of rioting, criminal damage, looting, or the use of weapons of offence.

Unrest: This is the period, sometimes prolonged, when the rebuilding of relationships takes place. Sensitivity and trust are key factors in this process.

Progression through all stages of the model is not necessary. In some circumstances, it may be possible to return to a state of normality from an earlier stage.

Tactical Options Available To Security Forces

5. The tactics and resources used by police depend very much upon the circumstances. A police officer, armed only with handcuffs, a police baton and personal-issue incapacitant spray, may be able to handle single-handedly a low scale incident of the type shown at the bottom end of the scale mentioned earlier. The careful use of well-chosen and appropriate words and the management of human interaction will resolve many situations. Serious disorder, however, will require a proper command structure, well thought-through strategy, good use of tactics, large police (or even Army) numbers, protective equipment and the effective use of available resources. Firearms and terrorist incidents will also require specialist knowledge and skills. The graduated response is a well-established and necessary approach to managing conflict in a democratic society.

6. Unfortunately, disorder cannot always be put into neat compartments. In the middle of serious disorder, for example, a firearms incident may occur or a particular person in the crowd may act in a way, which requires the intervention of an individual police officer. Tactical options available to police must therefore be planned on the basis of threat and not just on the basis of circumstances. The conflict management model, shown below, helps to explain this point.

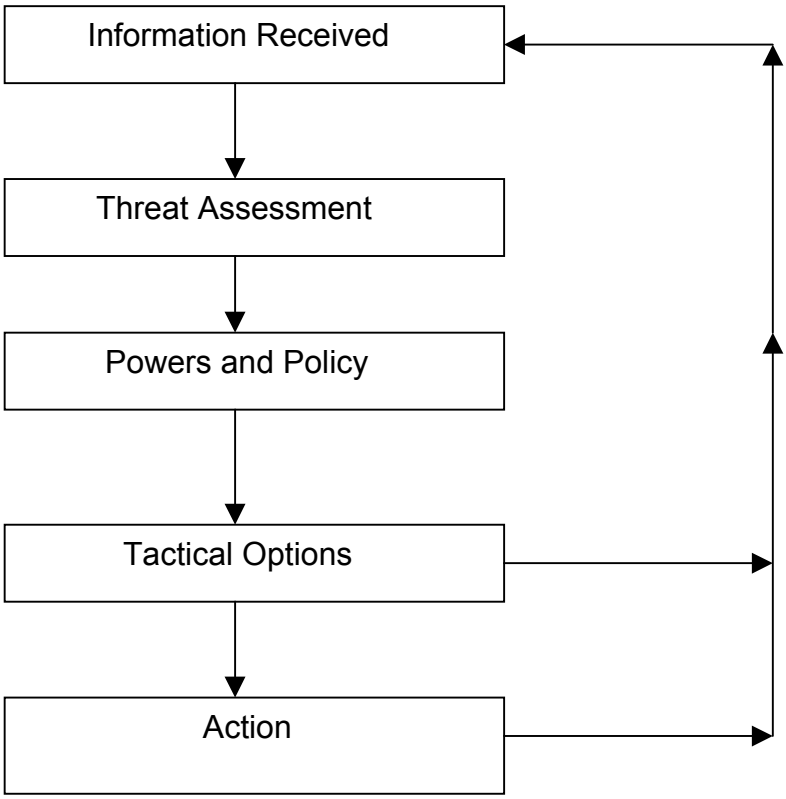
7. The most appropriate tactical options on the day are determined through consideration of the objective, the threat faced and what officers are permitted or capable of doing in the circumstances. There may be a number of different ways of achieving the objective but the one involving least force, in all the circumstances is the one normally selected.

8. Consideration is also given to the impact that any tactics may have on any community-based partnerships and full account must be taken of the European Convention on Human Rights and Health and Safety legislation. Additionally, tactics and deployments used, whilst being flexible enough to meet changing circumstances, reflect the overall policing strategy.

9. The tests for determining the appropriateness of tactical options are discussed in some detail in the following chapter.

10. The main tactical considerations for police, when dealing with disorder, include those of negotiation, effective briefing/debriefing, the establishment of control, containment, regrouping, diversion, dispersal, arrest and the use of reserves and/or support services.

A Conflict Management Model



11. The police conflict management model shown above illustrates the various stages of decision-making used by police when dealing with disorder. The cyclical nature of the model allows for consistent reassessment of the situation and for appropriate action to be taken on the basis of the most up to date information or intelligence available. The model may be applied to low-key incidents and spontaneous disorder as well as to planned events.

12. The actions of the police, of course, must be lawful at all times and so individual officers may be called upon to account for what they did. In such circumstances, they need to show that any force used was necessary and reasonable on the basis of their honestly held belief of the information or intelligence available to them.

13. The policing of serious disorder is not, of course, something peculiar to Northern Ireland. Great Britain police forces also deal with such incidents; some more regularly than others. The force, which has dealt with this type of disorder much more frequently in the past, however, is without doubt the RUC. It is to be hoped that the Police Service of Northern Ireland, drawing support from a wider section of the community, and with its increasing emphasis on community policing with a human rights basis, will experience a reduction in future.

14. Indeed the police in Northern Ireland are developing a more holistic approach to dealing with conflict and the underlying tensions which are present in all communities.

15. Police officers in Northern Ireland have been proactively engaged in a tri-national project involving police officers, academics and community workers drawn from Belgium and South Africa focusing specifically on public order, community policing and the management of conflict. Emerging concepts include viewing conflict as a continuum to be managed across a time line of pre, during and post the event. The principles of provention – pro-active prevention addressing the underlying causes of conflict, prevention of disorder and criminality, de-escalation and the creation of a learning environment/community – are central to the model.

C. Public disorder in England earlier this year

16. In spring and early summer 2001, several forces in the north of England experienced significant levels of disorder. In each case, it proved necessary to deploy relatively large numbers of Police Support Units (PSUs) in order to quell the violent disorder and to facilitate the return to normality; and, during the early stages, the force concerned found it necessary to seek mutual aid from other forces.

17. The forces involved and the main locations were as follows:

Greater Manchester Police - Oldham
a metropolitan force of 6,800 officers

Lancashire Police - Burnley
a force of 3,300 officers

West Yorkshire Police - Leeds and Bradford
a metropolitan force of 4,900 officers

Staffordshire Police - Stoke
a force of 2,100 officers

18. The Home Secretary and some of the local authorities most concerned have set in hand enquiries into the causes of the summer disorders. Their conclusions are expected shortly.

19. Whilst tension may have been high in a number of communities across England and Wales, including in London, it was not easy to predict with accuracy where that tension might manifest itself as disorder on the streets.

20. The police were confronted, on occasions, by large numbers of youths acting in a relatively 'disorganised' fashion. They were attacked with a range of missiles and weapons, including petrol bombs, rubble, roof slates and cars that had been set on fire.

The police response

21. Nationally, the police work to agreed standards for public order tactics, training and equipment. There is, however, room for local variation at force level with regard to training and equipment levels.

22. The responsibility for dealing with disorder rests with the local police, who will establish the necessary command and control structure to deal with the problem as it develops. This includes the management of officers from other forces supplied on mutual aid.

23. Local police were aware of raised tension or specific events (eg in Bradford, a banned National Front march) and had provided officers to deal accordingly. The actual scale of the disorder and the level of violence offered to the officers on the ground had not however been fully anticipated.

24. Police utilised a range of tactics and equipment available to them. This included the use of personal protective equipment (flame resistant overalls, helmets and shields) by officers on PSUs; mounted officers and police dogs.

25. At its height, the violent disorder proved difficult for officers to contain. Conventional tactics embrace options for containment, dispersal and arrest. All of these are difficult, if officers are significantly outnumbered and confronted by high levels of violence. In those circumstances, the protection of life (for both the public and police officers) is paramount and police options are limited.

26. During the disorder, a large number of police officers, including about 350 from West Yorkshire, sustained personal injury albeit predominantly of a minor nature. A significant proportion were injuries to the lower legs sustained during periods of containment undertaken by officers equipped with intermediate shields. Where appropriate, long shields can provide a far greater level of protection.

27. This fact has generated discussion on police tactics at national level given that forces have limited options available when it comes to maintaining a safe distance between a violent crowd and officers on cordons.

28. Forces in England and Wales are also authorised to use baton rounds in public order situations. The majority of forces have had this capability but baton rounds have never actually been used operationally by any force.

29. In the 1980s, at the height of the disorder on Broadwater Farm in London, the Metropolitan Police deployed baton gunners on the ground but authority was never given for them to fire. There were also subsequent deployments on other occasions when serious public disorder was feared, or where there was imminent danger to police lines. One reason they have not been used has been the availability of officers from other forces on mutual aid. (Mutual aid from other police forces is not of course available in the same way to the police in Northern Ireland.)

30. Two further points are worth noting. West Yorkshire Police have borrowed a number of protected landrovers from various other services, including the RUC. The Yorkshire experience highlighted in an English context the difficulty – often experienced in Northern Ireland – of the police being required to defend static lines. This provides rioters with greater opportunity to prepare assaults on the police and use other material in their attacks.

Recent developments

31. A number of forces have been reviewing their public order capability in a new light. This has included the purchase of the new generation of baton guns and rounds (the L21A1) developed through a joint project begun in 1997 between the

Home Office, the Ministry of Defence and the Northern Ireland Office, and authorised for use by the Home Secretary. Another factor taken into consideration by forces has been a renewed debate around less lethal options in situations other than public disorder.

32. The disorder also prompted a debate within forces and at national level both by the government and ACPO as to whether water cannon should be made available in Great Britain. Account has been taken of the recent experience of the RUC in this regard. That debate is ongoing but centres on the need to provide distance between officers on static cordons and a violent crowd.

33. There is no doubt that the service has been troubled by the events of the summer. Based on the hard-won practical experience during recent disorder, work is in hand at both force and national level to analyse and learn lessons from the events that occurred and the extent to which changes in current public order tactics, training and equipment might be necessary. Naturally, these deliberations will take account of the duty of care to provide officers with suitable training and equipment to meet predictable demands being made of them. Similarly, account has to be taken of the services' responsibility under current human rights legislation to have due regard to the rights of members of the public – including rioters - not to be put at unnecessary risk by police action when officers are called upon to deal with levels of disorder which are, inevitably, dangerous for all those involved.

D. Disorder in Northern Ireland in 2001

34. It is not necessary for the purposes of this report to set out in detail the range or variety of situations, including public disorder, to which the police in Northern Ireland are required to respond. It may nevertheless be helpful, in this chapter, to refer briefly to the rioting that occurred over an extended period in North Belfast, as one illustration.

35. The nature of this disorder was well described in an article in the Police Review, published on 19 October 2001. The circumstances have also been described by the Chief Constable in the same magazine in the previous week's edition. That article noted that the disorder on the streets of Belfast in the summer had been described as the worst rioting in Northern Ireland in over 20 years. According to RUC sources, around 300 officers had been injured during the violence, in which they had been targeted with petrol bombs, acid bombs, blast bombs and even automatic gunfire.

36. As the Chief Constable himself noted, police officers were required to prevent one community from effecting injury to the other. This meant police officers being put between two communities and absorbing violence from one or the other side – and sometimes both.

37. The 19 October article quoted the Head of the Belfast Mobile Support Unit who said that the potential costs of leaving communities unprotected were unthinkable. Another senior police officer, based in Belfast, said that a large number of injuries were sustained after rioters advanced right up to the shield walls before hurling bricks, concrete blocks and other missiles at the feet or heads of officers.

38. At a practical level, it was also noted that riots were getting noisier from a constant din of blast bombs, pipe bombs and industrial fireworks exploding just feet away from officers.

39. Finally, the article observed that rioters were aware of the police rules of engagement too. This led to rioters coming close up to shield walls in the expectation that officers would be highly unlikely to fire baton rounds at a shorter range.

40. A few further points about the general context of public disorder in Northern Ireland should be noted:

- often the nature of the disorder is organised (as opposed to the spontaneous rioting referred to in English towns earlier in this chapter);
- there are paramilitary groups in the background (including members who have had access to and experience in the use of firearms);
- serial rioters gain an understanding of police tactics and look for vulnerabilities to exploit;
- the greater incidence of use of firearms and acid bombs by rioters.

E. The broad operational requirement

41. In consultation with the Patten Steering Group, ACPO expanded its existing firearms and self defence operational requirement, taking account of the needs of public order, resulting in the following broad operational requirement. It was recognised from the start that it might need to be revisited in the light of the fuller operational needs analysis. That consideration has not yet been completed. The text is set out below:

*"**Accuracy***

42. The option should be discriminating over a range between 1 and 25 metres. This range is chosen as an approximation to that within which a firearms containment can reasonably be provided by officers with handguns, accounting for their general accuracy. In public disorder situations, accuracy at range will be particularly important since it may be necessary to target individuals in a tightly packed group. Considerable further benefit will arise if an option is discriminating over a greater distance (eg up to 50 metres), allowing it to be deployed as part of a wider containment, and making it more readily transferable to some public disorder scenarios. Naturally, options that are shown to be effective over only part of this range will still merit consideration.

Immediacy

43. The option should be rapidly effective – ideally immediate. Although certain scenarios may benefit from a delayed action, these will be limited.

Subject population

44. The option should be effective against the maximum proportion of the population (taking account of both permanent and transitory differences eg ergonomics/ drunkenness).

Ease of operation

45. The option should be capable of being operated by one officer. It should be suitable for use by the majority of officers with appropriate training, regardless of physical size or gender. It should not rely on complex motor skills.

Judgement

46. The option should minimise the number of judgement issues arising from its use (ie clear intention/targeting/outcome).

Injury/lethality

47. The option should minimise the risk to any person of serious injury and/or lethality at all ranges.

Effect

48. The option should at least temporarily neutralise the threat, rendering a subject incapable of carrying out an immediate threat of violence. The duration of such incapacitation must be sufficient to permit officers to safely approach a subject and restrain them, which may include the need to overcome an obstruction (ie locked door/barricade).

Environment

49. The option should be effective in all operating conditions (eg weather, indoors/outdoors, lighting, temperature etc) and in confined spaces.

Mobility/Flexibility

50. The option should be effective against a moving target. It should be easily transported to the scene of an incident, and ideally portable at the scene.

Cumulative effects

51. The use of the option should not preclude the use of other tactical options before/after. It should not increase or reduce their effects if they are subsequently employed.

Safety/security

52. The use of the option, and the equipment required, should be safe to operate and store, and should have the minimum security considerations.

53. It is naturally recognised that few, if any, options will meet all of the above requirements. They will, nevertheless, enable the production of a matrix to derive the 'best fit' available, probably involving a combination of options. The resulting capability, combined with appropriate tactics and training should equip officers involved in the widest range of scenarios.

Other issues

54. The following additional issues need to be considered in arriving at this capability set which will have a bearing on the practicality of adopting specific options:

- *Repeat operation – speed of multiple use*

  Are repeated applications of the option likely to be required? How feasible is such repetitive operation (by one officer/several)?

- *Specialist –v- general use*

  Is the option appropriate for deployment in all officer roles, or only by specialists (eg dog handlers, tactical firearms units, new team)?

- *Training*

  What are the training periods associated with the option's deployment, both initially and in terms of refresher training? What training facilities are required?

- *Costs*

- *Legal implications*

  Would the adoption of the option require new legal authority (eg prohibited weapons)? What are the tactical considerations in the light of human rights (eg proportionality, least intrusive option)?

- *Acceptability (police and public)*

  What is the external and internal impact assessment associated with the options considered?

- *Visual effect (on subject/third party)*

  Does the option involve equipment looking like a firearm? Can the option be carried/used covertly?

- *After-effects*

  How long do potential after-effects last? What treatment/training is required to deal with potential after-effects?

- *Durability*

  How robust is any equipment required for an option? Over what period can an option be said to be reliable – what checking is required?

- *Authority required to use*

  Who should authorise the use of the option? Who should review its use, when, and how often?

- *Audit trail*

  Does the option have a secure system for recording use? Will this enhance a documented system for decision making?"

F. An Operational Needs Analysis

55. As set out in the Introduction, Chapter 1, the Steering Group identified the need for an in-depth study of the issues as perceived by officers called upon to respond to public disorder. A small team was established, comprising researchers, supported by academic staff from the University of Surrey.

56. The initial approach was through questionnaires. In particular, through an in-depth structured interview format, the study focussed on factors such as threat, distance, time and desired outcome.

57. Over 50 police officers (half from Northern Ireland and half from Great Britain) and a number of military personnel were interviewed.

58. While there was a significant difference between the experience of the officers from Northern Ireland and those in Great Britain forces, the majority of those interviewed had direct, recent experience of at least two of the following threats:

- Violent physical contact, including attack with edged, pointed or sharp weapons
- Thrown blunt/sharp missiles
- Petrol bombs
- Thrown explosive devices
- Firearms, crossbows, etc.

59. The interviewees were asked about their experience, training, experience of less lethal weapons, and were asked to describe situations where they had encountered the threats, both in public order and single aggressor situations. They were also asked about lessons identified and where they perceived there to be gaps in capability in being able to achieve their aims in such situations. Where possible, they were asked to quantify the distances and times over which they wanted to achieve effects and whether to a single aggressor, a portion of a crowd or the whole of a crowd.

60. This study has shown the difficulty in answering what transpired to be a very complex question concerning distances, timings and desired outcomes for less lethal options. To answer the question better would require a much larger subject population and a longer study duration. Nevertheless the report identified the great majority of relevant issues. The remainder of this section of this chapter contains the

full summary section of the report. It is planned to publish the full report in due course.

Background

61. There is wide variation between police forces in terms of the equipment issued to police officers and their policies for dealing with incidents. Other factors such as the geographic make-up of the force area contribute to these differences.
Although there are large differences in the experience of those serving in the GB police forces and those in the RUC, both have common experiences such as having to deal with angry individuals, those who are impaired through drink, drugs or mental illness, and in policing Saturday night crowds; similarities in the latter generally apply to areas in Northern Ireland where there is less sectarian violence. In addition, some of those police officers serving for example in Oldham have experience of serious disorder such as that faced regularly by police officers in Northern Ireland.

62. Talking to someone is still considered to be the police officer's main weapon, supported by empty-handed techniques if someone has to be moved or restrained. Defensive weapons are required where these have failed or the risk assessment deems otherwise.

Threats

63. The five threats that formed the basis of the study were generally considered to be representative of those faced by operational police officers, with acid bombs and burning vehicles being noted as also present during serious disorder.

64. Apart from petrol bombs, none of those interviewed were able to discriminate between different types of thrown missile during serious disorder.

Distance

General points

65. Just under half of the police officers interviewed were able to express views as to the distance they would wish to maintain between themselves and the crowd during serious disorder. When considering single aggressor scenarios, there was greater variability as the range of circumstances and impact factors is that much greater.

66. The distances quoted for single aggressors were generally those that had been taught during training or, for serious disorder, sometimes appeared to reflect the distances imposed by the baton round.

67. There was some evidence that the police officers had difficulty in quantifying distance in an interview situation and/or in judging distances on the ground. There were also widely differing perceptions as to what is acceptable in terms of 'safety' based on the perceived risk from a given threat and its intensity.

Public disorder

68. Those involved in serious disorder require a sterile zone of 30 to 40 metres to be maintained from a determined and experienced crowd.

69. If a determined and experienced crowd has closed down this distance, there is a requirement for a less lethal option, possibly in conjunction with tactics, to create a sterile zone from close-up.

Single aggressor/ small crowd

70. A less lethal option for use by operational police officers would need to work against the main threats of violent physical contact and attack with sharp, edged weapons. This implies an effective distance of zero to 7 metres; however, the actual range of the less lethal option could be less than this, as the critical factor is being able to incapacitate the aggressor before they can close down the distance.

71. There was also a requirement noted for a less lethal alternative to firearms where a major weapon is being threatened. Again, issues such as accuracy and effectiveness are critical. No quantifiable distances were provided for this threat.

Time

72. There was general agreement that a less lethal option needs to provide instantaneous incapacitation that lasts long enough to go forward and restrain the person. The time that the effect needs to last in order to achieve this was generally described as being in the order of 30 seconds to a minute, possibly less.

Effect

73. Some police officers felt that partial incapacitation such as that imposed by CS spray would be sufficient but most of those expressing an opinion wanted total incapacitation; with selective sensory deprivation, an aggressor can still use those senses unaffected by the less lethal option.

74. The less lethal option needs to be effective against 100% of the population, whilst being specific enough not to affect police officers or bystanders.

75. Future less lethal options would need to be portable, fast to deploy, easy to use accurately against a moving target, and allow repeat applications. They should also be specific to the person being targeted and contamination of police officers should be avoided. There should also be no requirement for subsequent medical intervention.

Capability gaps

Public order

76. For serious disorder, the major gap in capability is the ability to create and maintain distance. Crowds in close proximity to the police line increase the risk of injury to police officers and once the distance has been allowed to break down, it is hard to re-create. Other key capability gaps identified were shortages of human resources and lack of an immediate arrest option.

77. There were a number of comments regarding the loss of the 6 foot shields. Although short and intermediate shields encourage mobility, they do not offer sufficient protection when police officers have to form a static line. It was suggested that a range of equipment should be available to allow flexibility of response according to the needs of the situation.

78. The majority of criticisms concerning equipment availability referred to (a) the failure to authorise the use of baton rounds during serious disorder and (b) the restricted access to water cannon. Concerns were also expressed about the reduced psychological impact of the new baton round on the crowd and the geographical and logistical problems associated with water cannon.

Beat and patrol

79. Most of the police officers interviewed in Great Britain have not used the defensive weapons currently on issue. This is for a wide range of reasons, ranging from never having felt the need to use them through to concerns about using force, the difficulties in using them effectively, fear of worsening the situation, or lack of confidence in the weapons currently issued.

80. With the exception of weight of numbers, there is currently no reliable less lethal option to deal with those of a positive mind-set as a result of mental illness, rage, drink or drugs.

81. Nearly half of those RUC officers interviewed noted the requirement for a defensive weapon in addition to the baton and sidearm; it was noted that this must not be at the expense of a sidearm as the latter would be needed if a police officer were to be attacked and isolated.

82. A small number of army personnel noted that they have no less lethal option between using their hands and the baton gun for dealing with physical, close quarter confrontation.

Public order tactics

83. One of the major difficulties faced by commanders is the relationship between strategic and tactical goals. When the higher level goal is to contain a crowd within a given area, there were reported to be greater limitations on the tactics that can be employed by the police units on the ground. If dispersal is not an option, a determined crowd will tend to take advantage of static lines.

84. A crowd was reported to be more difficult to police than an individual and the tactics used will depend on factors such as the size of crowd, how compliant its members are, their attitude towards the police, and resources available to the police. For certain types of crowd an effective tactic is often isolation and containment until they became bored and/or the ringleaders are arrested. However, this is not possible where the crowd is determined, on their home turf, and/or is willing to injure police officers.

85. There were reported to be advantages in early intervention in dispersing crowds as they can grow in size and confidence if no proactive action is taken. It was reported that bystanders will also join in if there is no fear of personal sanctions being taken against them. Proactive tactics, however, require greater police resources and these are not always available. There is also a danger of inflaming a situation further and this is a judgement call based on the risk assessment.

86. Less experienced crowds were reported to be easier to manage as they can be controlled by a lower level of force such as verbal instructions and officers with shields. Usually the threat of a credible sanction is sufficient and it rarely has to be carried out.

87. Impact factors such as alcohol affect the efficiency of the measures deployed against a crowd. Crowds will also adapt to counter the options used against them, including tactics.

Training

88. Where relevant, some police officers reported the public order and/or annual officer safety training provided by their police force to be very, very good. However, a third of those interviewed in Northern Ireland and Great Britain identified limitations in public order training, and some police officers noted limitations in the training provided to beat and patrol officers.

89. The comments were generally concerned with the following:

- *The adverse impact of health and safety regulations on the realism of all forms of training carried out; this makes it difficult to replicate stressful situations in a training environment (eg dealing with serious disorder, managing and dealing with violent or dangerous situations, handcuffing someone after a hard struggle, dealing with the threat of lethal weapons).*

- *The comparative lack of officer safety training carried out in Northern Ireland (as the emphasis is on public order training).*

- *Limitations in the range of tactics taught for public disorder situations including those where specialist options such as water-cannon are present.*

- *Teams that work together during public disorder do not necessarily train together; this applies both to Great Britain and Northern Ireland.*

G. Concluding Observations

90. During the second phase of the programme, a number of significant policing events, involving violent confrontation, have taken place within the United Kingdom. In addition media reporting of recent court cases in respect of use of force by police has provided a stimulus to the work on the needs analysis and operational requirements.

91. The subsequent debriefs and internal debates together with the needs analysis initiated as part of this study have provided the basis for the observations about elements in a potential capability gap.

92. While it is convenient and at times necessary to distinguish between public disorder, individual officer protection and situations where police are responding to armed individuals, it is often the case in practice that these situations overlap and merge. For example, in dealing with serious public disorder involving riotous crowds, officers can become isolated, the subject of individual attack and require to defend themselves; in addition the crowd can be infiltrated by individuals or groups determined to use firearms or other lethal weapons including explosive devices. It is nevertheless useful to consider the issues under the following headings:

Individual officer confrontations,
Armed and Violent individuals,
Public Order Duties.

Individual Officer Confrontations

93. Individual officers rely primarily on interpersonal and negotiation skills in defusing situations and resolving conflict. Often however, responses that are required include using the officer's physical presence, negotiating ability and where necessary physical force. Physical force includes what are referred to as empty hand skills, and extends to use of batons, incapacitant sprays or in the most extreme situations firearms. Both empty hand techniques and the use of batons call for skill and strength on the part of the user. Both approaches require officers to close on the violent individual and enter what is referred to as a vulnerability gap.

94. The use of incapacitant sprays which is dealt with fully at Chapter 8 of this report does in part address this issue by providing officers with a means of partially incapacitating an individual without making direct physical contact. However the sprays require to be used at relatively close quarters (1-3 metres) and are not 100% effective. The option is not currently available to officers in Northern Ireland.

Armed and Violent Individuals

95. The threat posed by individuals armed with sharp and bladed weapons was of great concern to officers who were interviewed in the study both in Great Britain and Northern Ireland. Unarmed officers considered this one of the most hazardous threats to deal with. Whilst armed officers have the re-assurance that ultimately they could utilise their firearms to defend themselves from lethal attack, there is both a desire and requirement to have a viable less lethal alternative. Such an alternative would need to be effective in bringing about immediate incapacitation at ranges out to 10 metres.

96. Officers considered the maximum range of the personal incapacitant sprays to be too restrictive in these situations and they wished the ability to maintain a distance of in excess of 7 metres. They also realised the importance of being at a distance which enabled effective verbal negotiation to take place.

97. It is noted that the Association of Chief Police Officers has recently recommended the use of baton guns as a less lethal option for use in these types of situations with a minimum engagement distance of 1 metre.

Public Order Duties

98. In responding to threats of serious violence in public order situations, police use a range of standardised Public Order tactics. These include cordons and formations of officers using shields, batons and vehicle tactics to contain and disperse groups.

99. The needs analysis study has revealed that some patrol duty batons are unsuitable for use as part of co-ordinated public order tactical responses, this was particularly true of the ‘side handled batons’ issued to some GB forces.

100. Conventional public order tactics are most effective in dealing with semi or disorganised groups. Dealing with mobilised and organised communities, who study police tactics with a view to identifying and exploiting critical vulnerabilities, becomes much more difficult and raises specific issues in respect of protective equipment, tactics and weaponry.

101. Static lines of police, albeit in full protective equipment, are hard to defend as has been recently evidenced in North Belfast, Portadown and North Yorkshire. In each of these situations violent crowds were able to close on police lines resulting in serious police injuries of a type not normally encountered when distance is maintained. It is recognised that there are situations where rapid police advances into areas (especially housing estates and residential areas) is neither practical nor desirable and would result in an escalation of both the conflict and the danger to police.

102. The ability to create and maintain distance (forcibly if necessary) at an early stage of the disorder is considered essential. The only equipment that police currently have for maintaining distance, in a public order situation, is baton rounds; they are not suitable for creating distance. Baton rounds are intended for use against targeted individuals as opposed to the crowd in general and are used in the most serious of public disorder. (Moreover it has been shown that the absence of bang or flash with the new L21A1 round limits the effect, if any, that it has on the wider gathering.)

103. There is thus perceived to be a requirement for equipment or technology which can be used as a de-escalatory and pre-emptive measure to create distance (ie drive back the crowd), defuse disorder and disperse the crowd. This must be capable of being used at distances of between 1-20 metres. As the comparative table in Chapter 5 shows, traditional methods widely used outside of the UK include incapacitant smoke (often referred to as tear gas). However, this has the disadvantages of being indiscriminate, difficult to control due to variability in wind factors and of having limited effect.

Conclusion

104. The specific issues in relation to capability that have been identified are as follows:

- The non-availability of personal hand held incapacitant sprays to officers in Northern Ireland,
- The suitability of some batons in use in some Great Britain forces, for use in serious public disorder,
- The lack of ability to incapacitate immediately a violent individual armed with a sharp or bladed weapon at a distance of around 10 metres,
- The non-availability of a weapons system which can generally be used in serious public disorder at ranges of between 1-20 metres,
- The lack of an acceptable approach that allows the police to force a violent crowd back and cause them to disperse, other than by rapid forward advances by public order formations.

105. The first of these issues is covered more fully in Chapter 8, as it was specifically mentioned in the Patten Report. The second is not directly a matter for this report which is largely – though certainly not exclusively – concerned with the Northern Ireland context. The remaining observations have influenced the context of the review of technologies and the suggested priorities for further research in Chapters 6 and 7.

CHAPTER 3: THE HUMAN RIGHTS, LEGAL AND ACCOUNTABILITY CONTEXT

A. Human rights and legal issues

The relevance of human rights and legal requirements

1. Why are human rights and the legal context important?

2. There are many reasons, but it is worth highlighting four in particular:

   (a) the incorporation of the European Convention on Human Rights through the Human Rights Act 1998 means that actions must be compliant with the provisions of the Convention;

   (b) the direct relevance of other international documents, particularly the United Nations Basic Principles on the Use of Force and Firearms by Law Enforcement Officials;

   (c) the development of the human rights and accountability ethos within the Police Service of Northern Ireland in line with the implementation of the Patten report;

   (d) for the very reason illustrated in the following quotation from Professor Ralph Crawshaw:

   "One of the consequences …… is that those who are subjected to [police abuse] become radicalised, and more prepared to join or support violent, subversive opposition groups. Another consequence is that such groups benefit hugely from the propaganda value of serious lapses of behaviour by state security forces. There are, therefore, practical, as well as ethical and legal reasons for respecting lawful human rights standards when confronting groups of that nature." [Crawshaw, 1995, "Human Rights, the Rule of Law and Policing" quoted in O'Rawe and Moore "Human Rights on Duty",[1] 1997.]

3. The issue of human rights and the law can appear both arid and abstract, but they are of direct relevance to:

   - police officers in the front line;
   - police managers;
   - rioters and others in public order situations;
   - other individuals who may get caught up in such situations.

4. The history of public order in Northern Ireland, as well as elsewhere, makes it all the more important that full account should be taken of human rights and legal issues.

5. In addition, as noted in the Framework Document, included as part of the phase I report published in April this year, ethical and cultural grounds are also important. Later in this chapter, in the section dealing with ethical issues, regard will be had to two source documents in particular – "Policing, Ethics and Human Rights",

by Neyroud and Beckley[2] (2001), and "The Ethics of Policing" by Kleinig[3] (1996). This section draws too on Starmer's[4] "European Human Rights Law" (1999).

6. In the following section, the relationship between human rights and legal requirements is brought out in the consideration of the Audit Tool Kit.

7. The Phase I Report identified that as part of the second phase the views of interested parties would be sought and assessed. Members of the Group were keen to ensure that they understood the perceptions and assessments of others. Meetings, some involving Northern Ireland Office Ministers, have been held with the Northern Ireland Human Rights Commission (NIHRC), the Committee on the Administration of Justice (CAJ) and other bodies. Some were, in addition, invited to send papers or offer written contributions to the Steering Group. The CAJ has written on several occasions and material was also received from the Omega Foundation.

The United Nations basic principles on the use of force and firearms by law enforcement officials

8. The basic principles were adopted by the eighth United Nations Congress in 1990. The preamble, as well as the individual provisions, are worth noting.

> *"Whereas the work of law enforcement officials is a social service of great importance and there is, therefore, a need to maintain and, whenever necessary, to improve the working conditions and status of these officials."*
>
> *"Whereas a threat to the life and safety of law enforcement officials must be seen as a threat to the stability of society as a whole."*
>
> *"Whereas law enforcement officials have a vital role in the protection of the right to life, liberty and security of the person, as guaranteed in the Universal Declaration of Human Rights and reaffirmed in the International Covenant on Civil and Political Rights."*
> *……..*
>
> *"Whereas article 3 of the Code of Conduct for Law Enforcement Officials provides that law enforcement officials may use force only when strictly necessary and to the extent required for the performance of their duty."*
> *……*
>
> *"The basic principles set forth below, which have been formulated to assist Member States in their task of ensuring and promoting the proper role of law enforcement officials, should be taken into account and respected by Government within the framework of their national legislation and practice, and be brought to the attention of law enforcement officials as well as other persons, such as judges, prosecutors, lawyers, members of the executive branch and the legislature, and the public."*
>
> *General provisions*
>
> *"1. Governments and law enforcement agencies shall adopt and implement rules and regulations on the use of force and firearms against persons by law enforcement officials. In developing such rules and regulations, Governments and law enforcement agencies shall keep the ethical issues associated with the use of force and firearms constantly under review.*

2. Government and law enforcement agencies should develop a range of means as broad as possible and equip law enforcement officials with various types of weapons and ammunition that would allow for a differentiated use of force and firearms. These should include the development of non-lethal incapacitating weapons for use in appropriate situations, with a view to increasingly restraining the application of means capable of causing death or injury to persons. For the same purpose, it should also be possible for law enforcement officials to be equipped with self-defensive equipment such as shields, helmets, bulletproof vests and bulletproof means of transportation, in order to decrease the need to use weapons of any kind.

3. The development and deployment of non-lethal incapacitating weapons should be carefully evaluated in order to minimise the risk of endangering uninvolved persons, and the use of such weapons should be carefully controlled.

4. Law enforcement officials, in carrying out their duty, shall, as far as possible, apply non-violent means before resorting to the use of force and firearms. They may use force and firearms only if other means remain ineffective or without any promise of achieving the intended result.

5. Whenever the lawful use of force and firearms is unavoidable, law enforcement officials shall

(a) Exercise restraint in such use and act in proportion to the seriousness of the offence and the legitimate objective to be achieved;

(b) Minimise damage and injury, and respect and preserve human life;

(c) Ensure that assistance and medical aid are rendered to any injured or affected persons at the earliest possible moment;

(d) Ensure that relatives or close friends of the injured or affected person are notified at the earliest possible moment."

9. Throughout this phase 2 report, as in the phase 1 report, reference is made to "less lethal" systems. This term has been deliberately chosen and needs to be used very carefully. There is a range of less lethal weapons and systems available. Implicit in all applications of force is the potential for injury, and indeed lethal, outcome. The design of the equipment and the way in which it is used can substantially reduce this risk. The extent to which the risk becomes acceptable very much depends on the situation in which the weapon or system is used. (For example, if less lethal weaponry is being deployed as an alternative to a conventional firearm, this represents a de-escalation of force.) Other issues relating to acceptability are dealt with elsewhere in this section of the report. In the past, as in the United Nations Basic Principles, such options have been referred to as "non-lethal" or "less than lethal". Both of these terms imply that death will not result, following the use of these weapons, but this is not always the case. The United States National Institute of Justice now uses the following definition for this type of equipment:

> "Devices or agents used to induce compliance with law enforcement personnel without substantial risk of permanent injury or death to the subject."

10. Also under the aegis of the United Nations is an earlier Code of Conduct for Law Enforcement Officials, drawn up in 1979. The first three articles are relevant:

Article 1

"Law enforcement officials shall at all time fulfil the duty imposed upon them by law, by serving the community and by protecting all persons against illegal acts, consistent with the high degree of responsibility required by their profession."

Article 2

"In the performance of their duty, law enforcement officials shall respect and protect human dignity and maintain and uphold the human rights of all persons."

Article 3

"Law enforcement officials may use force only when strictly necessary and to the extent required for the performance of their duty."

The European Convention on Human Rights

11. It is not necessary to include here the full text of the European Convention on Human Rights. Under certain circumstances, Articles 2, 3, 5, 8, 9, 10, 11 and Article 1 of Protocol 1 could be relevant. However in the context of public order issues, Articles 2, 3, and 8 are of particular significance – as below.

Article 2 – Right to life

"1. Everyone's right to life shall be protected by law. No one shall be deprived of his life intentionally save in the execution of a sentence of a court following his conviction of a crime for which this penalty is provided by law.

2. Deprivation of life shall not be regarded as inflicted in contravention of this article when it results from the use of force which is no more than absolutely necessary:

(a) in defence of any person from unlawful violence;

(b) in order to effect a lawful arrest or to prevent the escape of a person lawfully detained;

(c) in action lawfully taken for the purpose of quelling a riot or insurrection."

Article 3 – Prohibition of torture

"No one shall be subjected to torture or to inhuman or degrading treatment or punishment."

Article 8 – Right to respect for private and family life

"1. Everyone has the right to respect for his private and family life, his home and his correspondence.

2. There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others."

12. The deprivation of life will be considered under Article 2. Articles 3 and 8 are then relevant where non-lethal measures are taken which affect the moral or physical integrity of the individual. There have been a number of judgments by the European Court of Human Rights that have borne on the use of force by state police services. In the context of Article 3, general cases have looked at the degree of force which could constitute inhumane or degrading treatment. In each case conduct must "attain a minimum level of severity" before Article 3 is breached. In "European Human Rights Law", Starmer notes that "the assessment of this minimum is relative; it depends upon the circumstances of the case, such as:

(1) the duration of the treatment;
(2) its physical or mental effects; and
(3) in some cases, the sex, age and state of health of the victim .....

Moreover conduct not reaching the threshold of severity required under Article 3 may nonetheless breach article 8, which protects physical and moral integrity as part of an individual sphere of privacy."

13. Articles 2, 3 and 8 have two facets: first they control the circumstances in which the use of force can be justified; second they define when preventative action should be taken to avoid the use of lethal force either by law enforcement agencies or others (ie criminal third parties). Physical integrity is also protected under article 8 as an aspect of private life. The threshold for a breach is lower than that under article 3. However rights under article 8 can be restricted, unlike those under article 3. The European Court's case law is evolving in this area, specifically in relation to positive obligations in the context of protecting physical integrity under article 8. One example is Osman v. UK (1999) 1 FLR 198.

14. Several points should be noted in relation to existing policy and practice. In Northern Ireland the Chief Constable has issued a number of instructions to the service in the form of Force Orders. For over two years, the Force Orders have specifically highlighted the significance of these Human Rights Articles, and have drawn the attention of officers to key European Court judgments on points in relation to them. The Force Order on Human Rights and Police Use of Force, which was externally audited in respect of its Human Rights component, is explicit in making the point that simply because a person is engaged in one of the activities referred to in Article 2(b) or 2(c) of the European Convention, this is insufficient grounds for the use of lethal force – hence the requirement for a less lethal alternative.

15. The Force Order on policy in relation to the issue, deployment and use of baton rounds, issued in December 2000, contains the following section:

"If the death of any person results from being struck by a baton round the provisions of Article 2 of Schedule 1 to the Human Rights Act will take effect. The tests to be applied under these circumstances will be those of:

(a) a degree of force which is no more than absolutely necessary in order to achieve one of the purposes defined in Article 2(2)(a), (b) or (c) of Schedule 1 to the Human Rights Act 1998;

and is

(b) strictly proportional to the achievement of one of the aims set out in sub-paragraphs 2(a), (b) of (c) of Article 2 ECHR;

(c) where the use of lethal force has been part of a planned operation, Article 2 reinforces the positive duty to protect life. In McCann –v- UK (1995) the [European] Court [of Human Rights] held that the state must provide appropriate training, instructions and briefing to those who are placed in situations where the use of lethal force may be required. The state must also exercise 'strict control' over operations which may involve the use of lethal force."

The significance of Article 2 in relation to the planning of an operation is also brought in Starmer's[4] book (at paragraphs 14.30 to 14.31) where he assesses – and contrasts – the European Court's judgment in McCann with its judgment in Andronicou and Constantinou v Cyprus.

16. Moreover, the ACPO guidelines on the use of baton rounds that were published on 27 July 1999, and that have applied in Northern Ireland, England and Wales since 1 August of that year, specifically stipulate that:

> "In discharging their duties police officers will be cognisant of the provisions of the UN Code of Conduct for Law Enforcement Officers and of their obligations to uphold human rights."

17. Again the Use of Force Order stipulates that "police officers will, therefore, apply the test of 'no more than absolutely necessary' when considering the use of potentially lethal force". It is worth noting that Starmer (op cit) states (at page 395):

> "The European Court has accepted that the use of lethal force by state agents or servants can be justified under Article 2(2) where it is based on an honest belief that the use of such force is absolutely necessary, even if that belief subsequently turns out to be mistaken. To hold otherwise would be to impose an 'unrealistic burden' on the state and its law enforcement personnel in the execution of their duty, perhaps to the detriment of others."

Other texts

18. The steering group has also had regard to other international texts, for example the International Covenant on Civil and Political Rights, and the Council of Europe Declaration on the Police. The NIHRC has previously recommended to Government that regard should be had to a wide range of sources.

19. Neyroud and Beckley[2] (op cit) have identified four key principles from these documents:

- Legality;
- Proportionality;
- Necessity;
- Accountability.

20. Legality – the United Nations texts lay great stress on police officers complying with their obligations under the law and upholding the rule of law. The ECHR adds important clarification to the concept of "legality".

21. Proportionality – as Starmer has commented, the principle of proportionality is about the "need to find a fair balance between the protection of individual rights and the interests of the community at large" (Starmer, 1999). It requires a police officer to balance the means proposed against the outcome intended or, in other words, to ensure that any action is "proportionate to the legitimate aim pursued". One key aspect of proportionality is whether a less restrictive alternative is/was available.

22. Necessity – this is linked closely with proportionality. Article 2(2) of the ECHR brings out the concept of "no more than absolutely necessary". Force is absolutely necessary if it is strictly proportionate to the achievement of the permitted purpose. Even more than proportionality, this principle requires that alternatives have been considered and either tried and failed or have been rationally discarded.

23. Accountability – as a consequence of developments in recent years, the use of less lethal force by the police in Northern Ireland is subject to an unprecedented degree of accountability.

The criminal law and the common law

24. It would be a mistake to focus exclusively on international texts. When the police in Northern Ireland are required to use force to achieve a lawful objective, for example making a lawful arrest, acting in self-defence or protecting others, the main legal authorities are to be found in the following:

(a) the common law;
(b) section 3 of the Criminal Law Act (Northern Ireland) 1967; and
(c) Article 88 of the Police and Criminal Evidence (Northern Ireland) Order 1989 (PACE).

25. Section 3(1) of the Criminal Law Act (Northern Ireland) 1967which is identical to the Criminal Law Act 1967 states:

> "A person may use such force as is reasonable in the circumstances in the prevention of crime or in effecting or assisting in the lawful arrest of offenders or suspected offenders or of persons unlawfully at large."

26. Article 88 of the 1989 Order states that:

> "Where any provision of this Order –
>
> (a) confers a power on a constable; and
>
> (b) does not provide that the power may only be exercised with the consent of some person, other than a police officer,

the constable may use reasonable force, if necessary, in the exercise of the power."

27. The police have generally relied upon the provisions of section 3 of the 1967 Act as both the legal authority and the benchmark against which any use of force will be judged. Both it and PACE require that any force used is "*reasonable in the circumstances*". The test is based upon the circumstances as they existed at that particular time.

Commentary

28. It will be seen that there are two distinct tests in relation to the use of force. The first, set out in the 1967 Act, is that the force used must be reasonable in the circumstances. The second applies specifically to use of force which results in deprivation of life and derives from Article 2 of the European Convention. It is clear therefore that the test for using both lethal and potentially lethal force is that it is absolutely necessary. However, as Starmer[4] has written (page 388, op cit) "In the light of the Government's assertion that, as interpreted by the domestic courts, there was no significant difference between the 'reasonably justifiable' and 'absolutely necessary' tests, the [European] Court found no issue arose under Article 2(1)". Always to require the absolutely necessary test per se could impose the 'unrealistic burden' to which he referred. Proportionality is a key factor if the likely consequence of the use of force by the police is not potentially lethal. In practice much will depend on the honestly held belief of the officers concerned – their assessment of the situation, their training, their briefing and their experience.

Other legislation that has a bearing

29. Section 32 of the Police (Northern Ireland) Act 2000 sets out the general functions of the police:

> "32. – (1) It shall be the general duty of police officers –
>
> (a) to protect life and property;
>
> (b) to preserve order;
>
> (c) to prevent the commission of offences;
>
> (d) where an offence has been committed, to take measures to bring the offender to justice."

30. There are other issues too, with legal backing, that have a bearing. One example is health and safety at work. The original 1974 Act was not applicable to serving police officers because they are not, in legal terms, employees. However, for the purposes of the 1974 Act, and Regulations made thereunder, the Chief Constable is now deemed to be the employer of constables (section 1 Police (Health and Safety) Act 1997). This means that the Chief Constable is required to provide safe and healthy working conditions in more or less the same way as any other employer. (Arthur Brown, "Police Governance in England and Wales", 1998). Chief Constables could certainly be liable were they judged to have failed to provide appropriate measures in line with their duties under this legislation.

31. In Northern Ireland the Health and Safety Executive has been proactive in engaging with the police service in respect of protection for officers involved in policing serious disorder.

B. Ethical principles

32. Kleinig's book[3] has an important chapter on the use of force. He emphasises that "to keep the social peace it is sometimes necessary to deal with people who are recalcitrant and/or dangerous. And if this is to be done effectively, coercive force will sometimes have to be used or at least threatened." He identifies five factors that he sees as relevant to the ethical assessment of the use of intermediate and indeed deadly force:

- Intentions: must always be 'honest' and not improper, such as 'for punishment'.
- Seemliness: must not be 'inhuman or degrading'. This links well with the case law under Article 3 of ECHR.
- Proportionality: must be made strictly necessary by the subject's conduct or circumstances.
- Minimisation: must be the least force necessary and, therefore, officers must be trained in a range of options and capable of deploying them appropriately.
- Practicability: must be relevant to the legitimate aims the officer is seeking to accomplish, not a substitute for something else.

33. Kleinig[3] goes on to consider advantages and disadvantages of certain equipment, before concluding:

> "In some, then, given the overall peacekeeping mandate of police, the limited role that they have in law enforcement (protection and apprehension rather than punishment), and the variety of circumstances in which they find themselves, it is important that police develop a variety of low – and middle – range coercive techniques for achieving their ends when other alternatives are not available to them."

34. Police Codes of Ethics will also have a direct bearing. Section 52 of the Police (Northern Ireland) Act provides that:

"(1) The Board shall issue, and may from time to time revise, a code of ethics for the purpose of -

(a) laying down standards of conduct and practice for police officers;

(b) making police officers aware of the rights and obligations arising out of the Convention rights (within the meaning of the Human Rights Act 1998).

(2) In preparing the code, the Chief Constable and the Board shall have regard to the terms of the declaration set out in section 38(1).

(3) A draft of the code shall be submitted by the Chief Constable to the Board for it to consider.

(4) The Board may adopt the draft code –
- *(a) as submitted by the Chief Constable; or*
- *(b) with such amendments as the Board may determine, after consultation with the Chief Constable.*

(5) Before issuing or revising the code the Board shall consult –
- *(a) the Police Association;*
- *(b) the Secretary of State;*
- *(c) the Ombudsman;*
- *(d) the Northern Ireland Human Rights Commission;*
- *(e) the Equality Commission for Northern Ireland; and*
- *(f) any other person or body appearing to the Board to have an interest in the matter.*

(6) After consulting under subsection (5), the Board may make such further amendments to the draft code as it may determine, after consultation with the Chief Constable.

(7) The Board shall publish any code of ethics issued or revised under this section in such manner as it thinks appropriate.

(8) The Chief Constable shall take such steps as he considers necessary to ensure:

- *(a) that all police officers have read and understood the code as currently in force; and*

- *(b) that a record is made and kept of the steps taken in relation to each officer.*

(9) In order to enable it to carry out its functions under section 3(3)(d)(iv), the Board shall keep under review the steps taken by the Chief Constable under subsection (8).

(10) The Secretary of State shall, so far as practicable, ensure that the provisions of the code currently in force under this section are reflected in the regulations relating to conduct or discipline made under section 25 or 26 of the 1998 Act."

35. The Northern Ireland Police Service Code of Ethics is at an advanced stage of drafting. It seems highly likely that the code will contain a section on the use of force and that it will draw heavily on the United Nations Basic Principles on the Use of Force and Firearms by Law Enforcement Officials and on judgments of the European Court of Human Rights.

C. Accountability

The Provisions of the Police (Northern Ireland) Act 2000

36. Section 53 of the Police Act 2000 provides for the Secretary of State to issue and revise guidance on the use by police officers of equipment designed for use in maintaining or restoring public order. Before issuing or revising such guidance, the Secretary of State is required to consult:

- the Policing Board;
- the Chief Constable;
- the Ombudsman;
- the Police Association.

37. Moreover the Secretary of State is obliged to publish any such guidance in such manner as he thinks appropriate.

38. Other legislative and administrative arrangements provide unprecedented accountability in relation to police use of baton rounds.

39. Recommendation 71 of the Patten report stipulated inter alia that the use of baton rounds:

> "Should be justified in a report to the Policing Board, which should be copied to the Police Ombudsman"

40. Recommendation 73 stipulated that:

> "The Policing Board and, as appropriate, the Police Ombudsman should actively monitor police performance in public order situations, and if necessary seek reports from the Chief Constable and follow up on those reports if they wish."

41. Section 3 of the Act requires the Board to monitor the performance of the police in carrying out their duty under section 32(1) which includes the protection of life and property and the preservation of order. The updated Implementation Plan published in August 2001 specifies that:

> "… the Board will be provided with a report on every occasion baton rounds are used by the police. Such reports will also be made available to the Police Ombudsman who issues out an investigation if it is in the public interest."

42. In addition the Oversight Commissioner, Mr Tom Constantine, will also have a scrutiny role.

The Police Ombudsman's Role in Northern Ireland

43. In Northern Ireland, the Police Ombudsman, is informed of every discharge by a baton round by a police officer. Her office has been fully operational since 6 November 2000. She has now published the result of the first inquiry into the firing of rounds in Northern Ireland during 2001. The issues that she addresses include:

- the circumstances in which the round or rounds were fired;
- whether the discharge was justified and proportionate in those circumstances;
- the appropriateness of the authorisation and the direction given;
- whether deployment and use was fully in compliance with the ACPO guidance introduced on 1 August 1999.

The interest of the Northern Ireland Human Rights Commission

44. On 31 May the Northern Ireland Human Rights Commission published the results of a small-scale study on a random sample of files provided by the Royal Ulster Constabulary which recorded incidents of the firing of baton rounds between 1997 and 2000. The report included a series of recommendations as to how the recording system could be improved.

45. Many of the files predated the coming into force of the ACPO guidelines on 1 August 1999. The report did contain a number of criticisms and recommendations; for example new forms should require more information to be recorded than at present, as the study felt the files did not give a full enough picture about the level of violence at the time the rounds were fired.

46. Although the police did not accept all the report's findings, they did review their reporting format and took into account comments and suggestions made by the Human Rights Commission. As all reports are now made to the office of the Ombudsman, her officers will in effect provide an independent mechanism for ensuring that reports received are of sufficient standard to enable the investigation.

47. On 17 July the Human Rights Commission published a statement calling for the Chief Constable to declare he would no longer use baton rounds as a method of crowd control in Northern Ireland. The Commission's statement said that it believed using what it called plastic bullets as a method of crowd control was a disproportionate use of force. However, in a radio interview the following day, the Chief Commissioner said that there were situations where plastic baton rounds could be justified. On 18 July the President of ACPO, Mr Tony Burden, issued a statement on behalf of the Association of Chief Police Officers of England, Wales and Northern Ireland making it entirely clear that they reserved the right, on behalf of the public, to use baton rounds where the circumstances would make their use appropriate. The Chief Constable said in a statement that baton rounds were directed at individuals who were identified as behaving in a way that brings about a risk to life. [The police] would never use them for crowd control.

48. The then NIO Minister responsible for security (together with the representatives of the Steering Group) invited the chairman and senior members of the Commission to a discussion on 31 May seeking their views on the issues flowing from the Patten recommendations. He invited them to submit further views in writing; his successor has arranged to meet a similar group. The Commission has said it will publish a second report on injuries caused by "plastic bullets" in recent years, this autumn. The Chief Commissioner has also pointed out that the proposed Bill of Rights for Northern Ireland that the Commission published earlier this year could also have a bearing.

References

1. Mary O'Rawe and Linda Moore, 'Human Rights on Duty, Principles for Better Policing – International Lessons for Northern Ireland', 1997.

2. Peter Neyroud and Alan Beckley, 'Policing Ethics and Human Rights', 2001.

3. John Kleinig, 'The Ethics of Policing', 1996.

4. Keir Starmer, 'European Human Rights Law', 1999.

CHAPTER 4: ACCEPTABILITY

A. The Strategic Audit Framework

It became clear to both the Patten Steering Group and ACPO that a set of criteria would need to be drawn up against which any particular proposal or equipment could be evaluated. Both groups considered that the Human Rights Audit Framework that had been used by UK forces in preparation for the commencement of the Human Rights Act provided a valuable precedent and model.

2. Another starting point was the high level categorisations, adopted for example in Neyroud and Beckley (op cit), in turn drawn from legal judgments and elsewhere. From this, individual criteria were developed under one of four headings:

- strategic;
- ethical;
- operational;
- societal.

3. These are set out in full in the table below. The contents were submitted to several non-governmental organisations for consideration - Amnesty, Liberty, Inquest and Justice; they have expressed an interest in being kept involved in the process.

TABLE 1

AUDIT FRAMEWORK

1 – Strategic Issues

Question	Identified Requirements	Evidence/Comments
1. Does it meet Legal Requirements?	1. Are the UN Basic Principles met? 2. What are the Human Rights Act implications? 3. Are there Criminal Law Act implications? 4. Are there Police and Criminal Evidence Act implications? 5. Is agreement required under the Police (Northern Ireland) Act? 6. Is the Firearms Act relevant? 7. Are there Common Law implications?	
2. Does it meet the ACPO Operational Requirement?	1. Have the views of the ACPO portfolio-holders been sought?	
3. What are the physical and financial resource implications?	1. What would be the initial capital investment? 2. What training and requalification would be necessary? 3. What maintenance is required of the technology?	
4. Are there any inter-operability issues between Police organisations?	1. Are there compatibility considerations? 2. Is recruitment likely to be effected? 3. Would cross-boundary protocols be required?	

Question	Identified Requirements	Evidence/Comments
5. Is deployment nationally being considered?	1. Is Home Office agreement necessary, if so has it been obtained? 2. Is Northern Ireland Office agreement necessary, if so has it been obtained? 3. Is Scottish Office agreement necessary, if so has it been obtained? 4. Has Chief Officers agreement been obtained?	
6. Is imminent emerging technology likely to have an effect?	1. What is the identified ongoing research? 2. Is there potential for obsolescence in the near future?	

2 – Ethical Issues

1. Does it meet health and safety requirements?	1. Does it meet the requirements of the risk assessment? 2. Does it meet the evaluation criteria? 3. Is there any environmental impact?	
2. Have medical considerations been met?	1. Has a medical assessment been done and what was the result?	
3. Are there any ethical and/or cultural issues?	1. Does it meet relevant codes of Police Ethics? 2. Is there a Northern Ireland perspective? 3. Is there a Great Britain perspective? 4. Is there an International perspective? 5. What is the product history? 6. What is the product source?	

3 – Operational Issues

Question	Identified Requirements	Evidence/Comments
1. What issues pertain to the tactical use?	1. Is the technology environmentally specific? 2. Is the technology incident specific? 3. Is the technology subject specific? 4. What is the subject vulnerability? 5. Against what threat assessment is the technology considered appropriate to use? 6. Is there a requirement for decontamination? 7. Is there the potential for misuse of the technology?	
2. Are there restrictions with regard to deployment capability?	1. Are there any availability and accessibility issues and if so, what are they? 2. Who might be considered for training with the technology?	
3. What are the requirements for a community impact assessment?	1. Is there a requirement for a community impact assessment in operational deployments?	
4. What would be the training requirement?	1. What would be the likely duration of training? 2. Is a suitable venue required for training purposes?	
5. What monitoring of the technology will take place?	1. Will operational re-evaluation be required? 2. Will the gathering of statistics with regard to use be needed and what information would be required?	

Question	Identified Requirements	Evidence/Comments
6. What post incident review would occur?	1. Would a de-brief of each use be necessary? 2. Would post use investigation be required? 3. Would there be a reporting requirement for deployment of the technology?	

4 – Societal Issues

1. What stakeholder and public consultation is appropriate?	1. Have the views of stakeholders and representative organisations been considered? 2. Have the views of NGOs and other interested parties been considered?	
2. What justification is there for adopting the technology?	1. What current need does the technology address? 2. Is a future need also to be addressed by the technology? 3. Is the technology of use on all occasions or at specific incidents or events?	
3. What is the environmental impact of the technology?	1. Is there an environmental risk as a consequence of deployment of the technology? 2. Is decontamination a requirement and if so what decontamination is necessary?	
4. What is the public liability of using the technology?	1. Have liability issues in respect to exposure of the subject been considered? 2. Have liability issues in respect to exposure of the public been considered? 3. Have the staff associations raised any issues with respect to exposure of their members to the technology?	

CHAPTER 5: USE OF BATON ROUNDS AND OTHER EQUIPMENT

A. Experience in Northern Ireland

1. No consideration of the alternative to the plastic baton round would be complete without an account of the usage of the round in Northern Ireland and elsewhere.

2. Table 2 below shows the annual usage of baton rounds by the police and the Army since 1981. The first usage of plastic rounds was in 1973 – prior to that they had been made of rubber. Before 1981, just under 70,000 rounds were fired.

Baton round use (1981–2001)

YEAR	POLICE	ARMY	TOTAL
1981	19649	9952	29601
1982	335	154	489
1983	545	116	661
1984	1503	265	1768
1985	906	266	1172
1986	1462	325	1787
1987	1908	663	2571
1988	2292	817	3109
1989	836	101	937
1990	211	46	257
1991	235	88	323
1992	39	49	88
1993	497	26	523
1994	214	35	249
1995	273	-	273
1996	6949	1387	8336
1997	2527	440	2967
1998	1236	63	1299
1999	111	1	112
2000	22	4	26
2001 (to end October)	89	7	96
TOTAL	**41,839**	**14,805**	**56,644**

3. According to the Patten report, 11 deaths had been attributed to plastic baton rounds since 1981 (and five before that), and 615 injuries; others suggest that the total of deaths is 17. The most recent fatality was in 1989. All fatal casualties, except one, have been Catholics.

4. This is not the place for a full account of these incidents. Accounts have been given in books and booklets written by those critical of the use of such rounds, for example Fathers Faul and Murray[1] in "Rubber and Plastic Bullets Kill and Maim", 1981. Nearly half of those killed were children, and one, Norah McCabe, a woman. (The information in the following three examples is taken from "Lost Lives".) The inquest jury, in giving its verdict on that case, said:

> "At the mouth of Linden Street the leading vehicle in the patrol turned sharply to the right and stopped briefly, at which time a plastic baton round was discharged from an off side port-hole. There is no clear evidence to suggest that there was a legitimate target to be fired at in that street. Neither is there evidence to suggest that the deceased was other than an innocent party."

5. Three years subsequent to her death in 1981, her family was awarded compensation, after bringing a case against the then RUC Chief Constable. In a statement read out in the Court, counsel for Sir John Hermon said that he and the Assistant Chief Constable accepted that at all material times the dead woman was an innocent passer-by.

6. Stephen McConomy was an 11 year old Catholic boy fatally injured in 1982 by a plastic baton round fired by soldiers. Again the round struck in the head. The inquest jury concluded that he was hit at a range of 17 feet and that the gun was defective, in terms of its accuracy.

7. The one non-Catholic death was that of Keith White, a 20 year old who died on 14 April 1984, having been hit by a round on 31 March during an Apprentice Boys march in Portadown. The inquest found that he was a rioter – jury members were shown a police video which included footage of White throwing missiles at the police. He too was struck on the head. It was reported that the round was fired from a range of 22 metres.

8. It was in part concerns about the accuracy of the round in use in the 1990's, although itself an improvement on earlier rounds, that led to a joint project between the Ministry of Defence, the Home Office and the Northern Ireland Office to develop an improved round and better delivery system. This project, which took over three years and cost over £1.65 million, began in 1997. It resulted in the introduction of the L21A1 round with effect from 1 June 2001. That project pre-dated the Patten report, and was not part of the programme taking forward recommendations 69 and 70 in the Patten report. The independent medical committee concluded that, with a new optical sight, the new baton round was more consistently accurate than the old and the probability of it causing serious or life-threatening injury had been reduced.

9. The requirement for the new system included the following important criteria:

- operational range
- accuracy
- trajectory
- maximum kinetic energy

10. The introduction of the L21A1, together with the new sighting system, was announced by the Home Secretary on 2 April 2001. Since then, in addition to the police and the Army in Northern Ireland, and the Army in a number of overseas situations, the L21A1 has been recommended for deployment by ACPO, in particular for use as a less lethal option in situations where conventional firearms may previously have been deployed. As well as the great majority of forces in England and Wales, it is now being acquired by some Scottish police forces which had not previously had baton rounds. When the current procurements are complete, 43 forces in Great Britain will have the baton gun. The great majority of those already equipped with it intend to use it as a less lethal option, should the circumstances require it.

11. It can be seen from table 2 that the two years in which there were the highest number of baton round discharges in Northern Ireland were 1981 and 1996. The former was during disorder to do with the hunger strikes, and the latter in the context of a procession at Drumcree and subsequent disorder.

12. The table demonstrates very clearly the great drop in baton round use since the introduction of the new guidelines in 1999. (On 27 July 1999, the then Home Secretary announced that, with effect from 1 August of that year, revised guidelines for the use of baton rounds in situations of public disorder would be applied in the same terms in England, Wales and Northern Ireland.) It is particularly notable that, notwithstanding serious public disorder over extended periods of the year and a high level of injuries sustained by police officers, fewer than 100 rounds were fired in the first ten months of 2001.

13. The Government has made clear its intention of expediting the research programme to implement Patten recommendations 69 and 70. The publication of this report is a tangible demonstration of that commitment.

14. The Government has reaffirmed that the use of baton rounds will be avoided except where there is an immediate threat of loss of life or serious injury. After consultation with the Chief Constable, the Government has also made clear that in future no newly-recruited officer will be trained in the use of the equipment either during their initial two year probationary period or during the following two years in the service. Arrangements will also be made for ensuring close liaison between the Policing Board and the Steering Group with a view to ensuring that the Policing Board's views are taken into account. Responses from interested parties to this report will of themselves be valuable contribution to the programme. It is the Government's aim to have carried out as much as possible of the programme by summer 2002.

B. The response to public disorder elsewhere

15. Critics of baton round usage in Northern Ireland sometimes overlook their use elsewhere.

16. For example, the Royal Canadian Mounted Police announced on 2 May 2001 that it had used 3,009 canisters of teargas and 502 plastic baton rounds while dealing with protesters at the Summit of the Americas in the previous month. Those figures were in addition to a previously released statement that Quebec Provincial Police used 1,700 teargas canisters and 320 baton rounds (37 millimetre). (Water Cannon were also used.) An investigation has yet to be completed. The baton round system used by the Canadians had previously been considered for use in the United Kingdom, but was considered to be inferior in comparison to the L21 round. Baton

rounds were also used by American police forces at the Seattle disturbances the previous year.

17. In Europe, during 2001, the police encountered serious disorder at political summit meetings in both Gothenburg and Genoa. A live round was fired at both; in Genoa it caused a fatality. These experiences have led to inquiries and research programmes in other European countries, as well as a special committee in Sweden that has been tasked with looking at police use of certain types of equipment in public disorder.

18. Table 3 sets out for a number of countries in Europe and elsewhere our current understanding of the range of less lethal equipment that is now available to their security forces, including the police. The Patten Steering Group, ACPO and PSDB have established links to some of the current research projects in other countries and are ensuring that helpful developments overseas are fully taken into account.

19. Enquiries have confirmed there is no equipment that is currently used, or proposed for use, in these other countries that does not feature within the list of technologies under consideration by PSDB, the Steering Group and ACPO.

20. Finally, it should be noted in regard to table 3 that, with few exceptions, police officers in the countries listed are routinely armed with conventional weapons.

TABLE 3

Country	Baton	Incapacitant	Impact	Firearms carried	Electrical	Water Cannon	Other
Australia	Yes	OC Spray, OC Aerosol projectors for public disorder, CS for building entry	Bean-bag rounds	Yes	No	Yes	40mm soft foam and bean bag rounds
Austria	Yes	CS Spray (OC/PAVA Spray 1995-99)		Yes	No	Yes	
Belgium	Yes	OC Spray, CN for public disorder	No	Yes	No	Yes	
Canada	Yes	OC Spray, OC Aerosol Projectors/Pepperball for public disorder. CS grenades	Arwen/sage baton round, Bean-bag/sock rounds	Yes	Tasertron, M26 Advanced Air Taser	Yes (have used in past)	
Cyprus	Yes	CS Spray and CS for public disorder	Arwen/sage Launcher/baton rounds, Bean-bag rounds	Yes	No	No	
Denmark	Yes	CS for public disorder/building entry etc.	No	Yes	No	No	
Finland	Yes	OC Spray	No	Yes	No	No	
France	Yes	OC Spray (CS Spray 1984-2000)	Flash Ball	Yes	No	Yes	
Germany	Yes	OC/PAVA Spray (CS/CN used until 1999). CS/CN for public disorder	Foam baton rounds (military)	Yes	M26 Advanced Air Taser	Yes	
Hong Kong						No	
Ireland	Yes	No	No	Yes (by some)	No	No	
Italy							
Luxembourg	Yes	OC/PAVA Spray, CS for public disorder	Bean-bag rounds	Yes	No	Yes	
Malaysia						Yes	
Netherlands	Yes	OC Spray (since 2000), CS for public disorder	No	Yes	No	Yes	
New Zealand	Yes	OC Spray	No	No (Available in operational vehicles)	No	No	

Country	Baton	Incapacitant	Impact	Firearms carried	Electrical	Water Cannon	Other
Russia		OC Spray					
Singapore						Own but not used	
Sweden	Yes	No	No	Yes	No	Yes	
Switzerland	Yes	CS/OC/PAVA Spray, CS/CN for public disorder	Sting Balls	Yes	No	Yes	
USA	Yes	OC Spray (CS prior to early 1990s), *Pepperball,* CS for public disorder	Baton rounds, Bean-bags, Sock rounds, sting balls	Yes	Tasertron, M26 Advanced Air Taser	Yes (limited)	Laser dazzlers

References

1. Fathers Faul and Murray, "Rubber and Plastic Bullets Kill and Maim", 1981.

2. David McKittrick, Seamus Kealters, Brian Feeney and Chris Thornton, "Lost Lives", 1999.

CHAPTER 6: THE REVIEW OF LESS LETHAL TECHNOLOGIES UNDERTAKEN BY THE POLICE SCIENTIFIC DEVELOPMENT BRANCH

A. Introduction

1. The Police Scientific Development Branch of the Home Office has been tasked with reviewing all the available technologies that have the potential for use as an option that is less lethal than a firearm. This work is being carried out at the request of ACPO and the Steering Group set up to take forward Patten recommendations 69 and 70.

2. The phase 1 report, published in April, contained the results of the PSDB review of commercially available and near-market less lethal technologies. That report highlighted a wide range of technologies and a large number of products that could potentially be employed in situations where a less lethal option is considered appropriate for use. Many of these devices are used operationally in various countries throughout the world. It was essential to distinguish between systems that might have potential for use in the United Kingdom and those that were judged not to.

3. Since the report in April, prioritisation of these technologies has taken place based on evaluations of the technologies and comparison with the Operational Requirements. The Patten Steering Group and ACPO have identified three separate categories for prioritisation:

Category A - Devices which may be subject of immediate more in-depth research.

Category B - Devices warranting further research over a more extended timeframe.

Category C - Devices which presently do not require further research.

Chapter 8 sets out in brief a summary of the range of devices, under these categories, as identified in this chapter.

4. This chapter reports on the work that has been carried out in Phase 2 of the project and demonstrates how devices have been selected for further research from the large number of technologies considered in the April report. Information is provided on testing which has been carried out on the various technologies, information that has been gained, both operational and technical, and the current status of each of the prioritised areas.

5. A number of devices have been identified within each prioritised category as meeting the basic evaluation criteria. Further testing of these devices will now be carried out to assess how their performance relates to other aspects of the operational requirement. This will be followed by a full medical review of those devices that appear most suitable.

6. The technologies selected for Category A, ie those devices meriting immediate further research, are summarised as:

- Impact Devices or Kinetic Energy Rounds
- Long Range Chemical Delivery Devices
- Water cannon, both vehicle mounted and portable

- Electrical Devices, particularly the taser
- Distraction/Disorientation Devices, particularly laser/light devices and noise generating devices

The methodology used to evaluate the devices within each of the technology areas in Category A is essentially the same. Initially, information is gathered on all devices that are available from a wide range of countries. Manufacturers are asked to supply technical information relating to their product and, if suitable, to submit their products for evaluation.

7. Submitted products take part in a progressive sifting process. The testing is carried out in stages with the quickest, easiest and cheapest tests being carried out first on all products. This highlights those that clearly do not meet the necessary requirements and excludes them from further testing. Those products that meet the basic criteria are put through to the second stage at which point any deficiencies will again be highlighted. This continues until only those products that have shown the best performance and most closely meet the operational requirements are subjected to the more time consuming and expensive testing, such as the work required for a full medical evaluation.

8. Information on the operational use of the various devices in different countries is also gathered. This information often comes from police forces but may also be gathered from government agencies, literature and the prison service. This information provides an insight into the extent of use of each device and an indication of its effectiveness.

9. Those devices that meet all of the scientific and technical evaluation criteria will then be assessed by a medical committee (DOMILL) which will comment on their effects on the human body. This committee will consist of a number of independent medical professionals who have expertise in the technology or effects being considered (see also Chapter 7). The rest of this chapter contains an assessment of individual items of equipment or systems within these various technologies.

B. Impact devices

10. There are a large number of manufacturers producing a wide variety of impact munitions. Many of these rounds may be safe and effective when they strike one part of the body, but may cause serious injury or even death if they strike a different part. Many manufacturers, for instance, recommend that the round is not fired at the head, neck, face or spine. It may be impossible to be sure of avoiding this if the round is inaccurate. Accuracy is therefore one of the more important attributes of these types of round if unintended injuries are to be minimised.

11. The performance of these rounds, including their accuracy, varies dramatically depending on the composition of the round, the weapon from which they are fired, and the quality of the manufacturing process. Manufacturers' data can often not be relied on to provide an accurate assessment of the rounds' capabilities. It is important, therefore, that these rounds are tested thoroughly to ensure that they meet both the manufacturer's claims and the requirements of the user.

12. Less lethal impact rounds tend to fall into specific classes. These were outlined in the April report[2] and are summarised below:

- **Bean Bag:** A square, rectangular or circular fabric bag containing lead shot. The round is intended to flatten on impact, hitting face on, and spread its energy over a large area. These rounds are intended to be fired directly at an individual;

- **Sock Round:** A modification of the bean bag, designed to have no edges or corners which could lead to penetration, and tending to have a 'tail' to aid stabilisation in flight. These rounds are intended to be fired directly at an individual;

- **Single Flexible Ball Round:** This consists of a single ball (generally rubber or plastic) of various sizes, which may deform on impact to spread the energy over a larger area. These rounds are intended to be fired directly at an individual;

- **Multi-Ball Rounds:** Also known as pellets. A single cartridge can contain from 2 to over 200 pellets, each varying in size from about 0.25 to over 0.75 inch (6-19mm). These rounds can be fired directly or skip-fired off a hard surface in front of the target. They can be used to target a number of people together and are not as discriminate as many of the other rounds;

- **Fin-Stabilised Rubber Projectile:** A single rubber round with a finned tail to aid stability in flight. These rounds are intended to be fired directly at an individual;

- **Multi-Baton Rounds:** These generally consist of 3 or 5 batons in a single cartridge, generally made from rubber, wood or foam. These rounds can be fired directly or skip-fired in front of the target. As the batons spread during flight, these tend not to be as discriminate as other rounds;

- **Single Baton Rounds:** This class includes sponge and foam grenades and other rubber or plastic batons that are present as a single round per cartridge. This class also includes the current UK baton round, the L21A1, although this has not been included in this study as extensive testing has already been carried out for this round. These rounds are intended to be fired directly at an individual;

- **Encapsulated Rounds:** These include projectiles that contain a liquid, powder or other material within a protective coating or shell; upon impact, the contents should be dispersed. These are dealt with in Section C, under the heading 'long range chemical delivery devices'.

13. Most of the rounds detailed above are available in a range of calibres, mainly 12 gauge, 37mm and 40mm. There are also a number of rounds available that are fired from launchers specific to that munition. Figure 1 shows a selection of various impact munitions.

FIGURE 1: ***Various Impact Rounds***

14. It is clear that there are a vast number of less lethal impact rounds available. Manufacturers also make many versions of each of the different types of munition. The remaining sections of this chapter provide some information regarding the performance of these rounds.

LASD/Penn State Impact Testing

15. In February of this year 'The Attribute-Based Evaluation (ABE) of Less-Than-Lethal, Extended-Range, Impact Munitions', prepared by the Los Angeles Sheriff's Department (LASD) in conjunction with the Applied Research Laboratory of Pennsylvania State University, was published[3]. This report detailed a study in which 80 different types of impact munitions were tested for accuracy. The tests, carried out in Los Angeles, provided a preliminary evaluation of off-the-shelf less lethal munitions to allow a side-by-side comparison of different classes of round, different calibres and different manufacturers' products.

16. It is important to note that only 5 rounds of each type were fired in these tests, and the authors recommended that further tests be conducted using larger sample sizes. The results do, however, give an indication of the capabilities of the various munition types. It is also worth noting that the weapons were fired by hand throughout the study by experienced LASD officers, and the weapon was not clamped. A summary of the most important points from the study is given below.

17. Table 1 splits the 80 rounds tested into weapon used and class of munition, using the previous definitions (the L21A1 baton round was not included in these tests). This table gives an indication of the range of munitions available and the

relative proportions of each class of munition. It can be seen that, of the rounds tested, 5 used launchers other than standard weapons.

Class of Munition	12 gauge	37mm	37/40mm	40mm	Other	Total
Bean bag	10	4	3	4	0	**21**
Sock Round	5	1	0	0	0	**6**
Single Flexible Ball Rounds	0	0	1	0	0	**1**
Multi-Ball Rounds	6	5	9	5	1	**26**
Fin-Stabilised Rubber Projectile	4	2	0	0	0	**6**
Multi-Baton Rounds	1	1	3	4	0	**9**
Single Baton Rounds	0	4	0	2	0	**6**
Encapsulated	1	0	0	0	4	**5**
Total	**27**	**17**	**16**	**15**	**5**	**80**

TABLE 1: ***Distribution of Rounds by Class and Calibre***

18. All of the rounds were fired at a target from a distance of 21 feet (6.4m). Table 2 shows the spread (in mm) that was achieved for each class of munition within each calibre (spread is taken as the maximum distance between two shots in a grouping).

Class of Munition	12 gauge	37mm	37/40mm	40mm	Other
Bean bag	65 – 75	100-305	150 – 290	100 – 340	-
Sock Round	140 - 790	90	-	-	-
Single Flexible Ball Rounds	-	-	140	-	-
Multi-Ball Rounds	140 – 790	650 - 1150	405 – 1195	585 - 1170	215
Fin-Stabilised Rubber Projectile	75 - 255	65 - 125	-	-	-
Multi-Baton Rounds	75	330	915 – 990	380 - 1120	-
Single Baton Rounds	-	90 - 265	-	90 - 230	-
Encapsulated	100	-	-	-	90 - 240

TABLE 2: ***Spread of Rounds (in mm) at 21ft (6.4m)***

19. The results at 21ft (6.4m) show that the multi-ball rounds in all standard calibres and the multi-baton rounds in 37mm and 40mm calibres produce the largest spread, with a number of types producing a spread of greater than 1m at this range. This is as expected as these classes of rounds are designed to spread their impact over a larger area. The variation in spread between different devices within a particular class is also highlighted, for instance 5 different types of 12 gauge sock round that were tested produced a spread of 140mm for one type, up to 790mm for a different type of sock round. The most consistent round at this range was the 12

gauge bean bag, with 10 different types producing a spread from only 65mm to 75mm.

20. A number of rounds were then fired at a target from a distance of 75 feet (22.9m). Table 3 shows the spread (in mm) for each class of munition within each calibre. Only 38 of the 80 munitions were tested at this range. The numbers in brackets (n) indicate the number of each type of munition that was tested within each class.

Class of Munition	12 gauge	37mm	37/40mm	40mm	Other
Bean bag	240-915+ (n=10)	380-915+ (n=4)	530-915+ (n=1)	370-915+ (n=4)	-
Sock Round	165 – 620 (n=5)	650 (n=1)	-	-	-
Single Flexible Ball Rounds	-	-	915+ (n=1)	-	-
Multi-Ball Rounds	NR	NR	NR	NR	NR
Fin-Stabilised Rubber Projectile	190 – 380 (n=4)	495 – 545 (n=2)	-	-	-
Multi-Baton Rounds	NR	NR	NR	NR	-
Single Baton Rounds	-	280 – 405 (n=2)	-	125 – 255 (n=2)	-
Encapsulated	125 (n=1)	-	-	-	915+ (n=1)
KEY: NR indicates that no results were obtained for this class of munition. 915+ means that the spread was greater than 915mm, the maximum size of impact plate.					

TABLE 3: ***Spread of Rounds (in mm) at 75ft (22.9m)***

21. The results at 75ft (22.9m) highlight the inaccuracy of many of the rounds at this range; a number of rounds did not strike the impact plate, which had a diameter of 915mm. The variation in performance of different rounds within a class is also once again highlighted, for example 10 types of 12 gauge bean bags showed a variation in spread of between 240mm for one type of round up to greater than 915mm for another type.

22. Two of the observations made by the authors in this report are worth noting:

i) They were 'struck by the general inaccuracy of these munitions';
ii) They had observed several misfires.

A full copy of this report can be downloaded from the website:
http://www.arl.psu.edu/areas/defensetech/defensetech.html

PSDB Testing and Initial Evaluation Criteria

23. The purpose of the PSDB testing programme is to identify those rounds that meet the necessary requirements. It has already been demonstrated that there is a wide variation in performance of rounds, both between classes and between individual

rounds within a class. It is necessary, therefore, to verify that the rounds can perform to the agreed requirements.

24. The initial evaluation criteria for this type of munition (other than the L21A1), which have been agreed with the Patten Steering Group and ACPO, are summarised below:

- The device should be accurate and suitable for use within the range 1-20 metres, and up to 50 metres if possible;

- Accuracy is defined as the ability to hit a 400mm wide x 600mm high target: should achieve a 95% probability of hit with a bench-mounted system and an 85% probability of hit when fired by an officer dressed in appropriate patrol/public order dress and equipment, from the standing and kneeling positions (this criterion is designed to reduce as far as possible the risk of a round striking an inappropriate part of the body);

- The device should have a single point of aim;

- The round should not be of greater energy than that of the L21A1 baton round at 20m;

- Any platforms for delivery are acceptable other than conventional firearms, for example a 9mm handgun or an MP5 (note: a 12 bore shotgun is an acceptable platform);

- The round is intended to deliver a blunt impact and not to penetrate the outer skin;

- The round should consistently strike the target in the manner in which it was intended.

These initial criteria are likely to be refined further as more is learned about the capabilities of the various rounds.

Procedure

25. PSDB have had positive responses from a number of manufacturers producing a range of impact rounds, interested in submitting products for evaluation. Some of these manufacturers produce a wide range of different classes of impact munition, of varying calibres. PSDB are carrying out a number of basic tests on all submitted less lethal impact munitions. These are designed to measure a number of different characteristics of the rounds and to address some of the initial evaluation criteria:

- **Accuracy** – this is recorded by measuring the spread of the rounds at various distances (spread is taken as the maximum distance between two shots in a grouping). The rounds are fired from a suitable weapon that is securely clamped and mounted. Generally, 10 rounds of each munition are fired at each distance (5, 10, 15 and 20m) for the initial tests.

- **Kinetic Energy** (KE) – the velocity (v) of each round is measured at the muzzle and the target. Using the mass (m) of each round, kinetic energy values can be calculated for each munition at the muzzle and the target ($KE = \frac{1}{2} mv^2$).

- **Orientation of the round on impact** - with the use of a high-speed video camera, it is possible to record how the round is oriented as it strikes the target. This is important as, for example, problems have been noted with bean bags that did not open correctly in flight and struck edge-on, thus leading to a higher energy density (ie energy per unit area) than intended and the possibility of penetration.

- **Reliability and Consistency** - throughout these tests, a general assessment can be made of reliability and consistency and any problems noted, for example any misfires or variations in muzzle velocity.

As mentioned previously, the testing of these rounds is carried out in stages. The initial stage involves the testing of products to determine accuracy, range, velocity, kinetic energy, orientation on impact, consistency and reliability. In these initial tests, generally only ten rounds of each type are fired in order to obtain some basic information about their performance. Many more rounds would need to be fired to obtain more statistically significant results and this will be carried out if initial results are promising.

Results

26. These results are discussed below using the classes defined earlier.

i) Bean Bags

A number of bean bags have been tested so far, of rectangular, square and circular shape. With the square and rectangular rounds, the high speed video camera footage showed that many of the rounds hit the target edge-on while some were still folded in half when they struck the target. This leads to a much higher energy density (energy per unit area) at the target than the intended presentation, ie the bag striking face on with the largest surface area hitting the target. This variation in impact energy affects both the operational performance of the round and the degree of risk to which a person is exposed; indeed a number of deaths have been associated with the penetration of bean bags into the body. This effect has been observed elsewhere and is one reason why manufacturers have developed the sock round.

As this effect is well known, and has occurred with a number of different rounds which PSDB have tested, it can reasonably be assumed that the effect is inherent to all bean bags of this type. This does not meet the part of the initial evaluation criteria for impact devices which states that "the round should consistently strike the target in the manner in which it was intended". For this reason, **square and rectangular bean bags will no longer be included in the PSDB test programme**.

Similar initial tests carried out on circular bean bags show that some varieties are not folded in the cartridge in the same way that the square and rectangular versions are. This means that they may not be subject to the same problems with orientation as previously identified with square and rectangular varieties. Further testing of these types of rounds is required.

ii) Sock Rounds

The sock rounds that have been tested so far have passed the basic requirements for accuracy at 20m. In terms of the orientation of the rounds on impact, the high speed video camera footage showed that, for most of the rounds, the 'stabilising' tail was

generally not trailing behind the round as expected but was usually standing straight up or hanging below the main body of the sock round. It may be that this behaviour will not cause any undesired effects, and **therefore further testing of these rounds will continue**.

iii) Multi-Ball Rounds

The rounds of this class that have been tested spread quite considerably when fired and are very inaccurate. This is an inherent property of this class of round as they are designed to spread their impact over a larger area and may even be used to target a number of people at one time. This characteristic does not meet with the part of the initial evaluation criteria for impact devices which states that "the device should be accurate and suitable for use within the range 1-20m, and up to 50m if possible". For this reason, **multi-ball rounds will no longer be included in the PSDB test programme**.

iv) Multi-Baton Rounds

No multi-baton rounds have so far been submitted to PSDB for testing. These rounds have the same inherent characteristics as the multi-ball rounds, ie they are designed to spread after firing and impact over a larger area. It is highly unlikely that this class of round will meet the basic accuracy requirements, however a selection of products **will be tested**, if submitted, to verify this.

v) Fin-Stabilised Rubber Projectile

A number of products of this class have so far been tested at PSDB. The performance of these rounds varied considerably between individual products, but some have met the basic requirements for accuracy and orientation on impact at 20m. These rounds will go through to the second stage of testing which requires more rounds to be fired to provide statistically significant results. The variation in performance of these rounds demonstrates the **importance of submitting each of the products for testing** in order that the better performing rounds can be identified and separated from those with poor performance.

vi) Single Flexible Ball Rounds

All of the rounds within this class that have been submitted have failed to meet the necessary basic accuracy requirements at 20m and will not go through any further stages of testing. This could be due to the quality of the submitted products, rather than an inherent problem with all single flexible ball type rounds, therefore **initial testing will continue** on any other products of this class that are submitted.

vii) Single Baton Rounds

Only one product of this class, apart from the L21A1 which is mentioned in paragraphs 30 and 31, has so far been found to meet basic requirements for accuracy and orientation on impact at 20m. **This round will therefore go through to the second stage of testing**, which requires more rounds to be fired to provide statistically significant results. **Testing will also continue on any other products** of this class that are submitted.

Further Work

27. It can be seen that a number of products have been identified as meeting the basic requirements for accuracy and orientation of the round on impact. This is based on ten rounds of each type fired from a clamped and bench mounted weapon, ie under ideal conditions. These tests are necessary to allow a scientifically accurate comparison between different types of rounds. The tests are also relatively easy and less time consuming than others, and can therefore be applied to the volume of rounds received for initial testing. Further tests are, however, necessary to provide more realistic and statistically significant results. These will be carried out on those products that have passed the initial stages of testing.

28. The types of further tests to be carried out are summarised below:

- Multiple shots (50) fired from a bench mounted system for each round to ensure reliability;
- Testing of rounds at distances greater than 20m;
- Rounds subjected to extremes of temperature then assessed for performance and accuracy;
- Point of aim/point of impact data obtained for rounds fired at a range of distances from an appropriate weapon;
- User handling trials to assess the performance of the weapon system when hand-fired at stationary and moving targets and under non-ideal conditions;
- Further multiple shots (hundreds) fired from bench mounted and hand held systems to obtain statistical values for accuracy;
- Additional tests as required by the medical committee for assessment.

29. This series of tests is written in an order which allows the less expensive and time consuming tests to be carried out first, with rounds being progressively dismissed if they fail to meet the requirements at any of the stages. For example, if a round fails to meet the necessary criteria after 50 bench-mounted shots are fired, it will be dismissed from the testing and will not go through the extreme temperature tests.

L21A1 Baton Round

30. The round that is currently available has been used operationally and a few of its characteristics are worth mentioning here. The L21A1 round was introduced in June 2001 following an extensive development programme. The round is part of a system that includes the L104 37mm baton gun fitted with a new optical sight. The use of this system will have significant accuracy advantages over the previously used L5A7 with the L104 fitted with iron sights. The statement of the independent medical committee (DSAC)[4], which reviewed this system, concluded that the new system (in comparison to the previous system) would, by virtue of its increased accuracy, reduce the incidence of people other than the targeted individual being struck directly. This would also reduce the incidence of direct head or upper thorax impacts and thereby reduce the incidence of life-threatening injuries, though very serious head injuries

would still occur should the round strike the head. These statements assume that both systems are being used according to the guidelines.

31. The grouping of rounds is exceptionally good, surpassing anything else tested to date. At 20m rounds are grouped well within a 300mm circle and extending out to 50m still fall within the required target area. This is illustrated in Figure 2, which shows a grouping from a typical proof firing of 30 rounds at 50m. The target size is 250mm wide x 750mm high and the rounds have fallen within an area of approximately 150mm wide x 350mm high (well within the desired values as detailed in the initial evaluation criteria, paragraph 24).

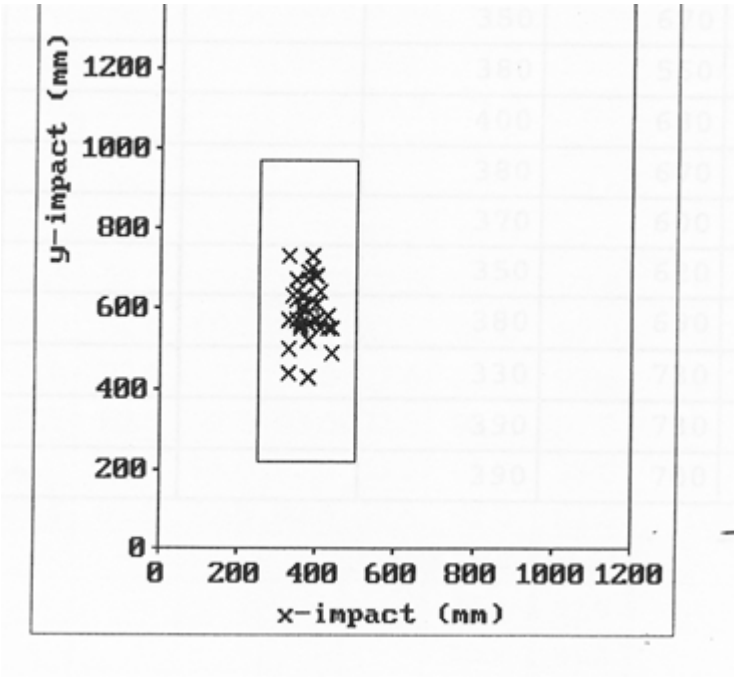


FIGURE 2: ***Grouping of L21A1 at 50m***

Operational Information

32. Impact munitions are a widely used category of less lethal device throughout the world and different countries often use different types of round. Impact projectiles were first introduced in the United States for operational purposes in police departments during the 1960s. A wide variety of rounds have been used throughout the various forces with bean bags being the most widely used round and baton rounds also proving very popular. Encapsulated rounds filled with chemical irritant have also been used. Some police forces in Canada have also used each of these rounds.

33. Some Australian police forces also provide their Tactical Operations Units with twelve gauge bean bag rounds. These have been used operationally but other rounds are now being researched as the results from the bean bags have been 'inconclusive'.

34. The L21A1 round is only currently available to the UK military and police but there has been some expression of wider interest.

Conclusions

35. The initial testing phase for kinetic energy rounds, involving testing of all submitted products for accuracy, range, velocity, kinetic energy, orientation on impact, consistency and reliability, is almost complete. Many rounds are highly inaccurate and failed to meet even the basic accuracy requirements; these products have been dismissed from further stages of testing. Additionally, all square and rectangular bean bags and multiple ball rounds have been dismissed from further testing due to inherent problems with the rounds.

36. A number of products have been identified which meet the basic accuracy and orientation requirements at 20m. These rounds will be subjected to more detailed testing (Phase 3 of the project) to assess various other aspects of their performance. Any rounds failing to meet the necessary criteria in future testing stages will be dismissed from all subsequent testing.

37. Those products that pass all stages of testing will be passed to the medical committee which will assess the effects they are likely to have on the human body.

C. Long range chemical delivery devices

38. The report in April[2] highlighted a number of chemical irritants that are available for use in various countries throughout the world. The most widely used of these are CS (o-chlorobenzylidene malononitrile), OC (oleoresin capsicum, also known as pepper), PAVA (pelargonic acid vanillylamide), CN (chloroacetophenone) and CR (Dibenz (b.f.)-1:4-oxazepine). CS is currently the most widely used chemical incapacitant within the UK police and the one that will be considered in this section.

39. CS is a peripheral sensory irritant that works as an incapacitant by producing irritation of pain receptors in the skin and production of a burning sensation over exposed areas. Secondary symptoms include involuntary blinking of the eyes, disorientation, running of the eyes and nose, sneezing and coughing.

40. The April report also highlighted a number of ways of delivering a quantity of chemical irritant to a subject. These are summarised below:

- Grenades and Projectiles – This method is indiscriminate and is used either for crowd control or to fill a room or vehicle with the irritant. The range of these devices can vary from 10m up to 300m.

- Personal Incapacitant Sprays – Hand held CS sprays have been widely used by police forces in Great Britain since 1996. These sprays are very discriminate and have a maximum range of 3-4m.

- Long-Range Discriminating Devices – These devices should be capable of delivering a quantity of chemical irritant discriminately to one individual at a range greater than that possible with the hand-held sprays.

41. It is the long-range discriminating devices which have been selected as a priority for further research and for which there is the greatest requirement (the other two types of device are currently available and have been fully evaluated in previous years[5,6]). This type of device tends to combine kinetic impact effects with chemical irritant effects to produce incapacitation of the target. The degree of each effect varies

with each system and is dependent on attributes including the velocity, size, shape and design of the round as well as the quantity of irritant contained within it.

42. This class of round, which has also been described as an encapsulated round, includes projectiles that contain a liquid, powder or other material within a protective coating or shell; upon impact, the contents should be dispersed. These rounds may provide some degree of incapacitation by their direct impact effects, however the material contained within the round, generally a dye, malodorant or chemical irritant, is also designed to have an additional effect. A number of impact devices are currently available, or are being developed, to contain one or more of these materials.

43. Most of the rounds are available in a range of calibres, such as 12 gauge, 37mm and 40mm. There are also a number of rounds available that are fired from launchers specific to that munition.

44. As with the impact devices, a number of initial evaluation criteria have been agreed with the steering committee and applied to long range chemical delivery devices. These are shown below (note, these devices can be split into two types: those that are intended to strike the target directly and; those that are intended to strike the ground in front of the target):

i) Subject Specific Rounds:

- The device should be accurate and suitable for use within the range 1-20m if possible, and ideally up to 50m;
- Accuracy is determined by the ability to hit a 400mm wide x 600mm high target: should achieve a 95% probability of hit with a bench-mounted system and an 85% probability of hit when fired by an officer dressed in appropriate patrol/public order dress and equipment, from the standing and kneeling positions;
- The incapacitant 'cloud' must rise to meet the face of the target;
- The distribution of the incapacitant 'cloud' must be greater than the grouping capacity of the rounds when bench fired at a specific range;
- Secondary missiles should not cause serious injury;
- Minimum potential risk from hazardous debris;
- The round should consistently strike the target in the manner in which it was intended.

ii) Multiple Subject Incapacitant Rounds:

- The round should strike a point on the ground within a $1m^2$ area of the point of aim;
- The incapacitant 'cloud' must rise to meet the face of the target;
- The incapacitant 'cloud' should be no greater than 3m in diameter;
- Secondary missiles should not cause serious injury;

- Minimum potential risk from hazardous debris.

Once again, these initial criteria are likely to be refined further as more is learned about the various rounds' capabilities.

45. Section B highlighted 5 rounds of this class that were included in the Attribute Based Evaluation for accuracy. To summarise these tests:

- The 12 gauge encapsulated round gave a spread of 100mm at 21ft (6.4m) and 125mm at 75ft (22.9m);

- The other 4 encapsulated rounds, which used launchers specific to that projectile, gave a spread of between 90mm and 240mm at 21ft (6.4m);

- When one of these projectiles was fired at 75ft (22.9m), it gave a spread of greater than 915mm.

PSDB Testing and Initial Evaluation Criteria

46. PSDB are carrying out tests on this class of round to identify those products that meet the necessary requirements. The submitted products are put through a series of initial tests very similar to the kinetic energy rounds. These tests are used to assess various characteristics of the rounds such as accuracy, range, velocity, kinetic energy, orientation on impact, consistency and reliability. Subsequent testing will also follow much the same method as that discussed previously for impact munitions.

47. Only a limited number of products of this class have so far been submitted to PSDB for testing, despite a large number of manufacturers having been contacted. None of these products has met the basic accuracy requirements at 20m, nor indeed even at 15m. Further rounds, which appear to have greater potential than those tested, are currently in development and some will be available soon for testing. One such round, the Ring Airfoil Projectile, is still in the development stages and will not be available for initial testing for some time. Efforts are also continuing to identify additional manufacturers who may be interested in providing their rounds for assessment.

D. Water cannon

48. Water cannon have been selected for further and immediate investigation and work is proceeding on the investigation of operational issues and technical specifications of water cannon. Water cannon were considered for use in the UK in the early 1980's and the Home Office conducted extensive research into the feasibility of using them at that time. A summary of this work is given below, along with the reasons why water cannon were not adopted at that time. This is followed by a summary of the work that is currently being conducted in relation to water cannon.

Summary of Home Office Work on Water Cannon, 1981-1987

49. Following the disturbances during the summer of 1981, the then Home Secretary authorised the use of plastic baton rounds and CS pyrotechnic irritant devices for use as a last resort in situations of extreme public disorder. He also

initiated an investigation into the feasibility of water cannon for use in these situations and a large programme of work was set up to explore this issue.

50. Members of the Home Office visited police forces in Belgium, Holland and West Germany in August 1981 to determine the effectiveness of water cannon for riot control and to examine the type of equipment used by the police service in these countries. They found that six models of water cannon were used operationally in the three countries. In most models examined, the jets of water did not have the force and range required to keep rioters at a distance or to disperse a crowd; they achieved little more than making rioters wet. However it was felt that, even when the jet power was not sufficient to keep back rioters, the water cannon were still of some use in that they attracted missiles and hence took some pressure off the police. The use of a large advancing vehicle would also cause the crowd to retreat and hence ground could be gained.

51. The prototype MK9 under test in Germany had a higher jet power and was capable of preventing the approach of rioters closer than about 30m. The tank capacity was also larger to allow for the higher pump rate. This model was extremely well protected against attack as it was very high with smooth sides and possessed no hand or foot holds, making it very difficult to climb onto while moving. This model was the only one thought capable of driving rioters back and 'distancing' them from the police.

52. The Home Office concluded that water cannon are only effective when used in pairs. It was also noted that no continental studies had been undertaken on the danger of injury to demonstrators from the use of high-pressure water jets.

53. Water cannon had been used in Northern Ireland in the early 1970s. However problems were noticed due to poor manoeuvrability, difficulty in obtaining adequate water supplies, inadequate protection and small capacity. A (medically safe) dye added to the water was also found to look like blood when seen on the television.

54. In September 1981, based on the findings from the initial visit, the Home Office Scientific Research and Development Branch (SRDB, now PSDB) provided a draft specification for a UK water cannon incorporating all of the best features seen during the visit. UK manufacturers of fire fighting vehicles were invited to meet the UK police specification which sought performance equal to, if not better than, the West German MK9 water cannon.

55. A committee was set up to develop a prototype water cannon for use in the UK. Two vehicles were built, compatible operationally but containing different features to allow comparisons to be made. They were delivered for evaluation in the summer of 1983 and underwent extensive mechanical and road tests. The opinion of the crews working the machines was taken into consideration during their evaluation. The machines' capabilities were demonstrated to senior police officers.

56. The committee made recommendations for further work on various parts of the machines and advice on operational issues. One of the recommendations made was that a medical evaluation of the risk of injuries from the use of water cannon should be carried out before the vehicles were operationally deployed. The lack of medical information at that time made it impossible for the committee to provide a firm recommendation about water cannon, although the exercises that had been carried out indicated that police use of this equipment in situations of public disorder was a viable proposition.

57. In 1984, the Chemical Defence Establishment (CDE) at Porton Down provided a tentative assessment of the hazards of the Home Office water cannon, making predictions that the HO water cannon had the potential for significant risks of both primary injury to the trunk and of secondary skeletal injuries.

58. To avoid such injuries the then Home Secretary decided that the use of the water cannon in the 'spray mode' (ie firing over the heads of rioters) should be evaluated instead. This method of spraying would reduce the force per unit area and hence injury potential. The original prototypes were modified to incorporate this; the end of each monitor (or spray nozzle) was fitted with a mechanical device to 'spread out' the jet over a larger target area. The possible use of additives, namely dye and/or CS was considered and a system to allow the use of dye or irritant was fitted to each prototype (dye was ruled out for operational reasons at an early stage).

59. The spray mode was however found to be ineffective and other inherent drawbacks with water cannon were identified, such as the quick exhaustion of the water supply; the need to protect refill sources; their recommended usage in twos and threes; their lack of manoeuvrability; and their vulnerability to attack.

60. As a result, the Secretary of State produced a statement in 1987 stating that any benefits in the deployment of water cannon would be outweighed by their operational and tactical disadvantages as outlined above and that it was not proposed to add water cannon to the range of police equipment. Any developments, including the use of water cannon overseas, would continue to be monitored so that the position could be reviewed if necessary.

Current Water Cannon Work

Technical Specifications

61. A number of international manufacturers have been contacted and asked to provide technical specifications of their vehicles. To date, a limited number of responses have been received. A summary of the technical specifications of currently available vehicle mounted water cannon is provided below.

i) Vehicle Size

Water cannon tend to be large vehicles, with their size largely determined by the capacity of the water tanks on board. Length varies between 6 and 9m, height from 3.6 to 4.2m, and width is generally about 2.5m. Their weight ranges from 18,000kg up to 21,000kg when full. A typical vehicle is shown in Figure 3.

FIGURE 3: ***A typical vehicle mounted water cannon***

The large size of the vehicles can prevent access to some narrow streets. Some forces use hoses attached to the sides of their water cannon to allow water to be used in alleyways and some buildings.

ii) Capacity, Flow Rate and Pressure

The capacity of the tank is the most obvious limiting factor in the use of water cannon. Vehicles tend to hold between 4000 and 9000 litres of water and, at maximum flow rate and with all jets operating, the total water capacity can be used in as little as 4 minutes. Flow rates range from 250 to 1200 litres per minute per monitor and pressure varies between 5 and 25 bar (500-2500kPa).

Firing the cannon in short bursts preserves water and allows assessment of the effectiveness of the water cannon during operation. Some models of water cannon are also available with a "pulsed jet" firing system, which allows conservation of the limited water supply. These vehicles can fire in three different modes:

- Short pulse - a single burst of 5-15 litres of water is fired;
- Automatic pulse - 40 to 70 pulses per minute;
- Continuous Stream - pumping around 900 litres per minute.

Most vehicles have an additional tank to hold either a dye or an irritant additive, which is mixed with the water stream. The capacity of this tank tends to be between 132 and 190 litres, and more than one tank may be present in a vehicle. The concentration of dye or irritant in the water stream can usually be varied by controls within the crew cabin.

iii) Accuracy

Aiming of the monitors requires practice. Visibility from the crew cabin can be limited and the cannon operators are usually seated in the rear of the cabin. They rely on directions from the driver and commander in the front of the cabin to target and direct the water stream. Visibility is further decreased when the monitors are firing.

With practice the crew should be able to effectively target individuals in a crowd, although the width of the water stream prevents the water cannon from being a fully discriminate weapon. Figure 4 shows the cannon being used for practice in a precision shooting exercise.

FIGURE 4: ***Precision Shooting Exercise***

iv) Refilling

If the water tanks are emptied during operational use then refilling will be necessary. Most of the available vehicles are capable of refilling at water hydrants or from open water sources such as rivers and lakes. The refilling operation itself may take 10 minutes to complete, with additional time required for setting up refilling equipment.

Water cannon crews are trained to carry out the refilling procedure. Another option is to have a second team ready at the refilling point who will connect the hoses and carry out the refill and clear away equipment, allowing the water cannon to leave and return to operation more quickly.

v) Range

The force of the water jet decreases with distance from the vehicle. At close ranges and high pressures there may be risk of serious primary or secondary injuries, while at long ranges the water may not be a sufficient deterrent to protesters.

Most manufacturers claim a range of 40-60m for the water jet. As an example, a total range of 60m may be possible when both monitors are fired together, although at this range the pressure of the water may be insufficient to push back or hold a protester; it may, however, act to deter any closer approach. With the same system, a person could be held at a distance of 40m.

vi) Armour and Protection

Armour levels vary from vehicle to vehicle. Protective features may include the following:

- Steel body panels;
- Fixed polycarbonate glazing, fitted as standard to most vehicles;
- Water spray systems on the vehicle body, windscreens, roof and wheel arches to protect against petrol bombs;
- Pressurised cab to prevent penetration of smoke and gas;
- Barbed wire on the top of the vehicle;
- Smooth outer panels and the absence of foot/hand holds to prevent protesters from climbing onto the vehicle;
- Run flat tyres;
- Protective grille screens on windows.

vii) Additional Equipment and Requirements

Vehicles may be equipped with video equipment to improve visibility from the cab and assist in evidence gathering. A public address system may also be used to warn the crowd of the use of the water jets. Radio equipment for communication between crew and officers on foot may also be available in some models.

The specialist nature of these vehicles means that dedicated technical support will be required to provide maintenance and ensure the machines remain in a working condition. A technical officer is often present as a member of the vehicle crew.

Portable Water Cannon Systems

62. Portable water cannon offer the obvious advantage over vehicle mounted systems in that they are much smaller and therefore more manoeuvrable. These types of device tend to hold the water in a pack which is strapped to the users back, or in a trolley that can be wheeled along by the operator.

63. One system, primarily designed as a rapidly deployable fire-fighting tool, consists of a 13 litre water reservoir, a compressed air supply and an impulse gun. The 13 litre tank is strapped to the back of the operator who then fires the highly pressurised water at the target area using the impulse gun. The water is discharged as small, high velocity 'packets', which use the minimum amount of water therefore helping to conserve the supply.

64. The overall size of the backpack is 360x260x625mm and it weighs 10.3kg when empty, 23.3kg when full. The impulse gun uses 25 bar compressed air as the power source. It is 800mm in length and weighs 6.8kg. When the valve opens, the compressed air forces the water out of the barrel at high velocity within milliseconds; this is usually accompanied by a loud noise. A choice of three gun barrel sizes is available filled with one, half or quarter litre charges of water. The maximum shot range is said to be 16m, with the width of the spray being 3m at a distance of 5m from the gun.

65. Trolleys are also available with a capacity of 35 or 50 litres. This unit is assembled on a wheel base with brackets for the impulse gun, the air cylinder and a 15m coaxial hose.

66. This technology has also been incorporated into a small vehicle. The vehicle is equipped with a 1000 litre water tank and two 12 litre impulse guns. The maximum range of the water shot is said to be 64m and the operating pressure of the system is 25 bar (2500kPa).

67. Figure 5 represents a portable water cannon system that is similar to the one described.

FIGURE 5: ***Portable Water Cannon***

Health and Safety Issues

68. It is accepted that water is capable of inflicting serious injury. These injuries may be classified as primary or secondary injuries. Primary injuries are those resulting from the distortion of the body wall by the impact of the jet. These injuries are likely to occur within the first 0.1-0.2 seconds of impact and may include bruising of internal organs. Secondary injuries occur as a result of the acceleration of the body as a whole resulting in collision with hard surfaces. These injuries are largely skeletal, such as bone fractures. Other injuries could be caused by debris, accelerated by the force of the water, striking the person.

69. The effects of high-pressure water on the human body have not been extensively studied. The internal kinetics of water jets are complicated, the impact of a jet of water will have a different effect on the human body than a hit from a solid object with similar kinetic energy and must be considered differently. Different models of water cannon have different characteristics, such as coherence of water jet, water pressure, etc. This means that the operational effectiveness and the risk of injury will vary depending on the model used.

70. A small number of papers[7,8] have been published which describe eye injuries caused by high-pressure water jets and fire hoses. The fire hose operated at a pressure of 10 bar (1000kPa), which is within the range of pressures attributed to water cannon; the distance from hose to target was less than 5m.

Operational Issues

71. Water cannon have never been used in Great Britain, so information is being gathered from international contacts on the operational effectiveness of water cannon in public order situations. Visits have been made to Belgium and Germany to obtain information on their experiences with water cannon. Contacts have also been made in other countries and communication will continue to allow more information to be gained. GB officers have also visited Northern Ireland.

Northern Ireland

72. The RUC in Northern Ireland has operated two vehicle mounted water cannon on loan from Belgian forces for the past three years. In their first year the water cannon were not deployed, in the second year they were deployed and used twice and in this third year the cannon have seen extensive use.

73. The water cannon are currently deployed in pairs with one water cannon used up front while the other is in reserve behind. The vehicles can change position with one covering while the other refills, for example. A crew of five people is used to operate the cannon. The water cannon are effective in dispersing crowds and keeping people at a distance from the police lines, with an effective distance of approximately 20-30m.

74. The water cannon are thought to fulfil a useful role and are an important resource for public order policing, although the model currently used is felt to be lacking in a number of areas. These include the age of the vehicle (affects vehicle maintenance); the vehicles' large size, which restricts their movement and deployment and prevents access to some narrow streets; limited space and visibility within the cab; lack of sufficient protection from attack and; limited operation before refilling is required.

75. While some of these factors are inherent to all vehicle mounted water cannon, others may be improved by using newer models of cannon with different features such as a pulsed rather than a continuous stream of water. Other features that may be desirable include the use of camera equipment, both for evidence gathering and in helping to aim the cannon jets.

Belgium

76. The Belgian water cannon are 14 years old and were manufactured to a specification drafted by the Belgian Gendarmerie. The vehicles cost around £250,000 to £300,000, although this is dependent on the specification and the number of cannon required. The Belgians have used the water cannons successfully in many operations since their introduction, and have not reported any fatalities or injuries connected with their use.

77. The Belgian Gendarmerie has a total of 24 fully trained crews and 18 water cannon vehicles. At least 10 of these vehicles are kept operational at any one time, allowing necessary repairs and servicing to be carried out and to allow for regular crew training. A crew of 5 people is used to man the water cannon, each of whom undergoes specific training prior to operational deployment. Vehicles operate as a single unit, supported by officers on foot.

78. At maximum flow rate using both jets, the operational time is limited to 4 minutes, however the operators are trained to use the water sparingly, firing in bursts of 10 to 15 seconds then judging the response before firing again. This preserves the water supply and allows an assessment of the effectiveness of the water cannon; the Belgians have not experienced any problems with the capacity of the water cannon. The length and pressure of the bursts may be gradually increased until the crowd complies with police instructions. The jets are able to fire water up to 60m when used simultaneously and to keep a person at a distance of 40m.

79. The vehicles have a number of features to protect them from attack. They also have a number of other items of equipment fitted such as: a video monitor and a number of cameras; a public address system; search lights; a double sound horn coupled with blue lights; intercom and radio systems to allow communication of the cabin crew with ground officers, central command and other deployed units. The Belgian water cannon also have the facility to add chemical irritants or dyes to the water supply, although these measures have not been used in practice.

Germany

80. There are 117 water cannon in service across Germany, operated by the 16 regional police forces. 30 cannon also belong to the federal police. Many of these are older models but a number are of a newer variety, recently introduced. Each vehicle costs approximately £300,000.

81. The vehicles have a crew of four people. A minimum of two vehicles are deployed to an incident and each will have a unit of nine officers on foot to provide protection. An extinguishing agent (Expyrol) can be injected into the water jet to fight fires and CN is also carried as an irritant additive. The water jets can be sprayed up to 60m. The vehicles have a number of measures to protect them against attack including no foot holds or hand holds, heavy-duty polycarbonate windows and run-flat tyres.

82. Water cannon were used in a number of German cities to disperse May Day protesters this year, and also during March at Dannenberg against nuclear fuel shipment protests. 30 vehicles were also assembled at the Gorleben rail terminal, the intended destination of the nuclear waste flasks.

83. A death was reported in Germany relating to water cannon. A person reportedly fell under the wheels of the vehicle; no injuries resulting directly from use of the water jets have been reported.

Other Use of Water Cannon

84. There are four water cannon in the Netherlands, two in Amsterdam, one in Den Haag and one in Rotterdam. These are all of an older type, although they are now being replaced by newer models.

85. France has seven water cannon. Three of the new generation cannon are in Paris, four older style models are used in other areas.

86. The Swiss police have recently purchased the same models of water cannon as used in Germany.

87. The prison service in England and Wales has one of the portable water cannon systems available, but has never used it. They consider its primary role to be for use in hostage situations, although they do not intend it to be fired directly at a person. Rather, it is intended as a means of distraction by firing against a wall or ceiling and using the effects of the water and the loud noise.

E. Electrical devices

88. This section includes any device that uses the effects of electricity to incapacitate the target. There is a variety of different devices available but their principle of operation is the same. They are battery powered and use a low current, high voltage impulse shock to provide incapacitation. The electrical stimulus delivered by the device temporarily interferes with the normal electrical signals generated by the human nervous system. Incapacitation by electrical means appears to offer a virtually instantaneous method of incapacitation with almost instant recovery, although some questions remain on delivery methods and on health effects.

Tasers

89. Taser devices operate in the following way: a cartridge is attached to the front end of the weapon, which contains two barbs (the electrodes) each of which is attached to a coiled length of wire. The barbs are fired and attach themselves to the skin or clothing of the targeted individual. When the barbs attach themselves to a person, a current can be sent down the wires and through the person's body between the two barb points. Figure 6 shows a selection of models of taser that are currently available.

FIGURE 6: ***Selection of Currently Available Models of Taser***

Taser Properties

90. There are a few different suppliers of tasers and each of their models differs in some way. In many respects, the devices made by each of the manufacturers are very similar as they are essentially designed to do the same thing. The main similarities between current models of tasers are:

- The device consists of a cartridge attached to a hand-held battery operated unit. When fired, it propels a pair of barbed darts attached to two trailing wires at the subject. Once contact is made, it begins discharging a metered and pulsed current through the subject's body resulting in involuntary muscle spasms and severe loss of motor control.

- The current maximum range of any model of taser that we know of is 21ft (6.4m), which is the maximum length of wire in the cartridge. 15ft (4.6m) cartridges are generally also available.

- Most companies now provide new higher powered tasers (up to 26W with a reported pulse energy of 1.4-1.8 Joules) as well as the older 5-7W systems. These higher powered tasers only came into operational use in 1999. This will affect the amount of operational information that can be used to predict the likely risks associated with these devices.

91. There are also a number of differences between different companies' products that may affect the users' decision as to which one is most suitable. These differences are summarised below:

- Some models are single shot only, ie only one cartridge can be inserted at any time, and this must be removed before a new cartridge can be inserted. Other models allow two cartridges to be inserted together, resulting in an immediate second-shot capability if required (note: with all models of taser, multiple discharges of electricity can be applied to the subject using the same initial cartridge, providing both barbs are still suitably attached to the subjects body/clothing);

- Some models of taser resemble a handgun (see Figure 6);

- Models are available using single laser sights that are intended to show where the top barb will land on the target. Others use dual laser sights, which are intended to provide a better judgement of distance and dart angulation by showing where both barbs will land;

- A data port is available on some models, which can be plugged into a computer, with the appropriate software, and downloaded to give information on how often the taser had been used and the time duration of every activation. A remote firing capability may also be possible. Other models do not have this capability;

- Probe-like connections are available on some models, which provide a touch stun capability at distances of up to 3ft (0.91m);

- Some models can also be used in 'stun-gun mode', which does not require the use of a cartridge. This involves using the electrodes on the taser to touch directly against the subjects' body;

- Some models provide a continuous timed burst of electricity when the trigger is pulled, although it may be possible to stop this at any time by flicking the safety switch. Other models require the firer to keep their finger on the trigger for the entire time that the electricity is required to flow;

- Some types of cartridge use a rifle primer as the propellant while others use compressed nitrogen;

- Different cartridges have different angles of separation between the barbs. This means that, at a given distance, some barbs will have separated further than others – this can have implications on the maximum and minimum effective range of the devices;

- After being fired, some cartridges will release a large number of small, confetti-like pieces of paper with the serial number of that particular cartridge printed on them. This helps provide evidence of the use of a particular cartridge at a scene.

92. In 1999, Sgt Darren Laur of the Victoria Police Department, Canada, published an 'Independent Evaluation Report of Taser and Air Taser Conducted Energy Weapons'[9]. This report is an unbiased assessment and comparison of a number of models of taser available at that time; it discusses the strengths and weaknesses of each of the models (a full copy of the report can be found at http://www.airtaser.com/laur/report.html). It is worth noting, however, that although only two years old, this report is already out of date as a number of additions have been made to the available products since its publication. Members of the Steering Group visited the Victoria Police Department in September to discuss the

pros and cons of the usage of tasers at first hand with both practitioners and manufacturers. They also discussed training, effectiveness and medical issues.

Taser Operational Issues

93. A number of important generic points have been learned about tasers that can affect their use operationally.

i) Batteries

Different models of taser require different types of batteries, usually either lithium, alkaline or rechargeable are recommended. Different types of batteries have varying levels of performance in terms of their power, both in use and when stored, and when used in different climates.

The voltage rating and current delivered vary with different types of battery, so the output power produced will also vary. This will affect the amount of electricity that is passed through the target. Higher powered batteries will produce a higher spark rate compared to lower powered batteries.

The performance of the different types of batteries with continuous use also varies. For instance, the performance of alkaline batteries declines steadily throughout the lifetime of the batteries, with the voltage dropping with every use. With rechargeable batteries, however, the voltage and therefore performance remains essentially constant until the batteries are almost exhausted, even after multiple use, at which point there will be a rapid decline in power.

These effects can be observed by firing two of the same models of taser side-by-side, one powered by alkaline batteries and one by rechargeable batteries. With continuous cycles, the spark rate of the rechargeable batteries will be maintained whereas with the alkaline batteries the spark rate will decrease rapidly with continuous cycles. Note: when the taser is not fired in continuous cycles, this decline in performance will not be as rapid as the batteries will have had time to recover in between uses.

The performance of different types of batteries also varies in cold conditions. Alkaline batteries are affected much more by the cold than rechargeable batteries. This will result in a lower spark rate, and subsequent lower power output, than at room temperature.

When the spark rate is lower than normal, due to either partly exhausted or cold batteries, the number of pulses per second reaching the target will be lower. This will result in muscular contraction/relaxation cycles at the target instead of the overall complete muscle stiffening required for total muscular control. This effectively means that tasers operating at lower spark rates are not as likely to lead to incapacitation.

Rechargeable batteries offer a number of advantages over other types of battery, however they do self-drain at approximately 1% per day. Therefore, if the taser is not used for a period of time and the batteries are not recharged, there will be a large reduction in the power. If rechargeable batteries are used, it is extremely important to remember to recharge them at regular intervals – one manufacturer recommends doing this every two weeks.

ii) Effectiveness

John Cover built the first taser prototype in 1970. The name taser was chosen as an acronym for "Thomas A Swift's Electrical Rifle", after the Tom Swift fantasy stories. At this time, North American law enforcement agencies did not show much interest in the device and it was sold mainly to the civilian market. In 1976, some American police departments began successfully using the taser, which led to further interest by other police departments, and a growth curve within the American law enforcement community has existed ever since. Today, hundreds of police departments in the United States use taser technology (note: there are approximately 17,000 police forces in North America). There have been at least 10,000 operational deployments of the device. Canadian police forces first began using tasers in December 1998, and an increase in use and sales has also followed there.

Effectiveness ratings for the 5-7W systems have been quoted as between 85% down to as low as 50%. It was found that focused individuals were able to fight through the effects of the electricity and could continue with an attack. 26W tasers were introduced as an alternative to 5-7W systems as they were expected to be more effective. The lower-powered systems are believed to interfere with the communication signals within the nervous system of the target, while the new higher-powered tasers are believed to completely override the central nervous system and directly control the skeletal muscles, causing an uncontrollable contraction of the muscle tissue. This is said to be close to 100% effective regardless of the pain tolerance or mental focus of the individual, providing of course that the barbs attach.

Since the introduction of the higher powered tasers, a large number of volunteers have been subjected to their effects, mainly American and Canadian police officers, including those who had previously been able to fight through the effects of the lower-powered versions. The feedback from these volunteers indicates that the higher-powered tasers are indeed more effective, with few people capable of fighting through the effects. Tests were recently carried out in Canada, using volunteer police officers armed with firearms loaded with blanks, who were subjected to the effects of a higher powered taser. The objective of the exercise was to determine whether the officers were still capable of discharging their firearms. It was found that, often, the officers were able to voluntarily discharge their firearms while the electricity was passing through them.

Operationally, there have been a number of cases where individuals have not been fully incapacitated by the device. Their muscles have contracted while the taser is active, but they have not fallen to the ground and, as soon as the power is turned off, they have been able to remove the barbs from themselves and continue with their attack.

Since the introduction of the higher-powered tasers, there have been a number of operational uses allowing some initial effectiveness data to be obtained. To summarise some of this data, of 356 incidents where cartridges were fired, 38 of these (10.7%) were ineffective in producing the desired effects, ie incapacitation. These figures relate to the same model of taser and are combined from a few different sources. Significantly, the portion of these figures which came from Canada show an ineffectiveness rating of 26.0%. This could be due to the cold climate affecting the batteries as well as the thickness of the clothing worn by the subject.

There are a number of possible reasons for the failure of taser devices. These are summarised below:

- **Clothing** – although the electricity can arc across a gap up to a certain distance, there may be some situations where the thickness of the clothing worn exceeds this distance. This is particularly so in cold climates where heavy jackets are worn. Also, if clothes are loose and hanging and the barb(s) penetrate the clothing only and not the body, then the current flow could be broken when the clothes lift away from the body;

- **Low battery charge** – the issue of batteries has been discussed already and reasons have been given as to why they are likely to fail. This has been recognised as a serious issue by the users and trainers in America and Canada and a number of failures, which had initially been thought to be due to clothing, are now suspected to have been caused by low battery charge. They have often found that when an officer first receives their taser they will demonstrate its sparking to colleagues, usually a number of times. They may also do a 'spark-test' before taking their taser on duty with them to ensure it is working correctly. These actions combined can seriously affect the performance of the taser when the time comes to use it operationally;

- **One or both darts miss the target** – this could be due to a number of reasons including: operator error, errors in the sighting system, errors in the cartridge, a moving target and the target being out of range. Generally speaking, unless both barbs attach to the target, the circuit will not be completed and the electricity will not flow through the target;

- **Subject fought through the effects of the electricity** – this has been discussed already and it is recognised that this may still be a possibility even with the new higher-powered tasers. Reasons for this happening could include the barbs not being sufficiently separated, or affecting a group of muscles that are not sufficiently sensitive;

- **Cartridge failure** – identified as the cause of failure in some cases;

- **Problem with taser** – other than due to cartridge failure or low battery charge, such as a mechanical or electrical failure in the circuit;

- **Operator error** – for example, failure of the operator to hold down the button to discharge the current.

The path that the electric current will take after the barbs have been fired at a target is often difficult to predict. Essentially, electricity will flow along the path of least resistance. Although ideally the full charge would travel along the wire to the first barb, through the subject's body, then out through the second barb, this is not always the case. Contributing factors to the unpredictability include the presence of metal or other good conductors; the presence of water; highly resistant material at the target; and arcing across the wires.

All of the figures for effectiveness quoted previously have only included those cases where a cartridge was actually fired from the taser, however the taser is often also used to gain compliance in other ways and often the use of the laser sight(s) alone (if

available) will be enough to gain compliance. In other instances, firing the taser without a cartridge inserted is enough to gain compliance; this allows the subject to see the effects of the electricity sparking and hear the loud crackling caused by the electrical discharge across the electrodes (note: this is not possible with all models of taser). Additionally, some tasers can be used in stun gun mode to provide a touch stun capability, this method of application is often used in some American and Canadian forces. Some figures for effectiveness in this mode show that 118 uses out of 552 (21.4%) of one model of taser had been a touch-stun application, with a reported 88.1% success rate.

PSDB Testing

94. A number of tests have been carried out on various models of taser to measure characteristics such as their accuracy and electrical output. These aspects of performance are important from both an operational perspective and also in terms of the effects they will have on the human body.

i) Accuracy

Tasers can use either a single laser sight that is designed to show where the top barb will land on the target; a dual laser sight that indicates where both barbs should land, or no sights at all. While a large separation of the barbs is desirable to provide maximum incapacitation, it is also important that both barbs will penetrate the target or at least attach onto their clothing, otherwise the circuit cannot be completed and the electricity will not flow through the target.

Accuracy tests are therefore carried out to determine the position of the barbs relative to the laser dot(s), where present, and the separation of the two barbs at different distances. Initial tests were carried out indoors at room temperature, with no wind effect and with the taser clamped firmly using a tripod, therefore representing an ideal situation and the maximum possible accuracy of the devices.

- Results

The maximum current range of any model of taser that we know of is 21ft (6.4m). This is the maximum length of the wires within the cartridge and cannot be exceeded. 15ft (4.6m) cartridges are also generally available, these tend to have a wider angle of separation between the barbs, meaning that the barbs will be further apart at any given distance than with the 21ft (6.4m) cartridges. The 15ft (4.6m) cartridges may be more suitable for use at close-quarters in order that sufficient separation of the barbs is achieved at relatively close range.

Table 4 shows the typical results that can be expected from 21ft (6.4m) cartridges fired from a single sight taser. Values given are the separation between the top barb and the point of aim (the laser-sighting dot), and the separation between the top and bottom barbs. The ranges show the maximum and minimum values for these while

the mean gives the average values at each distance. These results were obtained from at least ten shots fired at each range from the same model of taser.

	Separation between top barb and laser dot		Separation between top barb and bottom barb	
Distance from taser to target	**Range (mm)**	**Mean (mm)**	**Range (mm)**	**Mean (mm)**
5ft (1.5m)	20 - 55	39	205 - 260	225
10ft (3.0m)	15 - 135	63	305 - 440	378
15ft (4.6m)	90 - 140	109	534 - 685	601
20ft (6.1m)	105 - 410	287	563 - 905	786

TABLE 4: ***Results of Accuracy Tests carried Out at PSDB***

These results are represented in Figures 7 to 10. The figures show the position of each of the barbs at each distance as they would fit on a man-sized target, with the outline showing torso, leg and arm areas. The point of aim is taken as the centre of the chest area just above the nipple line (0,0).

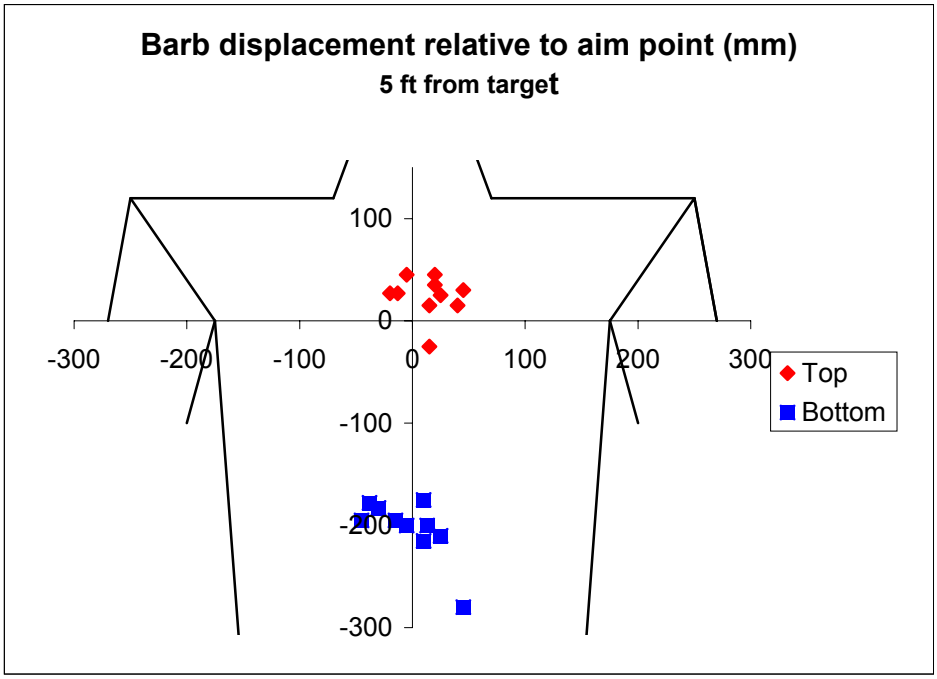


FIGURE 7: ***Position of Taser Barbs at 5ft (1.5m)***

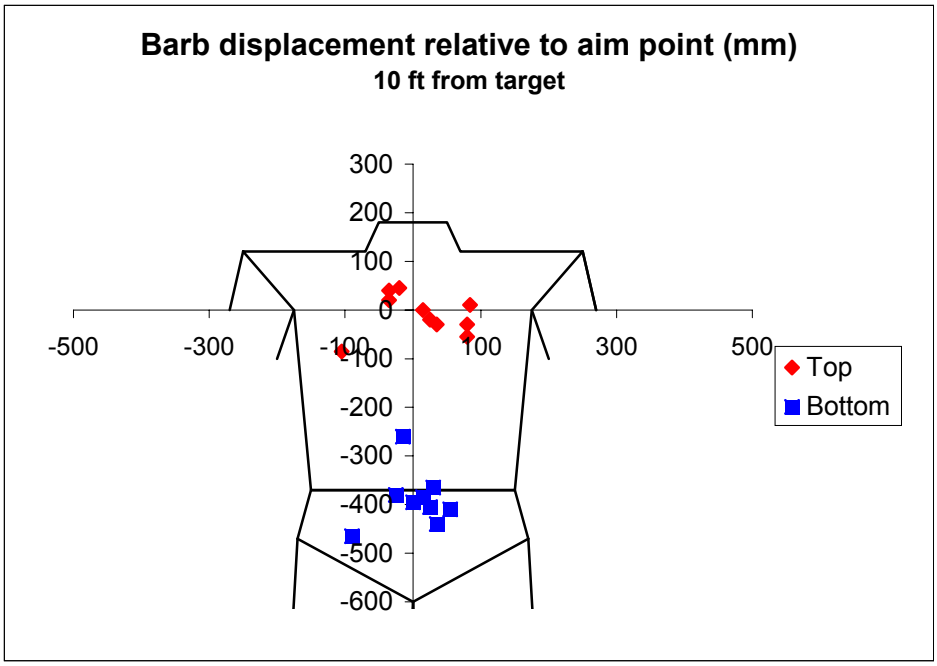


FIGURE 8: ***Position of Taser Barbs at 10ft (3.0m)***

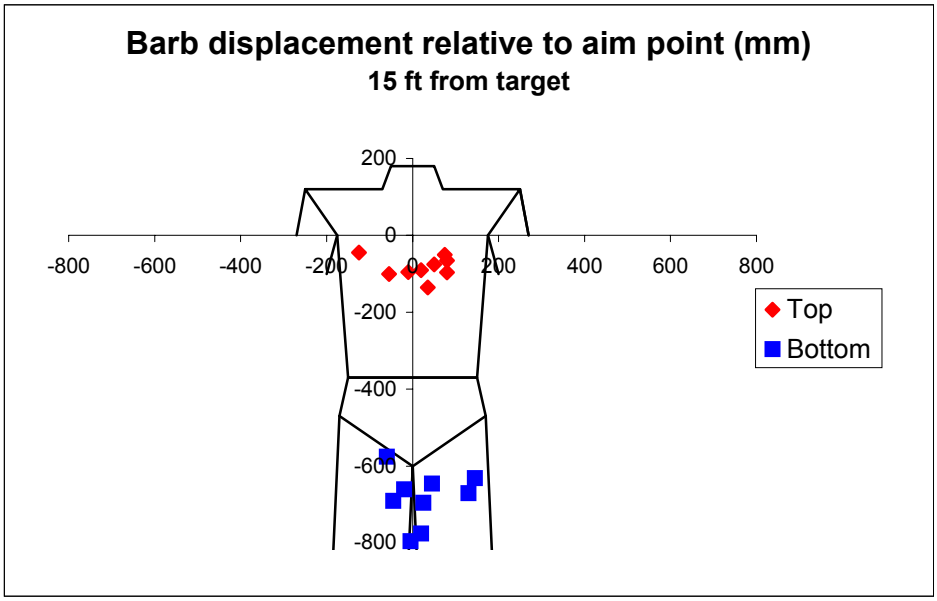


FIGURE 9: ***Position of Taser Barbs at 15ft (4.6m)***

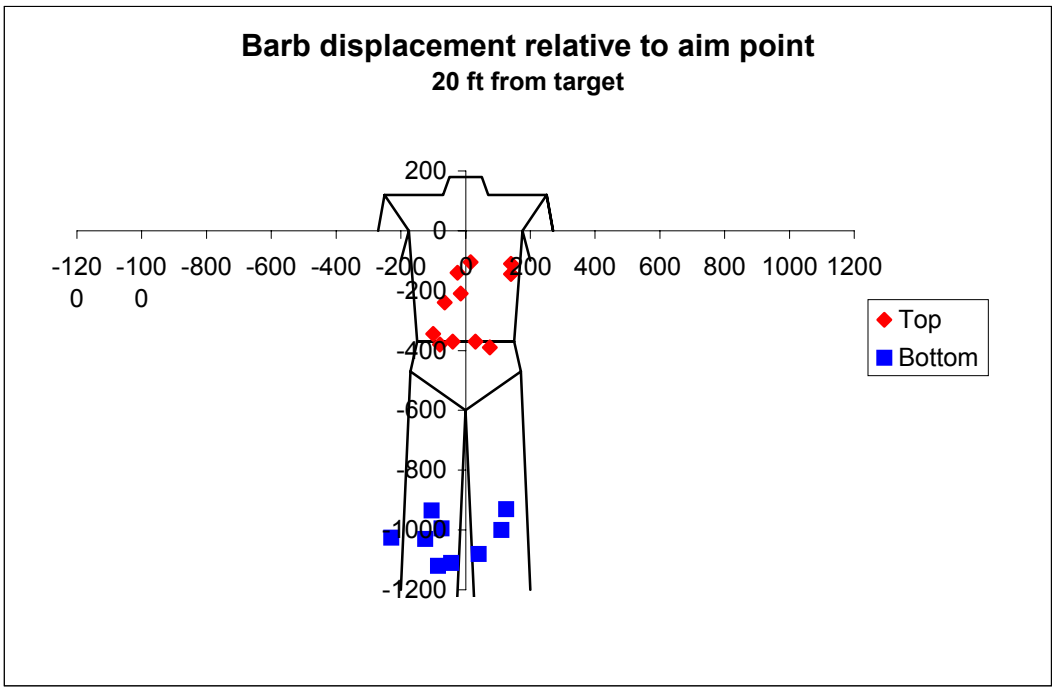


FIGURE 10: ***Position of Taser Barbs at 20ft (6.1m)***

ii) Electrical Output

PSDB have also carried out tests to determine the electrical output of the tasers in terms of waveform, current, voltage, pulse-width, energy and power. Measurements were also made of any changes that occurred to these when an air gap was incorporated into the circuit (as would be the case if a barb did not penetrate the skin of the target but instead attached onto their clothing). These tests were necessary not only to give us a fuller understanding of the taser output, but also to provide information to an independent medical committee to help them assess the effects of the taser on the human body. The results provided in this report are not exhaustive and further analysis of some of the electrical effects is necessary. A more detailed report of this testing will be prepared for the medical committee to provide them with the information they require.

The electrical signal produced by a taser is very different from the signal produced from household electricity. Household electrical appliances in the UK have a continuous alternating current (AC) with a peak voltage of 340V, a root mean square (rms) voltage of 240V and a frequency of 50Hz (ie 50 oscillations per second). This type of waveform is represented in Figure 11.

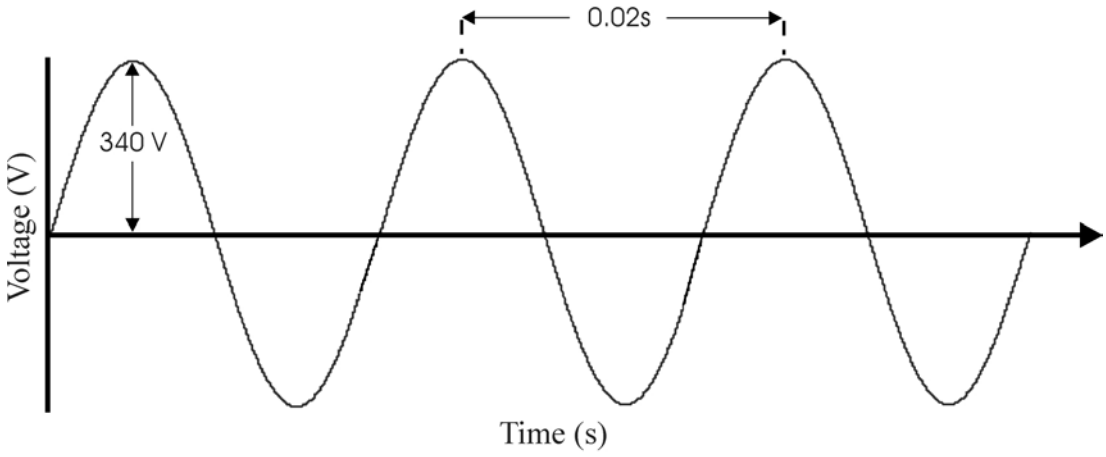


FIGURE 11: ***Waveform for Household Electricity***

The taser operates by charging up and then instantaneously discharging a capacitor. The result is a series of pulses of very high voltage and very short duration. The pulses last only a few microseconds, while the pulse separations are relatively long in comparison, lasting tens of milliseconds. Current commercial devices tend to have between 10 and 30 pulses per second. The high potential difference (or voltage) is necessary to allow the electricity to jump across an air gap, such as would be the case if the barbs attached onto a subject's clothing, rather than penetrating their skin. The power (wattage) relates to the rate at which the energy is transferred. Figure 12 shows the typical waveform that is produced from a taser discharge – only one pulse is represented in this figure.

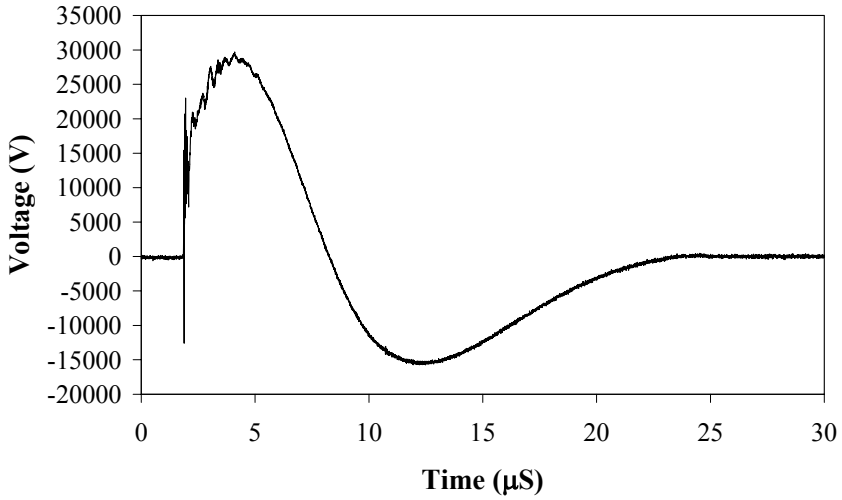


FIGURE 12: ***Typical Waveform for Taser Output***

Another important distinction between the mains electricity and the output from the taser is the availability of energy. Each pulse from the taser represents a discrete package of energy of a more or less constant value, therefore the number of sparks or packages per second will be the maximum power delivered. Power from the domestic mains is not limited in this way, the current that can be drawn (which is proportional

to the energy) is not limited to discrete packages and will increase until the load (or resistance) is met or the fuse or safety device operates.

- Method

The electrical output of the tasers was measured in the following way: a potential divider of total resistance R_t was placed across the ends of the barbs, which had been ejected from the taser cartridges, in order to complete the circuit. The output pulse from the device was discharged across R_t and the output voltage measured using an oscilloscope. The total resistance was intended to simulate that of the human body, but this resistance is highly variable and depends on what part of the body the electricity is flowing through (tissue, bone, organs, etc) and also on the individual. A range of values was therefore chosen for measurement; these values were based on those previously used in measurements of this type by other agencies[10].

Measurements were made of the change of current and voltage with total resistance. These tests were then repeated with an air gap of a certain distance incorporated into the circuit. The effects of an air gap on the waveform must be considered if the taser barbs do not penetrate the skin of a subject, but instead attach onto their clothing. In this case the electricity can still arc across the gap and be passed through the subject's body (depending on the distance of the air gap). In these tests, a gap was created between one of the barbs and a potential divider of total resistance R_t; the gap was then increased in 5mm increments. These measurements were repeated using different values of R_t.

Measurements were also taken of the maximum air gap that could be introduced into the circuit before the electricity started to arc across the electrodes on the head of the taser, rather than through the circuit. The limit of the gap was taken as the distance at which approximately half of the discharges sparked between the two electrodes on the taser rather than passing through the circuit. These measurements were repeated using different values of R_t. These measurements were taken as it is important to establish how the length of the gap will affect the amount of electricity flowing through the subject. The less electricity that flows through the subject, the less likelihood there is of incapacitation occurring.

- Results

In general, the peak output voltage from the tasers increases as the total load resistance within the circuit increases. When an air gap is incorporated into the circuit at a set resistance, the waveform changes slightly so that there is a high-voltage, short-duration spike immediately in front of the first main pulse. There is an increase in the voltage of this spike as the size of the air gap is increased, probably correlating to the voltage necessary to ionise the air and allow the spark to jump the gap. This large spike in front of the pulse has a much higher peak voltage than the main pulse, although it only lasts for a very short period of time. It is as yet unknown what difference, if any, this will have on the effects of the electricity on the human body. This information, along with all the other electrical output data, will be passed to the medical committee when they make their assessment.

At resistances of 500 ohms and greater, the maximum air gap that allows only approximately 50% of the current to flow through the circuit is 20mm (less than an inch).

iii) Clothing Penetration

Tests were carried out to determine whether a selection of clothing materials could prevent the taser barbs from either penetrating through them or attaching on to them. Taser cartridges were fired at a mannequin dressed in a variety of different clothes of various materials. In general, most of the materials tested did not stop the barbs from at least partly penetrating and attaching onto the material. When a number of thick layers were present together, for example the overlapping section of a leather jacket, then the barbs would have difficulty in penetrating all of the layers. The zip area was also a problem as the barbs could not penetrate or attach onto this. Most thin or single layer materials did not present any problem in terms of barb penetration.

iv) Flammability

Tests were carried out to determine the risk of ignition if a taser is fired at a person with flammable liquid on their clothing. The liquid used in these tests was methyl isobutyl ketone (MIBK), the solvent present in the CS sprays used by the UK police.

A full canister of one model of CS spray, containing MIBK only (30ml) was sprayed at a mannequin wearing a standard jogging sweatshirt (material is 65% polyester, 35% cotton). The mannequin was first covered in foil to allow conduction of the electricity through the barbs. The entire canister was sprayed at the front of the sweatshirt. A taser cartridge was then fired at the mannequin from a distance of 5ft (1.5m). This was repeated a total of seven times with a new, but otherwise identical, sweatshirt used each time.

In five of the occasions, there was no ignition at the mannequin, although sparking was observed at the barbs attached to the mannequin, indicating that electricity was flowing through the circuit. On the other two occasions, however, ignition occurred at the mannequin after the barbs penetrated the sweatshirt. On one occasion the sweatshirt ignited as soon as the barbs attached to it, and on the other occasion a second or two passed before the flames began. In both cases, the flames produced were severe and engulfed the entire top half of the mannequin, including the head.

It is clear from these tests that there is a serious risk of ignition if the taser is fired at a target that has a flammable solvent on their clothing. This risk will extend to all flammable environments, for instance a petrol station.

v) Other Tests

Tests were also carried out to determine how the various models of taser could withstand treatment such as exposure to extremes of temperature (-10^{O}C to +40^{O}C) and dropping onto a hard surface. These tests are important as they represent the types of treatment that the device is likely to be subjected to in the real world when used by police officers. The performance of the system after it had been subjected to these conditions was then assessed. Various parts of the system could be affected, such as the batteries, the laser sights, the cartridges and the taser itself and the impact on each of these areas was measured.

Previous tests had highlighted that the electricity can sometimes arc across the wires at various points along the circuit, and tended to happen when the resistance of the target was very high. Tests were therefore carried out to determine at what load resistance the electricity starts to arc across the wires. This assesses the quality of the insulation of the wires and is important from an operational perspective since, the

more electricity that is arcing between the wires, the less that is flowing through the target.

Future Tests

95. The initial tests have looked at aspects such as accuracy, electrical output, penetration characteristics, flammability and performance under extreme conditions. These characteristics affect both the operational and health and safety aspects of tasers. Further tests to be conducted will include handling trials. This will involve the hand-firing of a variety of taser models by police officers at both stationary and moving targets, including in non-ideal conditions such as low or artificial lighting.

96. On completion of all of the testing, including the electrical output testing, the results will be passed to the medical committee for assessment. They will then suggest any further testing that is necessary before they can provide a full and accurate assessment.

Other Electrical Devices

97. Although most recent interest in the UK has been in the taser devices, it is worth detailing the other types of electrical devices that are available (note: performance data has not been verified).

Stun Guns

98. Many people may be familiar with the concept and appearance of stun guns. They are hand-held units generally ranging in size from 100-220mm in length and weighing between 200 and 300g, including the batteries. The probes or electrodes that deliver the electricity are permanently connected to the unit. These probes are not generally designed to penetrate the skin of the target, but are intended to be held close up to the body to allow the flow of charge.

99. There are a large number of commercially available hand-held stun guns. Some versions are available which contain extras such as pepper spray or a flashlight as part of the device. Alternatively, a high intensity flash of light or loud noise may be emitted when the device is activated. In some cases, optional screw-on lengthening bars are available to increase the range of the devices; these also increase the distance between the two probes allowing a greater number of muscle groups to be affected. Other than in these cases, close contact is required for operation of these devices, as the probes must be held close to the subject's skin for effect.

100. The devices available range in output from 40,000V to 625,000V. Unlike tasers, which have a large separation of the two barbs, stun guns generally have only 2-3 inches (51-76mm) between the probes. This will result in less muscle groups being affected by the electricity, making placement of the probes more important. Also, unlike the tasers, the stun gun does not attach the probes to the subject's body, with the result that close contact must be maintained to prevent the subject voluntarily or involuntarily 'jumping' out of the way of the probes.

101. Stun guns have been widely used by American law enforcement since the 1970s. Many forces also reportedly use the taser without a cartridge to act as a stun gun. Stun guns have not been selected as a priority for further research within the current less lethal weaponry programme.

Stun Batons

102. Stun batons are like standard police batons with an added electrical component. The batons generally have probes attached to the front end; when the probes are touched against a person, the trigger is pulled to deliver a shock. Some versions also have metal bands running part-way along or up the entire length of the baton. In these cases, if a person grabs the baton along its length, they will receive a shock.

103. Stun batons are available in 'one-length only' and in telescopic/retractable styles with lengths generally ranging from 300mm to 700mm. Some versions are also available that contain pepper spray or a flashlight as part of the device. The output from the batons ranges from 50,000V to 500,000V. Stun batons have not been selected as a priority for further research within the current less lethal weaponry programme.

Electrified Riot Shields

104. Riot shields are also available which have a stun capability. These polycarbonate shields with electrical contacts fitted to the edges or surface can be supplied as a unit or alternatively, the electronic package can be modified to mount on other types of non-conductive riot shields. Electrified riot shields have not been selected as a priority for further research within the current less lethal weaponry programme.

Electrified Nets

105. One company has produced an electrified net that combines entanglement and electricity to provide temporary incapacitation. When triggered, a large net is deployed which falls over the subject causing some degree of temporary incapacitation via entanglement. A pair of long, continuous electrodes is woven into the net and is attached to a high voltage discharge circuit. These electrodes fall randomly on the subject's body, contacting either the skin or clothing. A high-voltage stunning pulse is then delivered remotely; the net employs a 60,000V electrical pulse at 25-second intervals for up to 30 minutes to keep the subject subdued. The net has a claimed range of up to 30ft (9.1m). Electrified nets have not been selected as a priority for further research within the current less lethal weaponry programme.

Sticky Shocker

106. The Sticky Shocker was designed to extend the range for electrically stunning a person. It is a combination of an impact device and an electrical device. The Sticky Shocker is a wireless, self-contained 37/40mm projectile fired from compressed gas or conventional 37/40mm less lethal weapon launchers. It sticks to the target with a glue-like substance or with short clothing-attachment barbs; a combination barb/adhesive attachment head is also available. The projectile incorporates a battery pack and associated electronics that impart a short burst of high-voltage pulses said to be capable of penetrating several layers of clothing. The pulse characteristics of the device are said to be similar to commercial stun guns, with an output of nearly 50,000V.

107. At present, accurate range is claimed to be 10m although it may be possible to increase this by reducing the weight and/or increasing the speed of the device. A

remote control option for application of a secondary pulse series and longer-range units may be developed at a later stage.

108. In 1999, the NIJ funded a health assessment of the Sticky Shocker. The conclusion from this was that little information and data currently existed on the health risks of electrical devices. Further work has therefore been commissioned by the NIJ to assess the health effects of the Sticky Shocker and other electrical devices. If the Sticky Shocker is found to be safe, field trials will be conducted thereafter.

Electronic Devices for Security Applications

109. There are currently a number of unmanned or remotely controlled electronic devices available for security applications; essentially a less lethal alternative to the Anti-Personnel Landmine. These devices use taser technology for perimeter control by causing incapacitation of personnel attempting to enter/exit a protected area. One particular company produces three separate devices of this type. All use cartridges similar to those used on tasers, ie two wires with barbs on the end. One device contains multiple, independent taser cartridges (15–30ft, 4.6-9.1m) that, when activated by a sensor, can simultaneously incapacitate a number of subjects. A modified version of this device allows the remote firing of the cartridges from a security station rather than the automatic firing when the device's sensors are tripped. Each unit will simultaneously launch seven or more independent pairs of darts over an arc of 120 degrees and out to a distance of up to 30ft (9.1m). The lower dart would propel out horizontally, hitting at a height of approximately 1.5–2.5ft (457-762mm) at a distance of 25ft (7.62m). The upper dart would reach a height of 5ft (1.5m) at maximum range. A timing circuit on the unit, which allows periodic, one second breaks, is designed to keep the subject(s) incapacitated until security personnel can attend to them, or until the batteries are depleted.

110. The third device of this type by the same company is intended to protect key facilities and a number of the devices would be attached to the outside of the building or facility, or could be used to cover internal corridors and access doorways. The device is a permanently installed, armoured, motorised unit incorporating a gun-sighted video camera and the previously mentioned unit, modified to remotely fire one cartridge at a time. The remote operator, located in a security room, can rotate the unit to accurately aim at subjects within 30ft of the device. Once a cartridge is fired, it remains activated until manually deactivated by the operator. These devices have not been selected as a priority for further research within the current less lethal weaponry programme.

A3P3

111. The A3P3 (A3: Aerosol Arresting Agent, P3: Pulse Projected Plume) has been reported in Police magazine. The device is intended to incapacitate an attacker without excessive force by discharging a highly controlled and debilitating plume of incapacitant over a range of between one and twenty feet (0.3-6.1m). An 'on board' computer determines distance from the subject and makes a choice on spray pattern, discharge rate and concentration. The device is also fitted with a data recorder (video and sound) for assessment of potential threat and, presumably, later enquiry into user action. Developers also envisage that if the device is fitted with a '*dual stream configuration*' the liquid discharged can be used to conduct and transfer a high voltage/low amperage electric charge to the individual. It is suggested that this will improve the effectiveness of the incapacitant by making the subject inhale in a

natural response to the electric shock. This product is still very much in the development stages and a fully built device is not yet ready for evaluation.

Electrified Water Cannon

112. One company has developed a means of delivering an electric shock via water cannon. A single stream of high pressure, electrified, conductive fluid is emitted from a gun at high velocity making contact with the target. The high-voltage, low current pulse that is delivered is said to be capable of delivering a shock even through thick protective clothing. The water stream can be moved among targets until the selected target is positively engaged before the high voltage is applied; this avoids stunning innocent bystanders (or hostages). Ranges of up to 20ft (6.1m) have been demonstrated with this system (by the manufacturers) but ranges of up to 100ft (30.5m) or more are claimed to be feasible with improved nozzles and fluids.

113. The technology can also be used in conjunction with a vehicle-mounted water cannon for use in crowd or riot control. Longer ranges and longer run times are likely to be achieved in the vehicle-mounted configuration. The manufacturers have demonstrated this product in both the hand-held and vehicle-mounted configurations at distances of up to 20ft (6.1m) although no testing has as yet been performed on live targets.

Stun Belts

114. Stun Belts consist of a 'sleeve' or a band containing the stun power pack that is placed on the arm or leg of an individual. A remote control transmitter/receiver is used to activate the device when necessary at distances of up to 200-300ft (61.0-91.4m) away. The hand-held transmitter sends a signal to the battery-operated receiver located in the sleeve that activates the stun pack. Stun Belts are intended for use during the transportation and/or containment of potentially violent individuals. The wearing of the device in itself may also act as a psychological deterrent against violent behaviour.

115. Amnesty International has raised some particular concerns about stun belts. They believe that the belt should be banned because, even when not activated, it is inherently cruel, inhuman and degrading. The reasons they give for this is that '*the fear of infliction of severe pain, in a setting of total powerlessness, constitutes mental suffering and cruel, inhuman or degrading treatment or punishment*'. They have therefore called for a ban on the manufacture, promotion, transfer and use of the stun belt and not just a suspension of its use as they have for other electrical devices. Stun belts have not been selected as a priority for further research within the current less lethal weaponry programme.

Telescopic Electronic Restraint Staff

116. This device is essentially similar to a stun gun; ie it has two non-penetrating probes at the end of it that are touched to a subject's body to allow incapacitation. The difference is that this device is 2ft (0.6m) long and can be extended to either 4ft (1.2m) or 8ft (2.4m), using an extendable telescopic pole. This allows a greater standoff distance to be achieved. This device has not been selected as a priority for further research within the current less lethal weaponry programme.

Considerations For Acceptability

117. It is prudent to mention a number of issues that may need to be borne in mind if electrical devices are being seriously considered for use in the UK.

118. Amnesty International is one organisation that has often expressed concerns about electrical devices (termed 'electro-shock weapons' by them). They do not believe that sufficient health and safety data are currently available with regards to the effects of this type of electricity on the human body. They have asked that '*the stun belt should be immediately banned and the use of other electro-shock weapons such as stun guns, stun shields, and tasers should be suspended pending the outcome of a rigorous, independent and impartial inquiry into the use and effects of the equipment*'.

119. As regards relevant health and safety information, it is worth noting the conclusion of a health assessment on the Sticky Shocker, funded by the National Institute of Justice (NIJ) in 1999. This review, carried out by a body of independent experts, concluded that little information and data exist on the health risks of electrical devices (note, this relates to electrical devices in general although the review was intended to look at the Sticky Shocker only). Further work has therefore been commissioned by the NIJ to assess the health effects of the Sticky Shocker and other electrical devices. This work, some of which uses live pigs to provide data, is due for completion in 2002.

Conclusions

120. It has been agreed that only those electrical devices that can be used at range will be considered a priority for further research. Devices such as stun guns, stun batons and electrified shields will therefore not be put forward for further testing at present. Electrified nets and stun belts have also been dismissed as a priority. The taser is probably the best known and widely available (and used) of electrical devices that can be operated at range.

121. A number of limitations in the operational use of tasers have been identified. These mainly relate to the maximum range of the devices and problems with getting both barbs to attach on to the target. For this reason, particular interest will be shown to any developments that allow a greater range to be achieved and/or use other methods to deliver the electricity to the target.

122. Tests carried out on tasers so far have included accuracy, electrical output, clothing penetration, flammability and performance under extreme conditions. These tests relate to both operational performance of the tasers and their effects on the human body. Police handling trials will shortly be conducted to assess the relative merits and disadvantages of various models of taser.

123. All of the information gathered will shortly be passed to the independent medical committee, who are likely to suggest further tests that they consider necessary before providing an assessment of the effects of this type of device on the human body.

F. Distraction/disorientation devices

124. A number of diversion and distraction devices that could be classed as less lethal weapons were highlighted in the April report[2]. These devices tended to use the method of overloading the senses by sound, light, smell or a combination of these to

produce a distracting or disorienting effect. Laser and light devices and noise generating devices have been selected for further immediate research.

Laser/Light Devices

125. Laser and light devices can be used to cause:

- Aversion response (turn away)
- Psychological impact (eg fear, confusion)
- Hesitation/distraction
- Disorientation and reduction in functional effectiveness (possibly leading to indirect injuries)

126. Generally, these devices do not incapacitate a person, although there may be some deterrent effect as the target becomes aware that he/she has been picked out. The effects of bright light/laser devices can range from dazzle or glare (lasting seconds) to image formation (after-image lasting seconds to minutes), flashblindness (lasting seconds to minutes, with after-images lasting from minutes to days) and irreversible damage. Strobe lights may cause temporary incapacitation. A device that dazzles at large distances may cause irreversible damage at close range. These devices are also considerably less effective in daylight or in the presence of strong artificial light (range reduced by at least a factor of 10).

Lasers

127. It is claimed that the effective range for laser light may exceed 500m (at night) and can provide an effective 'optical shield' even in daylight. However, laser light intensity may be severely reduced by smoke and dust.

128. Blinking and turning away (aversion) is a natural reflex and offers some protection against low-power, long-pulsed lasers but not high-rate, short pulses which cause damage after very brief exposures (nanoseconds) and at very low energies (microjoules).

129. In general, the eye is most sensitive to 555nm (yellow-green light). Therefore lasers at this wavelength should achieve the same perceived brightness at lower powers than more common red lasers.

130. At least two devices have been developed for law enforcement applications. One uses red light (650nm) with an optional strobe and has been certified according to international standards as being inoffensive to the eye. The device is similar to a conventional police torch in size and form and is battery powered with a maximum continuous use time of 20 minutes to avoid overheating. The second device uses green light (532nm at 140mW) with a built in strobe effect to add to the distraction effect. The device is about 13 inches (330mm) long, weighs 2.1lbs (953g) and is designed to look and be operated like a conventional police torch. The device needs to be recharged after an hour of operation and costs between £3,000 and £6,000 each depending on quantity ordered.

131. The power rating of laser distraction devices is relatively high at 100-500mW compared to less than 5mW in a common laser pointer. The energy received by the eye remains low as the beam produced by the device has a diameter of up to 2 feet, spreading the total energy across a wide area.

Lights

132. Light devices have a shorter range and are less easily focused than lasers. Possible light devices include high intensity lights and flash discharge units as well as more conventional flashlights and strobe lights. New LED technology may also lead to high intensity light devices requiring less battery power. At short range a high intensity flashlight may be as effective as a laser and is potentially less harmful.

133. There are many light devices available, the two most common types are:

- Flashlights - These typically have light outputs from approximately 20,000-300,000 candela and are 6-9 inches (152–229mm) long, weighing 7-12 ounces (198-340g).
- Portable floodlights - These typically have a light output of 750,000-6,000,000 candela and have dimensions of around 12 inches (305mm) long by 6-15 inches (152–381mm) high and a weight from 3-25 pounds (1.4–11.3kg). Some require external power sources.

Laser Hazards

134. Laser and bright light eye injuries are extensively documented. Injuries are almost always retinal, ranging from lesions through intraocular haemorrhage to nerve fibre damage and loss of sight. Treatment for injuries is limited. If pupils are dilated (eg at night) or the eyes are more heavily pigmented, there is greater absorption of energy and therefore more damage. The effects of coloured laser light on people who are colour-blind must be considered as some reports suggest they may be less sensitive to laser light. The impact of strobe lights in triggering epileptic fits has been widely publicised.

135. Lasers have been used for many years in various disciplines, including the medical world, and as such there are several British standards that already deal with laser safety issues. In the British Standard EN 60825-1:1994, Clause 13 deals with 'Maximum Permissible Exposure (MPE)'. This is defined as:

> "That level of laser radiation to which, under normal circumstances, persons may be exposed without suffering adverse affects. The MPE levels represent the maximum level to which the eye or skin can be exposed without consequential injury immediately or after a long time and are related to the wavelength of the radiation, the pulse duration or exposure time, the tissue at risk and, for visible and near infrared radiation in the range 400nm to 1400nm, the size of the retinal image."

136. The MPE at the cornea for ocular exposure to laser radiation, and the same to skin, is summarised in the standard.

137. It is widely known that lasers present a hazard to the eye but the skin is also vulnerable. However, injuries caused to the skin by lasers are less likely to be permanent, especially at comparatively low energies and so hazards to the eye will be concentrated upon here.

138. The British Standard mentioned above considers several determining factors on which damage to tissue can depend, the first of these being wavelength. The shorter

the wavelength of the radiation, the higher the power. The width of the beam, however, may spread the power over a wider region, so the power per unit area is also important. The mechanism of injury is generally accepted to be thermal when the exposure is of around 0.1s to 10s for a continuous wave laser or arc lamp, or of around 1 to 10ms when the exposure is from a long pulsed laser or flashlamp. Injury appears to result from protein denaturation and enzyme deactivation so the variation of temperature with time must be considered. This is where the size of the beam can be important again as heat can be conducted away by surrounding tissue far more efficiently for image sizes of 10μm-50μm than for 1mm. So, although a smaller spot has a higher power density (power per unit area), this has to be balanced against the benefits of a smaller spot size in heat conduction. For example, 10W/cm^2 for a 1mm image is the threshold for injury whereas 1kW/cm^2 is required in a 20μm image.

139. Wavelength is also a factor in the site of the tissue injury. Figure 13 shows the types of injury that can be inflicted at different wavelengths. Some of these injuries may heal (the cornea completely regenerates every 48 hours), some may be operable (cataracts) and some are permanent (severe retinal burns leading to blindness). Visible light and infrared radiation is focussed sharply on to the retina, directly on to the fovea - the area with the greatest concentration of cone photoreceptors (see Figure 14). This can cause a blind spot in the irradiated area. Outside the fovea it would be in peripheral vision and not particularly noticeable but inside a severe visual handicap could occur. At a more detailed level, green lasers are absorbed by the surface layer of the retina causing abnormal blood vessel growth in front of the photoreceptors whereas yellow lasers penetrate to damage the photoreceptors directly.

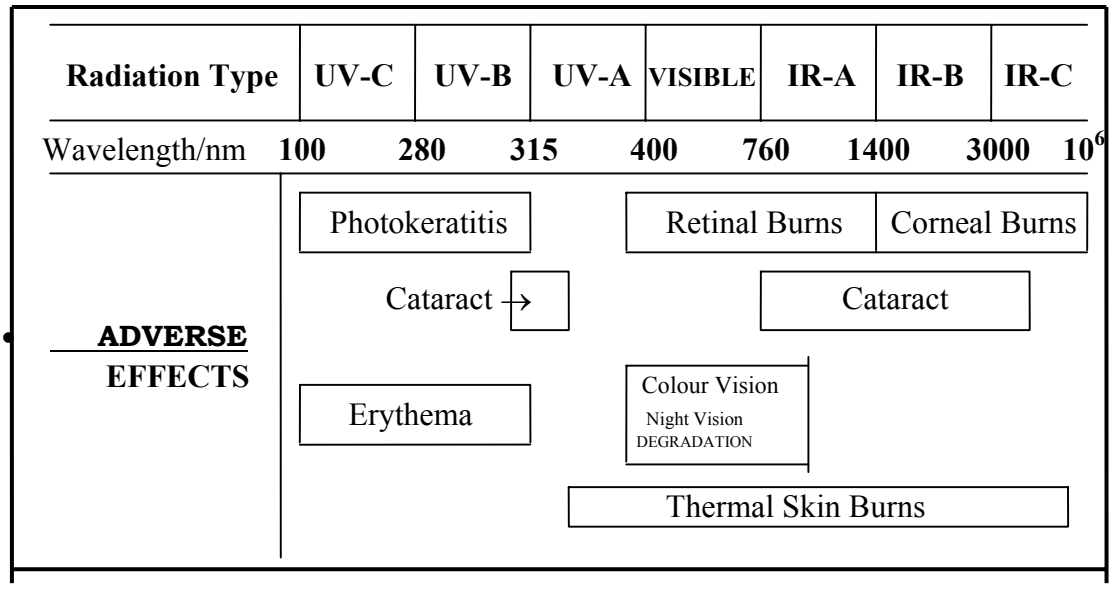


Figure 13: ***Dependency of tissue effects on the wavelength of the incident radiation***

140. The retina is also sensitive to the near ultraviolet region but the lens is a strong absorber of wavelengths shorter than 400nm down to 315nm while the cornea absorbs heavily at wavelengths below 300nm. It must also be considered that if a laser has any wavelengths that are outside the human visible range there will be no aversion response. Therefore, damage can be caused even when the subject is unaware that they are being exposed.

141. The British Standard also considers pulse duration and exposure time. The latter is self-explanatory, energy delivered (and thus injury suffered) increasing with time. Pulses are often created by so called "Q-switching". This is a kind of electronic switch that allows very short, high powered pulses of light to be emitted. It is significant in that the length of the pulse is often much shorter than the time it takes to blink or look away so bodily defence against the light is ineffective.

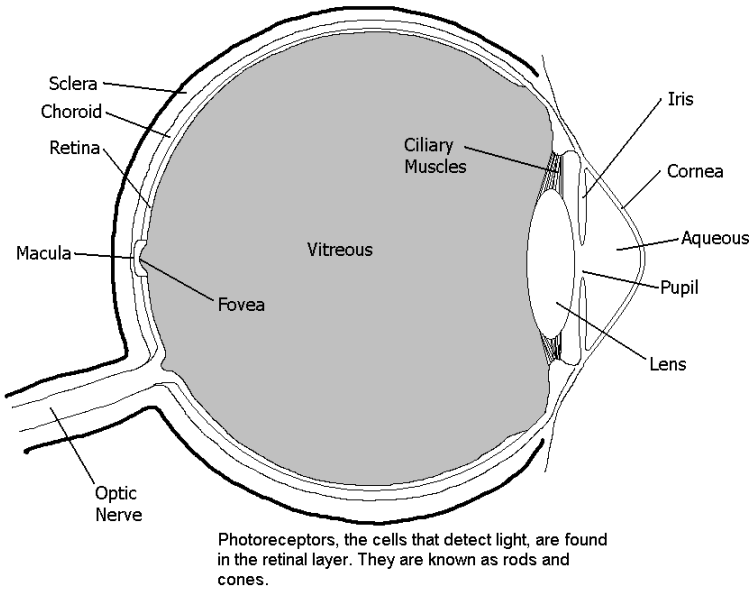


FIGURE 14: *Composition of the Eye*

PSDB Evaluation

142. PSDB are gathering information on all of the laser and light systems that are available and have the potential for use in a policing role. The characteristics of these devices will be assessed, such as power output, wavelength, size of the beam, etc. This data will then be compared to existing standards. The performance characteristics of the various devices can then be compared to the operational requirements, and the most suitable system(s) identified.

Noise Generating Devices

143. Audible sound may be used in a variety of ways using soothing, unpleasant or very loud sounds (up to 135dB) in an attempt to pacify a crowd or clear an area. Devices may range from whistles and hand-held sirens to large vehicle mounted speakers. Studies have shown anti-social behaviour decreasing in areas where soothing music is played. In one example classical music was successfully used to prevent graffiti in problem areas.

144. Effects of various noise levels are shown below[11]:

Discomfort	120dB
Threshold of pain	145dB
Eardrum rupture	185dB
Lung damage	200dB
Lethality	220dB

145. As a comparison, a busy office typically has a sound level of 65dB, heavy traffic 90dB and a jet aircraft taking off 125dB.

146. The Health and Safety Executive have defined acceptable sound levels at work to be equivalent to no more than 85dB for 8 hours, or a peak level of 140dB regardless of frequency or duration. Hearing protection must be provided for workers exposed to sound at higher levels.

147. High volume (above 150dB), low frequency (50-100Hz) audible sounds are reported to cause 'intolerable coughing and choking respiration' with 'unpleasant but tolerable respiratory effects' at lower volumes and frequencies (20-50Hz)[12].

148. Standard stun grenades use a bright flash of light, a loud bang and intense blast waves to disorient and/or incapacitate the target(s) (see paragraphs 162-167). Some of these devices fragment on impact, which could be hazardous to persons in the immediate area depending on the composition of the grenade. The pyrotechnics used to create the flash can also be hazardous as they may set fire to combustible materials, such as paper or fabrics. In addition to this, blast injuries can be caused by discharge when in contact with or in very close proximity to an individual. The requirement now is for a non-fragmenting and non-pyrotechnic device that creates a loud noise, sufficient to disorient and/or incapacitate a target, with no risk of injury from blast effects.

149. PSDB are gathering information on all available noise generating devices of this type. Measurements will be made of the peak noise level and sound exposure level of any device that appears suitable. The performance characteristics of the various devices can then be compared to the operational requirements, and the most suitable system(s) identified.

Category B technologies

150. Within the second category of prioritisation, as described in the introduction to this chapter, two types of technologies have been identified as meriting further research, although the current state of knowledge and/or the commercial availability of workable devices has meant that this will necessarily occur over a longer timescale. These technologies are malodorants and tranquillisers, a description of each is provided below.

G. Malodorants

151. A malodorant is an extremely bad-smelling compound, traditional stink bombs being an example of this. Malodorants may be of assistance in dispersing crowds although they are unlikely to prevent a determined assailant at short range. The possibility of developing malodorous devices has not been fully explored. Very little has been published on possible devices.

152. The US army has proposed that any malodorant used should be perceived highly unpleasant by most people, quickly detected and dispersed, not easily habituated and not incapacitating or a sensory irritant.

153. Studies found odours named 'Bathroom malodour' and 'Who me?' most repellent, with transient symptoms of nausea and gagging, but other odours such as cortyl mercapton (Skunk Perfume) have also been promoted. Recently 'rotting flesh' was felt too repulsive for use with an exhibit at the Natural History Museum in London. There are a number of companies specialising in creating chemical smells and flavours for the food and perfume industries that may be capable of developing suitable odours in addition to those already on the market.

154. Means of independently delivering these smells could include similar methods to those used for delivering CS, dyes, or stun grenades, for example in spray form or within an encapsulated round. Some manufacturers offer malodorants as an additional component within other devices (see Section C).

155. The above mentioned studies[13] reported reduction in respiratory volume, an increase in respiratory rate, change in the electric resistance of the skin and other symptoms consistent with tachygastria (nausea). The degree of these responses will be determined by the concentration of the odour.

156. The possible effects on people suffering from respiratory illnesses should be considered and the toxicity of the chemicals used must be established. There may also be issues about decontamination following deployment, especially in residential or heavily populated areas.

H. Tranquillisers

157. Strictly speaking, tranquillisers will not produce sleepiness or unconsciousness so, in the context of using a drug to incapacitate a person, anaesthetic may be a better term to describe these drugs. However, for the purpose of this report 'tranquilliser' will be used as a generic term to describe drugs that can be used to incapacitate or calm a person.

158. Tranquillisers and delivery methods were investigated in the late 1980s and early 1990s in the US. One class of tranquilliser was identified as having a large safety margin between the onset of unconsciousness and death as well as possessing rapid antidotes. However, the substance also caused muscle relaxation and consequently could cause a person's breathing to stop. The typical delay between delivery and effect was about 30 seconds but could be less if the target was agitated and the drug was circulated round the body more quickly.

159. The work was stopped because of perceived liability issues surrounding the injection of drugs without consent. There was also concern that the type of offender the system was likely to be used on would possibly be under the effect of some other sort of drug, either legal, illegal or prescription, and unpredictable effects may occur.

160. The Department of Health have also been consulted and although they say they could not comment without specific details of the type of drug being considered they did say that the idea of using tranquillisers was fraught with the difficulties identified by the Americans.

I. Category C technologies

161. As set out in the categories of prioritisation, described in the introduction to this chapter, these technologies have been chosen as not requiring further research at the present time, although further consideration may be given to some of the devices at some point in the future.

Stun Grenades

162. These are also referred to as concussion grenades, distraction devices or flash-bang devices. These devices aim to disorient and/or incapacitate the target(s), usually by causing flashblindness (lasting seconds) and temporary deafness (lasting minutes) along with the disorienting effects of intense blast waves. The devices are indiscriminate, affecting anybody within range.

163. Stun grenades are available in a range of forms and sizes depending on the application. Typically, smaller grenades have impact up to 10m from the centre of the detonation, with light intensity of 2 million candela and sound levels of up to 175dB at 2m. More powerful grenades are available with light intensity of up to 8 million candela and sound levels of 185dB at 2.5m (note: sound levels are discussed in paragraph 144). These larger devices are designed for use only outdoors or for large indoor areas (eg a warehouse).

164. The body of the grenade may be metal, cardboard or rubber. Rubber and cardboard-bodied grenades split or fragment relatively harmlessly on impact, although they sometimes contain sub-munitions that can fragment when discharged. The pyrotechnics employed to create the flash may set fire to paper, fabrics and other combustibles.

165. Grenades may be hand thrown, fired from a launcher (delivery ranges quoted up to 130m) or slid under a door. Multiple munitions, smoke, chemical irritants (eg CS), rubber stingballs and/or malodorants may also be incorporated, extending the area and effectiveness of the device.

166. There may be injuries to sight or hearing, especially for people close to the centre of the detonation. With metal-bodied grenades there is a danger of metal fragments causing shrapnel injuries. Blast injuries may be caused from discharge in contact with or very close to a person. Where grenades also contain other ingredients, such as multiple munitions or CS, additional caution must be used in their deployment. Officers entering an area immediately after detonation require protective equipment dependent on the grenade type used.

167. Stun grenades have been successfully employed to return order in US prison riots as well as in a number of hostage situations. They have been used against street protesters and rioters, primarily as a means of dissipating crowds. Stun grenades have also been used in the United Kingdom in dynamic entry situations and some injuries have been reported by officers, both in use and in training. Manufacturers have been addressing these issues and a limited number of devices reach the ACPO requirements.

Smoke

168. The primary use of smoke is to obscure the vision of the target(s). However, this also obscures the vision of police officers and may provide a screen to hide people/actions from the police. Similarly, smoke may be used to screen police movements. The smoke, once deployed, is unpredictable and may be affected by weather conditions.

169. In general, smoke devices have similar deployment characteristics to chemical gas devices or stun grenades. Ideally the smoke should be non-toxic and have no chemical/biological effect on the target (these will not incapacitate the target). However, some commercially available devices do contain toxic chemicals.

170. The smoke grenade is an indiscriminate device and cannot be targeted at individuals. There may be issues surrounding decontamination of an area and the fire risk of these pyrotechnic devices. In addition, the possible effects of repeated exposure on the police must be assessed.

171. Some medical studies have been carried out on types of 'smoke' used in military and fire service training. These show that some long-term toxicity effects are possible dependent on exposure and chemical content of the smoke.

172. The possibility of ill effects on people with respiratory problems (eg asthma), or secondary injuries caused by panic and obscured vision, resulting from use of such devices must be considered.

Acoustic Devices

173. Acoustic devices can be sub-divided into three categories:

- Infrasound (less than 20Hz), below the threshold of hearing
- Audible (20Hz-20kHz) (dealt with in paragraphs 143-149)
- Acoustic shock wave devices

174. Some reports claim physical effects from sound at distances up to 100m. However, as directionality and attenuation (the way in which volume decreases with distance) are frequency dependent, the reported effectiveness and directionality of sound devices are challenged – suggesting a maximum range of a few tens of meters[14]. Other than whistles and compressed air-horns and stun-grenades, current devices are generally large and unwieldy (semi-portable or vehicle mounted).

Infrasound devices

175. There has been much speculation about the effectiveness of infrasound devices. Frequencies of 19Hz have been reported to have the capacity to cause the subject to observe apparitions in enclosed spaces. Violent nausea has been reported at 12Hz and lower frequencies of 3-7Hz are reported to cause death by resonance with internal organs[15]. The lowest frequencies (less than 3Hz) are claimed to enhance relaxation and drowsiness or sexual excitation. However, when exposed to infrasound not everybody experiences the same effects. It has also been suggested that such frequencies may cause structural damage to buildings. Scientific publications on these devices are not available, leaving no hard evidence for the effects claimed.

176. Possible dangers posed to the operators of such devices (and their colleagues) must be taken into consideration. Leakage, reflections from buildings and the natural spread of the sound waves will potentially have equal effects on targets, enforcement personnel and bystanders.

177. It is reported that, even at low amplitudes, some frequencies (3-7Hz) can kill. At other frequencies (7-20Hz) side-effects (to eyes and internal organs) are reported to last several days. However, medical confirmation of the reported effects of infrasound has not been found.

Acoustic shock wave devices

178. Combustion powered high pressure acoustic shock waves are reported to be more directional than the loudspeaker systems described above. It is claimed that some of these devices are capable of producing Mach disks (pulses or packets of sound energy) of sufficient power to knock the target over. Such devices generally need to be vehicle mounted. At least one smaller, lower-powered, device has been developed (360 degree output, designed primarily for pest control/area exclusion with sound levels in excess of 125dB).

179. This is not yet a mature technology and there is a lack of scientific evidence on the effectiveness and risks of infrasound and acoustic shock wave devices.

Electromagnetic Waves

180. The US Air Force Research Laboratory has developed a device that creates a heating effect in the skin using a beam of high frequency (95GHz), near microwave electromagnetic radiation. The device is intended for use as an area denial or crowd control system. A fixed installation is being tested in the US and a vehicle-mounted version is to be developed.

181. The radiation generates a burning sensation in the target (reported to be like touching a hot lightbulb) such that the target is motivated to move out of the beam. The radiation penetrates clothing but does not enter more than one sixty-fourth of an inch (0.4mm) into the skin. The device is intended for use in 2-second bursts and has a reported range of 700yds (640m). It is possible that wet, heavy clothes or aluminium shielding may be sufficient countermeasures.

182. Initial tests in the US on volunteers show no ill effects beyond some skin tenderness after repeated exposure. Testing is continuing in the US throughout 2001. The exposure time for permanent injury and results of studies of long-term effects have not been released. It has not been reported how exposure at different distances from the source affects the target. No studies have been carried out in damp, rainy weather conditions. The radiation does not interfere with electrical devices (such as pacemakers or computers).

Nets and Wire Entanglement Systems

183. Nets and bolas systems are designed to disable a target through entanglement. In the case of nets the whole body may become entangled, bolas devices are designed to affect the legs of the target. A number of devices are available commercially.

184. Some of the nets are supplied as 37mm cartridges to be fired from a standard weapon or a one-shot launcher, while others rely on a specialised reusable launcher device. The bolas devices are generally fired from standard firearms such as a 12-gauge shotgun, or even a 9mm handgun using a blank cartridge to launch the projectile.

185. A number of variations on the standard net are available. These include a sticky net coated with glue to further impede motion, an irritant net where the net fibres are coated with an irritant chemical such as OC, and an electrical net where a high voltage electrical discharge (60kV) is passed through the net.

186. The claimed operational ranges for the nets vary between 2m and 9m. The nets themselves also vary in size, with one model having a 3m diameter, while another uses a 5m x 5m square net. Both nets employ a series of weights attached to the outside edge for stability during flight and expand the net to the correct shape. One model uses fifteen 25mm long flat lead weights, the other uses eight lead ball weights enclosed in a tube of foam padding.

187. One available bolas device can be used in one of two ways, either as a kinetic energy round at ranges between 2 and 15m or as an entangling device at distances between 3 and 11m. The round contains 1.7m of thin nylon rope. Other bolas systems consist of three rubber balls connected by a few metres of thin rope. The claimed effective range of these devices is 18-36m.

188. Previous small-scale testing on earlier versions of nets showed that they were ineffective and that the target was able to tear through the net, although it is believed that higher strength nets have been produced since then.

Glue, Foam and Grease

Anti-Personnel

189. Sticky foams (also referred to as “Stick'ems”) were investigated by Sandia National Laboratories, USA (SNL). The foam is held under pressure until it is dispensed, when it will expand up to 30 times its original volume on exposure to atmospheric pressure. The foam then sets to form a rigid solid. Various compositions have been developed; common ingredients include rubbers, resins, oils, fire retardants and stabilising chemicals.

190. Trials were carried out by SNL on the use of sticky foam in prison and law enforcement situations. A shoulder slung dispenser was developed and tested. SNL have discontinued research on sticky foams for prison/law enforcement purposes due to problems with decontamination and clean up, as well as fears of suffocation.

191. One commercial product consists of a glue contained in an aerosol can. The quoted range for the glue spray is 7-8 m with a spray time of 6-7 seconds. The glue is intended for use in marking suspects for later identification as well as slowing the target and inhibiting motion. The spray was developed in association with the Japanese police authorities.

Area Denial

192. The US Army Edgewood Research and Development Engineering Centre (ERDEC) researched aqueous foams, similar to soap suds, for area denial purposes.

The foam can be used as a visual obscurant, fire suppressant, explosive blast suppressant or irritant carrier. Aqueous foam applications were developed by SNL for use in the nuclear industry and later, for use in prison scenarios. The foam itself is not intended to provide an impenetrable barrier and can be easily crossed. The foam could be used to carry an irritant chemical, as part of its chemical make-up, or to hide a more physical barrier.

193. Southwest Research Institute, USA, investigated the use of rigid foams for area denial (eg sealing entrances to buildings). Some commercial rigid foam systems were developed, mainly used in high security vehicles.

194. Anti-traction materials ("slick'ums") have been developed by US military researchers. The intention is to deny access to an area by creating a slippery area of ground, which cannot be crossed on foot or, in some cases, in vehicles. Various chemicals have been investigated for this purpose including dry polymer powders activated by addition of water, hydrocarbon based lubricants and Teflon or polyethylene confetti.

195. US Army investigations into anti-traction systems have focussed primarily on water activated polymers as these have been shown to present few environmental or health hazards and are easily cleared by use of high-pressure water jets. The water/polymer mixture was found to provide satisfactory results on smooth non-porous surfaces such as pavements, runways and well-compacted soils. Heavy rain, high temperatures and high humidity were found to reduce effectiveness. While these materials will effectively immobilise personnel and vehicles they will also adversely affect emergency services until a clean-up operation is carried out.

J. Conclusions

196. A large amount of information has been gathered about a wide range of less lethal options. Five main areas have been agreed as meriting immediate further research; these are summarised as:

- Impact Devices or Kinetic Energy Rounds
- Long Range Chemical Delivery Devices
- Water Cannon, both vehicle mounted and portable
- Electrical Devices, particularly the taser
- Distraction/Disorientation Devices, particularly laser/light devices and noise generating devices

197. Evaluation of each of these areas is at an advanced stage and operational and technical information gathered from various sources has been validated and expanded by an intensive testing programme within PSDB. The initial phase of testing is almost complete for most of these technologies and a number of devices have been identified as meeting the basic criteria for further evaluation. Further testing of these devices will continue to assess their performance against other aspects of the operational requirement.

198. Those devices that meet all of the scientific and technical evaluation criteria will then be assessed by a medical committee who will comment on their effects on the human body. This committee will consist of a number of independent medical professionals who have expertise in the technology or effects being considered.

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CHAPTER 7: MEDICAL ASSESSMENT

A. Introduction

1. This section of the report has been produced by the Defence Scientific Advisory Council[1] for the Patten Steering Group and ACPO.

2. Its purpose is to:
- Provide an introductory overview of some of the potential medical issues associated with the use of certain less lethal weapon technologies directly or indirectly against individuals;
- Briefly review the biophysical and ballistic considerations that underpin the prediction of injury from the various generic classes being considered by the Patten Steering Group and ACPO. This will provide insight into the nature and scope of information that may be required to formulate a judgement for Ministers on the medical consequences of use.

3. The paper does not offer a formal medical review of published clinical information on the historic use of the systems, nor on the models available to predict the effects of specific weapon systems. This will shortly be undertaken in preparation for the formal experimental evaluation of specific weapon systems to be declared to DSAC in February 2002. It is not a critique or review of the work undertaken to date by the Police Scientific Development Branch (PSDB) in the preliminary evaluation of specific candidate weapon systems – those data have been gathered to assess the weapon systems against performance criteria and are not specifically designed to inform medical issues.

B. Background

4. Independent medical advisers from DSAC have been requested to provide an opinion on the medical implications of the deployment and use of specific LL weapon systems. The sub-committee constituted to undertake this task is the "DSAC sub-committee on the Medical Implications of Less-lethal weapons" (DOMILL).

5. The role of DOMILL is to provide:

(1) Advice on the biophysical, biomechanical, pathological and clinical aspects of generic classes of less lethal weapon systems;

(2) Independent statements on the medical implications of use of specific less lethal weapon systems given specific guidance to users;

(3) Advice on the risk of injury from specific less lethal weapon systems striking specific areas of the body in a format that will assist users in making tactical decisions, and developing guidance to users to minimise the risk of injury.

6. In order to discharge these responsibilities, DOMILL will be able to call on additional DSAC members with relevant expertise. Furthermore, DSAC may co-opt and seek advice from other individuals (from within UK or abroad) with appropriate scientific and clinical expertise.

7. The request to DOMILL arises from the Patten Steering Group and ACPO. DOMILL will provide the opinion to Ministers of the Northern Ireland Office (NIO), Home Office (HO), and the Ministry of Defence (MOD).

8. The acquisition of additional less lethal weapon capabilities aims to fulfil two requirements:

- Recommendations 69 & 70 of the Patten report on policing in Northern Ireland[2]: (a) a research programme should be carried out to find an acceptable, effective and less potentially lethal alternative to the baton round, (b) police should be equipped with a broader range of public order equipment;

- ACPO's desire to have a wider range of options in conflict management scenarios, including those most commonly associated with self-defence and restraint, and the Police use of firearms.

9. PSDB has undertaken a review of available commercial equipment, and is currently assessing specific devices in some of the classes, against interim evaluation criteria[3]. The classes of less lethal weapons being considered by PSDB for PAT and ACPO are:

- Impact devices (kinetic energy projectiles);
- Chemical devices capable of being delivered to individuals at a distance;
- Water cannon;
- Electrical incapacitation devices (EID);
- Distraction/disorientation devices.

10. The independent DOMILL members will be advised on the biomechanical principles of injury and the performance of the candidate weapon systems by the Defence Science and Technology Laboratories (Dstl), Porton. DSAC, supported by Dstl, was responsible for advice to the Chief Scientific Adviser MOD and through him to Ministers in the three Departments, on the medical implications of the use of the new L21A1 Baton Round. The DSAC statement was placed in the Library of the House of Commons.

11. PSDB is also reviewing the use of drugs (tranquillisers) to incapacitate individuals; at this stage, DOMILL have nothing to add to PSDB's statement on this topic in previous chapter.

C. Overview of this Chapter

12. Some general medical and biophysics principles that underlie the use of less lethal technologies are briefly outlined in section D. The potential impact on medical implications of use posed by the infrastructure that supports the use of less lethal is briefly discussed in section E. Section F considers specific implications of each class of candidate less lethal technology. Some concluding remarks are made in section G.

D. Medical and Biophysical Principles of Injury from Less Lethal Technologies

13. Foremost of the general medical and biophysical principles that underlie the use of less lethal technologies against personnel, should be the recognition that any application of energy (whether kinetic, electrical, electromagnetic or chemical) to the

human body carries a risk of harm. The acceptability of specific injuries may be defined both in terms of clinical criteria (threat to life; long-term complications; disability; poor outcome), and political/operational criteria; it is not the role of DOMILL to judge acceptability of injury. It is important that DOMILL define its use of terms such as "serious" or "minor" injury at the outset.

14. **Hazard** is the capability of a system to cause harm. **Injury potential ("risk")** is related to the **nature and severity** of injury given an interaction, and the **probability** of an interaction occurring:

- The injuries given an impact or other type of interaction (eg electric shock, chemical) depend on the vulnerability of the specific contact area to that form of energy; this vulnerability will be different for the various body regions. There will also be variations in response amongst individuals. For each type of energy application, the vulnerable areas need to be identified[4].

- The probability of impact on the intended location is a function of **accuracy** and **dispersion** of the projectile[5], and therefore internal (weapon) and external (flight) ballistics have important medical implications - accuracy and consistency are key issues.

15. For some forms of energy transfer such as kinetic energy (impact), the biophysical interactions and patho-physiological consequences are relatively well understood and can be modelled. For others (such as electrical incapacitation devices), the mechanisms are not well understood and predictive models are unavailable.

16. Absolute prediction of injury is difficult, even when the biophysical principles are understood. Inherent human variability and limitations in the predictive models (which may be based on animal experimentation, work on human cadavers or fundamental studies on the material properties of the body) necessitate caution in predicting absolute injury in living humans[6]. Confidence may be acquired in the veracity of opinion by comparing with similar systems where there is information from operational use, and where the existing system may be used as a benchmark. However, there nearly always remains an element of subjectivity in interpretation.

17. Experimental or modelling data may allow a comparison of the injury potential of the candidate system with that currently deployed, but laboratory studies cannot model true operational use; it is desirable that retrospective and prospective casualty data are acquired and reviewed to gain further confidence in the laboratory work.

18. It is also desirable to engage a broader focus beyond biophysical interactions and the direct consequences of energy transfer operationally:

- The outcome of unintended serious injury is also dependent on the timeliness and quality of available medical care; in an operational setting these may not be optimal.

- Although it is natural to focus an assessment of the **less lethal** technologies on physical injury - both acute and long-term - the psychological impact of injury or even non-injurious exposure should also be reviewed.

- The statements of DOMILL will address operational use of the **less lethal** technologies, but there may also be medical implications of the use of certain technologies (such as laser dazzle) in training.

E. Medical implications of the infrastructure that supports the use of less lethal technologies

19. The infrastructure that supports the use of less lethal technologies by users may also have an impact on the medical implications of use:

- **Guidance to firers:** one of the primary documents reviewed by DOMILL will be the written guidance provided to firers; this is the overt statement on the tactical use of the weapon system and the recommended method of use - normal operating range, aim points, constraints on use etc.;

- **Training:** the overall accuracy of the system is in the hands of an individual; effective training will also reduce the incidence of inadvertent inappropriate use;

- **Quality control:** this will affect accuracy, dispersion, and weapon output such as minimum and maximum velocity, contaminants in irritants etc.;

- **Reports on use:** users must be responsive to medical issues that may arise in operational use. It is essential that DOMILL receives feedback - this may enable changes in procedure that minimise unexpected injuries (type and severity) whilst maintaining operational effectiveness;

- **Equipment/user support:** apparently small changes in the design of a weapon system or in the guidance for its use may have profound medical consequences; it is essential that these changes are notified to DOMILL for a review of the medical implications.

F. Specific comments on each class of less lethal technology

20. The overview of the biophysical and medical consideration of technologies below has been guided primarily by evaluation criteria provided by PSDB[7] and its review of commercially available technologies[8].

Impact Devices

21. Injuries from projectiles (baton rounds; water; the darts of electrical incapacitation devices) are classed as penetrating or non-penetrating. Plainly, less lethal equipment relying on kinetic energy for effectiveness should not penetrate the body wall. It is important that penetration potential should be assessed, both for the intended orientation of the projectile at the moment of impact, and for other impact orientations that might arise (for example, because of inherent instability of the projectile, or following ricochet). In general, a reduction in contact area will increase the probability of penetration.

22. Serious injury may still be caused to internal organs and structures by a non-penetrating impact, indeed, this is the most common form of trauma observed in UK hospitals. The most vulnerable areas (in terms of potential for serious or life-threatening injury) are:

- head - facial skeleton, brain, eyes;

- thorax - rib fractures, lung contusion/laceration, heart injury and associated electrical disturbances;

- abdomen - the liver is also vulnerable to some forms of non-penetrating impact. Although not strictly a thoracic organ, it is overlaid by the rib cage. Damage to the liver may result in serious internal haemorrhage.

23. From a biomechanical perspective, non-penetrating projectiles produce injury primarily by moving the body wall rapidly; this motion will lead to the transfer of energy internally to the organs. The transferred energy does work on the tissues of the body, and thereby may lead to laceration (tearing) and contusion (bruising). The nature of this energy transfer (stress [pressure] waves, shear waves, local shear) depends on the:

- rate of energy transfer;

- mechanical properties of individual tissues at different rates of strain;

- overall structure and strength of the part of the body struck.

24. These biomechanical considerations have two important implications:

1. Kinetic energy alone is not necessarily an appropriate indicator of injury potential. The rate of energy transfer is dependent on factors such as mass and velocity of the projectile - a light, fast projectile may produce a different pattern of injury to a heavy, slow projectile of identical kinetic energy. The use of a single figure of kinetic energy as a criterion for injury to the body is flawed.

2. In order to predict the nature and severity of an injury, it is important that models appropriate to the "strain rate" of the impact are employed. Many of the models available have been developed by the automotive industry; in biomechanical terms these are "slow", high momentum impacts and they are unlikely to be appropriate for some less lethal weapon technologies that are "fast", low momentum interactions.

25. The duration of energy transfer mechanisms leading to injury are very short (less than 5 milliseconds for a baton round, for example). It must not be assumed that supposed energy attenuation systems (such as foam on the front end of a projectile) automatically offer a significant reduction in injury potential. The material properties of the foam need to be matched to those of the body wall to allow efficient attenuation (for example by absorbing energy or increasing the contact area) within the few milliseconds of the interactions that result in the injury.

26. The properties of the body also affect the rate of energy transfer, and the mechanical consequences of the energy - it is important to recognise that **biomechanical** tolerance varies with age and with stature (also gender); the **clinical** response to injury is also dependent upon age. Stature *per se* is also important in considering the dispersion (variability around the average point of impact) of projectiles - the shorter dimensions between acceptable contact areas and vulnerable areas will have an effect on the probabilities of serious injury. A large dispersion of a

kinetic energy projectile in an acceptable contact area (say, the lower torso) of a person of short stature will lead to a higher statistical risk of projectiles entering the high-risk head area, than in a tall person. In a tall person, the head is further away from the intended impact point.

27. In assessing injury potential, it is important to consider both **accuracy** and **consistency,** since both factors critically affect the probability of an impact on a vulnerable body area. Accuracy and consistency will both be influenced by engineering characteristics of the weapon and the projectile (manufacturing tolerances, susceptibility of the projectile to cross-winds, aerodynamic stability, etc.). However, it is important to realise that they may also both be affected by less tangible factors. These may include, for example:

- the quality of the training of the user;
- the ease of use of the weapon's sights - the sighting system is inevitably a compromise between ease of use in difficult circumstances and having a complex sight that is matched to the trajectory over the operational range;
- distractions that will arise in an operational situation.

Chemical delivery devices

28. There are two principal aspects to the medical implications of use of chemical "incapacitants" on people:

- physical injury from impact of the carrier system, or from the means used to disperse the material (eg pyrotechnics);
- the toxicity of the active material and associated contaminants, or materials (such as solvents) that may be included to enable dispersion.

29. Assessment of the physical injury from the carrier and dispersion system can be undertaken using the same general principles as outlined above. However, there are some specific additional considerations. For example, ACPO and the Patten Steering Group may wish to consider systems that strike a point on the ground within 1 metre of the point of aim (not defined). Ricochet under these circumstances will need to be addressed. Also, some devices might produce sub-components when they initiate, whose flight and potential impact on the body would need to be assessed - notwithstanding the impact risk (the eyes will be vulnerable) there may also be a risk of burns if the "incapacitant" is being produced pyrotechnically.

30. The identity of the "incapacitant" being dispersed is plainly important. In particular, the acute and long-term toxicity of the incapacitant will need to be established, if it is not already known. Reports provided to DOMILL indicate that the material is likely to be a sensory irritant such "Pepper" (capsaicin and its analogues) or CS. The toxicity of the "Pepper" materials is not well defined; long-term toxicity in particular is poorly understood. If this type of material is being considered, it will be necessary to evaluate its potential for respiratory effects such as bronchoconstriction (narrowing of the airways).

31. CS is a well-characterised sensory irritant used currently and historically in a number of law enforcement roles. The acute and long-term toxicity of CS is well

described in the literature. This should not promote complacency; it would be helpful to review some of the toxicological issues surrounding its deployment.

- There are a number of manufacturing specifications for CS and the synthetic route to CS varies. This may have an impact on the chemical nature of the impurities, the overall yield of active material and the physical nature of the product (eg the particle size). It is important to understand the effect that these factors may have on the overall toxicity.

- The toxicity and effectiveness of CS is also dependent upon the method of dissemination. The principal modes are: (a) pyrotechnic, to produce particulate aerosol; (b) dissolved in an appropriate organic solvent; (c) solid particulate in micronised form. The particle size range varies according to the dissemination method. The particle size determines the potential for deposition in the various parts of the respiratory tree. The Himsworth Report[9] on the toxicity of CS primarily addressed pyrotechnically generated CS.

- Most of the currently perceived health effects from police use of CS sprays probably arise from the use of the solvent, not the CS. If CS in a solution is proposed, the combined toxicity of the CS and the solvent will need to be reviewed; the toxicity of mixtures is notoriously difficult to assess.

32. The documents provided to DOMILL suggest that micronised CS is a favoured option. Micronised particles are small (5-20 micrometers diameter) and a large proportion will be inhaled into the respiratory tract, giving respiratory effects: coughing, tight chest and perception of breathing difficulty.

33. If micronised CS is to be dispersed directly on a human from the impact of a frangible projectile, the dispersion characteristics must be determined - specifically the particle size (including aggregated material) and the concentration density in the facial area. Aggregated material might cause blisters in skin and mucous membranes, and may cause corneal chemical burns.

34. Himsworth recognised susceptible groups such as the young, the elderly and those with pre-existing pulmonary disease. Although age *per se* is unlikely to have a significant effect on inherent toxicity, in operational use (particularly indoors) the young and elderly tend to be more seriously affected due to inhalation. This will be compounded by factors such as their reduced ability to escape/move away.

35. From an effectiveness perspective, it is important to recognise that although all personnel exposed to CS will experience the physiological and sensory effects, determined individuals can overcome the effects and may still present a threat to the user or those he seeks to protect. It must also be recognised that with micronised CS, the chance of cross-contamination between targets at very close range and the users, is likely to be high.

<u>Water Cannon</u>

36. The injuries from a jet of water could occur from:

- the direct impact of the water (primary injury);

- street furniture or other debris that has been energised by the water jet and strikes the individual (secondary injury);

- displacement of the individual with subsequent contact with the ground or another hard surface (tertiary injury).

37. Water represents a high energy, high momentum loading. The high momentum results in the displacement of the individual and in this respect (and others) differs from kinetic energy less lethal projectiles. There is remarkably little information in the open medical literature regarding injuries from operational use of water cannon. This should not be interpreted as implying that injuries do not occur – it may simply be that the nature and frequency of the injuries do not warrant reporting in the clinical press.

38. Water is a difficult medium to assess in terms of probability of a potentially hazardous interaction, and characterising the energy transfer:

- water cannon and other types of water-dispensing devices are inherently inaccurate systems due to the nature of the jet and difficulties faced by the operator from spray, etc. They do not tend to be used to engage specific individuals;

- a jet of water will not be uniform in terms of the mass and velocity of the water comprising the jet (longitudinally and in cross-section), and in terms of the effective contact area on a target. It will be difficult to describe in terms of the magnitude and time-course of energy or impulse applied to a target.

39. DOMILL are not aware currently of any models capable of predicting primary injury from water jets but there may be information from the Fire Service. Some work was undertaken by MOD in the late 1970s on the injury potential of water boli but direct application of this work to continuous or pulsed water jets may not be appropriate.

40. Given an impact from a jet of water, the organ most vulnerable to injury is probably the eye. Work was undertaken by MOD in the late 1970s and early 1980s; this may provide insight into the nature of the injuries and the forces applied to the eye. There is also a risk of eardrum rupture from high-speed water jets. The abdomen is also vulnerable to the gross body wall displacements arising from high momentum impacts.

41. Irritants and dye may be added to the water; the latter is more likely in the current context. The toxicity of these materials to the eye in particular, would need to be assessed.

42. Injury may also result from the overall acceleration and subsequent motion of parts of the body, due to the action of the water jet. Some parts of the body (such as the brain) are susceptible to the absolute motion of the individual body part. In the case of the brain, head acceleration in linear and in rotational senses can both be injurious. Others (such as the neck) are susceptible to *relative* motion between one body part (eg the head) and another (eg the shoulders). In the case of the neck, relative acceleration, velocity and displacement may all be important. The automotive industry has models, such as the Hybrid III dummy, that may be useful in assessing the risk of injury. Dstl Porton has recently undertaken studies using these models to

address head/neck rotation from explosions. However, note the caveats about the use of models in a footnote to section 4.

43. Displacement of an individual as a whole by the high momentum impact may result in head injuries from contact with hard surfaces such as the ground, long bone fractures and minor injuries such as bruising. Head injury could be life threatening. Injury prediction is extremely difficult due to the inevitable uncertainty about the relative locations of the subject and the hard surface and the precise loading applied by the water jet. However, the risk of injury can be assessed if contact velocities of the head with the hard surface can be estimated.

Electrical Incapacitation Devices

44. Although electrical incapacitation devices (EID) such as “Tasers” have been used for many years by law-enforcement agencies in the US, the biophysical and physiological basis of their effectiveness and safety does not appear to be well understood. DOMILL has not yet formally reviewed the body of data on use of EIDs, nor the medical evidence compiled by the manufacturers and so the discussion below is largely speculative.

45. These devices cause the subject to collapse. The cause of the collapse requires review. Severe pain *per se* may cause collapse but there is also likely to be a neuromuscular basis: possibly tetanic direct stimulation of nerves supplying skeletal muscle. There may be other neurophysiological interactions that lead to disturbances in posture and balance - the "controlled fall" described in victims of EID use. It is alleged that some modern EIDs interact directly with skeletal muscle, and “override” nervous tissue.

46. The accuracy and consistency of the weapon system(s) that fire projectiles such as darts will determine the:

- probability of impact to areas where the darts may produce potentially serious mechanical injury – principally the eye;

- electrical current density and current path in the tissues between the darts, or between the dart(s) and ground.

47. The darts may also produce local injury to the skin, and they may also require surgical removal (depending on design). It is known that electric shock with high current may produce necrosis of soft tissue well beyond the local current entry point; EIDs are relatively low current devices but the risk of this injury should still be assessed.

48. An organ potentially at greatest serious risk from the application of pulsed electrical fields is the heart. The current flowing in the heart will be influenced by the location and separation of the current application darts, the pulse length and repetition frequency and the frequency content of the current pulse(s). The former will be affected by the inherent accuracy and consistency of the delivery system, the presence of clothing and the guidance given to firers with regard to dart location.

49. Externally applied current flowing in the heart may result in arrhythmias (disturbances in the normal rhythm of the heart) and in extreme circumstances these could progress to ventricular fibrillation (an uncoordinated contraction of heart

muscle that results in no effective output of the heart, and thereby, death). It is also known that there is a very short period in the normal cardiac cycle – the "vulnerable period" – when the heart is relatively unstable electrically during its repolarisation phase. Domestic electric shocks during this vulnerable period may produce life-threatening arrhythmias such as ventricular fibrillation. It is also known that non-penetrating impacts from projectiles during the vulnerable period may also produce these effects – a condition known as *commotio cordis*.

50. It is essential to review surveys and apocryphal data describing the use of EIDs to determine if the conditions described above have actually occurred with operational use of the devices. Susceptible groups of individuals need to be identified. A recent paper in The Lancet[10] discusses experimental work on pigs, and two retrospective surveys of EID use against humans. In one of the surveys, 16 deaths associated with EID use were reviewed, but in only one case was the EID thought to have contributed to the death. These surveys and other published information on electrical devices will be critically reviewed by DOMILL; proprietary information from manufacturers will be requested.

51. Dstl Porton is developing models to predict current flow and the location of peak fields and power absorption in the body from pulsed RF sources (for RF safety studies); this model could be modified to address the output of the less lethal electric devices. Modelling the current flow may also give insight into the mechanism of the collapse from application of the EID. It is known that application of current to the torso produces collapse, but the current flow to the lower limbs under these circumstances is not likely to be notable, unless there is considerable leakage to ground. The modelling could clarify this issue.

52. It is reported that a notable proportion of those that died following use of EIDs had taken drugs and/or were in an agitated state. Both of these factors may alter the metabolic status of an individual, and this could pre-dispose the heart to ventricular arrhythmias; it has also been stated that the metabolic consequences of the contraction of skeletal muscle (which could be tetanic) would also aggravate the metabolic disturbances.

53. It is unclear whether EIDs may produce direct effects on the brain - either brief unconsciousness, or perhaps even a seizure during application. Others issues that require review are: risk of damage to nerve endings; incidence and duration of apnoea (cessation of respiration) during, or subsequent to use; the effect on the performance of implants such as pacemakers, and whether implants may increase current density to the heart and neuro-physiological structures.

54. The thresholds for direct life-threatening injury from EIDs do not appear to be known. The various commercial devices have different outputs in terms of peak voltage, pulse repetition frequency, pulse shape and duration. If retrospective data from historic use in the field are not available and the physiological basis of the effect and side-effects not known, an informed assessment of the changes in the risk of serious injury arising from differences in device output will be extremely difficult.

Distraction/Disorientation Devices

55. It is likely that only two general types of distraction/disorientation devices will be considered:

- noise (blast) generating devices; these may also produce light;

- laser/light devices.

Noise generating devices

56. These devices may use sound or light, individually or in combination. Contrary to popular belief, whilst these devices may well distract or disorient the subject(s), they do not "stun" personnel in a neuro-physiological sense.

57. The means of delivering the sound and light may present its own risk of injury: impact of the grenade (or components thereof), and if pyrotechnically generated, debris from sub-munitions and burns (from the device itself or as a result of setting fire to the surrounding room). The debris may carry little risk to exposed skin, but the eyes will be vulnerable and the probability of impact of debris to this area will require assessment. Even minor debris in the eye can cause problems, such as recurrent corneal erosion syndrome. Noise and light are normally generated pyrotechnically, although it is an aspiration of PSDB that non-pyrotechnic means will be used.

58. If the devices will be used by firing through windows, the risk of penetrating injury to the skin from glass shards will need to be assessed - this is likely to be low. However, the eye is particularly vulnerable and the probability of even very small pieces of glass entering the eye area will need to be determined.

59. Sound may be classed as continuous or impulsive. It is likely that impulsive (blast) sound will be used operationally. Temporary sensorineural hearing loss will undoubtedly occur, but it is essential that the risk of permanent loss of auditory acuity is determined. Fortunately, criteria are available to predict the risk to hearing if the peak sound pressure level, duration and repetition rate are known. Exposure in confined spaces may result in reverberation – a complex frequency spectrum of long duration - and so it is essential that the concept of use of the sound weapon is known and output measured in the appropriate environment. Eardrum rupture is unlikely, but the risk (particularly in confined spaces) needs to be determined.

Laser/light devices

60. It is presumed that the laser will be used to mark or dazzle individuals. It is extremely unlikely that the devices will have sufficient output to produce burns to skin, but this will need to be assessed from review of the output characteristics. The principal organ potentially at risk is the eye; retinal burns from laser light are serious injuries and will result in permanent impairment of vision.

61. It is critical that the output of the laser devices is characterised in terms of power and wavelength, and the temporal nature of the output: continuous wave (CW), pulsed, or modulated CW. The power and radial divergence at range also need to be determined. For a dazzle device, the eye will be the intended target, but the targeting of that small structure at range will be difficult, and the effective exposure time for targeted individuals and others must be calculated. The beam will diverge with range (also resulting in a reduction in energy density) and a larger number of people could be exposed at longer ranges.

62. Many models are available to predict the risk of permanent injury of the eye from lasers, if the characteristics above are known. Note that temporary effects such as persistent after-images may occur for minutes after exposure; it is possible to make judgements on the duration of these temporary ocular effects.

63. There are a number of factors pertinent to predicting effectiveness and injury risk:

- pupil diameter will have a significant impact on the energy gathered by the eye - low ambient light, emotional state and drugs may all have an effect on the diameter;

- for a given energy output, the eye is more susceptible to pulsed outputs than CW; another consideration is that the blink reflex can offer protection from CW, but not pulsed sources;

- the wavelength of the laser light will have an effect on effectiveness and safety - the eye is more sensitive to green wavelengths than to red.

64. Light may also be produced by incandescence. Many of the considerations outlined above apply to incandescent light, but this form of light may have a broad frequency content extending beyond the visible spectrum into the ultra-violet and infra-red.

G. Concluding remarks

65. Absolute prediction of the probability and nature of injury to the human body is very difficult, particularly in operational circumstances. Retrospective analysis of use of similar weapon systems can provide some insight that will allow validation of models and predictions, but the medical information in these data may be limited, and the characteristics of the engagement poorly defined.

66. Identification and prioritisation of key medical issues within the time constraints have not been undertaken in this paper; they will be addressed when the specific weapon systems likely to be deployed have been declared to DOMILL. The biophysical interactions of certain technologies - such as electrical incapacitation devices - are poorly defined and it may prove difficult if not impossible to offer an authoritative statement within short timescales without this underpinning knowledge. Biomedical studies are inevitably lengthy.

67. The key point to emerge from this brief review is that any assessment of the injury potential of a weapon system needs to address the system as a whole, and not simply the consequences of an interaction with the body. Consequently, for the specific weapon systems to be deployed, DOMILL will require a thorough review of the proposed operational criteria and circumstances of use, guidance to firers, and the technical performance in the hands of an operational user.

References and Footnotes

1 DSAC is a body of independent engineers, scientists and clinicians from academia and industry; their primary role is to advise MOD on the quality of its research activities, and its research strategy.

2 “Report of the Independent Commission on Policing in Northern Ireland”. Sep 99.

3 Chapter 6, paragraph 24.

4 It is also important to recognise that in addition to an increased risk of serious injury if energy is transferred to a vulnerable area, the effectiveness of less lethal technology is also dependent upon interacting with the intended target area.

5 In ballistics, the term “accuracy” refers to the mathematical average point of impact compared with the intended point of impact. It does not signify anything about the scatter about that average point. The measure of the amount of scatter is known as “consistency”, or "dispersion". To have a high probability that projectiles will strike the target at or close to the aiming point, it is necessary to have high accuracy and low dispersion (high consistency).

6 A model is a representation of the essential (in the opinion of the modeller) characteristics of an object or event in the real world. A model in the context of injury prediction is a tool that describes a biophysical process. The tool can be used to predict how changes in the input to the body or body part (eg energy, contact area etc.) would affect the potentially injurious output (eg pressure in the body, damage to a material). A model may be physical or mathematical (or a combination of the two). Any model is only as good as the data used to develop it. A common error with the use of models is use outside the boundaries of the assumptions and data that supports them (eg using a model developed using low-speed impact data to predict effects from high-speed impacts). Used with care, models are useful for “what-if” studies to determine the consequences of changing input parameters such as say contact diameter, or the stiffness of projectiles. However, all models are necessarily incomplete and have limitations; their use to predict specific injuries to personnel requires informed judgement (preferably reinforced by validation from human exposure), not blind faith. Models are not literal mimics of human response.

7 Chapter 6, paragraph 24.

8 'Patten Report recommendations 69 and 70 relating to Public Order Equipment', April 2001.

9 Himsworth H (1971). “Report of the Inquiry into the Medical and Toxicological Aspects of CS (Ortho-chlorobenzylidene Malononitrile). Part II. Enquiry into the Toxicological Aspects of CS and its use for Civil Purposes”. HMSO. Command 4775.

10 Fish RM, Geddes LA (2001). “Effects of stun guns and tasers”. The Lancet, 358 (1 Sep 2001), 687-688.

CHAPTER 8: TAKING THE PROGRAMME FORWARD

A. The Suggested Priorities for Further Research

1. The Patten Steering Group and ACPO have been in close contact with PSDB throughout this phase of the programme. Demonstrations of some of the equipment have been held. Each technology has been assessed against the broad operational requirement. Consideration has also been made of the human rights and legal issues and acceptability framework set out in previous chapters.

2. Against this background, prioritisation of a range of less lethal technologies has been undertaken. The following section sets out the combined views of the Steering Group and ACPO on the systems that warrant further evaluation, either immediately, or over a more extended time frame. The headings of the categories are those previously set out in paragraph 3 of Chapter 6.

3. Category A

Devices which may be subject of immediate more in depth research:

(i) Medium-Range (5-20m) to Long-Range (over 20m) Devices

a) Kinetic Energy Rounds

This generic category includes sponge grenades, bean bags, sock rounds and single and multiple ball rounds. (Note – the L21A1 has not been included in this study as extensive testing has already been carried out for this round.)

b) Discriminating Chemical Delivery Devices/Rounds

These devices/rounds can be used to deliver a quantity of chemical irritant (eg CS) to a target at an extended range, ie further than is possible using conventional hand held sprays (10-14ft). These tend to combine kinetic impact effects with chemical irritant effects to produce incapacitation of the target. The degree of each effect varies with each system and is dependent on the velocity, size, shape, material etc. of the round and also the quantity of irritant contained within it.

(ii) Water Cannon

Conventional vehicle mounted water cannon are in use throughout Europe and in other parts of the world. Work has been carried out by the Home Office between 1981 and 1987 but was discontinued by the then Home Secretary. A review of all currently available vehicle mounted and portable water cannon is underway to identify those systems which most closely meet the operational requirements of the UK police.

(iii) Electrical Devices (eg Tasers)

Electrical devices include any weapons that use the effects of electricity to incapacitate the target. There are a variety of different devices but their principle of operation is the same. They are battery powered and use a low current, high voltage impulse shock for incapacitation. The electrical stimulus delivered by the device interferes with the normal electrical signals generated

by the human nervous system. Incapacitation by electrical means appears to offer a virtually instantaneous method of incapacitation with almost instant recovery, although some questions remain on delivery methods and on health effects. Priority has been given to those devices that can be used at a range, for example the Taser.

(iv) Laser/Light Devices

The effects of bright light/laser devices can range from dazzle or glare to image formation, flashblindness and irreversible damage. Generally, these devices do not incapacitate a person, although there may be some deterrent effect as the target becomes aware that he/she has been picked out. A device that dazzles at large distances may cause irreversible damage at close range. These devices are considerably less effective in daylight or in the presence of strong artificial light.

(v) Noise Generating Devices

The potential of loud noise to distract and disorient is well known and can be incorporated into devices that are either hand thrown or fired from weapons. The requirement is for a non-fragmenting and non-pyrotechnic device that will provide a potentially less injurious alternative to the more traditional stun grenade.

4. Category B

Devices warranting further research over a more extended time frame:

(i) Malodorants

Malodorants may be of assistance in dispersing crowds although they are unlikely to prevent a determined assailant at short range. There may be issues about decontamination following deployment, especially in residential or heavily populated areas. The possibility of developing malodorous devices appears not to have been fully explored and exploration of this technology will necessarily be longer term. There may also be toxicological considerations for these types of device.

(ii) Tranquillisers

It has been suggested in some quarters that in a broadly similar way to that in which vets and game wardens are able to tranquillise animals, the police should have the capability to tranquillise subjects. However, the speed of reaction to any anaesthetic or drug will be an important factor in its use, as will the possibility that different people will react differently to it and the dose required to incapacitate one person may prove harmful to another.

5. Category C

Devices which presently do not require further research:

(i) Stun Grenades

These devices could be considered to be too indiscriminate and potentially dangerous.

(ii) Smoke

These devices could be considered to be too indiscriminate and potentially dangerous.

(iii) Acoustic Devices

This is not yet a mature technology and there is a lack of scientific evidence on the effectiveness and risks of infrasound and acoustic shock wave devices.

(iv) Electromagnetic Waves

This device is still subject to further development. It may also be potentially easily countered by adequate protection by the subjects.

(v) Nets and Wire

Potentially injurious due to the indiscriminate nature of the necessary weights attached to the devices.

(vi) Glue, Foam and Grease

Problems would appear to exist with respect to potential suffocation of subjects, decontamination and exclusion of emergency services as well as disorderly/dangerous individuals.

B. <u>The Fuller Evaluation Timetable</u>

6. This section sets out the latest timetable for evaluation.

The plans that are in place for the next stages of the project are necessarily subject to change. As the project progresses and more information becomes available, decisions can be made on the suitability or otherwise of particular equipment and technologies. Options may be discounted for ethical, operational or medical reasons. As equipment and technologies are discounted more time and resources will be available to devote to the remaining options. Conversely, it may be that unexpected delays occur because information needed to inform the decision making process proves more difficult or time consuming to obtain than expected. For example, the independent medical committee (DOMILL) may request extra work to be carried out because the information on a particular aspect of a device or technology is insufficient to allow an informed comment on its effect on the body.

Subject to these caveats, the following tables are given as a guide to timescales, quarter 1 being January – March.

(i) Impact devices and long range chemical delivery devices

These devices have been placed in category A of the shortlist. Initial evaluation criteria have been applied to these technologies which will help speed up the evaluation process while allowing the most appropriate devices to be identified. The testing procedure will involve the sifting out of unsuitable products – only those products which successfully pass the first stage of assessment will be put through the second stage, and so on.

Milestone	Date due
Evaluation of all available rounds to determine accuracy, velocity, energy, reliability and consistency. These tests are carried out using bench-mounted weapons and under ideal conditions	Quarter 4 2001
For rounds meeting initial evaluation criteria, multiple shots fired at maximum required distance to ensure reliability	Quarter 4 2001
Promising rounds/systems subjected to extremes of temperature then assessed for performance and accuracy	Quarter 4 2001
Point of aim/point of impact data obtained for rounds fired at a range of distances from an appropriate weapon. Also assess the compatibility of the round with existing weapon systems, where appropriate	Quarter 4 2001
User handling trials to assess the performance of the weapon system when fired at stationary and moving targets and under low light conditions. This will involve members of the police service	Quarter 1 2002
Multiple shots fired from bench mounted and hand held systems to obtain statistical values for accuracy	Quarter 1 2002
Appropriate rounds/systems passed to medical committee for assessment	Quarter 1 2002
Full evaluation of rounds, including medical evaluation	October 2002

(ii) Water cannon

These devices have been placed in category A of the shortlist. This category includes both vehicle mounted and portable water cannon systems.

Milestone	Date due
Research of available vehicle mounted and portable water cannon systems to determine their technical specifications eg pressure, flowrate, capacity, time to discharge and refill etc	Quarter 4 2001
Research to determine operational issues in relation to water cannon used in other countries eg effectiveness, injuries received, advantages and limitations etc	Quarter 4 2001
Agree necessary performance characteristics for an acceptable water cannon system	November 2001
Produce a draft specification for evaluation of water cannon	Quarter 4 2001
Identify most suitable systems from those available and obtain for evaluation	Quarter 1 2002
Water cannon passed to medical committee for evaluation	Quarter 1 2002
Full evaluation of water cannon, including medical evaluation	October 2002

(iii) Electrical devices

These devices have been placed in category A of the shortlist. At present, this category includes all types of electrical device that have the potential as less lethal options, although tasers will continue to take highest priority.

Milestone	Date due
All submitted electrical devices tested for accuracy, consistency and reliability, where appropriate	Quarter 4 2001
Electrical output measurements for all submitted electrical devices	Quarter 4 2001
Extreme temperature and handling testing for taser products	Quarter 4 2001
User handling trials for tasers to assess the performance of the weapon when fired at stationary and moving targets and under low light conditions. This will involve members of the police service	Quarter 4 2001
Electrical devices passed to medical committee for assessment	Quarter 4 2001
Report of evaluation of non-taser electrical devices	Quarter 1 2002
Agree necessary performance characteristics for suitable electrical devices	Quarter 1 2002
Full evaluation of tasers, including medical evaluation	Quarter 1 2002

(iv) Distraction/disorientation devices

'Non-injurious' laser/light devices and noise generating devices have been placed in category A on the list of priorities. Malodorants have been placed in category B as the technology is currently at an early stage and requires further development.

Milestone	Date due
Report on noise generating devices, particularly non-pyrotechnic and non-fragmenting devices	Quarter 4 2001
Report on laser/light devices, containing guidelines for use	Quarter 4 2001
Review of available products using malodorants and any existing research into this technology	Quarter 4 2002

All initial evaluation work is planned to be completed by early 2002 resulting in a shortlist of devices (1 or 2) in each of the priority categories. These devices will then need to be considered by the medical committee, this is planned to be complete by October 2002. Initial evaluations of electrical devices are expected to be completed by Quarter 4 2001 with the medical considerations complete by Quarter 2 2002.

(v) Tranquillisers

It has been suggested that it should be possible to use tranquillisers. A report will be prepared on this that should allow a decision to be made as to whether research should continue in this area.

Milestone	Date due
Initial assessment on the potential for using tranquillisers as a less lethal option against human subjects	Quarter 2 2002

C. The Evolving Context

7. The publication of this report represents the end of the second phase of the four-stage Patten-initiated research programme. It is a full account of the progress that has been made so far. It has sought to set out, in appropriate detail, the factors that must be considered. Key elements are:

- the Operational Needs and Requirements;
- the Human Rights, Legal and Accountability Context;
- the Audit Framework for assessing individual systems;
- the performance of individual systems against the evaluation criteria;
- the Medical Assessment.

8. The pattern of use of baton rounds in Northern Ireland in earlier years has, understandably, polarised the debate about the nature of police responses to public disorder in this society.

9. Moreover the advent of the Police Service of Northern Ireland, with human rights and community policing at its heart, places the issues in a fresh context. The analysis of operational need, not just in Northern Ireland but also in Great Britain, suggests that there will always be situations where police – on behalf of the wider community – are obliged to deal with public disorder. Often that may put the police between two opposing groups that are threatening physical violence against each other.

10. Police techniques towards managing such conflict are – as Chapter 2 brings out – not primarily based on the use of force or technology. Discussion, negotiation and an appreciation of crowd behaviour are essential preliminary stages. But any Government is failing in its duty both to society and to its police services if they are not provided with the equipment, the training and the leadership that are required to deal with potentially life-threatening disorder.

11. The Steering Group believes that alternative equipment or less lethal 'weapons' cannot be placed in a single hierarchical continuum of force. It is recognised that for some systems the risk involved in their use is situationally and intrinsically related to the training and skill of the user, whereas, for others, the risk for those on the receiving end is limited to discomfort and unpleasantness. As the report demonstrates, all kinetic energy impact rounds that have been reviewed implicitly carry the risk that is associated with an unintended impact on the head or cardiac areas. On the other hand, the more accurate and consistent of these rounds do have the distinct advantage of being among the most discriminating type of weapon systems as opposed to general use in crowd control. It is these features among other factors that have led to the greatly reduced usage of the baton round in Northern Ireland, as the Chief Constable has pointed out. It is, correspondingly, these features that have led to the L21A1 being adopted by nearly all constabularies in Great Britain, and considerable overseas interest in it.

12. Phase 2 of the programme has underlined that there is no 'off the shelf' panacea. The breadth of the current research programme is, the Steering Group

believes, as comprehensive as any that has yet been or is currently being carried out. Other countries have other mores. In one, the use of tear gas on crowd disorder may be culturally and ethically acceptable; alternatively the use of electrical devices may be seen as appropriate for responding to life-threatening situations. No external group in Northern Ireland, with which the Steering Group has been in contact, has come forward with specific recommendations for alternative technologies for a variety of situations.

13. The Group recognises that each jurisdiction may want a different solution to a common problem. The Group did not feel that it was appropriate, at this stage of the research programme, to set out categorically what systems were to be preferred. Rather the Group presents this report to Ministers in the knowledge that it will be published and made freely available, thereby helping to stimulate the next stage of the debate.

14. The Policing Board has now been established in Northern Ireland. It will have a keen interest in the issues and Ministers have made clear that the Steering Group will work closely with it.

15. This report is by the Steering Group set up after the Patten Report. In the context of recommendations relating to Northern Ireland, the report would be incomplete without further consideration of two specific items of equipment that are already available elsewhere.

D. Consideration of Two Technologies in the Northern Ireland Context

16. Patten's recommendation 70 was that:

> "the police be equipped with a broader range of public order equipment than the RUC currently process, so that a commander has a number of options at his or her disposal which might reduce reliance on, or defer resort to, the plastic baton round."

17. The rest of paragraph 9.16 is also worth quoting in full:

> "At present the RUC has, essentially, three options – the baton, the PBR or live fire. We believe that this encourages more rapid resort to the PBR than might otherwise be the case. The number of PBRs discharged on some occasions – perhaps hundreds in a single night – raises questions as to whether they are only used in cases where there is no available alternative to the PBR, for example when there is a need to intercept petrol bombers at long range. PBRs have, for example, been discharged at close range in some instances, causing deaths and injuries. If, in such a situation, an officer could use, say, a personal protection CS spray (these sprays are issued to most police officers in Great Britain but not to the RUC), that would provide an effective non-lethal alternative to the PBR, which becomes a much more dangerous weapon when used at short range. Another alternative worth exploring is the water cannon, where new technology has transformed what used to be a rather ineffective weapon into something which now looks much more promising for police purposes. We know the Northern Ireland police are looking into this (and had water cannon available at Drumcree in July 1999), and we welcome that."

18. The Steering Group has sought to address recommendations 69 and 70 holistically. The Group has specifically looked, again in consultation with ACPO, at

the two technologies mentioned in paragraph 9.16 – the incapacitant personal protection spray and the water cannon. It agrees with Patten, in principle, that both have considerable potential for use in Northern Ireland.

Personal Protection Incapacitant Sprays

19. The first point to note is that hand-held incapacitant sprays are not an alternative to baton rounds. They are effective at no more than a few metres.

20. The basic criteria in the operational requirement for a hand-held, essentially aerosol, incapacitant are that it should be:

- Safe;
- Effective;
- Accurate (at between one and three metres);
- Discriminating;
- Quick acting;
- Easy to use;
- With minimum cross-contamination.

21. The British authorities very carefully assessed alternative sprays in the mid-1990's. They noted the widespread use, for example in the United States, of Oleoresin Capsicum (OC). However OC is a natural product of the Cayenne Pepper and is not man made. Because of this, there are no guidelines requiring any type of medical research on the chemical in the United States. At that stage, there was no evidence available on the toxicity levels of OC.

22. The UK authorities were conscious of one of the recommendations in the Himsworth report following the use of CS in Londonderry in 1969, namely:

> "any chemical agent that might be used for the control of civil disturbances should be studied from the point of view more akin to that from which we regard the effects of a new drug than to that from which we might regard a new weapon".

23. It was therefore concluded that OC could not safely be introduced at that time.

24. Attention was focused on CS. CS had been widely used, for example in Western European countries such as France and was recommended by the Department of Health and Porton Down because of the extensive amount of data available on its toxicology. Medical advice was sought on after care, from the Department of Health and from Porton Down.

25. Although it is commonly described as a gas, CS is a solid that needs to be dissolved by a solvent, if it is to be used in a spray. Again, after consultation with the Department of Health and other experts, the solvent MIBK was chosen. It is acknowledged that there have been one or two reports suggesting that MIBK is not the ideal solvent, and that it might carry risks that another solvent might not. Other solvents identified include, for example, methylene chloride, which is classified as a class 3 carcinogen and therefore unsuitable. Further work has continued in Britain assessing the suitability of alternative solvents, and the steering group has had access to that research.

26. It was concluded that CS was suitable, and that a pilot study should go ahead, using one particular device, the Alsetex product, which most closely met the operational requirement. There were operational trials for six months from 1 March 1996. On 21 August 1996, prior to the end of the trial, the then Home Secretary gave his full support to any Chief Constable in England and Wales who wished to issue CS to officers on the beat. He said that it was "a dramatic improvement in police protective equipment … presenting no serious risk to health".

27. In 1998 CS spray was referred to Independent Standing Committees on Toxicity, Mutagenicity and Carcinogenicity of Chemicals in Food, Consumer Products and the Environment. The conclusion was that:

> "the available data did not, in general, raise concerns regarding the health effect of CS spray itself".

28. It was however noted that there were susceptible groups where exposure to CS could be a concern. These were those with chest complaints such as bronchial asthma or chronic obstructive airways disease, those with cardiovascular disease and persons on neuroleptic drugs (by virtue of the lack of data on the interaction between CS or M1BK and the drugs themselves).

29. Separately, research is ongoing into PAVA which is a single compound derived from a capsicum. There is a need for further toxicological data to be gathered, and it is now being referred to the Department of Health Independent Committees.

30. Forty-one of the 43 forces in England and Wales have introduced hand-held incapacitant sprays with CS. Sussex and Northamptonshire police have recently introduced a PAVA spray.

31. There is no doubt that, operationally, CS spray has proved effective. Although public order use is not the primary purpose, it has provided police officers with equipment that can be used at comparatively close quarters as a less lethal option. Moreover, returns from forces demonstrate that the act of drawing the spray and the warning have often themselves been sufficient. On the other hand, it is not a panacea. On a small, but significant, number of occasions, the spray appears to have little or no effect. This seems to be particularly the case when the subject is under the influence of drugs or alcohol. There are no reported deaths proven to be the result of CS spray in England and Wales, and very few reported cases of hospital treatment or complaints directly attributable to the effects of the spray.

32. Since its introduction in 1996, these sprays have been widely distributed to police officers. It is a standard item of equipment carried by patrolling officers – and for many forces it is an absolute requirement that it shall be so carried. All the forces' operational staff have been trained.

33. The Police Complaints Authority produced a detailed report on the effects of CS sprays in March 2000**.** Their study drew on every fully investigated use of CS spray over a one-year period in 1998/99 (135 cases), and a questionnaire sent to all forces in England and Wales. Research showed the use of the spray led to complaints in about 5% of the cases. While in 8 of the 135 cases the effects had lasted for more than 2/3 hours and/or required hospital treatment, <u>none of the injuries were permanent.</u> While in 7 of the cases, the injury was attributed to the MIBK solvent rather than the CS, in 4 the spray had reportedly been used at a distance of less than a metre.

34. The report stated that nearly half of the complaints arose from what it called public order situations (not necessarily riot type situations but including disturbances in the street and outside pubs and clubs):

> "Our concern about public order situations is that these are likely to involve a number of people and are not always ideal for the use of CS spray."

35. The report also notes that if it is used inaccurately or inappropriately, both the police and the public may be affected by it. It welcomed the further ACPO Guidelines in 1999 which dealt with its use in public order situations.

36. The report also noted a failure rate in the sample of 18%, close to the ACPO figures of 20% ineffectiveness. It expressed some concern about the complex and emotive issues around CS spray and mental illness. It stated that more research was needed on the effect of CS spray on those with a mental disorder and in relation to drugs which are commonly used.

37. Their conclusions were broadly positive, including:

- on balance, the spray did not appear to present a serious risk to the public;
- it had made a real impact in making life safer for police officers equipped with it;
- adherence to the ACPO guidelines was important, as was training and recording;
- research into alternative solvents and incapacitants should continue.
- although the study found no evidence to suggest that CS spray in its current form should be withdrawn, significant concerns remained amongst important groups.

38. While research into alternative solvents is continuing, it has not as yet pointed to any alternatives that are demonstrably better in all respects.

39. The introduction of incapacitant sprays in Northern Ireland is largely, though not wholly, dependent upon the operational need. As previously noted, they are not primarily a public order tool. Their use is more appropriate by beat officers and others on patrol. It seems likely that one of the consequences of the emphasis, post-Patten, in the Police Service of Northern Ireland on community policing will be to strengthen the case for equipping such officers with incapacitant sprays. A further factor is the increasing number of attacks by a bladed weapon. This phenomenon has become increasingly familiar in Northern Ireland, over the last nine or 12 months.

40. Previous consideration has been given to the introduction of CS-based incapacitant sprays in Northern Ireland. A working group was formed by the RUC, including representatives of the Police Authority. It concluded that there was a sound case for the introduction of such sprays. The Patten Report itself suggested they might be appropriate. It is now a matter on which the views of the Policing Board should be sought at an appropriate stage.

The use of Water Cannon

41. The Patten report suggested that water cannon was another alternative worth exploring, and welcomed the fact that Northern Ireland police were looking into it.

42. Two water cannons have been loaned from the Belgium gendarmerie for part of the summer in each of the last three years. They were most extensively used in 2001, as they were also deployed in Belfast, for example, in the Ardoyne area, as well as at Drumcree.

43. There are undoubtedly limitations with the water cannon. These include the capacity of the vehicles which requires regular refilling, their manoeuvrability, especially in some terrain, and their armouring against some forms of attack.

44. There is limited, up-to-date medical information on their effects. On the other hand, the Belgian police and others on the continent have deployed and used water cannon for many years. The Belgian police have not suggested that there was a significant risk in their usage, and it has been observed that their mere presence, for example at contentious football matches, often defused potentially violent situations. In addition to vehicle-mounted water cannon, there is also equipment that can be carried on an officer's back, or drawn on a trolley. One of the English forces has been trialing personnel-mounted equipment for the fighting of fires. While it would gain in manoeuvrability (albeit with a weight of 25kg), its capacity would be limited.

45. Both the Patten Steering Group and ACPO have concluded that water cannon certainly merit further investigation, and more in-depth medical research. To this effect, water cannon have been placed in category A as devices which may be subject to immediate more in-depth research. The current timetable envisages that the information needed for the medical assessment will not be available until next spring. The Patten Steering Group has specifically asked if this programme can be speeded up, so that the position can be clarified before next summer. Their use does seem to have been favourably received in Northern Ireland, and they would appear to be a valuable addition to the range of equipment, as envisaged by Patten. The Police Service of Northern Ireland are currently formulating a business case for the procurement of vehicle-mounted water cannon. The Steering Group intends to apply the audit framework set out in Chapter 4 to consideration of the water cannon.

E. Less Lethal Alternatives to the Police Use of Firearms

46. Drawing on the material in the needs analysis, paragraph 92 of Chapter 2 referred to three scenarios – public disorder, individual officer protection and situations where police are responding to armed individuals. It noted that it is often the case in practice that these situations overlap and merge. The Patten Report recognised (in paragraph 9.15) that the use of live rounds would lead to more fatalities and serious injuries caused by police action. This is equally true of police action that may be required in certain situations other than serious public disorder. Therefore a parallel strand of work on the less lethal alternatives to the police use of firearms is being led by the Association of Chief Police Officers. ACPO has already endorsed the L21A1 for use as a less lethal option to be used in conjunction with a conventional firearms capability. Further work, which is part of this programme, includes the evaluation of taser, a number of impact rounds, chemical incapacitants and malodorants for consideration of their potential deployment.

F. Next Steps

47. The last two chapters have already set out the main elements in the third phase of the programme:

- in-depth assessment of the performance of alternative technologies and individual systems;
- further sifting of products as and if they fail to meet the necessary criteria;
- detailed medical evaluation.

48. In addition the Steering Group will:

- maintain close liaison with developments in other countries;
- take due account of feedback received on this report;
- oversee the costing of alternative technologies and the preparation of business cases for their procurement or further development as appropriate.

49. It is the intention to complete as much as possible of this work by the end of next summer, although full medical evaluation will not be possible by then in all areas. It is envisaged that there will again be a published report on the work up to that stage, although the precise format will be determined nearer the time.

Glossary of Terms

A ACRONYMS and ABBREVIATIONS

ABE	Attribute Based Evaluation
AC	Alternating Current
ACPO	Association of Chief Police Officers
CDE	Chemical Defence Establishment
CN	Chloroacetophenone
CR	Dibenz (b.f.)-1:4-oxazepine
CS	*O*-Chlorobenzylidene Malononitrile
HO	Home Office
LASD	Los Angeles Sheriff's Department
Laser	Light Amplification by the Stimulated Emission of Radiation
LED	Light Emitting Diode
MPE	Maximum Permissible Exposure
NIJ	National Institute of Justice
NIO	Northern Ireland Office
OC	Oleoresin Capsicum
PAVA	Pelargonic Acid Vanillylamide
PBR	Plastic Baton Round (now generally referred to as baton round)
PSDB	Police Scientific Development Branch
PTSD	Police Technical Services Division
rms	Root mean square
SRDB	Scientific Research and Development Branch
Taser	Thomas A Swift's Electrical Rifle (from the Tom Swift fantasy stories)

B TECHNICAL TERMS

Ampere (A)	The basic SI unit of electric current.
Bar	Unit of pressure in the C.G.S. system. 1 bar = $1x10^5$ newtons per square metre.
C.G.S. system	Centimetre-gram-second system. A system of physical units derived from the centimetre, gram mass and the second.
Candela	The SI unit of luminous intensity (the amount of light emitted per second in unit solid angle by a point source, in a given direction).
dB	Decibel, a measure of sound intensity. One decibel = one tenth of a bel.
Electric Current	An electric current is said to flow through a conductor when there is an overall movement of electrons through it. The SI unit of current is the ampere.
Energy	The capacity for doing work. The various forms of energy, interconvertible by suitable means, include potential, kinetic, electrical, heat, chemical, nuclear and radiant energy. Interconversion between these forms of energy can only occur in the presence of matter. Energy can only exist in the absence of matter in the form of radiant energy. The derived SI unit of energy is the joule.
Erythema	A general term signifying several conditions in which areas of the skin become congested with blood, and consequently a red eruption appears. The eruption is accompanied by tingling, and often by itching and pain.
Hertz (Hz)	The derived SI unit of frequency. Defined as the frequency of a periodic phenomenon of which the periodic time is one second; equal to 1 cycle per second.
Joule (J)	The derived SI unit of work or energy. The work done when the point of application of a force of 1 newton is displaced through a distance of 1 metre in the direction of the force. The joule is also the work done per second by a current of 1 ampere flowing through a resistance of 1 ohm.
Kinetic Energy (KE)	The energy which a body possesses by virtue of its motion. The kinetic energy of a mass m, moving with velocity v, is $\frac{1}{2}mv^2$.
Metre (m)	The SI unit of length.
Ohm	The derived SI unit of resistance defined as the resistance between two points of a conductor when a constant difference of potential of 1 volt, applied between these two points, produces in the conductor a current of 1 ampere.

Pascal (Pa)	The derived SI unit of pressure, equal to 1 newton per square metre.
Photokeratitis	Inflammation of the cornea in front of the eye due to light.
Power	The rate of doing work, measured in units of work per unit time. The derived SI unit of power is the watt.
R_t	Total resistance.
Second (s)	The SI unit of time.
SI units	An internationally agreed coherent system of units now in use for all scientific purposes.
Volt (V)	The derived SI unit of electric potential. Defined as the difference of potential between two points on a conducting wire carrying a constant current of one ampere when the power dissipated between these points is one watt. Also the unit of potential difference and electromotive force.
Voltage	The potential, potential difference or electromotive force of a supply of electricity, measured in volts.
Watt (W)	The derived SI unit of power, equal to one joule per second.
Waveform	The shape of a wave, illustrated graphically by plotting the values of the periodic quantity against time.

C METRIC (SI) MULTIPLIERS

Giga (G)	10^9
Mega (M)	10^6
Kilo (k)	10^3
Deci (d)	10^{-1}
Centi (c)	10^{-2}
Milli (m)	10^{-3}
Micro (μ)	10^{-6}
Nano (n)	10^{-9}
Pico (p)	10^{-12}

PSDB has drawn heavily on its overseas contacts, including organisations in the United States, Canada and Europe. The particular organisations that have provided assistance are detailed below.

Organisation	Country
Amt fur Wehrtechnik	Austria
Belgian Gendarmerie	Belgium
Canadian Police Research Centre	Canada
Royal Canadian Mounted Police	Canada
Victoria Police Department	Canada
Drug Law Enforcement Unit	Cyprus
National Commissioner of the Danish Police	Denmark
Ministry of the Interior – Police Department	Finland
Police Technical Centre	Finland
Ministry of Interior	France
Bundeskriminalamt (BKA)	Germany
Polizei-Fuhrungsakademie (PFA)	Germany
Garda Siochana	Ireland
Police Operations and Training Dept.	Luxembourg
Politie (Police Institute for Public Order)	Netherlands
Rikspolisstyrelsen (Swedish National Police Board)	Sweden
Kantonpolizei Bern	Switzerland
Association of Chief Police Officers and many individual police forces	UK
Defence Science and Technology Laboratories (dstl)	UK
Department of Health (DoH)	UK
Ministry of Defence	UK
NCIS Liaison Officers	UK
Prison Service	UK
Qinetiq	UK
Royal Ulster Constabulary	UK
Air Force Research Laboratory	US
Joint Non Lethal Weapons Directorate	US
Los Angeles Sheriff's Department	US
National Institute of Justice	US
National Institute of Standards and Technology	US
Pennsylvania State University	US
United States Marine Corps at Quantico	US
Wayne State University	US

The assistance of manufacturers and suppliers has also been invaluable, but for commercial confidentiality reasons, a list cannot be included.