

**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 FIFTH REPORT PREPARED BY THE UK STEERING GROUP LED BY
THE NORTHERN IRELAND OFFICE, IN CONSULTATION WITH THE ASSOCIATION
OF CHIEF POLICE OFFICERS

SEPTEMBER 2006

Contents

	FOREWORD BY PAUL GOGGINS MP	3
1	Introduction to the Report of the UK Steering Group	5
2	Developments in Conflict Management	9
	Previous Reports of the UK Steering Group	9
	Policing with the Community	11
	Police Code of Ethics	13
	Human Rights Standards	14
	Orange Order Parade - Ardoyne 12 July 2004	14
	Attenuating Energy Projectile (AEP)	15
	Orange Order Parades - Ardoyne 12 July and Whiterock 10 September 2005	16
	Independent Assessor of Military Complaints Procedures	20
	Managing Conflict	20
	International Involvement	21
	Less Lethal Technologies	23
3	Introduction of the Attenuating Energy Projectile (AEP)	25
	Programme Management	25
	AEP Programme	26
	Working with Industry	27
	Defence Ordnance Safety Group (DOSG) Testing	29
	Medical Evaluation	29
	Introduction of the AEP	29
	Effectiveness	30
4	Development of the Discriminating Irritant Projectile (DIP)	33
	The Discriminating Irritant Projectile (DIP) Programme	33
	Technical Summary	35
	Programme Timescales	36
5	Use of Less Lethal Technologies within the UK	37
	L21A1 Baton Rounds	37
	AEP Impact Rounds	40
	Operational Trial of Taser in England and Wales - update	40
	Incapacitant Sprays	46
	Water Cannon	49
	Long Range Acoustic Device (LRAD)	50
6	The International Context	53
	The International Law Enforcement Forum	53
	International Peer Review of the Steering Group Methodology	55
	International Less Lethal Weapons Database	56
	Commercial off the shelf product evaluations and update	57
	European Working Group on Non Lethal Weapons (EWG-NLW)	58
	The Stern Commission	59
	The Barr Tribunal Report	61
7	The Way Forward	63
	Consultation and Human Rights	63
	Engaging with Interested Parties	66

Annexes

Annex 1:	Glossary of Term	69
Annex 2:	DOSG Safety Advice on Use of L21A1 in Training	70
Annex 3:	DOMILL Statement on the Comparative Injury Potential of AEP (L60A1) and L21A1 Baton Round	71
Annex 4:	ACPO - Notes for Guidance on Police Use of AEP	75
Annex 5:	Notes for Guidance on Military Use of AEP	85
Annex 6:	DSAC Statement on the Review by MOD of medical issues arising from use of the L21A1 Baton Round from June 2001 - May 2003	87
Annex 7:	DOMILL Statement on medical implications of the use of the M26 TASER®	88
Annex 8:	DOMILL Statement on the comparative medical implications of use of the X26 TASER® and the M26 Advanced TASER®	91
Annex 9:	COT Statement on PAVA Spray	96
Annex 10:	COT Statement on CS Spray	106
Annex 11:	DOMILL Statement on the medical implications of the use of the Somati RCV9000 Vehicle Mounted Water Cannon	120

FOREWORD BY PAUL GOGGINS MP

PARLIAMENTARY UNDER SECRETARY OF STATE FOR NORTHERN IRELAND

This Fifth Report marks another milestone in the work carried out by the UK Steering Group, currently chaired by the Northern Ireland Office, which is examining alternative policing approaches towards the management of conflict. The Steering Group, drawn from across the United Kingdom, includes representatives from accountability bodies, senior police officers, practitioners and others who possess an extensive range of scientific, technical and operational experience in conflict management and issues associated with policing potentially violent incidents.

Whilst initially established to address a specific Northern Ireland issue, the work of the Steering Group has intentionally been developed within the context of policing across the United Kingdom and has provided a vehicle for identifying and selecting less lethal technologies for police use in the wider UK context. The Group has also ensured that international links have been maintained and that developments in respect of this area of policing have been monitored. This has included engagement with international experts and pressure groups.

Major progress has been made in taking forward Recommendations 69 and 70 of the Report of the Independent Commission on Policing for Northern Ireland (The Patten Report). In June 2005, the Steering Group introduced the new Attenuating Energy Projectile (AEP), a safer replacement for the L21A1 baton round. The introduction of AEP does not represent the end of the Group's work, as it continues to progress towards the assessment of the suitability of the new Discriminating Irritant Projectile (DIP), which is detailed within this report. Work in relation to DIP forms only part of its ongoing activities. This report also monitors other developments, such as the introduction of TASER® in Great Britain, as well as reporting on the range of accountability measures that are in place.

The work of the Steering Group has necessarily had a strong focus on the science and technology required to produce an effective and less potentially lethal alternative, but it has also had an emphasis on the development of stringent training and operational guidance, designed to maximise the safety of all concerned.

However, I have not lost sight of the concerns shared by a number of interested parties on the issue of less lethal weapons. For our part, it is the Government's intention to continue to engage with these groups as outlined in this report. As before, I would invite their comments on this report. We will also continue to monitor emerging technologies, to ensure that those systems with real potential are medically evaluated and properly assessed.

I commend this report, and the progress that it represents, and will continue to take a close personal interest in developments.

1 Introduction to the Report of the UK Steering Group

- 1.1 This is the Fifth Report of the UK Steering Group initially set up to take forward Recommendations 69 and 70 of the report of the Independent Commission on Policing for Northern Ireland (the Patten Report¹) which was published in September 1999. Since then the work has taken on a UK-wide dimension, in line with Recommendations 69 and 70 and the normalisation of policing in Northern Ireland.
- 1.2 The Oversight Commissioner who monitors policing reforms in Northern Ireland, in his recent report² published in June 2006, indicated that Patten Recommendations 69 and 70 will be considered to have been fully implemented when the Steering Group issues its Fifth Report.
- 1.3 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)”*.
- 1.4 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”*.
- 1.5 Previous Steering Group reports have shown that the L21A1 baton round was part of a very different weapon system from that used previously. It is notable that there were no fatalities associated with the use of this baton round or indeed previous designs of the baton rounds fired from the L104A1 launch platform.
- 1.6 Police services across the UK are no longer dependent on rigid baton rounds as a less lethal weapon option when confronted with serious violence, whether within the context of a single aggressor or within a situation of serious public disorder.
- 1.7 Earlier Steering Group reports have set out the range of options now available including the research, development and introduction of incapacitant sprays, water cannon and conducted energy devices (TASER®), and the development of the Attenuating Energy Projectile (AEP), a new soft nose impact round.
- 1.8 This Fifth Report outlines the development and introduction into service of the AEP and its operational use across the UK from 21 June 2005. It also includes information on how the new range of less lethal options is being used to resolve incidents without resorting to



Report of the independent Commission on Policing for Northern Ireland, September 1999 (The Patten Report)

It is notable that there were no fatalities associated with the use of this baton round (L21A1) or indeed previous designs of the baton rounds fired from the L104A1 launch platform

1 "A New Beginning: Policing in Northern Ireland". The report of the Independent Commission on Policing for Northern Ireland September 1999 (The Patten Report) is available from the following website:

<http://www.belfast.org.uk/report/fullreport.pdf>

2 The Oversight Commissioner's Report is available from the following website:

<http://www.oversightcommissioner.org/reports/pdfs/june2006.pdf>

conventional firearms, and reports on the current work programme which is focussing on the development of the Discriminating Irritant Projectile (DIP) against stringent medical and other standards.

- 1.9 Section 2 of this report traces the considerable progress which has been made in relation to developments in managing conflict and the openness and transparency which has been adopted in this process. In particular, it references the report commissioned by the Northern Ireland Policing Board into the Ardoyne and Whiterock Parade incidents on 12 July and 10 September 2005 respectively.
- 1.10 Section 3 of this report makes clear that, unlike its predecessors, the AEP impact round is not a rigid baton. It performs very differently from a traditional baton round and is both distinct and safer when compared to the L21A1, in the way in which it:
- attenuates its energy by reducing peak forces;
 - extends the duration of impact; and
 - spreads the area of contact.
- 1.11 It also maintains the accuracy characteristics introduced with the L21A1 and L104/L18 (launch platform and sight), which reduces the risk of an inadvertent strike to a vulnerable part of the body.
- 1.12 Importantly, medical evaluation has concluded that the risk of serious and life-threatening injury to the head from the AEP will be less than that from the L21A1, which already has a low risk of such injury.
- 1.13 The rigorous training that accompanies the use of all less lethal weapons, including AEP, is an essential component of ensuring technologies are used appropriately and safely. The select number of officers who are equipped with the new projectile have to demonstrate, and regularly re-demonstrate that they:
- are aware of law, policy and human rights issues;
 - can meet high levels of target accuracy; and
 - can meet stringent training requirements.
- 1.14 The command protocols, training, equipment and operational guidance now being used by the Police Service of Northern Ireland is in line with that being used across the rest of the UK, and is now recognised as a world leading model of best practice.
- 1.15 Section 4 of this report outlines the work that has been carried out on the development programme for the DIP. The stringent testing requirements dictate that it can never presume that any new technology, such as the DIP, will enter operational service. The work on this programme to date, however, has been significant.
- 1.16 The Patten Commission was clear in stating that the police should be furnished with a wider range of equipment in order that the need to deploy baton rounds might, where possible, be avoided. Section 5 of

The command protocols, training, equipment and operational guidance now being used by the Police Service of Northern Ireland is in line with that being used across the rest of the UK, and is now recognised as a world leading model of best practice

this report outlines the progress that has been made through the increased availability of water cannon, as well as noting developments in other technologies including incapacitant sprays, and TASER®.

- 1.17 Whilst there has been a strong focus on emerging technology, this report also makes clear that attention was not diverted from continually assessing the safety performance of existing systems.
- 1.18 This report talks about ‘systems’ rather than just ‘projectiles’, because development work is deliberately systems-based. It is the whole less lethal weapons system which is evaluated. This includes the launch platform, the sights, the cartridge, storage, carriage, training and guidance for use.
- 1.19 The Steering Group also remains acutely aware that the potential to reduce the lethal nature of weapons is enhanced, not only through technological developments, but also through a strong focus on how such weaponry is deployed.
- 1.20 This report includes the UK-wide police and military guidance on the use of the AEP, which makes clear that it should be deployed:
- “where it is judged necessary to reduce a serious risk of: loss of life or serious injury; or substantial and serious damage to property where there is, or is judged to be, a sufficiently serious risk of loss of life or serious injury to justify their use”.*
- 1.21 It is also noted that the guidance states that the AEP:
- “has not been designed for use as a crowd control technology but has been designed for use as a less lethal option in situations where officers are faced with individual aggressors whether such aggressors are acting on their own or as part of a group”.*
- 1.22 In Northern Ireland, the independent Police Ombudsman investigates any operational discharges of AEP by the Police Service (as was the case with the L21A1) before reporting her findings to the cross-community Policing Board. In Great Britain, firings are reported to the Association of Chief Police Officers.
- 1.23 In terms of the work of the Steering Group, there has been substantial investment in the research programme to find an acceptable, effective and less potentially lethal alternative to the PBR. Significant progress has been made and the range of options we have today are very different from those available when the Patten Commission reported and clearly constitute less lethal alternatives. However, police services internationally would prefer to have effective options to impact rounds. This also remains the Steering Group’s goal.

This report talks about ‘systems’ rather than just ‘projectiles’, because development work is deliberately systems-based. It is the whole less lethal weapons system which is evaluated

- 1.24 Whilst the remaining technological development programme of the Steering Group is time bound i.e. to the end of the scenario based trials for the DIP, the UK government remains committed to continue the search for (even more) potentially less lethal alternatives, beyond this programme. To that end, the Chair of the UK Steering Group will move from the NIO to the Home Office following completion of the DIP trials.
- 1.25 Section 6 of this report makes clear the continuing importance of the international context. The Steering Group's involvement with the International Law Enforcement Forum (ILEF) has been particularly successful. By gaining consensus to an agreed international law enforcement operational requirement, and seeking to develop common approaches to testing and an understanding of medical outcomes, the Steering Group has fostered an environment in which significant progress can be made.
- 1.26 Ultimately, the Steering Group is aiming for a situation whereby international manufacturers will be clear on the systems and products that are needed to meet its stringent requirements on effectiveness and safety, and will respond accordingly.
- 1.27 The Steering Group has published four earlier reports, all of which were laid before Parliament and distributed to a wide range of interested parties. This report, as was the case with its predecessors, is also available from the publications page on the Northern Ireland Office website: www.nio.gov.uk.
- 1.28 Comments on its contents and views on the way forward are particularly welcome. The Steering Group's communication strategy is summarised at paragraph 7.27 of this report. Written comments should be sent to:

The Secretary of the UK Steering Group
Room B4.22
Block B
Castle Buildings
Stormont
Belfast
BT4 3SG

or by email to: uksteeringgroup@nio.x.gsi.gov.uk

the UK government remains committed to continue the search for (even more) potentially less lethal alternatives, beyond this programme

2 Developments in Conflict Management

- 2.1 Over the lifetime of the UK Steering Group there have been significant developments in the approach of police services in Great Britain and Northern Ireland to the management of conflict. This has included issues relating to operational planning, command procedures, tactics and technologies used by police.
- 2.2 There have also been developments in relation to competency based accreditation of operational commanders, planners, tacticians and operational personnel. These changes have been reflected in UK-wide reviews and the Association of Chief Police Officers' (ACPO) guidance, procedures and operational practices.
- 2.3 Previous reports of the Steering Group set out the operational policy development and the emergence of common approaches to managing conflict and responding to violence by police across the UK with reference, where appropriate, to international developments. This report traces how those developments have been built upon and how in particular, given the genesis of the Steering Group's work, these have been introduced operationally in Northern Ireland.

Previous Reports of the UK Steering Group

- 2.4 In the First Report of the Steering Group, the overall approach to the research was set out. It was noted that the business of policing necessarily involves dealing with individuals and groups of people in a wide variety of situations. We also emphasised the importance of pre-event planning, community consultation, negotiation and mediation.
- 2.5 It was recognised that these proactive measures required well established community contacts, relationships and interpersonal skills. It was also acknowledged that in situations involving violence, the requirements of the police, in terms of less lethal tactical options, may differ considerably from one scenario to another. For example, in one situation a hand-held personal defence incapacitant spray may be an appropriate response, while in another very different situation, the use of water cannon might be considered.
- 2.6 In the Second Report of the Steering Group, the demands on a police service and its officers in managing conflict in the community were examined. It was noted that 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.
- 2.7 The report also placed conflict management in a wider context. It began with an overview of policing disorder in the community drawing on the experience of the programme co-ordinator, a Commander from the London Metropolitan Police Service.

Over the lifetime of the UK Steering Group there have been significant developments in the approach of police services in Great Britain and Northern Ireland to the management of conflict

- 2.8 A main section of the report was an operational needs analysis and concluded with the broad operational requirement, drawn up by ACPO, in consultation with the Steering Group. The report set out a disorder model and a conflict management model which included generic approaches adopted by ACPO as a whole. Specific instances of public disorder in Britain, Europe and North America were also reviewed.
- 2.9 The Third Report of the Steering Group set out the approaches being developed by the Police Service of Northern Ireland (PSNI) in its approach to conflict resolution and policing within the community. It was apparent that alongside a broader range of less lethal technologies, an equally vital investment was being made in situational awareness, managing human interaction skills and defusing conflict.
- 2.10 Where there were differences in policy, training, equipment or operational practice between police forces in the UK, these were identified. PSNI have ensured, in conjunction with ACPO (with whom it is an integral part), that new approaches and technologies have been examined and where appropriate, introduced.
- 2.11 All less lethal technologies used in the UK are now subject to centralised ACPO guidance. All of this necessitated a reappraisal of the core skills and training required for officers, who not only use less lethal technologies, but also those who command the situations in which they are used.
- 2.12 The Third Report also noted that across the UK and internationally, there had been significant advances in the way police protective and officer safety equipment was being carried and, when necessary, brought forward for use.
- 2.13 Moreover officers were being trained in conflict management and resolution skills relevant to community disorder and tension. These approaches have, through the work of the Steering Group, been audited against human rights principles, health and safety legislation and equated with modern international best practice, in relation to officer and community safety.
- 2.14 It was noted that there were now three ACPO manuals dealing with the spectrum of initial interventions in violent situations; these were the ACPO:
- Manual of Guidance on Police Use of Firearms³;
 - Manual of Guidance on Keeping the Peace⁴, dealing with issues of public order; and
 - Personal Officer Safety Manual⁵.

3 The Manual of Guidance on Police Use of Firearms can be located at the following website:
<http://www.acpo.police.uk/asp/policies/Data/firearms.pdf>

4 The Manual of Guidance on Keeping the Peace can be located at the following website:
http://www.acpo.police.uk/asp/policies/Data/keeping_the_peace.pdf

5 The Personal Officer Safety Manual provides UK police services with guidance relating to the use of force, relevant techniques and use of self defence arrest and restraint equipment.

It was apparent that alongside a broader range of less lethal technologies, an equally vital investment was being made in situational awareness, managing human interaction skills and defusing conflict

2.15 These have subsequently been augmented by ACPO in the following:

- National Police Firearms Training Curriculum; and
- Manual of guidance on public order standards, tactics and training.

Policing with the Community

2.16 Managing conflict in the community places heavy demands on any police service and its officers. These demands are felt particularly so in Northern Ireland. This core-policing task encompasses many functions, from negotiation, right through the conflict spectrum, to the application of force.

2.17 While the focus of the research led by the Steering Group has been on technological issues, it was imperative that seeking alternative approaches to managing conflict was not restricted to a search for technological solutions. It also encompasses other less tangible areas such as policing with the community, conflict resolution and community safety.

2.18 The inextricable link between community policing and policing disorder was set out in the Steering Group's Third Report where it was emphasised that the two should develop in synergy, each complementing the other, rather than competing. Both these areas are at the very heart of ACPO's 'Keeping the Peace' strategy.

2.19 At the time the Third Report was being prepared, PSNI were in the process of implementing a comprehensive strategy entitled 'Policing with the Community in Northern Ireland'⁶. Its mission statement is 'In Partnership making Northern Ireland Safer'. A common link can be made with the Belgian philosophy of using public order as a tool for the community and not against the community.

2.20 A major objective of the community policing strategy was to establish an active partnership between the police and the community through which crime, service delivery and police community relations can be jointly analysed and appropriate solutions designed and implemented. This, however, requires that the police should consciously strive to create an atmosphere in which potential community partners are willing and able to co-operate with them. Important aspects of the community policing approach within Northern Ireland were identified as including:

- Service delivery;
- Partnership;
- Problem Solving;
- Accountability; and
- Empowerment.

Managing conflict in the community places heavy demands on any police service and its officers. These demands are felt particularly so in Northern Ireland

⁶ The Policing with the Community in Northern Ireland was subsequently published and is available from the following website:
http://www.psnipolice.uk/6652_pwc_policydoc.pdf#xml=http://www.psnipolice.uk/scripts/texis.exe/webinar/search/xml.txt?query=community+policing&pr=internet&order=r&cq=&id=4450a74b2a

- 2.21 It was evident that considerable effort had been expended in developing each of these principles and, in ground breaking effort, designed to manage out conflict particularly in respect of violence, which often occurred at community interfaces during marches and demonstrations.
- 2.22 In the spring of 2003, the Northern Ireland Policing Board asked for research to be undertaken in regard to the dynamics of crowds. This work built on the Third Report of the Steering Group.
- 2.23 The research report was commissioned from Dr Neil Jarman in Belfast. A summary of the report entitled *"Nothing Happened? - A Review of Public Order during the Summer of 2003"* was published in the Fourth Report of the Steering Group. Dr Jarman's report noted that no baton rounds had been fired in Northern Ireland since September 2002, despite some very serious public disorder.
- 2.24 His report highlighted the importance of community leaders promoting positive outcomes and assisting in managing the conflict out. It noted that:

"It [was] broadly agreed that all of the key political, paramilitary and community actors wanted the 2003 marching season to be peaceful and that this desire was broadly disseminated within and between the relevant communities in the run up to the marching season. Furthermore this desire for a peaceful summer was also translated into action on the ground by a broad range of organisations. Community networks mobilised to respond to potential disorder at interfaces; protests over parades were well stewarded and protesters kept informed of intentions and unfolding events; the parades themselves were well marshalled and largely well ordered; and a diverse range of monitoring groups were mobilised to support the work of other groups and to improve communication between key parties".

- 2.25 His report also recognised the key role played by PSNI for continuing to revise their approaches to the management of public order. It was observed that:
- "There was a greater willingness to work in partnership with community-based groups and to share strategies for event management; there was a more sensitive deployment of police officers and vehicles on the ground; and a greater willingness to stand back and let partner groups intervene at potential flashpoint incidents".*
- 2.26 It was evident that many of the structures which had been put in place over the previous years were paying dividend, however, his report noted:

"It is impossible to fully evaluate the relative merits of all or any of these activities based on one summer. At this stage it is impossible to judge whether the quiet summer of 2003 is the start of a new cycle in which protests against parades are peaceful, well ordered and are more sensitive to the local context and in which more established and mutually respectful relationships are built between the police and local communities".

Police Code of Ethics

- 2.27 It was notable that, in 2003, the Northern Ireland Policing Board, in conjunction with the Chief Constable, launched the PSNI Code of Ethics⁷. The Code of Ethics is intended:
- (1) to lay down standards of conduct and practice for police officers; and
 - (2) to make police officers aware of the rights and obligations arising out of the European Convention on Human Rights within the meaning of the Human Rights Act 1998.
- 2.28 The statutory authority for the Code can be found in Section 52 of the Police (NI) Act 2000. The contents of the Code are drawn from a number of sources including, the European Convention on Human Rights and other relevant Human Rights standards. These include:
- (a) The United Nations Code of Conduct for Law Enforcement Officials;
 - (b) The United Nations Basic Principles on the Use of Force and Firearms by Law Enforcement Officials; and
 - (c) The European Police Code of Ethics.
- 2.29 The Code reflects the European Convention on Human Rights, relevant United Nations standards and what is seen as best practice in ethical policing in this and other countries. In addition to setting out the standards of conduct expected of police officers, the Code provides an ethical context within which PSNI devise their policies and plan operations.
- 2.30 The Code is specific in stating that:
- “Police officers responsible for the planning and control of operations where the use of force is a possibility, shall so plan and control them to minimise, to the greatest extent possible, recourse to force and, in particular, potentially lethal force (page 8 paragraph 4.2)”.*
- 2.31 The Code is more than an aspirational guide to police conduct, in that a breach of the Code can amount to a breach of professional discipline. The Code makes this clear in stating:
- “Police officers are required, at all times, to carry out their duties in accordance with the provisions of this Code. They should remember that a breach of its standards could lead to a loss of public support and, in appropriate circumstances, a criminal or disciplinary investigation, either by the Police Ombudsman or police staff (page 5 paragraph G)”.*

The Code is more than an aspirational guide to police conduct, in that a breach of the Code can amount to a breach of professional discipline

⁷ The PSNI Code of Ethics is available at the following website:
http://www.psni.police.uk/nipb_ethics-nonotes-1.pdf

Human Rights Standards

- 2.32 Coinciding with the launch of the PSNI Code of Ethics, the purpose of which was to secure human rights standards in everyday policing, the Northern Ireland Policing Board appointed a leading human rights expert, Mr Keir Starmer QC. He is responsible for advising the Board on how best to meet its legislative requirement under the Police (NI) Act 2000, in terms of monitoring the performance of police compliance with the Human Rights Act 1998.
- 2.33 The Board also appointed a lawyer, Ms Jane Gordon, to work with Mr Starmer. Ms Gordon has worked extensively on human rights cases before the European Court of Human Rights.
- 2.34 Both Human Rights Advisors were commissioned by the Board to prepare a report⁸ into the policing (including planning and preparation) of the Orange Order Parade in the Ardoyne area of Belfast on 12 July 2004.
- 2.35 In compiling the report, the Advisors had in-depth meetings with senior officers responsible for the planning, preparation and execution of the policing operation and were provided with all the briefing material generated by the PSNI in preparation for the operation.

Orange Order Parade - Ardoyne 12 July 2004

- 2.36 The Advisors attended briefings at Gold, Silver and Bronze command level. They also attended the Ardoyne shop fronts on 12 July as observers on the ground, while the parades passed through the area, both on the way out in the morning and on the way back in the evening. At other times on 12 July they observed the policing operation from the Silver Command room.
- 2.37 The Advisors were given full and unrestricted access by the police to all relevant information. The key questions addressed within their report were:
- Whether the policing of these parades complied with the requirements of the Human Rights Act 1998;
 - Whether the PSNI properly policed the determinations made by the Parades Commission and took appropriate operational decisions to that end, within the framework of the applicable law; and
 - Whether any use of force by PSNI officers was justified.
- 2.38 The Advisors' report concluded:

“that the policing operation was carefully planned and executed, and that the human rights implications of all the key decisions taken were considered at every stage”.

*(Ardoyne 12 July 2004)
Keir Starmer QC, Jane Gordon (Policing Board’s Human Rights advisors) said: “that the policing operation was carefully planned and executed, and that the human rights implications of all the key decisions taken were considered at every stage”*

⁸ The report into the policing of the 12 July 2004 Orange Order Parade is available from the following website:
http://www.nipolicingboard.org.uk/word_docs/PDFs/ardoyne_parades.pdf.

- 2.39 The use of force by the police was referenced and commented upon as follows:

“There was some violence in the evening when the parade was returning. There were five occasions when the police used force in response. Most of these involved the police use of batons however on one occasion the police used water cannon”.

- 2.40 Commenting on the use of water cannon, the Advisors stated:

“In our view, each instance in which water cannon was used complied with the requirements of PSNI policy on the deployment and use of RCV9000 vehicle mounted water cannon. That policy incorporates the requirements of the Criminal Law (NI) Act 1967, the Police and Criminal Evidence (NI) Order 1989 and the Human Rights Act. On that basis we are satisfied that the use of the water cannons in the circumstances described above was justified”.

- 2.41 The concluding section of the report stated:

“Our conclusions are that the policing operation was carefully planned and executed. The human rights implications of all the key decisions were considered at every stage and the advice of the PSNI human rights lawyer was taken on several occasions. Tactical advice was also taken from a fully qualified and experienced tactical advisor. Those responsible for the policing of the 12th July Ardoyne parades followed the advice they were given by the PSNI human rights lawyer and the PSNI tactical advisor.

Force was used by the PSNI on five separate occasions. In respect of three of those occasions we are satisfied that, as a general tactic, the use of force was justified. In respect of the other two occasions, we are not able to make any assessment without access to a great deal of further evidence. If individual complaints are made about the use of force, those complaints would fall within the remit of the Police Ombudsman for Northern Ireland”.

- 2.42 It is notable that the whole incident was policed without the need for police to resort to the use of baton rounds, although these were available throughout the policing operation. In fact baton rounds were not discharged operationally by police or military in Northern Ireland during 2003 or 2004.

Attenuating Energy Projectile (AEP)

- 2.43 In June 2005, the new Attenuating Energy Projectile (AEP) was introduced to replace the L21A1 rigid baton round. The guidelines for using the AEP impact round were developed in a very different format from guidelines previously issued for baton rounds. These took account not only of the different technology which was being used, but placed its use within the context of situational risk assessment. It also clarified that the AEP was not to be used as a means of crowd control, but for use against identified aggressors.

- 2.44 It was clear from the research undertaken by the Steering Group that internationally there were conflicting views as to whether some less lethal technologies, especially kinetic energy impact rounds, should be used to deal with rioting crowds, as opposed to a contingency for dealing with identified violent individuals.
- 2.45 Within the UK, this issue has been specifically addressed in the new ACPO guidelines on use of the AEP. The guidelines are specific on this issue stating:

“The AEP has not been designed for use as a crowd control technology but has been designed for use as a less lethal option in situations where officers are faced with individual aggressors whether such aggressors are acting on their own or as part of a group.

The AEP may be deployed in a variety of operational situations, however the objective will remain the same. The AEP is intended for use as an accurate and discriminating projectile, designed to be fired at individual aggressors.

In the event of it becoming necessary to use an AEP in a public order situation this must be restricted to use against clearly identified individuals who are presenting a threat which must be countered and other tactical options available for countering the threat posed are considered inappropriate in the circumstances”.

- 2.46 As part of its review of public order policing, the Policing Board committed itself to a first hand review of the policing of certain parades in 2005. They asked the Human Rights Advisors to produce a report⁹ on two parades, which were due to take place in Belfast during the Summer of 2005. Firstly, the parade that was due to pass through the Ardoyne on 12 July, and secondly, the Whiterock parade which was to have been held on 25 June, but was postponed and held on 10 September.

Orange Order Parades - Ardoyne 12 July and Whiterock 10 September 2005

- 2.47 Unlike the previous two years which passed over relatively peacefully, the period between June and September 2005 was to see some of the worst violence in Northern Ireland for several years. Sir Hugh Orde, Chief Constable of the PSNI, said:

“it was one of the most dangerous riot situations ever faced by officers in the UK”.

- 2.48 On 12 July disorder erupted at Ardoyne. In response the police discharged 21 AEP rounds. There was further disorder on 4 August when the police discharged 11 AEP rounds. After the re-scheduled Whiterock parade on 10 September, violence was sustained over a 3

(Whiterock 10 September 2005) PSNI Chief Constable, Sir Hugh Orde said: “it was one of the most dangerous riot situations ever faced by officers in the UK”

⁹ The Policing Board report is available from the following website:
http://www.nipolicingboard.org.uk/word_docs/PDFs/sep_parades.pdf

day period with petrol and blast bombs and a range of other missiles being thrown at police and Army personnel.

- 2.49 Updated PSNI figures for the disturbances between 10 and 13 September quote 117 confirmed strikes on police vehicles from live rounds, and an estimated 150 live rounds were fired at the police and Army personnel. The police and Army responded with 11 live rounds and 389 AEP impact rounds.
- 2.50 Reporting on the events, the Advisors said:
- “that no-one was killed and that there were so few serious injuries to police officers, the military or members of the public is remarkable”.*
- 2.51 As part of their study, the Advisors attended all planning meetings and briefings for the Ardoyne parades on 12 July 2005 at all levels of operational command, Gold, Silver and Bronze. They also attended planning meetings and briefings for the planned Whiterock parade on 25 June and the postponed Whiterock parade on 10 September.
- 2.52 Their 65 page report into the planning, preparation and operational conduct of the policing operation, provides a chronology of events and goes into considerable detail and analysis including comment on whether:
- the policing of these parades complied with the requirements of the Human Rights Act 1998;
 - the determinations of the Parades Commission were properly policed; and
 - overall, the use of force by the PSNI was justified.
- 2.53 Similar to the 2004 incidents, the Advisors were given full and unrestricted access to all information by the police including meetings, officers controlling the police operation and all relevant documents including intelligence reports, briefings, risk assessments, tactical and legal advice and available video footage.
- 2.54 They observed and attended strategic planning and operational briefing sessions in the run-up to the Ardoyne and Whiterock Parades and observed both policing operations on the ground, and from within the main police command centre. Meetings were also held with a number of community representatives.
- 2.55 Commenting on the police operations, the Advisors said:
- “In respect of each parade we are satisfied that the policing operation was carefully planned and executed; that the human rights implications of all the key decisions were considered at every stage; and that the use of force overall complied with the requirements of the Human Rights Act 1998. All Senior Command decisions taken in relation to authorisation for the issue, deployment and use of AEP impact rounds and water cannon were justified proportionate and in accordance with the PSNI policy guidelines in place.*

*(Ardoyne 12 July 2004)
Keir Starmer QC, Jane Gordon (Policing Board’s Human Rights advisors) said: “that no-one was killed and that there were so few serious injuries to police officers, the military or members of the public is remarkable”*

The human rights of paraders and their supporters, protesters, residents, police officers and the military were taken into account at all stages of the planning process and the senior command responsible for both operations reacted to the changing circumstances of the operations as events unfolded with care and diligence”.

2.56 In relation to the use of force, the Advisors emphasised that the remit of the report did not make specific findings on the use of force by individual officers during the policing operations but whether, overall, the use of force complied with the Human Rights Act. Whilst they noted that public complaints about the use of force fall within the jurisdiction of the Police Ombudsman, two specific incidents arising from the Whiterock Parade were identified for review by the Chief Constable.

2.57 In respect of the ensuing violence in many areas across Belfast following the Whiterock Parade during the day and night of 10 September 2005, the Advisors recorded that:

“difficult decisions had to be taken very rapidly at all levels of police command” and stated “that we did not personally see or hear anything that we considered to be a breach of the Human Rights Act 1998”.

2.58 The Advisors also noted that the PSNI allowed them complete and unrestricted access to all aspects of the police operation during the period of sustained violence. The report made no findings as regards localised violence throughout Belfast in the week following the parade.

2.59 In their report they provided a resume of the PSNI policies in relation to use of force, and less lethal weapons. These policies are central to alternative PSNI approaches to the management of conflict.

2.60 The report records:

“The PSNI has adopted several policies¹⁰ intended to give effect to this legal framework. Four are of particular importance to the policing of the Ardoyne parades on 12th July last year: (1) the Use of Force Policy; (2) the Water Cannon Policy; (3) the (recently adopted) AEP Impact Rounds Policy; and (4) the Use of Firearms Policy. We reviewed the Use of Force Policy, the Water Cannon Policy and the Use of Firearms Policy in our Human Rights Annual Report 2005”.

2.61 As in 2004, the Advisors also considered the use of force by the PSNI during the two events covered in their 2005 report. They also commented on the use of force including use of water cannon and AEP impact rounds:

(Ardoyne 12 July 2005 and Whiterock 10 September 2005) Keir Starmer QC, Jane Gordon (Policing Board’s Human Rights advisors) said: “The human rights of paraders and their supporters, protesters, residents, police officers and the military were taken into account at all stages of the planning process and the senior command responsible for both operations reacted to the changing circumstances of the operations as events unfolded with care and diligence”

¹⁰ The review of use of force policy and associated documents are available from the following website:
http://www.nipolicingboard.org.uk/word_docs/PDFs/HR_main.pdf.

"In relation to the use of water cannon, we have studied the videos and logs carefully. We have also examined our own notes made on the day. Having done so, we are satisfied that the deployment and use of water cannon was at all times within the PSNI Water Cannon Policy and compliant with the Human Rights Act 1998.

In relation to the use of AEP impact rounds generally, we are satisfied that the issue, deployment and use of AEP impact rounds was within PSNI AEP Impact Rounds Policy (as further defined in the Urban Region Gold Command Strategy on Parades 2005).

The authority to deploy and use AEP impact rounds was kept under constant review by Gold command and authority was withdrawn as soon as the threat to life had reduced. We conclude that the issue, deployment and use of AEP impact rounds were compliant with the Human Rights Act 1998".

- 2.62 The report also made the following assertion in respect of the human rights and protection of police officers:

"We have also considered whether the human rights of PSNI officers were adequately protected during the operation. Again, we have considered this very carefully. The extent of the injuries to police officers has already been noted. The question therefore arises whether better or more effective measures could have been taken to protect them from these injuries".

- 2.63 As with the Ardoyne parade, the Advisers attended a number of the strategic and tactical planning meetings for the Whiterock parade on 10 September. They also had access to all planning documents, including intelligence reports, briefings, risk assessments and tactical advice.
- 2.64 Between 10 and 13 September 2005, at least 150 live rounds were fired at the police and Army and hundreds of blast bombs and petrol bombs were thrown, along with various other missiles, including broken paving stones, bricks and bottles.
- 2.65 The police and military responded with live fire (the PSNI fired six live rounds; the military five), AEP impact rounds (the PSNI discharged 249 AEP impact rounds; the military 140), and used water cannon extensively.
- 2.66 During the course of the weekend, difficult decisions had to be taken very rapidly at all levels of police command.
- 2.67 Commenting on the use of force by police, the Advisers reported that:
- "Our general finding about the use of force by the PSNI on the West Circular Road, including the use of live fire and AEP impact rounds is that it was proportionate and compliant with the Human Rights Act 1998. The sustained attack on the police and the military was serious, life threatening and cannot be justified".*

Keir Starmer QC, Jane Gordon (Policing Board's Human Rights advisors) said: "The authority to deploy and use AEP impact rounds was kept under constant review by Gold command and authority was withdrawn as soon as the threat to life had reduced"

Independent Assessor of Military Complaints Procedures

- 2.68 It is also noteworthy that the Independent Assessor of Military Complaints Procedures in Northern Ireland, Mr Jim McDonald CBE LVO MBE JP DL, recently laid his Thirteenth Annual Report¹¹ before Parliament. Reporting on the use of AEP by the Army in September 2005 he concluded:

"In my judgement the response from the military was proportionate. The 140 Attenuating Energy Projectiles that they fired were used within the current guidelines; albeit that in those most dangerous engagements (with military specifically targeted by blast bombs, live rounds, petrol bombs and bricks), the gunners' aim at moving, ducking and weaving targets was often less than perfect-though certainly not reckless or inept. I am also satisfied that the thorough and realistic training gives the confidence and composure to soldiers which is necessary when facing extreme violence".

Managing Conflict

- 2.69 The challenge presented to police and military in addressing events such as those referred to earlier is enormous. The underlying causes of community conflict cannot be solved by the police alone and the government together with the police, other agencies and Non-Governmental Organisations continue to proactively work to address these issues.
- 2.70 What is notable, however, is the processes which have been developed by the police services across the UK for managing conflict and in dealing with serious violence, when it breaks out. It is evident from the independent reviews carried out that PSNI have been applying these processes and practices, which are now embedded in their approach to event planning and response to critical incidents.
- 2.71 These approaches, together with the new broader range of equipment and the enhanced safety factors which have been designed into less lethal technologies, have contributed to minimising the use of force in often dangerous and exacting situations. The structures which are in place in terms of pre-event consultation and planning, the application of community policing principles to the management of conflict, together with the command and real time operational review structures and post event investigation, are making a real difference.
- 2.72 However it also remains the case, both in Northern Ireland and internationally, that police officers at all levels must be trained and equipped to enable effective responses to violence, whether from individual aggressors acting either on their own or as a part of a group, including in situations of serious public disorder.

¹¹ The Thirteenth Report of the Independent Assessor of Military Complaints Procedures is available from the following website:
http://www.nio.gov.uk/independent_assesor_of_military_complaints_procedures_in_northern_ireland_13th_annual_

The underlying causes of community conflict cannot be solved by the police alone and the government together with the police, other agencies and Non-Governmental Organisations continue to proactively work to address these issues

These approaches, together with the new broader range of equipment and the enhanced safety factors which have been designed into less lethal technologies, have contributed to minimising the use of force in often dangerous and exacting situations

- 2.73 The ACPO conflict management approach has been to develop effective frameworks, guidance, training competencies and operational processes, within a human rights approach to policing.
- 2.74 During the lifetime of the Steering Group, water cannon has been introduced as an approved tactical option by ACPO, for use anywhere in the United Kingdom.
- 2.75 PSNI currently have six water cannon, built to exacting standards. As with all other less lethal technologies used, they have been subject to rigorous technical, scientific and medical evaluations. The first operational use of the newly acquired PSNI water cannons was by the Garda Síochána during anti-globalisation protests on 1 May 2004. Since then, as detailed earlier, the PSNI has deployed them on a number of occasions, in circumstances where there has been a risk of escalation to serious public disorder.
- 2.76 Whilst there is a great deal of commonality in the types of technologies available to police, there are significant differences in the policies, guidance, training, operational tactics and after use procedures in relation to less lethal technologies across the world.

International Involvement

- 2.77 The work of the Steering Group has gained international attention and the UK approach to technology development, testing and use has been widely referenced in international reports. An illustration of this is the extensive reference to the UK Defence Scientific Advisory Council Sub-Committee on the Medical Implications of Less Lethal Weapons (DOMILL) report on TASER® technology, set out in the November 2004 Amnesty International report¹² entitled: *“United States of America Excessive and lethal force? Amnesty International’s concerns about deaths and ill-treatment involving police use of TASER®”*.
- 2.78 In its report, Amnesty International acknowledged the importance of the strict rules which applied to using this technology in the UK, stating:
- “Amnesty acknowledges that there may be situations where TASER® can effectively be used as “stand-off”, defensive weapons as an alternative to firearms in order to save lives. This appears to be the aim of the limited introduction of TASER® to UK police who operate under strict rules. (p67)”*.
- 2.79 International involvement in the discussion on appropriate use of technology has been pursued with members of the Steering Group, participating in discussion in the US and elsewhere, on issues of testing, selection, and use of force monitoring. The Steering Group approach has increasingly been recognised as an example of best practice.

The work of the Steering Group has gained international attention and the UK approach to technology development testing and use has been widely referenced in international reports

¹² The Amnesty International report is available from the following website:
<http://web.amnesty.org/library/index/ENGAMR511392004>

- 2.80 In 2005, a Police Superintendent with experience in policing public disorder in Northern Ireland was seconded to the US Police Executive Research Forum as part of a major study on Police Management of Mass Demonstrations. The study sets out and identifies key issues and successful approaches.
- 2.81 The full report entitled *“Chief Concerns: Police Management of Mass Demonstrations - identifying issues and successful approaches”* is available from the Forum website (www.PoliceForum.org). Key issues identified in the report include:
- Critical Planning issues and processes must be addressed by all agencies prior to an event;
 - ‘What ifs’, worst case scenarios and plans for mid course corrections must be included in the planning and training processes;
 - There is a balance to be struck between on the one hand, First Amendment and other civil liberties, and on the other hand the interventions required to protect public safety and property;
 - Recognising the serious potential risk of officers safety, policies must be in place to guide officers on the degree of force that may be used in response to perceived risks;
 - Operating procedures should address the issues of when it is appropriate to utilise full body armour or to issue special weapons, recognising the negative effect their appearance can have on the crowd;
 - The agency must make the best use of real time and strategic intelligence, managing it both internally and via the media; and
 - The agency must determine how best to educate and reassure citizens about professionalism and proportionate responses.
- 2.82 However, as evidenced by the response to two demonstrations of the many that took place across Northern Ireland during the summer 2005, violence can still occur despite investment in planning, communication and conflict resolution procedures.
- 2.83 It therefore remains important that police are appropriately equipped with the full range of resources, including less lethal technologies, and backed up by appropriate training, operational guidance and accountability mechanisms. It is for this reason that the search for and development of appropriate less lethal technologies has been within the context of the much broader review of alternative approaches to conflict management.
- 2.84 The early contact made by the Patten Commission in Northern Ireland with a range of other bodies with relevant expertise including, for example, the National Institute of Justice in America and Pennsylvania State University has been maintained. This has included continued involvement of Steering Group members and ACPO with the International Law Enforcement Forum on Minimal Force Options (ILEF) and the European Working Group on Non Lethal Weapons (EWG-NLF).

Violence can still occur despite investment in planning, communication and conflict resolution procedures

The early contact made by the Patten Commission in Northern Ireland with a range of other bodies with relevant expertise..... has been maintained. This has included continued involvement of Steering Group members and ACPO with the International Law Enforcement Forum on Minimal Force Options (ILEF) and the European Working Group on Non Lethal Weapons (EWG-NLF)

- 2.85 Through these organisations, there has been proactive involvement in monitoring and analysing police responses to disorder and use of force scenarios at both a national and international level. This has included access to reviews of police use of firearms and less lethal weapons, after action reports, and commissions of enquiry.
- 2.86 Building on the ILEF link, an international database on less lethal technologies held and used by law enforcement agencies has also been developed by the UK Home Office Scientific Development Branch and placed on the ILEF web site¹³. The database can be searched by country, policing organisation, less lethal technology or usage.
- 2.87 Members of the Steering Group have also maintained links with the US Police Executive Research Forum and actively participated in a wide range of forums on the use of less lethal technology.
- 2.88 In its contacts through ILEF, the EWG-NLF and other international groups, the Steering Group has remained up to date with current developments, in relation to testing, deployment and operational use of less lethal technologies, including emerging technologies.

Less Lethal Technologies

- 2.89 It is apparent that there is a high degree of commonality in the 'capability set' of modern law enforcement agencies. For the most part, police forces have routinely equipped patrol officers with batons, incapacitant sprays and in some cases with conducted energy devices (TASER®), although a number, as is the case in the UK, are restricting weapons such as TASER® to officers who perform specialist duties.
- 2.90 In addition, specialist units are equipped with kinetic energy projectiles and weapon-launched discriminating chemical projectiles. These technologies, which are designed to be used against individuals, are also on occasions used in situations of serious public disorder.
- 2.91 There has been considerable progress from the situation on which the Patten Commission reported, when it stated that the then RUC "had essentially, three options – the baton, the PBR or live fire".
- 2.92 The broader range of equipment and the AEP system, introduced during the life time of the Steering Group, has enabled a much more developed approach to managing situations involving conflict, especially in those where there is potential for violence.

The broader range of equipment and the AEP system, introduced during the life time of the Steering Group, has enabled a much more developed approach to managing situations involving conflict, especially in those where there is potential for violence

¹³ The Database on less lethal technologies is available from the following website: <http://ilef.nldt.org/database.html>.

3 Introduction of the Attenuating Energy Projectile (AEP)

Programme Management

- 3.1 The Attenuating Energy Projectile (AEP) programme was guided by the Steering Group and its Operational and Technical Sub-Committees (OSC and TSC).
- 3.2 The operational requirements presented in the Steering Group's Fourth Report provided the technical direction for the research into both the AEP and the Discriminating Irritant Projectile (DIP). Since that report, the AEP has completed its operational development, assessed safe and suitable for service, and became operationally available across the UK from 21 June 2005.
- 3.3 Subsequent to the issue of the Fourth Report, the following decisions were made that directed the design of the AEP:
- The original requirement stated that the AEP should be a 37mm or possibly 40mm device. The Steering Group decided to stay with the 37mm calibre for a number of reasons including:
 - the 37mm L104A1 launch platform and L18A1/2 sight was an in-service weapon system with an existing support infrastructure which had substantial use throughout the UK;
 - the non-standard calibre of 37mm minimises the likelihood of the wrong nature of ammunition being fired through the weapon; and
 - the risks and high costs associated with the introduction of a new launch platform and sight, and the potential delay this might bring to the programme;
 - The design of the AEP should aim to match the trajectory of the L21A1; and
 - The sighting system would be limited to a fixed setting. As with the L21A1, it was considered that multiple sight settings could have a detrimental effect on the overall performance of the system. For example, if a firer was to misjudge the range to the target and adjust the sight incorrectly, then that could result in a high fall of shot/flight, which would increase the risk of injury. Tests on systems with multiple sight settings have shown that visual range estimation is very difficult and the risks involved were seen as unacceptable for the AEP. These constraints limit the total range of the projectile, but bring the benefits and knowledge that the operating procedures have been proven in use.

AEP Programme

- 3.4 The programme maintained a focus on the careful balancing of the following system performance parameters:
- reducing injury potential;
 - maintaining effectiveness; and
 - consideration of accuracy with range.
- 3.5 Having decided on the weapon launch platform (and hence the calibre of AEP), the sighting system, and that the AEP and L21A1 were to be trajectory matched, the research and design effort became more focused, principally on the design of the energy attenuating part of the projectile, at the nose section.
- 3.6 The design philosophy adopted for the AEP was that should it impact a relatively soft part of the body (i.e. the intended impact area – the abdomen) then the body wall should be deflected. However, should an AEP strike an unintended ‘stiff’ part of the body, such as the head, then the AEP would deform in preference to the body.
- 3.7 Thus, the design effort concentrated initially on the material properties of the nose section, which includes a void that, on impact, deformed and extended the time over which the force is applied. This deformation also limited the peak force applied by the projectile.
- 3.8 Computer modelling was employed early in the design process to consider a range of different material properties and geometries of nose design. Computer modelling lent itself to these investigations and provided a good indication of the performance of various nose concepts against stiff and soft targets.
- 3.9 Subsequent work involved the physical testing of various designs against stiff and soft targets to characterise the nose deformation. Several iterations of this design process were required before the AEP nose concept was fully developed.
- 3.10 To test the design of the nose section further, a series of trials were conducted firing AEP prototypes against a range of physical models with differing stiffness. These practical tests were compared with the mathematical model results, and therefore informed the iterative design process.
- 3.11 When the design of the nose section was nearing completion, a quantity of AEP plugs were manufactured to a carefully controlled specification. These were used in an early trial to investigate the potential for the AEP to fracture a skull bone simulant, and were compared with the L21A1. The results of these tests gave a clear indication that the AEP had a lower risk of skull bone fracture, although not totally eliminated, compared with the L21A1.

- 3.12 The research then addressed the remaining performance parameters: effectiveness and accuracy. Effectiveness is a difficult performance parameter to measure and is partly based upon the perception of the firer and the individual that has been hit. The approach taken to assess the effectiveness of the AEP was to measure the motion of a model system that was designed to replicate the response of the body wall.
- 3.13 The AEP and L21A1 are both designed to be effective against individual aggressors because they cause pain to the individual by deflecting the body wall, stimulating pain receptors below the surface of the skin. If both the AEP and the L21A1 deform the intended target area of the body in the same way, then the effectiveness of both systems would be expected to be similar. Tests confirmed that the maximum body wall deflection for the AEP and L21A1 were the same, thus the effectiveness was predicted to be the same.
- 3.14 Throughout the design process for the AEP, careful consideration was given to the ballistic consistency of the round. The outer profile was designed using a ballistics computer model to ensure that critical features, such as the centre of gravity and centre of pressure, were in the right position to ensure stability in flight.
- 3.15 Due to the nature of the materials used for AEP, a very tight control was applied to all of the critical dimensions. This is necessary to ensure that the projectiles would fly consistently over a wide range of temperatures. During the development, a number of firing trials were conducted to assess the accuracy of the AEP over different ranges.
- 3.16 Prior to sealing the design, a large quantity of AEP rounds were manufactured and fired in a carefully designed test to assess performance. The AEP final design during development was shown to be as consistent as the L21A1, which was already established as remarkably consistent for a projectile of this type.
- 3.17 At this stage of the programme the final design for AEP demonstrated improvements in reducing the severity of serious injury, whilst maintaining effectiveness and consistency. The design was sealed and a technical data pack prepared for the commercial manufacture of the AEP prior to medical and safety testing.

Working with Industry

- 3.18 Throughout the research and development of the AEP, a range of suppliers and manufacturers were used. These ranged from the supply of various adhesives through to the manufacture of prototypes and the final design of the AEP projectile. It was necessary to work closely with the AEP plug manufacturers in particular, to ensure that the manufacturing processes being developed were suitable for large volume production and that the quality of the projectile could be controlled and maintained.



AEP Impact round

Throughout the design process for the AEP, careful consideration was given to the ballistic consistency of the round

- 3.19 Following on from the sealing of the design of the AEP, the programme moved towards a pre-production phase, whereby industry was requested, under contract, to produce larger quantities of the AEP using production tooling.
- 3.20 The techniques for volume production of the AEP were developed so that large quantities of plugs could be produced consistently to the plug specification, without affecting the key performance parameters such as reduced injury potential, effectiveness and consistency.
- 3.21 In addition to the drawings for the projectile, a specification was written which laid down the quality assurance requirements of the AEP. This was an important element of the programme to ensure that critical features, such as the material properties of the projectile, the tolerance of the driving bands, the bond strength and features such as the deforming nose section, were carefully controlled. This careful control was required as part of the process to ensure the AEP performed as expected in terms of its flight characteristics (accuracy), its reduced injury potential and its performance against the intended target area. The control of these critical features was encapsulated in a document defining the quality requirements for the plug.
- 3.22 A Proof and Sentencing Schedule¹⁴ was also produced which stipulated the acceptable performance characteristics of the assembled AEP. Instrumented test firings were conducted on random samples from every batch of AEPs produced. The firing results were compared with defined acceptance criteria, such as hit probability, mean velocity, and standard deviation of velocity.
- 3.23 Subsequent tests were also conducted to check aspects of the projectile such as bond strength and material hardness. The munition batch was only acceptable if it passed all aspects of the Proof and Sentencing Schedule.
- 3.24 This Proof and Sentencing Schedule was based upon the achievable performance of the projectile from the sealed design, rather than the requirements set out in the operational requirement, because the actual performance of the projectile exceeded the initial requirement i.e. it was more consistent than the specification.
- 3.25 The AEP plugs produced from the preproduction phase were all delivered to, and inspected by, the Defence Science and Technology Laboratory (Dstl).
- 3.26 Production techniques were improved during the initial phases of the contract to ensure that relatively large quantities of the projectiles could be reliably produced to the AEP specification. A large quantity of projectiles was then assembled into complete rounds at Dstl resulting in several batches of the AEP munition. Each batch was

¹⁴ The Proof and Sentencing schedule is a document laying down all of the testing and quality checks required to ensure each Lot of ammunition is produced to the required standard.

tested according to the Proofing and Sentencing Schedule. Overall, the production requirements were tighter for the AEP than predecessor impact rounds, mainly due to refinements in the production methods.

- 3.27 With the approval of the TSC, the rounds were submitted for the rigorous Defence Ordnance Safety Group (DOSG) testing and medical evaluation trials by the DSAC Sub-Committee on Medical Implications of Less Lethal Weapons (DOMILL).

Defence Ordnance Safety Group (DOSG) Testing

- 3.28 A comprehensive environmental testing protocol was devised by DOSG to allow them to provide advice on the safety and suitability for service of the AEP. The trial schedule was designed to subject the AEP (both packaged and unpackaged) to extreme storage, transportation and handling regimes.
- 3.29 The subsequent performance of the AEP was then assessed for potential degradation in performance due to changes in environment, such as hot and cold cycling, humidity, vibration testing, drop testing and immersion testing.
- 3.30 MoD requires a 'Certificate of Safety Ordnance Munitions and Explosives' (CSOME) for all stores before they could be used operationally. One of the roles of DOSG is to provide the Procuring Authority with advice on the safety and suitability for service of munition natures, including less-lethal rounds.
- 3.31 The environmental testing was completed in December 2004 and all of the evidence (the Safety Case) was presented to the Project Safety Panel in January 2005. After a review of the comprehensive safety documentation, the AEP was granted a CSOME and therefore could be made available for man-firing and training.
- 3.32 In addition, DOSG was asked to consider the safety aspects of using the existing L21A1 as a training round, although it would not be used for zeroing or qualification. Their advice on using the L21A1 as a training round is set out in Annex 2 of this report.

Medical Evaluation

- 3.33 DOMILL prepared a statement on the comparative injury potential of AEP and L21A1. This is attached as Annex 3, a copy of which was laid before Parliament in April 2005.

Introduction of the AEP

- 3.34 As part of the introduction of the AEP, discussions were held with ACPO, the Police Federation, the Northern Ireland Policing Board and others, to inform them of the reasons for its introduction and explain how it was an improvement on the existing L21A1 round. These discussions emphasised the expected reductions in the likelihood of

serious injuries reported in testing and the anticipated effectiveness of the AEP, including confirmation of its accuracy and consistency.

- 3.35 AEP training commenced in February 2005, ACPO and military guidance was produced and the AEP was introduced to service on 21 June 2005. This guidance is reproduced in Annex 4 and Annex 5 of this report.
- 3.36 PSNI also issued an operational general order¹⁵ which was made publicly available. The General order provides detailed guidance in respect of the issue, deployment and use of Attenuating Energy Projectiles Impact Rounds in situations of serious public disorder. The guidance reflects National ACPO Guidelines and takes cognisance of the provisions of the Human Rights Act 1998 and the UN Code of Conduct for Law Enforcement Officials, and should be read in conjunction with the Police Service of Northern Ireland Code of Ethics.
- 3.37 As a consequence of the introduction of the AEP, the L21A1 baton round is no longer used operationally by police or military in the UK.

Effectiveness

- 3.38 The Steering Group's Fourth Report identified a need to consider effectiveness issues when considering less lethal technologies. Since that time a great deal of work has been undertaken to develop further knowledge about the various factors that could influence the effectiveness of a technology. The Steering Group's OSC has, with assistance from Dstl psychologists, developed a matrix of specific questions to be addressed for each less lethal option. The matrix comprises 31 questions covering:
- Operational Availability/Deployment Issues;
 - Technical Reliability and Ergonomics;
 - Operational Accuracy;
 - Subject Response Factors;
 - Operational Use Factors;
 - Operational Use of Force Follow up Considerations;
 - Consequence of Use Factors; and
 - Tactical Constraints.
- 3.39 This matrix is being evaluated against existing technologies. It is hoped that a better understanding of what makes a technology effective will help inform the development of new technologies (such as DIP) and guidance and training on their use. For example, the framework is being used to assist the identification and development of appropriate operational scenario based trials as part of the DIP programme.
- 3.40 A considerable amount of work has been undertaken internationally in determining the effectiveness criteria for less lethal weapon systems. It was considered important to take cognisance of international developments in this area.

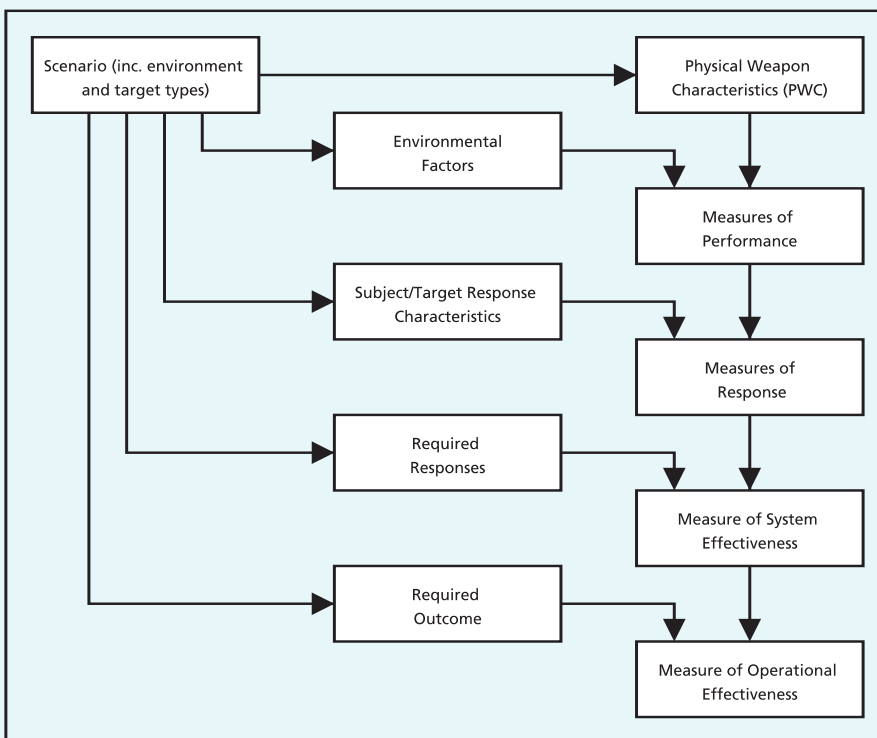
¹⁵ The PSNI AEP Guidance is available from the following website:
http://www.psnipolice.uk/service_guidelines_attenuating_energy_projectiles.pdf

The guidance reflects National ACPO Guidelines and takes cognisance of the provisions of the Human Rights Act 1998 and the UN Code of Conduct for Law Enforcement Officials

the framework is being used to assist the identification and development of appropriate operational scenario based trials as part of the DIP programme

- 3.41 There is a growing consensus amongst academics, medical experts and practitioners involved in the study of less lethal effectiveness, that effectiveness assessment can be best achieved by the identification and examination of interactive component parts inherent within the accomplishment of a desired result or outcome by using a Measure of Effectiveness (MoE) framework methodology.
- 3.42 A Measure of Effectiveness (MoE) framework takes account of the weapon characteristics, environmental factors, subject / target response characteristics and also addresses the issue of environmental and behavioural moderators which may affect overall operator and system performance in relation to the effects on the subject against whom they are used. Existing and future work in this area is taking account of these issues.

Example of a Measure of Effectiveness (MoE)



- 3.43 In addition, a sub-group of the UK Steering Group, the 37mm System Joint Management Group (formerly the Through Life Management Sub-Group), continues to consider future developments to the AEP/L104 launch system.
- 3.44 A research programme has also been initiated to look at the viability of extending the temperature range over which the AEP can be fired. This work is required prior to safety testing, should there be a requirement to use AEP for worldwide military operations in the future.

4. Development of the Discriminating Irritant Projectile (DIP)

The Discriminating Irritant Projectile (DIP) Programme

- 4.1 The operational requirement for the DIP was set out in the Steering Group's Fourth Report. Since then, this document has been further refined and a user requirement produced.
- 4.2 The objective is for the DIP to deliver a discrete localised cloud or burst of sensory irritant in the immediate proximity of an individual aggressor. It is not intended to cause serious or life threatening injury, but rather have sufficient effect to dissuade or prevent a potentially violent person from their intended course of action, and thereby neutralise the threat posed. The DIP may be deployed in a variety of operational situations however the objective will remain the same.
- 4.3 The research on DIP has continued to address some of the challenging technical issues presented in the Fourth Report.
- 4.4 The current design concept for the DIP comprises a cartridge case and a rigid, lightweight projectile with a crushable nose section containing the irritant. When initiated a propellant charge accelerates the projectile out of the launch system towards the target. On impacting the target, the crushable nose section compresses in such a manner as to disperse a small, localised, cloud of irritant.
- 4.5 The irritant is in a micronised form and acts quickly on the eyes, nose and respiratory system. The eyes and nose will experience an uncomfortable stinging sensation, tears will form and the eyes may close. On inhalation, the chest will tighten and there may be a shortness of breath. Depending upon the irritant employed, these effects diminish within a short time if the subject is moved into fresh air.
- 4.6 A review of available irritants is being undertaken and currently the project is progressing on the basis that the irritant of choice for DIP will be micronised 2-chlorobenzylidene malononitrile (CS) because of its well characterised toxicology, appropriate effects, ease of decontamination and high safety ratio. However, the use of PAVA (pelargonyl vanillylamide, a synthetic analogue of the active ingredient of natural pepper used as an alternative to Oleoresin Capsicum) is also under consideration.
- 4.7 The Steering Group decided to remain with the same launch platform used to discharge the AEP, currently the L104A1 system. It has also been agreed that DIP will only be available to suitably trained firearms officers, for use in situations where a significant threat to life or risk of serious injury exists.



Medium calibre variants (of different mass and aerodynamic properties) of 37 mm DIP concepts, showing the carrier body and irritant payload in the nose, within a frangible cap.

It (The DIP) is not intended to cause serious or life threatening injury, but rather have sufficient effect to dissuade or prevent a potentially violent person from their intended course of action

- 4.8 As the DIP is a new concept technology it is considered essential that development takes account of the full range of operational situations in which it may be used. This would include issues associated with storage, carriage, training, operational deployment, actual use across a range of scenarios, as well as issues relating to post-operational use, arrest, restraint and after care of persons who have been exposed to the irritant.
- 4.9 A series of scenario based trials (SBTs) have been proposed to form part of the system design assessment programme. The SBTs will be used to assess the likely level of initial sensory irritant contamination, the potential for cross-contamination and the subsequent need to manage 'users', targeted 'subjects' and other individuals in close proximity, following the use of a DIP projectile. The specific objectives are:
- To replicate operational scenarios following well defined policing procedures for arrest, restraint and follow-up 'subject' handling;
 - To simulate and quantify the degree of dispersal of sensory irritant on cross-contamination to users and subjects following realistic delivery of the DIP;
 - To identify subsequent de-contamination requirements for personnel, subjects, equipment and environment; and
 - To inform policy and procedural guidance relating to DIP consequence management issues.
- 4.10 The SBTs will be conducted in accordance with detailed ethical protocols and overseen by Dstl.
- 4.11 A considerable amount of research effort is being devoted on the design of the nose section. It has to be strong enough to withstand the launch from the weapon system, yet weak enough to reliably release the sensory irritant on impact with the target, which could be a soft clothing layer, at a potentially wide range of temperatures.
- 4.12 The mechanism of release has to be reliable so as to minimise the likelihood that the micronised irritant, such as CS, is not retained in the projectile. In addition to reliable irritant release, any fragments produced must not in themselves add to the injury potential of the system. Finally, the nose section has to be designed to maximise the ballistic stability of the projectile.
- 4.13 As the design of the nose section progresses, the most likely materials for use are being identified. Although these materials have been selected with the compatibility of the materials with irritants such as CS and PAVA in mind, it will be necessary to undertake some stability tests to demonstrate that the irritant will not migrate through the material in any appreciable quantities.
- 4.14 Research into the body of the DIP has to take into account manufacturing methods that will be needed to produce the DIP in the future. It is necessary to maintain tight control over the dimensional tolerances and the mass of the projectile, since these are fundamental requirements when designing a munition that has to be consistent.

As the DIP is a new concept technology it is considered essential that development takes account of the full range of operational situations in which it may be used

A series of scenario based trials (SBTs) have been proposed to form part of the system design assessment programme

Lightweight materials are being investigated that have low thermal expansion / contraction properties, and that will engage effectively into the rifling in the barrel.

- 4.15 In parallel with the research into the components of the DIP, effort is also being directed towards the integration of the DIP into the cartridge case. A new propellant charge system is being developed to match the pressure-time profiles required to discharge this lightweight projectile consistently from the launch system.

DIP Concepts

- 4.16 Testing the DIP concepts has shown that it is possible to achieve the accuracy needed to meet the operational requirement. It has been agreed that the DIP should be as consistent as the AEP currently in service, at 20 metres, and desirably at 40 metres.
- 4.17 Further testing has also been conducted to measure the dispersion of the irritant cloud at various positions from the impact point. These tests inform the design of the projectile to ensure that there is sufficient irritant to achieve the desired effect, whilst at the same time minimising the amount of dispersed irritant, to reduce the risk of bystanders being affected.
- 4.18 One of the significant technical hurdles still to be overcome is to limit the effectiveness of the irritant to within one metre of the intended target, as defined in the operational requirement. Numerical models have been used to understand fully the 'collateral' effects of the irritant cloud, and to assess the effects of crosswinds, temperature and local environment on its dispersion characteristics.
- 4.19 In addition to the operational projectile, there is the need to develop one or two further rounds for training purposes: a training round, used purely in training to identify where the round hit on firing ranges and in scenario based training; and possibly an inert simulant round, to demonstrate the cloud effect of the irritant. This will ensure that the police have a full range of training equipment to enable Police Firearms Officers to achieve a very high standard of competence.

Technical Summary

- 4.20 Research has progressed and continues to address the technically challenging operational requirement. Initial concept rounds have been manufactured, in relatively small numbers, and early work on consistency has demonstrated that DIP should be able to achieve the essential operational requirements.
- 4.21 There remain a number of difficult technical issues to overcome including:
- limiting the irritant cloud to within 1 metre of the target;
 - consistent fragmentation of the nose section, without introducing new injury mechanisms;

Initial concept rounds have been manufactured, in relatively small numbers, and early work on consistency has demonstrated that DIP should be able to achieve the essential operational requirements

- integration of the projectile into the case;
- the design of robust packaging, that will ensure that risk of the ammunition being damaged in transit is minimised and that if it has been, then it is obvious to the user so that it will not be used; and
- the design of the training rounds.

4.22 Evaluation by the Defence Ordnance Safety Group (DOSG) and the DSAC Sub-Committee on Medical Implications of Less Lethal Weapons (DOMILL) will be undertaken in due course.

Programme Timescales

- 4.23 The programme for the development of DIP remains fluid due to the number of taxing technical issues yet to be overcome.
- 4.24 An essential part of the programme will be conducting the SBTs, which will be undertaken under protocols submitted to and agreed by an MoD Ethics Committee.
- 4.25 The findings of the SBTs will be used to inform the future direction of the programme. It is intended that the SBTs will be completed by the end of 2007 and subject to development of a munition which is deemed suitable for service, it is anticipated that the DIP could become ready for operational use in 2009/10.

The findings of the SBTs will be used to inform the future direction of the programme

5 Use of Less Lethal Technologies within the UK

- 5.1 Throughout the UK, in common with police in many other countries, a number of less-lethal options are available to police to deal with violent individuals either on their own or where they appear as part of a crowd.
- 5.2 There has been a continued theme of police across the world deploying or testing various less-lethal technologies such as kinetic energy rounds, chemical irritants and conducted energy devices e.g. TASER®. These same technologies have been introduced in the UK, but only following rigorous technical, scientific and medical evaluation.

L21A1 Baton Rounds

- 5.3 The L21A1 baton round was brought into service in Northern Ireland in June 2001 and was replaced by the Attenuating Energy Projectile (AEP) in June 2005.
- 5.4 The last operational use of the L21A1 in Northern Ireland was in September 2002. It was however discharged operationally in England and Wales against single aggressors on a number of occasions after this date.
- 5.5 It was the accuracy and consistency of the L21A1 from the L104A1 launch platform, together with the introduction of a new optical sight, which enabled its use to be extended to situations other than serious public order incidents i.e. it has been used where police firearms officers were deployed, thus providing them with a less lethal option.
- 5.6 A comprehensive review¹⁶ was commissioned by the Association of Chief Police Officers (ACPO) Working Group on Police Use of Firearms, with support from the Home Office, to examine the use of L21A1 baton rounds in England and Wales. The study took account of all L21A1 baton rounds fired from the 37mm Heckler and Koch 104A1 launcher (sometimes referred to as the baton gun) from February 2002 up until the end of 2004. In this period a total of 50 baton rounds were discharged in 37 incidents by 22 police forces.
- 5.7 The review only dealt with situations in which L21A1 baton rounds were actually discharged. It takes no account of the many deployments of L104A1 launcher and conventional firearms, which are resolved without either type of weapon being discharged. All of the incidents involved the deployment of firearms officers, and each provided the potential for discharge of a conventional firearm.

The last operational use of the L21A1 in Northern Ireland was in September 2002. It was however discharged operationally in England and Wales against single aggressors on a number of occasions after this date

All of the incidents involved the deployment of firearms officers, and each provided the potential for discharge of a conventional firearm

16 The full text of the Review of the Discharge of Baton Rounds by Police in England and Wales 2002 - 2004 is available from the following website: <http://scienceandresearch.homeoffice.gov.uk/hosdb/publications-2/weaponry-publications/1206reviewbatonrounds?version=1>.

- 5.8 Typically the incidents involved a subject armed with a bladed weapon (75%) although in 51% (19) of the incidents the subject possessed, or claimed to possess, a firearm; often this was in addition to another weapon such as a knife or a sword. Alcohol or drugs had been consumed by 65% of the subjects and in 15 (40%) of the incidents the subject had a known mental health problem. Eleven (29%) of the subjects were described as suicidal and 20 (54%) described as aggressive, agitated or volatile.
- 5.9 Of the 50 rounds discharged, 46 struck the intended subject (in one of the incidents the round struck the long barrelled weapon being held by the subject). If these shots were considered 'hits', this would equate to a 94% success rate.
- 5.10 In 32 out of the 37 incidents the baton rounds were discharged at a distance of less than 15 metres and in 8 incidents the range was less than 3 metres.
- 5.11 There were no life-threatening injuries caused as a result of these firings. The most common injury was bruising to the strike area. In addition, post incident reports record the injuries as:
- perforation of the skin in the area around the strike to the abdomen (3 incidents);
 - small cut to knuckle of ring finger (direct strike to the hand);
 - fracture (1 incident) in which a single chest strike resulted in a fracture to the sternum and adjoining rib; and a
 - groin injury resulting in a decision to surgically remove one testis.
- 5.12 Consistent with using other weapons including conventional firearms, there was no uniform response to being struck with the L21A1 round. In some incidents there appeared to be a short delay of several seconds between the impact of the round and physical response from the subject.
- 5.13 The review enabled analysis in terms of the following tactical outcomes:
- 28 incidents concluded immediately after the discharge of the L21A1 round(s); and
 - 9 incidents continued after the discharge of the L21A1 round(s).
- 5.14 Of the 28 incidents concluded immediately after the discharge of the L21A1 rounds, there were 7 incidents in which the impact from the round 'neutralised' the threat and 21 incidents in which the discharge of the L21A1 enabled officers to advance forward and overpower the subject.
- 5.15 The review provides an insight into the need for a menu of tactical options, the inter-relationship between tactical options, and the anticipated and actual subject response to being struck by the L21A1 round. The decisions and tactics used by officers and commanders in dealing with a wide range of incidents are also drawn out during the review.

- 5.16 In 30 of the incidents it was reported that other less lethal weaponry and tactical options were immediately available. In 28 cases more than one other less lethal technology was utilised either prior to, simultaneously, or after the discharge of the L21A1 round.
- 5.17 Also highlighted is the distinction that requires to be made between 'tactical outcome' and 'weapon effectiveness'. As set out in the review report, the issue of less lethal system effectiveness requires to be considered within a holistic 'effectiveness' framework. This takes account of not only the subject response but also weapon characteristics, environmental factors, subject / target response characteristics and environmental and behavioural moderators, which affect overall operator and system performance on the subject against whom they are used.
- 5.18 It was noted that impact rounds are unlikely to physically incapacitate mature and highly motivated adults on a predictable basis, but they do offer a versatile and effective less lethal enabling technology.
- 5.19 Whilst impact rounds such as the L21A1 and its successor the AEP have limitations, particularly in respect of predictability of effect, they do provide a technology that:
- Can be used in most environments;
 - Can be used alongside other weapon systems; and
 - Provides officers with a window of opportunity in which to minimise operational risks.
- 5.20 However, it is evident from the review that there remains, despite the availability of impact rounds and conducted energy weapons such as TASER®, an operational capability gap. It follows that in the absence of a less lethal weapon system which consistently incapacitates at ranges out to at least 20 metres, there will remain a potential for the discharge of a conventional firearm in situations where less lethal weapons are deployed.
- 5.21 The review concludes that in at least 7 of the incidents reviewed, had the L104A1 weapon system not been available, it is most probable that conventional firearms would have been discharged with a high probability of fatal consequences. In the incidents reviewed, the availability and use of the L104A1 system using the L21A1 round has undoubtedly saved lives.
- 5.22 The Defence Scientific Advisory Council (DSAC) also made a statement on the review carried out by MOD of medical issues arising from use of the L21A1 Baton Round over the period June 2001 to May 2003. The text of the statement is attached as Annex 6 of this report.



L21A1 Baton round

had the L104A1 weapon system not been available, it is most probable that conventional firearms would have been discharged

AEP Impact Rounds

- 5.23 The AEP was introduced into operational service on 21 June 2005. Subsequently they have been discharged operationally by police officers in England, Scotland, Wales and Northern Ireland.
- 5.24 A total of 17 rounds were fired by officers in Great Britain in 12 different incidents. In three incidents more than one AEP was discharged. In one incident 2 rounds were discharged and in two incidents 3 rounds were discharged. The first discharges of the round occurred on 12 July 2005 in both Derbyshire and Northern Ireland.
- 5.25 The Derbyshire incident was in response to a violent incident in which a man was armed with a knife. In Northern Ireland, there were three different occasions when, during serious public disorder, police and military discharged AEP rounds.
- 5.26 The first of these was on 12 July when the incident involved the throwing of numerous petrol bombs and up to 10 blast bombs at police lines in Belfast. During this disorder a total of 21 AEPs were discharged at violent individuals.
- 5.27 There were a further two incidents in which police and military discharged AEP rounds, again during serious disorder. These were on 4 August 2005, when 11 AEPs were fired at identified violent individuals and between 10 and 13 September, when police and Army came under sustained attack involving petrol bombs, blast bombs and automatic gunfire. During the incident, the police discharged 249 AEP rounds and the Army, 140.
- 5.28 The Northern Ireland incidents have been reported on earlier in Section 2 of this report.

Operational Trial of Taser® in England and Wales - update

- 5.29 The Steering Group's Fourth Report contained an overview report on the trial of the M26 TASER® together with detailed reports on the medical testing and the DSAC Sub-Committee on Medical Implications of Less Lethal Weapons' (DOMILL) report on TASER®. It also included an interim report of its operational trial and the operational guidance for use during the trial.
- 5.30 On 15 September 2004 the then Home Secretary agreed to allow Chief Officers of all forces in England and Wales to make the M26 TASER® available to Authorised Firearms Officers as a less lethal alternative for use in situations where a firearms authority has been granted, in accordance with the criteria laid down in the ACPO Manual of Guidance on Police Use of Firearms.

On 15 September 2004 the then Home Secretary agreed to allow Chief Officers of all forces in England and Wales to make the M26 TASER® available to Authorised Firearms Officers as a less lethal alternative for use in situations where a firearms authority has been granted, in accordance with the criteria laid down in the ACPO Manual of Guidance on Police Use of Firearms

- 5.31 Since then, the X26 TASER® has been developed and placed on the market. On 22 March 2005, the then Home Secretary agreed that Chief Officers of all forces in England and Wales could make the X26 TASER® available to Authorised Firearms Officers as a less lethal alternative. Similar to the M26 TASER®, the use of the X26 TASER® was restricted to use in situations where a firearms authority has been granted in accordance with the criteria laid down in the ACPO Manual of Guidance on Police Use of Firearms. The authorisation for the M26 TASER® remains in force.
- 5.32 In March 2005, Home Office Scientific Development Branch (HOSDB) produced a further report¹⁷ on TASER® devices. The report contains evidence which addresses the medical concerns raised in the previous DOMILL M26 statement and provides an evaluation of the X26 TASER®.
- 5.33 The HOSDB report contains the following new information:
- The laser in the sighting system has been classified as 3R according to the British laser safety standard BS EN 60825-1. Although this class exceeds the internationally agreed maximum permissible exposure (MPE) values (1mW), because of the safety factors in MPE values, they are unlikely to cause eye injuries for accidental exposures but intentional viewing must be avoided. However, the M26 does not currently comply with the standard's labelling requirements;
 - There is a low risk of the TASER® affecting medical equipment in a dangerous way;
 - Further work commissioned by HOSDB has indicated that there is no significant risk of affecting the flight-critical systems of aircraft;
 - There is a significant risk of ignition if a TASER® is fired at a target that has been previously sprayed with either CS or PAVA incapacitant spray. CS spray is more likely than PAVA spray to ignite but PAVA solvent burns with a blue flame that is difficult to see in bright light conditions; and
 - The residual medical concerns over the M26 TASER® raised by DOMILL have been investigated by the Defence Science and Technology Laboratory (Dstl). The information provided was reviewed by DOMILL and contributed to their second statement on the M26, which is included in Annex 7 of this report. It concludes that the life-threatening or serious injuries from the M26 TASER® is very low. Throughout the testing and the handling trials covered in our report, and when compared to the Operational Requirement, the X26 TASER® performs marginally better than the M26 in most areas.



M26 TASER® manufactured by TASER® International



X26 TASER® manufactured by TASER® International

Similar to the M26 TASER®, the use of the X26 TASER® was restricted to use in situations where a firearms authority has been granted

¹⁷ The HOSDB report on TASER® devices is available from the following website:
<http://scienceandresearch.homeoffice.gov.uk/hosdb/publications-2/weaponry-publications/19-05-Taser-Report-2005-R1.pdf?view=Binary>

5.34 However:

- The M26 is approximately half the cost of the X26; and
- Of the eleven X26 units supplied to HOSDB, discounting the two that were used in drop testing, seven broke down under no more duress than repeated usage in a 6-month period. These X26 units were early production models and HOSDB received 20 replacements and tested them repeatedly over a month-long period. None broke down entirely during the test, but two units' pulse repetition rates slowed significantly (thus reducing the power being delivered). This shows an improvement over the previous units but should not be regarded as definitive reliability testing.

5.35 The following table details the use of TASER® in England and Wales since the commencement of its trial in April 2003.

TASER® 'Incidents'

	Drawn/ aimed/ red-dot	Arced	Fired/Drive Stun Mode	Fired/Probe Mode	Total incidents when TASER® 'used'
TOTAL	212	16	15	127	370

Table updated 10th May 2006. Note: The drive stun mode allows closer contact to the subject and the TASER is used as a touch stun gun. The probe mode constitutes the firing of a TASER cartridge from a distance with two electrical probes that conduct the electrical charge of the TASER to the subject.

5.36 It is notable that of the 370 occasions were TASER® has been used, on 228 occasions, either drawing, sighting the red dot or arcing the TASER® has been sufficient to resolve the incident.

5.37 In England and Wales, the Independent Police Complaints Commission requires the police service to report incidents where TASER® is discharged, if the discharge:

- resulted in death or serious injury;
- caused danger to the public, or
- revealed failings in command.

5.38 The independent evaluation of the operational trial of TASER®, the ACPO Policy on use of TASER® and the ACPO Operational Guidance have all been made publicly available¹⁸.

5.39 Amnesty International also acknowledges that there may be situations where TASER® can effectively be used as "stand-off" defensive weapons, as an alternative to firearms in order to save lives. An Amnesty International Report¹⁹ on TASER® notes that measures such as stricter controls and training on the use of force and firearms are likely to be more effective overall in reducing unnecessary deaths or injuries.

It is notable that of the 370 occasions were TASER® has been used, on 228 occasions, either drawing, sighting the red dot or arcing the TASER® has been sufficient to resolve the incident

18 The independent evaluation of the operational trial of TASER®, the ACPO Policy on use of TASER® and the ACPO Operational Guidance is available from the following website:

<http://www.westmercia.police.uk/publications/acpopoliceuseoffirearms.htm>.

19 The Amnesty International report is available from the following website:

[http://web.amnesty.org/library/pdf/AMR511392004ENGLISH/\\$file/AMR5113904.pdf](http://web.amnesty.org/library/pdf/AMR511392004ENGLISH/$file/AMR5113904.pdf).

- 5.40 This reflects the practice in England and Wales where TASER® is used only by Authorised Firearms Officers as a less lethal alternative, for use in situations where a firearms authority has been granted.
- 5.41 All forces in England, Wales and Scotland are now deploying TASER® operationally. In all forces, Taser® is deployed as a less lethal option alongside conventional firearms by authorised firearms personnel.
- 5.42 In keeping with this approach, the Chief Constable of the PSNI recently informed the Northern Ireland Policing Board that he intends to consider issuing TASER® on a restricted basis to members of the specialist tactical firearms team, for deployment in firearms incidents where a less lethal specialist option is required. To that end, an equality screening exercise is currently underway.

DOMILL Statements on the M26 Advanced TASER®

- 5.43 On 30 January 2003, the Home Secretary gave authority to proceed with an operational trial of the M26 TASER® as a less-lethal option in incidents at which authority to use firearms had been granted. The operational trial commenced on 21 Apr 2003.
- 5.44 Prior to the commencement of the trial, DOMILL provided an independent statement on the medical implications of the use of the M26 TASER® within the ACPO Policy. The statement, which was set out in the Steering Group's Third Report, was based primarily on an assessment of the medical risks undertaken on behalf of DOMILL by the Defence Science and Technology Laboratory (Dstl).
- 5.45 DOMILL also produced medical advice notes for the subjects on whom the M26 had been used, from hospital staff, and general practitioners. The DOMILL statement concluded that:
- "From the available evidence on the use of the device, the risk of life-threatening or serious injuries from the M26 Advanced TASER® appears to be very low."*
- 5.46 In the statement, DOMILL recommended that research be undertaken to clarify the cardiac hazards associated with use of the M26 TASER® on individuals who could be considered to have a greater risk of adverse effects.
- 5.47 The principal investigations addressed:
- the possible cardiac hyper-susceptibility to M26 TASER® currents arising from drugs commonly used illegally in the UK, acidosis and pre-existing disease;
 - a more thorough review of the vulnerability of pacemakers and other implanted electronic devices; and
 - the output of the sighting laser of the M26 TASER® should be measured and classified according to British Standards.

TASER® is used only by Authorised Firearms Officers as a less lethal alternative, for use in situations where a firearms authority has been granted

the Chief Constable of the PSNI recently informed the Northern Ireland Policing Board that he intends to consider issuing TASER® on a restricted basis to members of the specialist tactical firearms team, for deployment in firearms incidents where a less lethal specialist option is required. To that end, an equality screening exercise is currently underway

- 5.48 The Home Office commissioned the Biomedical Sciences Department of Dstl to undertake the first two items; the sighting laser classification was undertaken by the National Radiological Protection Board.
- 5.49 The Home Office and ACPO provided DOMILL with a synopsis of each incident in the operational trial at which the M26 TASER® was used²⁰. DOMILL was also given the opportunity to review some of the post-incident medical assessments undertaken by Forensic Medical Examiners.
- 5.50 From the evidence provided to DOMILL, it was concluded that there had been no primary or secondary injuries that could be classed as life-threatening, unexpected, or potentially leading to disability, and the first statement did not require modification in the light of this data.

Extension of the operational trial of the M26 TASER®

- 5.51 A report by PriceWaterhouseCoopers²¹ on the operational trial of the M26 TASER®, commissioned by ACPO, concluded that its use:

“helped secure a positive outcome to an incident, minimising the potential need for officers to deploy other, possibly more lethal technologies”

- 5.52 ACPO proposed that, subject to a review of the medical assessment and expression of Ministerial support, the trial should be extended to all forces (subject to Chief Officer agreement) for use by existing firearms officers, in situations where an authority for firearms would be granted in accordance with criteria presently laid down within the ACPO Manual of Guidance on the Police Use of Firearms.
- 5.53 Consequently, the Home Office requested that DOMILL review the extant medical statement and offer a second statement on the medical implications of use, consequential to:
- Revised and reviewed ACPO policy, operational guidance and training;
 - The outcome of the research to date addressing their recommendations in the extant statement; and
 - The data presented to them by ACPO on the outcome of the operational trial.

(TASER®) “its use helped secure a positive outcome to an incident, minimising the potential need for officers to deploy other, possibly more lethal technologies”

20 “Use” by ACPO’s definition is the: (i) drawing of a device in circumstances where any person perceives the action as a use of force or a threat of use of force; (ii) discharging the barbs at a subject; (iii) application and discharge in “touch stun” mode.

21 The PriceWaterhouseCoopers report is available from the following website:
<http://www.westmercia.police.uk/images/mog/evaluation%20.pdf> .

- 5.54 The second DOMILL statement was offered to the Home Office in July 2004; the medical and technical aspects of this statement on the medical implications of the use of the M26 TASER® are attached as Annex 7.
- 5.55 Subsequent to this statement, Dstl completed the modelling to predict the current flow in the human heart. The current density (A/mm²) in cardiac tissue is predicted to be low, and below the threshold for disturbance of cardiac rhythm in a normal heart.
- 5.56 Experiments have now been completed in which the predicted M26 TASER® currents were applied to an isolated beating heart (the Langendorff preparation). The capacity for these currents to induce premature ventricular contractions or ventricular fibrillation was assessed, and compared to the threshold currents required for square wave current pulses of different durations.

X26 TASER®

- 5.57 DOMILL was requested by the Home Office to offer a view on the medical risks associated with the use of the X26 TASER®.
- 5.58 In terms of the primary effects of the TASER® (effects that arise directly from the passage of current into the body), the output voltage waveform is different from that of the M26; for example, it has a lower peak voltage but a longer pulse duration.
- 5.59 Dstl has undertaken computer modelling on behalf of DOMILL to compare the current predicted to flow in the heart from the M26 and X26 TASER®. The predicted currents have been applied to isolated beating hearts to determine the risk of adverse cardiac events from both M26 and X26 outputs.
- 5.60 DOMILL reviewed this data in December 2004, and issued a statement in March 2005; this is attached as Annex 8. The statement concluded that the risk of a life-threatening event arising from the direct interaction of currents of the X26 TASER® with the human heart was less than the already low risk of such an event from the M26 Advanced TASER®.

Incapacitant Sprays

Police Use of CS Incapacitant Spray

- 5.61 All Home Office and Scottish Executive Office police forces now issue incapacitant sprays to uniformed patrol officers, subject to completion of the relevant training.
- 5.62 The International Commission on Policing in Northern Ireland (The Patten Commission) Report, published in 1999, referenced the non-availability to police officers in Northern Ireland. The spray has now been made available to PSNI officers along with associated guidance²².
- 5.63 There are now two different incapacitants being used: 2-chlorobenzylidene malononitrile (CS) and pelargonic vanillylamide (PAVA); with revised ACPO guidance²³ covering both incapacitants.
- 5.64 PAVA is a synthetic analogue of the active ingredient of natural pepper and is a potential alternative to CS spray which the majority of police forces in England and Wales have been using as self-defence equipment since 1996.
- 5.65 In 2001, the Home Office requested advice from the Food Standards Agency's Committee on Toxicity²⁴ (COT) on the health effects arising from the use of a chemical incapacitant spray containing PAVA. In April 2002, the Committee issued a statement on PAVA detailing areas where they felt there was insufficient data available to enable them to make a complete assessment of the health effects that could arise from the use of PAVA. Studies were commissioned during the period between this first statement and the current statement issued in November 2004 which address these gaps. The original and current COT statements are reproduced in Annex 9.
- 5.66 PAVA gave a positive result in one of the three in-vitro mutagenicity tests, indicating that it could have mutagenic potential. Because of this indication two different negative in-vivo test results were required.
- 5.67 One of these, the in-vivo liver unscheduled DNA synthesis study, was carried out as one of the extra studies mentioned above. The other, a bone marrow micronucleus test, was carried out prior to the original statement. The negative results from these two studies led the Committee to conclude that PAVA would not be expected to be an in-vivo mutagen.



Example of Hand-Held CS Incapacitant Spray

PAVA is a synthetic analogue of the active ingredient of natural pepper and is a potential alternative to CS spray

22 The PSNI Guidance on CS Spray is available from the following website:

http://www.psnipolice.uk/cs-spray_amended_030206.pdf.

23 The ACPO Guidance on CS and PAVA Spray is available from the following website:

http://www.acpo.police.uk/asp/policies/Data/cs_pava_notes_for_guidance_update_april05_web_18_x05x05.doc.

24 The Committee on Toxicity research material on PAVA is available from the following website:

<http://www.advisorybodies.doh.gov.uk/cotnonfood/pava.htm>.

- 5.68 As no data was originally available on the reproductive toxicity of PAVA, a developmental toxicity study was commissioned to assess the potential of PAVA to produce such effects. The negative results from this study led the Committee to conclude that PAVA does not give rise to any concerns regarding developmental toxicity.
- 5.69 The third area where the Committee asked for further information in the original statement was skin sensitisation. Although a study was commissioned to address this area, the Committee questioned the quality of the work. Further evidence was gathered from the manufacturers of PAVA, which is also used in topical medical products. This evidence, taken together with experience from usage, indicated to the Committee that PAVA is not a skin sensitising agent.
- 5.70 The Committee did note the possibility of adverse effects in individuals suffering from asthma and recommended the continued monitoring of experience-in-use. The Committee also noted that although PAVA will irritate the eyes, the evidence suggests there are no concerns regarding long-term effects. However, they noted that more marked effects could occur in subjects wearing contact lenses.

Comparison of CS and PAVA

- 5.71 A report called Comparison of CS and PAVA²⁵ has also been produced to provide comparative information on both chemical incapacitants. The aim of the document is to aid police forces in their decisions on which incapacitant to use, and to provide information to practitioners and occupational health departments on the effects and likely outcomes of their use.
- 5.72 The information is presented in a comparison format to allow the reader to directly compare the attributes of the sprays. The information gathered for the section on operational Issues came predominantly from interviews with officers who had experience of using both types of spray, although some information came from other sources.
- 5.73 Taking the comments from officers as a whole, the main advantage of PAVA is its lower probability of causing cross contamination whilst the main advantage of CS is described as the reduced need for accuracy.
- 5.74 The statements on PAVA spray and CS spray from the independent standing expert advisory Committee on the Toxicity (COT), Mutagenicity and Carcinogenicity of Chemicals in Food, Consumer Products and the Environment are reproduced in Annexes 9 and 10. The statements support the use of either CS spray or PAVA by UK police adhering to the current guidelines.

25 The Comparison of CS and PAVA report is available from the following website:
http://scienceandresearch.homeoffice.gov.uk/hosdb/publications-2/weaponry-publications/Comparison_CS_and_PAVA?view=Standard&pubID=339521

- 5.75 It has been recognised that there are benefits and disadvantages of each spray, and as different forces have different operational needs it is better that the decision regarding which incapacitant to deploy is made locally, rather than as a national standard. It is conceivable that there may be a place for both within certain forces for use in different operational situations. A short comparison summary of the COT statements on CS and PAVA sprays is set out below.

	PAVA	CS
Accuracy	Has to get in the eyes to have an effect	Just has to hit the target to have some kind of effect
Effectiveness	Immediate if it gets in the eyes	Can take up to 20 - 30 seconds for full effect but some effects will be immediate
Effect on Dogs	Can work on dogs but may make them more angry	No Effect
Cross Contamination	Less cross contamination than CS but will still cause secondary effects in closed areas.	Can effect people in the vicinity, particularly in confined spaces
Flammability	The solvent in PAVA spray is flammable and burns with a blue flame (harder to see). It is less likely to ignite, for example on application of TASER, than the solvent in CS Spray.	The solvent can ignite, for example on application of TASER. It burns with an orange flame.

- 5.76 More recently HOSDB asked the COT for advice on the potential effects of exposure to both CS and PAVA. HOSDB reported that as the use of PAVA increases there is a clear possibility that use of both incapacitants on the same individual would occur.
- 5.77 For example, cross border use by British Transport Police who use PAVA attending an incident in an area where the local police force uses CS spray. A further scenario would be use of one incapacitant in the field and a different incapacitant in the prison/detention cell area. There might also be operational reasons for use of more than one incapacitant in the field.
- 5.78 The COT produced a statement²⁶ on the combined exposure to CS and PAVA which concluded that co-exposure is likely to result in, at most, additive effects on skin, eyes and respiratory tract in most individuals, although in some individuals, a lower response might occur as a result of desensitisation.

It has been recognised that there are benefits and disadvantages of each spray, and as different forces have different operational needs it is better that the decision regarding which incapacitant to deploy is made locally

26 The COT Statement on the combined exposure to CS and PAVA is available from the following website:
<http://www.advisorybodies.doh.gov.uk/pdfs/cspava06.pdf>

- 5.79 The COT recommended that police forces should flag all incidents where a police surgeon had been called to attend an incident or police station and that a summary of the number of such incidents (relating to CS or PAVA or combined exposure) should be made available, together with any available on whether exposed individuals experienced breathing difficulties.
- 5.80 The COT agreed that ACPO should be asked to consider surveillance for potential skin sensitisation among police officers.

Water Cannon.

- 5.81 The Steering Group's Fourth Report presented a summary of the historical use of water cannon in Northern Ireland, the introduction of water cannon vehicles into the PSNI and the availability of a national UK tactical option.
- 5.82 The testing of the vehicles as part of the procurement process and an assessment of medical implications, were also summarised. At the time of writing the Fourth Report, the final medical testing of the vehicles still needed to be undertaken due to mechanical problems encountered during the final acceptance of the initial vehicles. The modification to the vehicles involved alterations to the power train for the water pumps and pipe system. It was considered necessary that further testing of the vehicles was required before full acceptance, and issue of a formal independent medical statement.
- 5.83 Vehicles 001 to 004 were tested in February 2004 and the results reported to the DOMILL. Additionally, an updated review of the worldwide literature was undertaken to determine whether there were recent reports of injuries from water jets or water cannon.
- 5.84 Overall, there were no reported fatalities and very few serious injuries reported in the world literature as a result of the use of water cannon in public disorder situations. The additional testing used a force plate rig with multiple sensing elements described in the Fourth Report, and compared the results from this device, to known and predicted injury mechanisms and criteria.
- 5.85 In March 2004, DOMILL reviewed all of the available technical data in the context of the 'ACPO Guidance on the Deployment and Use of Water Cannon' and produced a statement on the medical implications of the use of water cannon. This statement was placed in the library of the House of Commons on 16 March 2004. This statement, the ACPO Guidance and training of officers underpinned the operational capability of the PSNI.
- 5.86 In April 2004, vehicles 005 and 006 were tested immediately after manufacture using the force plate rig. The test results were collated and compared to previous results; no significant differences could be identified in the output of all six vehicles.



PSNI RVC 9000 Water Cannon



Overall, there were no reported fatalities and very few serious injuries reported in the world literature as a result of the use of water cannon in public disorder situations

- 5.87 A substantial body of data was reported to DOMILL in late April 2004 and they declared that the extant statement encompassed the medical implications of use of vehicles 001-006.
- 5.88 As indicated in the Fourth Report, DOMILL produced a report on the medical implications on the use of the Somati vehicle mounted water cannon. This report was published and the text of the statement is reproduced in Annex 11.

Long Range Acoustic Device (LRAD)

- 5.89 HOSDB carried out an investigation into the Long Range Acoustic Device (LRAD). Its aim was to firstly assess and detail the inherent acoustic properties of this technology, and secondly to investigate the performance of the LRAD against a Police operational requirement.
- 5.90 An experimental programme was conducted to determine the suitability of this technology as an effective long range communication device for UK Police forces. This was implemented by assessing the performance of the technology against the Police operational requirement.
- 5.91 The operational requirement was produced by the ACPO Conflict Management Portfolio Working Group on Self-Defence, Arrest and Restraint in collaboration with HOSDB. The requirement is intended to cover a wide range of conflict management scenarios, including those associated with public disorder and security threats. The desired outcome is effective and intelligible communication up to a range of 150 metres, in a variety of environments, to firstly relay orders/commands and secondly to assist in determining the intent/threat of subjects.
- 5.92 Human assessment has shown that the LRAD produced effective and intelligible communications up to ranges of 150 metres at the trials conducted on the River Thames (land based communications to stationary marine vessels) and at Copehill Down Village (land to land based communications in a built up environment). However, it is important to note that these results were only achievable when using pre-recorded human speech samples played through the LRAD's MP3 player.
- 5.93 It was found that speech intelligibility was substantially reduced for live speech through the LRAD's microphone compared to pre-recorded speech. Therefore it can be stated that the LRAD is capable of meeting the requirement for effective and intelligible communication up to 150 metres, assuming pre-recorded samples are used and the environment and conditions are appropriate. Appropriate conditions include the background noise levels at the receiving position being below 65 dB and with no objects directly between the LRAD and receiving position (low destructive reverberation and reflection in the environment).



Long range acoustic device

An experimental programme was conducted to determine the suitability of this technology as an effective long range communication device

- 5.94 Although the LRAD does demonstrate some degree of directionality for the audio output, it is not capable of meeting the requirement for discriminate communication within a crowd. Hearing damage is the main concern related to exposure to the LRAD and indeed any noise generation device.
- 5.95 The LRAD system features a function to limit the audio output of the device. This function provides a degree of protection for users and subjects from hearing damage by limiting the maximum output. However the device could still cause possible hearing damage in the limited mode, particularly at short ranges. Therefore use of the LRAD should ideally be based on a risk assessment (ideally both generic and operationally specific) taking account of safe exposure levels.
- 5.96 This would require a significant number of judgement issues to be made by operators including assessing whether intended subjects, operators and unintended subjects are exposed to excessive and potentially unsafe sound levels. Another difficult judgement issue faced by operators could be determining the languages spoken/understood by the subjects and determination of understanding and compliance, particularly at longer ranges.
- 5.97 Only one long range communications device has been evaluated at this time, therefore it is impossible to gauge its performance against other devices on the market. Hence ACPO have requested that further work is conducted in this area by HOSDB, specifically to evaluate a larger range of commercially available long range communications devices to their operational requirements.

Although the LRAD does demonstrate some degree of directionality for the audio output, it is not capable of meeting the requirement for discriminate communication within a crowd

6 The International Context

The International Law Enforcement Forum

- 6.1 The first two meetings of the International Law Enforcement Forum (ILEF) on Minimal Force Options were held in the United States, at The Pennsylvania State University, in April 2001 and October 2002. These meetings focussed on less-lethal and minimal force concepts, technologies, and deployment at the expert practitioner level.
- 6.2 ILEF provides the opportunity for professional discussion by practitioners on the development of new concepts, operational analysis and operational requirements in the area of minimal force options and less lethal technologies.
- 6.3 Shortly after the publication of the UK Steering Group's Fourth Report, a third meeting²⁷ of ILEF took place, between 3 and 5 February 2004, in London.
- 6.4 This 2004 ILEF meeting was hosted by the UK Home Office Scientific Development Branch (HOSDB) and brought together representatives from the UK, US, Canada, Republic of Ireland, New Zealand, Finland, Sweden, and Norway. It explored the further development of the less-lethal weapons database and resource sharing; effectiveness and injury potential; tactics; and common standards for development, testing, training, and operational use.
- 6.5 Since then, the ILEF structure also provided a mechanism for an international peer review of the UK Steering Group programme leading up to the introduction of the Attenuating Energy Projectile (AEP).

The ILEF Vision

- 6.6 Work has continued to develop the structures necessary to provide an ongoing international platform for the discussion and development of practitioner needs for less lethal technologies. An ILEF Advisory Board was established and a vision and mission was developed as follows:
- 6.7 The ILEF vision is:

"A position in which the less lethal systems and emerging technologies are developed and introduced, in a way that best meets the needs of law enforcement agencies on an international basis, is through the development of internationally agreed approaches to:

- a) *operational requirements;*
- b) *the identification of effects;*



International Law Enforcement Forum

ILEF provides the opportunity for professional discussion by practitioners on the development of new concepts, operational analysis and operational requirements in the area of minimal force options and less lethal technologies

the ILEF structure also provided a mechanism for an international peer review of the UK Steering Group programme leading up to the introduction of the Attenuating Energy Projectile (AEP)

²⁷ A report of the Third ILEF meeting held in February 2004 is available from the following website:
http://ilef.nldt.org/documents/2004_ilef_report.pdf

- c) *standards in respect of the development and testing of individual technologies;*
- d) *sharing information on trialling and the monitoring of outcomes;*
- *in line with the mandate of Articles 2 and 3 of the United Nations Basic Principles on the use of Force and Firearms, and consistent with civil and human rights standards in the local jurisdictions”.*

The ILEF Mission

- 6.8 Against this background, ILEF was formed to develop the capabilities of the international law enforcement community, and those involved in peace-keeping missions, in relation to minimal force options and less lethal technologies. The objective is to enhance its collective ability to resolve potentially violent encounters, increase public and officer safety, and establish, maintain and improve public order, while safeguarding civil liberties and the human rights of all.
- 6.9 In doing this, the Forum provides the opportunity for professional discussion by practitioners on the development of new concepts, operational analysis and operational requirements in the area of minimal force options and less-lethal technologies. It also provides and fosters subject matter expertise in operations, policy, technical evaluation, testing, training, human/medical effects, accountability and law, both domestic and international.

The ILEF Approach

- 6.10 In undertaking this work, the Forum adopts the principles of openness and transparency in the publication of reports and outputs. The ILEF Advisory Board is maintained with representatives drawn from individuals and organisations currently involved with ILEF, who have demonstrated relevant subject matter expertise in the following areas:
- Policy Advice;
 - Operational Law Enforcement;
 - Technology;
 - Training;
 - Best Practice guidance; and
 - Information-sharing.
- 6.11 Much of the work of ILEF is done in a virtual way, by exchange of e-mail through the Electronic Operational Requirements Group (EORG). The EORG process enables relevant experts, who are geographically dispersed, to discuss and debate key topics involving less lethal weapons and reach an agreed position. As the name suggests, the Group has developed an operational requirements document²⁸ which sets out the International Law Enforcement community's requirements in respect of less lethal technologies.



<http://ilef.org> home page of The International Law Enforcement Forum

The EORG process enables relevant experts, who are geographically dispersed, to discuss and debate key topics involving less lethal weapons and reach an agreed position

²⁸ The report of the EORG is available from the following website:
http://ilef.nldt.org/documents/2005_mfo_report.pdf.

- 6.12 The Fourth ILEF meeting was held in Ottawa, Ontario, Canada between 21 and 23 June 2005 and was hosted by the Royal Canadian Mounted Police (RCMP).
- 6.13 In organising and conducting the Forum, the RCMP was supported by the Institute of Non-Lethal Defence Technologies from Pennsylvania State University, with assistance from the US National Institute of Justice. The Forum addressed many issues relating to less-lethal technology research, development, testing, training standards, oversight and accountability.
- 6.14 Delegates from represented countries, disciplines and police departments examined: less-lethal weapons terminology and taxonomy; standards for testing, reporting, development and assessment; risk management; training; and information sharing.
- 6.15 There were six distinct workshop sessions in which the delegates participated: Development of Testing Standards; Accountability, Oversight, Review and Investigation; Medical and Psychological Effectiveness; Operational Policing - Strategic and Tactical Command Issues; Operational Policing - Tactics and Training Issues; and New Threats, Capability gaps, and New Technologies.
- 6.16 On the final day, there was an open session of ILEF to which the Chief Executives of leading less-lethal companies were invited. The purpose was to share the ILEF operational requirement for less-lethal technologies and to create a productive engagement leading to improved product development, which best reflected the requirements of the international law enforcement community's needs. This proved to be a meaningful session and represented the commencement of an ongoing interaction on a collective basis between ILEF and those involved in the manufacture and supply of less lethal technologies.
- 6.17 ILEF is also looking to extend its membership, including the development of closer working relationships with the European Working Group on Non-Lethal Weapons and contacts in Australia. ILEF produced a full report²⁹ of the 2005 proceedings.

International Peer Review of the Steering Group Methodology

- 6.18 In August 2004, a team representing the Steering Group visited Washington to undertake, with ILEF representatives and others from across the law enforcement spectrum, a peer and process review³⁰ of the methodology adopted by the Steering Group in its approach to the development of less lethal technologies.

29 A report of the ILEF 2005 proceedings is available from the following website:

http://www.nldt.org/documents/2005_ILEF_Report_FINAL.pdf

30 A report of the peer and process review is available from the following NIO website:

http://www.nio.gov.uk/international_law_enforcement_forum_-_visits_and_meetings_in_washington_august_2004.pdf?keywords=less+lethal+



Less-Lethal Weapons: Definitions and Operational Criteria, February, 2005

The purpose was to share the ILEF operational requirement for less-lethal technologies and to create a productive engagement leading to improved product development, which best reflected the requirements of the international law enforcement community's needs

- 6.19 The review concluded that the UK programme and process was comprehensive and thorough, especially in relation to methodology, scientific and medical evaluation, as well as the development of ACPO Operational Guidance on the use of the respective technologies.
- 6.20 The open publication of the work of the Steering Group, post-use reviews and published reports by the Independent Police Complaints Commission and the Northern Ireland Police Ombudsman has been recognised as being essential and important elements in progressing the issue of less lethal technologies. It also recognised that there were remaining issues, including matters in relation to training and tactics, consultation, and ensuring that there was public support for policing.
- 6.21 The Steering Group also stressed the importance of developing these issues within the international context of ILEF. It was also the view of the peer review group that the approach of the UK Steering Group could serve as a model process.

International Less Lethal Weapons Database

- 6.22 The International Less Lethal Weapons Database³¹ has been developed by HOSDB in response to recommendations made by ACPO, ILEF and the European Working Group on Non-Lethal Weapons.
- 6.23 The database aims to provide an independent and structured tool allowing access to original, open source material relating to less lethal weapons. The database was launched at the 2005 ILEF meeting in Ottawa, Canada, and demonstrated at the European Working Group meeting held in September 2005 in Belfast and at the Jane's International conference on less lethal weapons held in Leeds in October 2005.
- 6.24 The database is initially available to law enforcement, government, military and research organisations, who supply information for inclusion in the database. This will allow and encourage the database to be populated with information from a number of international sources. It contains publicly available information supplied by the original source, such as research or evaluation projects, aims and objectives.
- 6.25 The database contains 6 sections relating to different aspects of less lethal technologies:

Section 1: International Use of Less Lethal Technologies

This section provides information on the current range of less lethal systems used by law enforcement and military organisations internationally.

The review concluded that the UK programme and process was comprehensive and thorough

The database aims to provide an independent and structured tool allowing access to original, open source material relating to less lethal weapons

³¹ The Database is available from the following website: <http://ilef.nldt.org/database.html>.

Section 2: International Evaluation of Less Lethal Technologies

This section provides information on technical and medical evaluations conducted internationally into commercially available less lethal weapon systems.

Section 3: International Deployments of Less Lethal Technologies

This section provides information on previous occasions when less lethal weapons have been deployed and used operationally by law enforcement or military organisations.

Section 4: International Research and Development of Less Lethal Technologies

This section provides information on research and development projects being conducted internationally into new less lethal technologies or new systems.

Section 5: International Agencies working on Less Lethal Technologies

This section provides contact details of international agencies working in the field of less lethal technologies.

Section 6: International Manufacturers of Less Lethal Technologies

This section provides links and contact details for manufacturers producing commercially available less lethal weapons systems.

Commercial off the shelf product evaluations and update

- 6.26 HOSDB has not been presented with any new fully developed technologies to evaluate from the commercial sector. The large amount of work that resulted in the comparison of the 12 gauge sock round to the L21A1 baton round (reported in the Steering Group's Fourth Report) has already established that certain generic types of round, such as sock rounds and bean bag rounds, are very unlikely to match the accuracy and predictability of the AEP.
- 6.27 Feedback from the peer review carried out in August 2004 in Washington established that the L21A1 is seen as a benchmark to measure the performance of other rounds. As a consequence of this, the Steering Group has indicated that it will no longer actively seek alternative commercially available impact or chemical delivery rounds at this time.

the L21A1 is seen as a benchmark to measure the performance of other rounds

- 6.28 However, HOSDB will continue to monitor the international situation and availability of alternative less lethal options against the UK requirement, including the Advanced Ring Aerofoil Projectile (ARAP). Any emerging developments will be notified to the Steering Group and ACPO and, where there is potential, evaluated for suitability.

European Working Group on Non Lethal Weapons (EWG-NLW)

- 6.29 During 2004, the UK Steering Group decided to extend its range of international contacts to include the EWG-NLW. It was intended that this contact would:
- Ensure the Steering Group was further informed of developments in less lethal technologies across Europe;
 - Ensure the Steering Group was kept apprised of how less lethal systems were used in the European Union and beyond;
 - Encourage developers and researchers to take account of users needs when developing new less lethal concepts; and
 - Seek to encourage better co-operation between groups involved in less lethal technologies.
- 6.30 The EWG-NLW objective is to promote non-lethal weapons issues and research, the development of expertise, the coordination of activities, and the initiation of cooperation within the field of non-lethal options including:
- *“homeland security,*
 - *law enforcement,*
 - *peace support operations and*
 - *reduced collateral damage in armed conflict situations by:*
 - *exchange of information,*
 - *investigation of possibilities for joint projects within european and international programmes, and*
 - *conceptual and requirement discussions with non-participating nations and industry”.*
- 6.31 Representatives of the Steering Group have attended a number of meetings of the EWG-NLW and made a presentation to an international symposium of the EWG-NLW in May 2005 on the introduction of AEP and the overall UK programme of alternative ways of managing conflict.
- 6.32 Following the symposium, the EWG-NLW held one of its regular meetings in Northern Ireland. As well undertaking the normal business of the Group, the opportunity was taken to engage members of the Group on issues relevant to Northern Ireland. Furthermore they had an opportunity to see both AEP training and the water cannon.
- 6.33 The representatives of the Group reported that they had been impressed with police training, the AEP and water cannon, as examples of advanced less lethal technologies. They also felt that the EWG-NLW achieved a greater understanding of the depth and nature

HOSDB will continue to monitor the international situation and availability of alternative less lethal options against the UK requirement

of the potential for public disorder in Northern Ireland, as well as the importance of giving police various options to deal with disorder.

- 6.34 Progress has also been made to encourage co-operation between international groups. The international less lethal weapons database, mentioned earlier in this section, is an example of how the UK in conjunction with ILEF and the EWG-NLW has made arrangements for more effective information sharing. It is hoped that over time there may be further opportunities for co-operation between the UK, ILEF and EWG-NLW.

The Stern Commission

- 6.35 The UK Steering Group was particularly interested in a report published by the Stern Commission³². The Commission was appointed by the Police Commissioner of Boston Police Department, Kathleen M O'Toole³³, to examine issues arising from the tragic death of an 18 year old college student, Victoria Snellgrove, who was struck by a less lethal projectile fired by a Boston Police officer.
- 6.36 The incident occurred in October 2004 when the young woman was part of a group celebrating the Red Sox's victory over the Yankees in the American League series. The celebrations resulted in large crowds gathering in the area surrounding Fenway Park. The Commission report records that:

"the crowds were exuberant but mostly peaceful....A small minority seemed intent on public disorder and violence, in some cases throwing objects at the police destroying public and private property and lighting fires. In Kenmore Square and on Boylston Street that Department acted with restraint and discipline, and controlled the crowds.

Although the police units in these areas were called upon to deploy less-lethal weapons, there were no reported injuries. In contrast, on Landsdowne Street where Victoria Snellgrove was standing, very little went right: one person died and two others were injured in the face by shots from one particular weapon known as the FN 303".

- 6.37 The FN 303 is an impact projectile weapon which uses compressed air to fire a 0.68 inch diameter or 68 calibre (approximately 12 gage) blunt nose projectile, weighing 8.5 grams at a maximum muzzle velocity of 300 feet per second. The FN303 weapon uses primarily the pain induced from the blunt trauma impact of the projectile to produce a desired effect. The impact force is greater than that from a paint ball type weapon, but much less than that from a typical bean bag fired from a shot gun, or a baton round fired from a larger diameter launcher.

32 The Stern Commission Report is available from the following website:

<http://www.cityofboston.gov/police/pdfs/report.pdf>

33 The Boston Police Commissioner Kathleen M O'Toole was a former member of the Independent Commission on Policing, chaired by Chris Patten.

6.38 The Commission, while addressing issues associated with the characteristics of this particular weapon system, also focused on issues associated with the planning of the operation and training of officers in the use of less lethal weapons.

6.39 In summary, the Commission concluded that:

“inadequate planning and training, combined with a breakdown of command discipline set up a situation ripe to produce an unintended result”.

“The critical issues for anyone using such a device (not just the FN303, but other impact projectile systems as well) involves understanding that such risks are present, and that users must be thoroughly trained to ensure they get this message (and tested to prove they have learned it). In addition, they have to field test the system enough to ensure that they can hit their target. There is scant evidence to suggest that this understanding, training, or testing (written or field) occurred in Boston”.

6.40 The Commission made the following recommendations:

- Improve the planning process for managing large-scale events by incorporating scenario training and table-top exercises;
- Clearly delineate roles of commanders in each operational plan;
- In the planning for sporting events, obtain the co-operation of educational and business communities;
- Review Use-of-Force policies;
- Develop weapon-specific use-of-force policies for each lethal weapon;
- Restrict use of less-lethal weapons to certified officers;
- Improve the less-lethal weapon procurement process by establishing a detailed written protocol;
- Designate a lead officer for less-lethal weapon procurement;
- Improve training of police officers on less-lethal weapons to include instruction on the role and use of each weapon;
- Further tests on the Department’s FN 303 should be completed;
- Create national standards for certification of less-lethal weapons; and
- Establish a police-civilian injury board to review injuries to officers and civilians resulting from uses of force.

6.41 Notwithstanding the criticism of the Boston Police Department over this incident, the Commission clearly distinguished between the inappropriate use of a less-lethal weapon and the position of pressure groups and organisations who are keen to advance the cause for reducing the capacity of the police to resort to less-lethal options.

The Commission, while addressing issues associated with the characteristics of this particular weapon system, also focused on issues associated with the planning of the operation and training of officers in the use of less lethal weapons

The Stern Commission said: “inadequate planning and training, combined with a breakdown of command discipline set up a situation ripe to produce an unintended result”

6.42 The Commission, in this regard, concluded that:

“the use of less-lethal weapons by law enforcement offers some promising benefits. We want to raise cautionary flags not to discourage police departments from considering such weapons. There are instances where, when properly used, less-lethal weapons can reduce the likelihood of death or serious injury. But, we believe that those situations will be rare. More often the availability of less-lethal weapons provides law enforcement with additional tools to arrest a person, to disarm a person, or to handle public order situations.

However there are risks. Less-lethal does not mean non-lethal. Indeed, these very terms provide mixed, and at times, confusing messages. Less-lethal weapons can cause serious injury and even death. Moreover, the introduction of certain less-lethal weapons can actually increase the frequency and severity of injuries, unless safeguards are in place. So, we urge caution and care, not wholesale rejection of less-lethal weapons”.

6.43 The Steering Group believe that these conclusions are as applicable to the international law enforcement community, as they are to Boston Police Department. It is for this reason that the UK approach has been to adopt a ‘systems approach’ to the selection, testing, storage, carriage and use of less lethal weapons and munitions, which also includes the operational guidelines for use, as well as the post use audit and accountability arrangements that are in place.

6.44 In the context of the information contained in the Steering Group’s Fourth Report, and this Fifth Report, it is evident that the concerns and generic recommendations of the Stern Commission parallel many of those addressed by the Steering Group. In particular, the emphasis which has been developed in the UK on how potential conflict situations should be managed, including the importance of safeguards such as event planning and command protocols, and how, when necessary, less lethal technologies should be used. This includes the stringent training requirements, operational guidance and oversight structures which are now in place.

The Barr Tribunal Report

6.45 The UK Steering Group also noted a recent report published by the Barr Tribunal³⁴ in the Republic of Ireland set up to review the tragic circumstances surrounding the fatal shooting of John Carthy at Abbeylara, County Longford on 20 April 2000.

6.46 Part of the remit of the Tribunal was to consider whether alternative measures to live ammunition could have been used to deal with the threat posed by John Carthy. This involved an examination of ‘less lethal’ options and particularly, in the first instance, what options were available to the Garda Síochána; and secondly, what options, if any, were available internationally in April 2000.

The Stern Commission said: “There are instances where, when properly used, less-lethal weapons can reduce the likelihood of death or serious injury”

“However there are risks. Less-lethal does not mean non-lethal”

“So, we urge caution and care, not wholesale rejection of less-lethal weapons”

the UK approach has been to adopt a ‘systems approach’ to the selection, testing, storage, carriage and use of less lethal weapons and munitions, which also includes the operational guidelines for use, as well as the post use audit and accountability arrangements that are in place

³⁴ The Barr Tribunal Report is available from the following website:
<http://www.mulley.net/BarrTribunalReport/BarrTribunalReportChapter11.html>

- 6.47 It is noteworthy that the Tribunal concluded that TASER®, would seem to have had a greater prospect of success of averting the situation than any other less lethal option, if available at Abbeylara. Furthermore, the Tribunal recommended that the Garda should carry out research with a view to deciding whether TASER® should be adopted as part of their armoury and the inclusion of instruction in its use in their training regime.

7 The Way Forward

- 7.1 In terms of the Northern Ireland context, of the **175 recommendations** made by the Patten Commission, nine covered Public Order policing.
- 7.2 Specifically, 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)”*.
- 7.3 As we have already indicated, the UK Steering Group, initially established to take forward the Patten recommendations, has brought together a wide range of senior police officers, practitioners and others with invaluable expertise, in terms of operational, technical and scientific knowledge and experience.
- 7.4 This has aided the development programmes to establish new less lethal weapon systems that meet the criteria of being both effective and less potentially lethal. In terms of community acceptability, however, the Steering Group is aware that ultimately this will be gauged on a societal rather than a practitioner level.

Consultation and Human Rights

- 7.5 At the societal level, use of less lethal weaponry in Northern Ireland remains a deeply sensitive issue. There remain a number of pressure groups and organisations who are opposed to their existence in any form. This was a contributory factor in the Steering Group’s decision that the third day of the 2004 International Law Enforcement Forum (ILEF) Conference would concentrate, amongst other issues, on human rights, and would facilitate a new approach for engagement with these organisations.
- 7.6 The conference³⁵ took place at the Royal Society of Arts in London on 5 February 2004, on the theme of Article 2 of the UN Basic Principles on the Use of Force and Firearms which states that:
- “Governments 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”*.
- 7.7 Invited organisations included: Amnesty International; MIND; the Pat Finucane Centre; Relatives for Justice and Save the Children. Speakers included: Denis Bradley (the then Vice Chairman of the Northern Ireland Policing Board); Nuala O’Loan (Police Ombudsman for Northern Ireland); and Chief Constable Paul Acres (ACPO). The discussions that followed the speakers’ presentations provided a unique opportunity for represented groups to have their views heard.

35 A report of the third day of the ILEF Conference is available from the following website:
http://www.nio.gov.uk/report_on_the_3rd_day_of_the_international_law_enforcement_forum_5_feb_2004.pdf?keywords=ilef

In terms of community acceptability, however, the Steering Group is aware that ultimately this will be gauged on a societal rather than a practitioner level

- 7.8 Encouraged by the response received on the third day of the Conference, NIO members of the Steering Group undertook to meet with concerned groups, to follow up on the progress that had been made.
- 7.9 In Summer 2004, a series of meetings were held with representatives from: British Irish Rights Watch; Children's Law Centre; Committee for the Administration of Justice; Northern Ireland Human Rights Commission; the Pat Finucane Centre; Relatives for Justice; and Save the Children. Each of these gatherings offered a productive exchange of views.
- 7.10 As well as seeking to gauge the views of these groups, there were two main objectives for these meetings: to explain the rationale for internationalising the work of the Steering Group; and to keep the invited parties up to date, with regard to the development of AEP and DIP.
- 7.11 One of the main concerns of these groups was the use of less lethal technologies, particularly the use of AEP impact rounds, in situations where children and other vulnerable groups may be present. It is widely acknowledged by practitioners that the safety of children and all persons present when less lethal technologies are used is of paramount importance.
- 7.12 The tragic deaths of eight children that are associated with the use of earlier baton round systems in Northern Ireland remains an emotive issue. Interest groups have continued to highlight a number of incidents where these technologies have been used against children and other vulnerable people.
- 7.13 The importance of this should not, and has not, been ignored. It is notable that a paediatrician was directly involved in the independent review of the medical implications of the AEP, an even less potentially lethal alternative to the L21A1 system, which itself had never been associated with a fatality in Northern Ireland.
- 7.14 The independent medical evaluation had also direct access to scientific evidence and to a wide source of paediatric medical advice that enabled it to address the potential implications of the AEP system on children. Their statement, declaring that the AEP is less hazardous to the head than the L21A1, applies to men, women and children.
- 7.15 The ACPO guidance on the AEP includes specific reference to Article 3C of the United Nations Code of Conduct for Law Enforcement Officers. The use of firearms is considered an extreme measure, and every effort should be made to exclude the use of firearms, especially against children. In general, firearms should not be used except when a suspected offender offers armed resistance or otherwise jeopardizes the lives of others, and less extreme measures are not sufficient to restrain or apprehend the suspected offender. Although the UN Code of Conduct for Law Enforcement Officers does not apply to the Armed

One of the main concerns of these groups was the use of less lethal technologies, particularly the use of AEP impact rounds, in situations where children and other vulnerable groups may be present

it is notable that a paediatrician was directly involved in the independent review of the medical implications of the AEP

Forces in Northern Ireland the issue of children is vigorously addressed during Judgmental Training, which is a mandatory annual training requirement for all Riot Gunners.

- 7.16 With regard to concerns that guidance might not be followed, it is important to highlight that the stringent accountability measures which covered the use of L21A1 in Northern Ireland have subsequently been extended to cover AEP.
- 7.17 Within 24 hours of an incident where AEPs are discharged, the PSNI supply a report on the incident to the Northern Ireland Policing Board. In addition, each time the system is used, the circumstances are investigated by the independent Police Ombudsman, who reports her findings to the Policing Board. Each use must be judged on whether it was proportionate to the situation that was faced and in accordance with the guidance, which states that impact rounds must only be fired in direct response to **individual** violent aggressors.
- 7.18 The military also conduct stringent post firing procedures. Any firing is accompanied by an Impact Round Report (IMPACTREP); the Independent Assessor of Military Complaints Procedures is informed; and the Royal Military Police investigate the circumstances surrounding the firing to ascertain whether engagements were within the guidelines. In any cases where there was doubt as to the legality of firings, PSNI would conduct an independent investigation.
- 7.19 The stringent guidance which is enforced by these accountability measures allow us to counter strongly the idea that impact rounds are being used as an 'indiscriminate means of crowd control'.
- 7.20 The Steering Group acknowledges that there may be a perception that there has been an excessive focus on science and technology at the expense of human rights. However, a strong focus on science and technology is vital. Without the internationally recognised scientific expertise at our disposal, it would not have been possible to produce an even safer alternative to the previous L21A1 system.
- 7.21 What is vitally important, however, is the Steering Group's clear unified view that this strong focus on technology is in no way incompatible with a strong focus on human rights. A search for an even safer alternative necessarily seeks to contribute to the human rights of all concerned parties: the human rights of police officers who must be equipped to deal safely and effectively with violent individuals who are endangering themselves or those around them; and the human rights of the wider community who must be afforded protection from such aggressors.
- 7.22 We also recognise that violent individuals have human rights, despite their actions. Violent individuals do not forfeit their right to life despite their actions, and should always be afforded, wherever possible, protection from long term or lethal injury.

it is important to highlight that the stringent accountability measures which covered the use of L21A1 in Northern Ireland have subsequently been extended to cover AEP

More importantly, it remains the case that if technologies such as the AEP were not available, then there would be situations, as the Patten Commission acknowledged, that would necessitate the need to revert to live ammunition

- 7.23 The AEP impact round now in service is of a completely different design and is used under very different guidance from the baton rounds that were in service when the Patten Commission reported. Also, a broader range of less lethal equipment has since been introduced and ACPO guidance has been issued across the whole range of technologies.
- 7.24 More importantly, it remains the case that if technologies such as the AEP were not available, then there would be situations, as the Patten Commission acknowledged, that would necessitate the need to revert to live ammunition. This would vastly increase the risk of injury and fatality to the individual aggressor, the police and the wider community.
- 7.25 The UK Steering Group, ACPO, and all those involved in the development programme for less lethal technologies are simply not prepared to take that risk. This is why the Steering Group can confidently convey to all interested parties that the search for an effective range of less lethal technologies is, necessarily, a quest to maximise the human rights of all parties, be they community, police or aggressor.

Engaging with Interested Parties

- 7.26 Finally, following the publication of this Fifth Report, the NIO and the UK Steering Group would welcome the opportunity to re-engage and meet groups who have a specific interest, and importantly a specific insight, into the issue of less lethal technologies.
- 7.27 To that end, the NIO, on behalf of the UK Steering Group, has written to all interested parties and organisations welcoming comments and, if requested, meetings on the way forward. A summary of our approach follows:

Pre-dialogue Phase:

- Communicate with groups and organisations, welcoming comments and offering meetings.

Dialogue Phase:

- Receive written comments and / or hold meetings;
- Acknowledge input / feedback;
- Assess responses; and
- Pursue additional issues with key respondents.

Post-dialogue Phase:

- Circulate responses to groups and organisations;
- Prepare Response Report to include: highlighting areas of broad agreement and identifying areas of disagreement; and
- Publish Response Report on NIO website and circulate to interested parties.

- 7.28 If you are an individual or an organisation who have not received communication from the NIO following the publication of this report, we would also welcome your comments on its contents and views on the way forward.

Written comments should be sent to:

The Secretary of the UK Steering Group
Room B4.22
Block B
Castle Buildings
Stormont
Belfast
BT4 3SG

or by email to: uksteeringgroup@nio.x.gsi.gov.uk

GLOSSARY OF TERMS

ACRONYMS and ABBREVIATIONS

ACPO	Association of Chief Police Officers
ACPOS	Association of Chief Police Officers Scotland
AEP	Attenuating Energy Projectile
CS	2-Chlorobenzylidene Malononitrile
CSOME	Certificate of Safety Ordnance Munitions and Explosives
DIP	Discriminating Irritant Projectile
DOMILL	DSAC Sub-Committee on the Medical Implications of Less-Lethal Weapons
DOSG	Defence Ordnance Safety Group
DSAC	Defence Scientific Advisory Council
DSTL	Defence Science and Technology Laboratory
EWG-NLW	European Working Group on Non Lethal Weapons
HOSDB	Home Office Scientific Development Branch (formerly known as Police Scientific Development Branch)
ILEF	International Law Enforcement Forum
MOD	Ministry of Defence
NIO	Northern Ireland Office
PAVA	Pelargonic Vanillylamide
OSC	Operational Sub-Committee
PBR	Plastic Baton Round (generally referred to as baton round)
PSNI	Police Service of Northern Ireland
TASER	Thomas A Swift's Electrical Rifle (from the Tom Swift fantasy stories)
TSC	Technical Sub-Committee

DEFENCE ORDNANCE SAFETY GROUP (DOSG)

SAFETY ADVICE ON USE OF L21A1 IN TRAINING

INTRODUCTION

The current in-service Anti-Riot Round used by UK Security Forces is the Round Anti-Riot 37mm Baton L21A1. These rounds are fired through the L104A1 gun. It is now intended to replace this ammunition with a new round developed by Dstl Porton Down, designated Round 37 mm AEP L60A1. The L60A1 rounds will also be fired through the existing L104A1 gun.

Operator training and qualification using the L60A1 AEP will commence during February 2005 and will deploy operationally from June 2005. Current stocks of outgoing L21A1 round will still be high when they reach the end of their 18 month service life, which coincides with the introduction of the L60A1 AEP.

DOSG has been tasked (Ref A) by DGM IPT, to make a recommendation on the Safety of the L21A1 following a change of use from an operational round to a training round, for use within the UK. Also to give advice on an extension of service life for the L21A1 round.

AIM

The aim of this document is to provide advice on the safety of an extension of life and the suitability for service of the L21A1 round as a training only round.

INFORMATION

In Service History

The L21A1 round has been in service since 2001. There have been no reported incidents of a safety nature to cause concern over the design of the current round. An improved version of the round to rectify certain identified shortcomings in performance was proposed for the future. However, given the introduction of the L60A1 AEP the intended improvements were incorporated into that round. These shortcomings do not impinge on safety or usage of the round within its current operating parameters.

RECOMMENDATIONS

DOSG recommends that the L21A1 round will remain safe and suitable for service as a training round, with the following provisos:

- All L21A1 rounds are withdrawn from operational use;
- All L21A1 rounds are set aside and containers are marked " For Training Use Only";
- Where possible and practical all L21A1 rounds should be stored separately from L60A1 AEP rounds;
- The extension of life for the L21A1 round will be for 18 months from the successful completion of the DSTL Porton Down in-service proof;
- The storage and operating temperature for the L21A1 round of between -21oC and 40oC will remain extant.

If a further extension is required this will be the subject of separate DOSG advice.

DSAC Sub-committee on the Medical Implications of Less-lethal Weapons (DOMILL).

Statement on the comparative injury potential of the Attenuating Energy Projectile (AEP) L60A1, and the L21A1 Baton Round.

Introduction

1. This statement has been produced by the Defence Scientific Advisory Council (DSAC) subcommittee on the Medical Implications Of Less-Lethal Weapons (DOMILL). It provides an independent view for the UK Government on the medical implications of the use of the Attenuating Energy Projectile (AEP) L60A1 system in the UK, within the policy and guidance of the Association of Chief Police Officers (ACPO), and the UK Armed Forces. Specifically, it compares the predicted medical risks associated with AEP, and the L21A1 Baton Round; both are fired from the L104A1 Gun Riot fitted with an L18A1/A2 weapon sight.

The Attenuating Energy Projectile (AEP) L60A1

2. **Role:** The AEP is a projectile designed to deliver an impact to a violent individual in order to dissuade or prevent an intended course of violent action, and thereby mitigate the threat to law enforcement personnel and members of the public. It is not intended to cause serious or life-threatening injury.
3. **Requirement:** The AEP is a potential replacement for the L21A1 Baton Round. It has been developed by the UK Government and forms part of its response to:
 - a. a recommendation in DSAC's statement on the medical risks of the L21A1, to undertake research on energy attenuation features for future kinetic energy projectiles, in order to reduce the severity of head injuries.³⁶
 - b. recommendations 69 and 70 in the report of the Independent Commission on Policing for Northern Ireland (the Patten report)³⁷ to find an acceptable, effective and less potentially lethal alternative to the Baton Round;
 - c. its desire, supported by the Association of Chief Police Officers (ACPO), to offer appropriately trained police officers a broader range of less-lethal systems for use against violent individuals in the management of conflict.
4. The research and development of the AEP has been undertaken by a multi-departmental Steering Group, in consultation with ACPO. The Steering Group is chaired by the Northern Ireland Office (NIO). Reports summarising the work of the Steering Group are available on the NIO web-site³⁸.
5. The AEP has been developed by Government principally because despite an exhaustive review and assessment of commercially available less-lethal weapons (LLW) reliant on impact or the threat of impact for effectiveness, no system met the operational, technical or safety requirements of the Steering Group.

36 Statement on the comparative injury potential of L5A7 baton round fired from the L104A1 Anti-riot gun using the battle-sights, and the L21A1 baton round fired using the XL18E3 optical sight". Defence Scientific Advisory Council. 21 August 2000.

37 "A New Beginning: Policing In Northern Ireland". The report of the Independent Commission on Policing for Northern Ireland. September 1999.

38 "Patten Report recommendations 69 and 70 relating to public order equipment: A research programme into alternative policing approaches towards the management of conflict". Four reports on Phases 1-4 prepared by the Steering Group led by the Northern Ireland Office, in consultation with the Association of Chief Police Officers. www.nio.gov.uk/policing.

6. **Timescales:** The development of the AEP has been undertaken with some urgency, to fulfil the Government's requirements regarding alternatives to the Baton Round. The Steering Group required that, subject to satisfactory development, manufacturing capability, safety and suitability assessment, training and Strategic Audit, the AEP should be available for use by 31 December 2004. Subject to Ministerial approval, full operational deployment is scheduled for 21 June 2005.
7. **Further reduction of the risk of serious injury:** The principal life-threatening hazard from the impact of Baton Rounds is injury to the brain resulting from the transfer of energy through the overlying skull. There is also a risk of direct damage to the brain from fragments of fractured skull, or from the intruding projectile. The operational frequency of this injury is very low.
8. The L21A1/L104A1 system is an accurate and consistent system, and is designed to minimise the risk of the projectile striking the skull, or the chest. The technical performance is complemented by operational guidance and appropriate training. Its operational use, and the medical issues arising, are reviewed annually by DOMILL.
9. The AEP is a new LLW system. The principal technical requirements of the AEP with regard to risk of serious and life-threatening injury are that:
 - a. it should reduce the clinical consequences of an inadvertent impact to the head, compared to the L21A1;
 - b. its accuracy and consistency should at least match those of the L21A1, to maintain the very low risk of impact to the vulnerable areas of the body.
 - c. The AEP is designed to have the same mass and velocity at the gun muzzle as the L21A1.
10. **Principle of operation:** The energy attenuating feature of the AEP is a void in the nose of the projectile. The collapse of the void extends the duration of the impact forces, and thereby reduces the peak force on a stiff surface such as the skull. Distortion of the nose will also increase the contact area and distribute the forces over a larger area (i.e. a reduction in the average pressure). Energy is also expended by doing work on the nose during its collapse.

Role of DOMILL

11. DOMILL reports to the Secretary of State for Northern Ireland and the Secretary of State for the Home Office, as appropriate. The tasks, technical support and the distribution of DOMILL statements are coordinated through the Biomedical Sciences Department, Defence Science and Technology Laboratory (Dstl) at Porton.
12. The role of DOMILL is to provide:
 - a. advice on the biophysical, biomechanical, pathological and clinical aspects of generic classes of LLW;
 - b. independent statements on the medical implications of use of specific LLW systems given specific guidance to users;
 - c. advice on the risk of injury from specific LLW 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.

13. DOMILL was requested by the Steering Group to provide this statement for Ministers on the medical implications of the operational use of the AEP in the UK. This statement assumes that the system is used and maintained within ACPO and UK Armed Forces policy and guidance for the AEP, and that the system is zeroed according to the extant policy.
14. The technical data to support DOMILL's considerations were produced by Dstl and its contractors. The technical plan for the work was produced by the Official Member of DOMILL, and subsequently reviewed and endorsed by DOMILL in May 2004.

Technical work areas

15. A substantial body of work was undertaken to compare the hazards and risks from the AEP and L21A1. The principal technical work areas were:
 - a. Firing trials: a comparison of the dispersion and average trajectories of the AEP and L21A1 over their operational range, and ammunition temperature specifications.
 - b. Basic interactions: physical tests and mathematical modelling to characterise and contrast the performance of the AEP and L21A1 against targets of different stiffness, and the change of this performance with ammunition temperature.
 - c. Skull and brain injury: one physical model and two independent mathematical models were used to compare two indices of clinical risk for the two LLW systems:
 - skull fracture frequency and type (including intrusion of projectile and bone into the brain);
 - stresses in the skull, and pressures generated within the brain.
 - d. Skin/body wall penetration: mathematical and physical models were employed to compare stresses on the abdominal skin surface, and the effects of those stresses.
 - e. Non-penetrating (blunt) impact to torso: a physical model of the chest wall was used to compare the chest wall peak displacement and peak wall velocity; these responses indicate the risk of chest injury.
 - f. Post-ricochet injury potential: a public-order training facility in Northern Ireland was used to compare the speed, orientation and trajectory post-ricochet of the AEP and L21A1 after contact with complex surfaces such as rubble.

Conclusions

16. **Accuracy and consistency:** The AEP is at least as accurate and consistent as the L21A1, and in some respects is superior. The risk of impact to vulnerable areas such as the head and the chest will not exceed the already low risk of such impacts from the L21A1.
17. **Skin penetration:** The risk of skin penetration from the L21A1 is very low operationally; the AEP will have a lower risk.
18. **Non-penetrating torso injury:** Although the peak velocity of the chest wall was predicted to be lower with the AEP, the magnitude of the reduction is unlikely to offer significant benefits in the hazards to the chest wall and contents, upon impact to that body region. The AEP does not offer a greater hazard to the chest than the L21A1.

19. The hazard to the abdominal contents from the two projectiles is likely to be the same.
20. **Post-ricochet risk:** There is no evidence that AEP has a greater post-ricochet risk to personnel, nor that it is likely to offer significant benefit (notwithstanding the energy attenuation features in its nose, should a post-ricochet impact occur in this orientation).
21. **Head injury:** Both mathematical models of the interaction of the projectiles with the skull showed that the stresses in the bones of the skull, and the energy transferred to the brain were consistently less with the AEP. The severity and incidence of skull fracture is likely to be lower with the AEP, and should a fracture occur, the intrusion into the brain will be less. The AEP will result in less damage to the brain and the overlying skull than the L21A1, if an impact to this region occurs.
22. The clinical impact of the reduction in damage to the brain and overlying skull from the AEP cannot be assessed confidently because of limitations in current models for this type of impact. Notwithstanding the uncertainties in the actual clinical consequences, the AEP certainly demonstrates the potential for less severe clinical outcomes, compared to the L21A1.

Summary

23. The risk of serious and life-threatening injury to the head from the AEP will be less than that from the L21A1 Baton Round, which already has a low risk of such injury.

Recommendations

24. DOMILL re-affirms the recommendation in its statement on the L21A1, that operational research should be undertaken on the features of kinetic energy based weapon systems that are intrinsic to their use as deterrents, in order to provide the analysis tools for maintaining the required operational effectiveness but at a reduced risk of life-threatening injury. Specifically, there should be a prospective study of the operational effectiveness of the AEP in the hands of all users. The independent audit undertaken on the trial of the M26 Advanced Taser may be an appropriate model.
25. Twelve months after the first operational use of the AEP (and yearly thereafter), the Home Office should provide DOMILL with a report outlining the circumstances of every use of the AEP, the post-incident medical assessments undertaken by the Forensic Medical Examiners (FME), and the clinical consequences noted by the FME or clinical staff. DOMILL should be advised as soon as practical of any injury that could be classed as life-threatening, unexpected, or potentially leading to disability.
26. A paper should be prepared for a medical journal outlining the evidence considered by DOMILL in its assessment of the AEP.
27. DOMILL should be advised of any changes in:
 - a. the consistency of the system from the production rounds used in this assessment;
 - b. the design, specification or performance of the AEP system;
 - c. the guidance to users and training practices;
 - d. the policy and practice of deployment (including deviations from the extant zeroing policy), use and audit.

Chairman, CBRN and Human Sciences Board, DSAC.

ACPO - Notes for Guidance on Police Use of Attenuating Energy Projectile

AEP Operational Guidance Index

- 1) Preface
- 2) Introduction
- 3) Description of the AEP system
- 4) Human Effects of the AEP
- 5) Issue/Possession
- 6) Possession outside Force Area
- 7) Specific Risk Factors
- 8) Training
- 9) Use
- 10) Oral and Visual warnings
- 11) Aftercare
- 12) Post Incident Procedures
- 13) Weapon Maintenance
- 14) Auditing Reporting of Use
- 15) Storage and Administration

1. Preface

- 1.1 Managing conflict and responding to violence are core police functions. Police response is underpinned by Human Rights and in particular the obligation under Article 2 of the European Convention on Human Rights, to uphold the right to life.
- 1.2 This guidance is intended to inform the storage, carriage and use of the approved 37mm soft nosed impact projectile designated the L60A1. This is an Attenuating Energy Projectile (hereafter referred as the AEP) and is intended for use as a less lethal kinetic energy device. Operational use of the AEP will be limited within UK Police Services to authorised officers who have been specifically trained in the use of the system.
- 1.3 The use of the AEP will be informed by reference to the ACPO Conflict Management Model, and is intended to provide officers (including those armed with conventional firearms) with an additional means of dealing with threats of serious violence.
- 1.4 In accordance with ACPO policy on other less lethal weapons, the availability or deployment of the AEP should not be considered as a replacement for conventional firearms in situations where the deployment of conventional firearms has been authorised.
- 1.5 The AEP has not been designed for use as a crowd control technology but has been designed for use as a less lethal option in situations where officers are faced with individual aggressors whether such aggressors are acting on their own or as part of a group.
- 1.6 The AEP may be deployed in a variety of operational situations, however the objective will remain the same. The AEP is intended for use as an accurate and discriminating projectile, designed to be fired at individual aggressors.
- 1.7 In the event of it becoming necessary to use an AEP in a public order situation this must be restricted to use against clearly identified individuals who are presenting a threat which must be countered and other tactical options available for countering the threat posed are considered inappropriate in the circumstances.

Annex 4

- 1.8 It must be recognised that the use of a kinetic energy device in a situation of public disorder may have a profound impact on crowd dynamics with implications for public safety and order.
- 1.9 If officers armed with the AEP system are deployed the initiation and command of the operation will, dependant on the circumstances, be in accordance with the provisions set out in the ACPO:
- Manual of Guidance on Police use of Firearms
 - Keeping the Peace Manual.
- 1.10 Similarly, command and operational competencies, training standards and tactics will be in accordance with the ACPO:
- National Police Firearms Training Curriculum
 - Manual of guidance on public order standards, tactics and training.
- 1.11 Throughout the United Kingdom there are both authorised firearms officers trained in the Use of the AEP system, as a less lethal option in any situation to which they are deployed and officers who are not authorised firearms officers but specifically trained to use the AEP system in a situation of serious public order situation. This guidance applies to all officers involved in the training, authorisation, deployment, command and use of this less lethal option irrespective of the circumstances in which they are deployed.
- 1.12 Where Authorised Firearms Officers trained in the AEP are expected to also be deployed with the system in a public order situation then they will be trained in public order theory and tactics.
- 1.13 As with deployment of authorised firearms officers in situations of serious public disorder, deployment of officers armed with AEP should be authorised by an officer of Assistant Chief Constable/ Commander rank subject to the chief officer having agreed to AEPs being used in such circumstances. Officers armed with the AEP who are to be deployed within a public order situation should be fully trained in public order policing and regularly complete AEP training within that context.
- 1.14 Authorised Firearms Officers (AFOs³⁹) may, in accordance with the ACPO Manual of Guidance, on Police Use of Firearms, be issued with firearms where the authorising officer has reason to suppose that they, in the course of their duty, may have to protect themselves or others from a person who is
- in possession of a firearm; or
 - has immediate access to a firearm; or
 - is otherwise so dangerous that the officer's use of a firearm may be necessary.)
- 1.15 Officers trained in use of the AEP system may also be deployed in situations of serious public disorder where their use is judged to be necessary to reduce a serious risk of:
- (i) *loss of life or serious injury or;*
- (ii) *substantial and serious damage to property where there is, or is judged to be, a sufficiently serious risk of loss of life or serious injury to justify their use.*

39 In recognition of the special circumstances prevailing in Northern Ireland, the Chief Constable of PSNI has given standing authority for all officers, subject to successful training, to be issued with a personal issue handgun. This standing authority is kept under regular review in and is set out at Chapter 3 paragraph 8.5 of the ACPO Manual of Guidance on Police use of Firearms. Standing Authority arrangements also exist in other force areas within the UK. PSNI have, in keeping with national best practice provided a less lethal capability as an alternative to resort to conventional firearms in situations where officers are faced with individual aggressors whether such aggressors are acting on their own or as part of a group. Should it be necessary to deploy officers armed with an AEP in a Public Order or any other situation PSNI operational instruction will be in accordance with this ACPO Guidance and will contain additional requirements as deemed appropriate by the Chief Constable of PSNI to meet local legislation and oversight arrangements.

Annex 4

- 1.16 In assessing the risk of loss of life or serious injury occurring, in a public order situation, account should be taken of the risks to police officers and members of the to members of the public and others.
- 1.17 The AEP should be aimed to strike directly (i.e. without bouncing) the lower part of the subject's body i.e. below the rib cage. Officers are trained to use the belt-buckle area as the point of aim, at all ranges thus mitigating against upper body hits.
- 1.18 Unless there is a serious and immediate risk to life, which cannot otherwise be countered, use at under one metre or aiming the weapon to strike a higher part of the body at any range is prohibited. In these circumstances the risk of serious and even fatal injuries is increased and the firer must be able to justify the increased use of force.
- 1.19 This guidance recognises that the use of force involving firearms is an extreme measure. The guidance therefore incorporates Article 3C of the UN code of Conduct for Law Enforcement Officers, which deals and is specific in addressing use of force and firearms against children.
- 1.20 The police use of force is governed by:
- Common Law;
 - Section 3 Criminal Law Act 1967;
 - Section 117 Police and Criminal Evidence Act 1984;
 - The Human Rights Act 1998.
- 1.21 It is recognized that the use of a kinetic energy projectile has, in certain circumstances the potential for lethal consequences and, as such, Article 2 of the ECHR is of particular relevance when they are used.
- 1.22 The test of absolute necessity found in Article 2 provides a stricter test of proportionality than is required in other areas of the Convention. It is also a stricter test than is provided by the concept of reasonable force within s. 3 Criminal Law Act 1967, s. 117 of Police and Criminal Evidence Act 1984, the equivalent Northern Ireland legislation and Common Law. Even where the use of force may be seen as being reasonable it may not be absolutely necessary. In addition, the use of force must be based on an honestly held belief that it is necessary, which is perceived for good reasons to be valid at the time.
- 1.23 Article 2 of the UN Basic Principles on the use of Force and Firearms states that:
- 'Governments 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'.*
- 1.24 The availability of the AEP is intended to provide officers including those issued with conventional firearms, with a differentiated use of force and firearms. The AEP will, where appropriate, be deployed alongside conventional firearms and other less lethal technologies already on issue to firearms officers.
- 1.25 Police officers responsible for the planning and control of operations where the use of AEP or other uses of force are a possibility, shall so plan and control them to minimize, to the greatest extent possible, recourse to force and, in particular, potentially lethal force.
- 1.26 Standards of competence and related training requirements, as set out in the National Police Firearms Training Curriculum apply to those:
- who use the system,
 - who provide tactical advice in its use,
 - who might be called upon to command operations.

- 1.27 In forces where officers authorised in the use of AEP are not trained in conventional firearms, the training provided will include a basic understanding of conventional firearms theory and tactics including issues associated with ricochet potential.
- 1.28 The issue, deployment and use of the AEP will conform to the well-established guidance already laid down in the ACPO Manual of Guidance on Police Use of Firearms. The following issues are therefore relevant:
- The command issues as set out in the ACPO Manual of Guidance deal with the management of incidents at which firearms officers are deployed as opposed to specific use of force options.
 - The authorisation to deploy firearms will include the full range of conventional firearms and less lethal weapons available to those officers.
 - The post incident procedures set out in the Manual are specific to the use of conventional weapons.
- 1.29 AEP's should be issued only to officers assessed as competent to use them in accordance with the training and assessment procedures approved by ACPO.
- 1.30 Appropriate post incident procedures following the operational firing of the AEP will be implemented depending on the nature of the injury or harm occasioned or in accordance with the specific instruction pertaining in the force area where the firing took place.
- 1.31 This guidance will be regularly reviewed and it is anticipated that the use of the AEP will inform the development of operational good practice.

2 Introduction

- 2.1 The purpose of this guidance is to inform and support decision making in relation to training, deployment and use of the AEP.
- 2.2 The intention is to provide Chief Officers, operational commanders and officers trained in the use of the AEP system with written guidance on the use of the equipment.
- 2.3 Detailed instruction on the characteristics, operation and use of the AEP will be covered in the training and documentation provided to officers to be accredited in its use.

3 Description of the AEP System

- 3.1 The AEP forms part of the common weapon system approved for use by members of the police service or HM forces in the United Kingdom. It is therefore essential that a 'system approach' is applied to storage, maintenance, zeroing and operational use.
- 3.2 The common weapon 'system' comprises
- The weapon
 - The sight
 - The munition
 - The Zeroing Instructions
 - Maintenance and storage instructions
 - ACPO Guidance on Use and MoD rules of Engagement

Annex 4

- 3.3 The AEP is fired from a 37 mm breech loaded weapon. The approved launcher is the L104A1 equipped with an approved L18A1/A2 optical sight.
- 3.4 A collimator has also been provided to assist in checking the zero of the weapon and instructions on its use are contained at appendix D.
- 3.5 The projectile has been designed with a nose cap that encloses a void. This design feature is intended to attenuate the delivery of the impact energy by extending the duration of the impact and minimising the peak forces. It thereby delivers a high amount of energy to maximise its effectiveness, with reduced potential for life threatening injury. Reducing the rate of onset of the impact force and reducing the magnitude of the peak force, have both been shown in human impact to reduce the severity of injuries.

4 Human Effects of the AEP

- 4.1 The AEP is designed to deliver an impact which is not intended to cause serious or life threatening injury, but is of sufficient force to dissuade or prevent a violent or potentially violent person from their intended course of action and thereby neutralise the threat. However as with all applications of force, there is a potential for unintended serious and even fatal injury either as a direct result of an impact or as a result of secondary injuries caused by a subject falling. It should, however, be remembered that no weapon system, including conventional firearms, are universally effective.
- 4.2 The reaction of a person struck by the AEP will vary depending on the area of the body struck and the degree of motivation being exhibited by the individual. Persons who are under the influence of alcohol, drugs or who are suffering from mental health issues or exhibiting acute behavioural disorders may also exhibit a wider range of responses. Officers using the AEP should not rely on an immediate incapacitant effect and should always be in a position to consider other tactical actions should the individual continue to pose a threat.
- 4.3 Unless follow up action is taken a subject struck with an AEP may continue with their previous behaviour. It is therefore important that officers should continually assess the threat being posed and as necessary consider other tactical options.

5 Issue/Possession

- 5.1 The AEP will only be issued to authorised officers who have successfully completed approved ACPO training in the use of the device. The authority for the issue of AEP will therefore be in line with operating procedures pertaining in each Forces area for the issue of such equipment.
- 5.2 The authorised launch platform for the AEP is the Heckler and Koch L104A1 which may also be used for launching other projectiles which would bring it within the scope of a Section 5 Firearms Act 1968 (and equivalent legislation in Scotland and Northern Ireland). Police officers, whilst acting in their capacity as such, are exempt from the requirements of the legislation and do not need any additional legal authority to possess the AEP.
- 5.3 The AEP should not be regarded as a replacement for other routinely issued protective equipment or for conventional firearms but rather as part of the range of tactical options. An officer may also need to resort to another option if the device does not have the effect intended.
- 5.4 In circumstances where specialist firearms officers have been deployed to a situation, the authorisation to utilise their firearm will also include the authority to use any other less lethal option or technology with which they have been issued including where appropriate the AEP. In these situations it would be inappropriate for commanders or supervisory officers to attempt to restrict officers to a particular less lethal technology or use of force option.

Annex 4

- 5.5 However, in certain circumstances it may be appropriate to deploy firearms officers equipped with the AEP in public order situations. As with the deployment of specialist firearms teams in situations of public disorder this must be closely co-ordinated and gives rise to specific command issues. For this reason specialist firearms resources should not, in these circumstances, be deployed without the express authority of an officer of at least Assistant Chief Constable / Commander rank.

6 Possession outside Force Area

- 6.1 Officers armed with the AEP system may on occasions be deployed outside of their immediate Force area. Chief Officers will agree a protocol with neighbouring Forces (Appendix A) that enables officers equipped with an AEP capability to utilise the device should they be required to respond in a neighbouring Force area. Individual Chief Officers will remain vicariously liable in civil law for their own officers' actions. Guidance for the use of the AEP, whether within or outside the Force area, is set out below.

7 Specific Risk Factors

- 7.1 The Defence Scientific Advisory Council (DSAC) sub-committee on the Medical Implications Of Less-Lethal Weapons (DOMILL) have provided an independent view for the UK Government on the medical implications of the use of the Attenuating Energy Projectile (AEP) L60A1 system. In the UK, based on the policy and guidance of the Association of Chief Police Officers (ACPO) set out in this document, and also that provided to UK Armed Forces.
- 7.2 A full copy of the Domill statement is attached at Appendix 'B'. The Domill statement provides specific advice as to risk factors associated with strikes to certain parts of the body. This is predicated on the system being used in accordance with guidance and being zeroed in accordance with instructions set out at 'appendix 'C'.
- 7.3 All risk factors must be considered when assessing the 'appropriateness' and 'necessity' of using an AEP.
- 7.4 It is recognised that there are circumstances where the discharge of an AEP or other Less Lethal technology may be an appropriate alternative to the use of a conventional, potentially lethal firearm, and the discharge of the AEP irrespective of the additional risk is absolutely necessary to protect life.
- 7.5 Users should be made aware that AEP's can ricochet in some circumstances and that the presence of obstacles and of personnel other than the intended target should form part of their risk assessment in the decision to fire the weapon.
- 7.6 Consideration should also be given to the possibility of striking individuals behind the identified subject who is being fired at. This risk assessment should include to possibility of direct strikes and as a result of Ricochet.
- 7.7 The Article 3C of the UN Code of Conduct for Law Enforcement Officers is specific in stating that:
- 'The use of firearms is considered an extreme measure. Every effort should be made to exclude the use of firearms, especially against children. In general, firearms should not be used except when a suspected offender offers armed resistance or otherwise jeopardizes the lives of others and less extreme measures are not sufficient to restrain or apprehend the suspected offender.'*
- 7.8 Whilst the discharge of an AEP represents an option which is potentially a less lethal alternative to conventional firearms every effort should be made to ensure that children are not placed at risk by the firing of an AEP. This is particularly relevant in public order situations where children may be amongst a crowd and be placed in danger should an AEP miss its intended target.

Annex 4

- 7.9 Occasions will arise where it is necessary to use the AEP on a person who is exhibiting violent behaviour and who is also suffering from a mental disorder or illness. Where it is possible to discuss options with mental health professionals present at the scene, this should be considered.
- 7.10 In pre-planned operations or joint activities such discussions could form part of any briefing for the event. Consultation with friends, relatives etc. who are likely to know the person well may also assist in deciding on the most appropriate use of force response. Consultation with Health Authorities and Social Services in this respect will form part of the implementation plan. The final decision as to appropriate use of force options in these circumstances will rest with the officer concerned.
- 7.11 Similarly where it becomes apparent that the subject has an existing medical condition or is under the influence of drugs, assessment of these additional risk factors should be made in determining the appropriate option.

8 Training

- 8.1 The aims and objectives of training in the use of the AEP are contained in the AEP training manual.
- 8.2 Tactical training in the use of the AEP should emphasise precautions in relation to the specific risk factors contained in this guidance.
- 8.3 Qualification and zeroing of weapons must take place using the operationally approved L60A1 AEP.
- 8.4 Officers trained in the AEP are also trained in conflict management and must be aware of the dangers associated with the conditions known as positional asphyxia and acute behavioural disorder. This is relevant to the after care of any person who has been the subject of any use of force option.
- 8.5 It is important that officers have an appreciation of the physical and psychological effects of a strike by the AEP.

9 Use

- 9.1 Use of the AEP is one of a number of tactical options available to an officer who is faced with violence or the threat of violence. The purpose of using the AEP is to dissuade or prevent a potentially violent person from their intended course of action and thereby neutralise the threat.
- 9.2 The initial discharge and any subsequent discharge must be proportionate, lawful, appropriate, necessary and non-discriminate, in all the circumstances. Ultimately, the decision to discharge the AEP is an individual one for which the officer will be accountable. The Conflict Management Model should assist officers in making such judgements.
- 9.3 Officers will carry out functions checks as set out in the training manual on the weapon approved to launch the AEP whenever the weapon is issued and where possible prior to actual deployments.
- 9.4 It is essential that the AEP launcher is zeroed for the individual officers in accordance with the directions set out in the training manual.
- 9.5 As with conventional firearms AEP's should not be fired from moving vehicles.

Annex 4

10 Oral and Visual warnings

- 10.1 In a situation where the police can justify the use of force or an escalation in the use of force, warning messages should be given, if practicable and time permits. If a tactic is to be used over a period of time, or a large area, it may be desirable to repeat the warning messages.
- 10.2 In a public order situation warning can be invaluable in alerting the crowd of police intentions and providing the opportunity for the crowd to disperse or remove themselves from danger. Unless circumstances do not permit, AEPs are only to be fired after an oral warning, for example by means of a loud hailer or PA system, has been given telling the crowd to disperse and informing individuals that force will be used against them. The warning should make clear that if individuals do not stop their violent action that force will be used without further warning. A record is to be kept of the words used in giving the warning. The following words should be used whenever possible:
- “Attention, attention, this is a police message. The crowd should disperse immediately as force is about to be (or will again) be used against individuals engaged in violent activity. No further warnings will be given.”*
- 10.3 The above warning(s) should be given on as many times as is reasonably practicable in the circumstances, ensuring that police intention to deploy tactical options and/or use force are clearly communicated prior to use. When the use of a specific tactical force option is imminent, a final warning should be given, using words such as:
- ‘If you do not stop impact rounds will be fired’***
- 10.4 It may in certain circumstances be appropriate to provide a visual display of officers visibly armed with an AEP launcher as this may also have a deterrent effect.
- 10.5 Officers should be aware that the pointing of a weapon at an individual represents a use of force and may in certain circumstances constitute an assault.

11 Aftercare

- 11.1 Steps should be taken to ensure that early medical attention will be provided for persons struck by an AEP.
- 11.2 The provision of appropriate medical aid should always be considered at the earliest possible stage. This might involve such measures as the availability of officers trained in relevant First Aid measures and/or the placing of an ambulance on standby.
- 11.3 Where officers are informed or come to believe that a person has been struck by the AEP has a pre-existing medical condition that might lead to increased medical risk immediate referral to a hospital should be considered.
- 11.4 A Forensic Medical Examiner must examine all arrested persons who have been struck by an AEP, as soon as practicable.
- 11.5 Close monitoring of a subject throughout the period following a direct strike from any kinetic energy device is of utmost importance. If there are any signs of adverse or unusual reactions then medical attention should be provided immediately and if necessary this must be given precedence over conveying the subject to the police station. When a person who has been struck by an AEP is detained in a cell they should be subject to the same cell supervision provided for persons who have consumed alcohol or drugs.

- 11.6 Experience from previous incidents involving the use of any form of force has shown that the persons most likely to be at greatest risk from any harmful effects are those who are under the influence of alcohol, drugs or suffering from any existing medical condition. In addition, and as highlighted in other guidance, if there is any suspicion at all that the violent subject is being caused by acute behavioural disorder, they should be treated as a medical emergency and conveyed directly to hospital. In the event of a child or physically vulnerable person being struck with an AEP they should if at all possible receive immediate medical assessment and if necessary conveyed directly to hospital.

12 Post Incident Procedures

- 12.1 The AEP weapon system will have been issued under a firearms authority. Chapter 6 of the ACPO Manual on Police Use of Firearms sets out guidance to be followed where conventional police firearms are discharged.
- 12.2 In situations where an AEP is fired operationally, appropriate post incident procedures will be implemented depending on the nature of the injury or harm occasioned. An investigation will be undertaken by an Initial Investigating Officer.
- 12.3 Whenever possible, fired AEPs should be recovered, as should spent cartridge cases.
- 12.4 All firings of an AEP must be immediately reported [initially by radio] and the firer must complete a report pertaining to the reason for firing the AEP and information about the outcome and number of rounds fired. The record should also list any known injuries that may have occurred as a result of using AEPs. All firings will be reported to either the IPCC, NI Police Ombudsman or in Scotland to the Procurator Fiscal.
- 12.5 If used in a situation of public disorder in England and Wales the Chief Officer should supply to the Home Secretary a written report on the circumstances surrounding the firing of AEPs as soon as possible after the incident, similar arrangements will exist in Scotland. In Northern Ireland there is a requirement to inform the Northern Ireland Policing Board of any operational discharge of an AEP. The Police Ombudsman is also informed.
- 12.6 In the event of an unintentional discharge in a non-operational situation where there has been no danger to the public, this will be subject to an internal investigation. In this case referral to the IPCC/Police Ombudsman or Procurator Fiscal will, in accordance with local policy directives, be a matter for individual Force management.
- 12.7 The welfare of principal officers must be considered when undertaking any investigation following a critical incident even where little or no injury has been caused.

13 Weapon Maintenance

- 13.1 Proper maintenance of the AEP launch platform and sights is vitally important, as is proper storage and carriage of the AEP's. Guidance on this issue is included at Appendices 'D' & 'E'.
- 13.2 It is essential that weapon function checks are carried out when the weapon is issued and repeated whenever possible prior to deployment or intended use.
- 13.3 Any weapon or munitions failures should, in addition to any local police force instructions, be reported to the Home Office Scientific Development Branch of the Home Office in accordance with the guidance contained in the ACPO Manual of Guidance on Police Use of Firearms.
- 13.4 In the event of a misfire procedures should conform with those set out in the police training manual for AEP.

14 Evaluation of the AEP

- 14.1 The introduction of the AEP will be subject of a first year evaluation.
- 14.2 Operational usage will be reviewed at regular intervals to ensure that emerging issues properly reflected in training and operational guidance. Representatives of DSTL, DOMILL and HOSDB will be invited to contribute to the process. Evaluation questionnaires will be completed on every occasion where AEP is deployed to a policing operation where the use of firearms has been authorised.
- 14.3 This policy will be subject to regular review.

15 Storage and Administration

- 15.1 In storing the AEP the following legislation must be complied with: MoD Instructions for storage and carriage of the AEP:
- Health and Safety at Work etc. Act 1974;
 - Control of Substances Hazardous to Health Regulations 1989;
 - Management of the Health and Safety at Work Regulations 1992.
- 15.2 A generic risk assessment regarding the AEP is attached at Appendix 'F'. Individual forces should undertake appropriate risk assessments in respect of storage and carriage. Electrical devices should not be stored alongside pyrotechnics, ammunition, specialist munitions or flammable products.
- 15.3 A comprehensive list of Health and Safety legislation is provided at Appendix 'G'.
- 15.4 A use of force reporting (see Appendix 'H') is to be completed for every operation where the AEP is deployed. The project remains on course to meet the requirement set out in the fourth report that the AEP will be ready for full operational use by summer 2005.

Notes for Guidance on Military Use of Attenuating Energy Projectile

1. This guidance does not affect your inherent right to self-defence.

However in all situations you are to use no more force than absolutely necessary to achieve your aim.

PUBLIC ORDER CONTROL EQUIPMENT MUST ONLY BE USED WHEN THERE IS NO OTHER LESS FORCEFUL ALTERNATIVE TO PREVENT VIOLENT DISORDER

2. When guarding property, you must not use lethal force other than for the protection of human life.
3. Public Order Control Equipment is only to be used on the command of , and every effort must be made to minimise the risk of injury.
4. Personnel may only use items of Public Order Control Equipment if they have been fully trained in its use and the application of this guidance.

PROTECTION OF HUMAN LIFE

5. It is possible to use a baton and/or a shield in such a way as to cause a fatality. This constitutes the use of lethal force. You may only strike a person in such a way if he/she is committing or about to commit an act likely to endanger human life and there is no other way to prevent the danger.
6. After striking you are to re-assess the situation and then decide upon follow up action (e.g. strike again, restrain, give first aid).

CHALLENGING

7. A challenge **MUST** be given before any item of Public Order Control Equipment is used, unless:
 - a. To do so would increase the risk of death or grave injury to you or any other persons other than the persons committing violent disorder.

Or at the earliest opportunity:

'ATTENTION, ATTENTION. UNLESS YOU DISPERSE, BATONS/IMPACT ROUNDS MAY BE USED AGAINST YOU'.

It is for the senior commander at the scene to decide how many challenges use; when he judges that a challenge will be the last, he must end with phrase, 'NO FURTHER WARNING WILL BE GIVEN'.

9. Where possible, the senior commander at the scene is to order change in profile that visibly demonstrates intent to use Public Order Control Equipment.

OPENING FIRE

10. AEP rounds may be fired, if authorised by the senior commander at scene, when absolutely necessary to protect persons from physical violence.

11. AEP rounds are to be fired at selected individuals, not indiscriminately.

They are to be aimed so that they should strike directly (i.e. without bouncing) the lower part of the body (i.e. below the ribcage). They are not to be fired at range of less than 1 metre unless there is an immediate and serious risk loss of life or serious injury, which cannot otherwise be countered.

MEDICAL ASSISTANCE

12. Medical assistance is to be provided to casualties as quickly as possible.

April 2005

DEFENCE SCIENTIFIC ADVISORY COUNCIL

Statement on the review by MOD of medical issues arising from use of the L21A1 Baton Round from June 2001 - May 2003.

The statement of the Sub-committee (SC) of the Defence Scientific Advisory Council (DSAC) on the medical implications of the use of the new L21A1 Baton Round was placed in the Library of the House of Commons in April 2001. The statement compared the injury potential of the L21A1 system with that of the L5A7 Baton Round.

The SC, DSAC requested that one year after introduction of the L21A1, the MOD should review perceived or quantitative changes in the frequency and nature of serious injuries from the system. The review was due in June 2002 and the SC, DSAC received the report from MOD by the specified date. The SC, DSAC considered that on the data available, there was no reason to amend their statement that provided the medical advice to Ministers. The DSAC statement on the review was presented to Parliament in October 2002.

The SC, DSAC requested that the performance and medical consequences of use of the L21A1 remained under review and that a further review should be conducted by 31 July 2003, to consider the period 1 June 2001 to 31 May 2003, the first two years of operational use of the L21A1. With SC, DSAC's agreement, MOD's second report was delayed (to gather additional data) and presented to them in December 2003. The report encompassed use of the system by the Army and PSNI against individuals in public order disturbances in Northern Ireland, and use by some police forces in Great Britain against individuals posing a violent threat to either themselves, police officers or members of the public.

This second review (which also encompasses data presented in the first review) reaffirms the opinion expressed in SC, DSAC's original advice to Ministers: From the available data, there is no definitive or even indicative evidence that there is a higher frequency of thoracic impacts from the L21A1; thoracic impacts will occur occasionally in operational use. Additionally, SC, DSAC considers that on the basis of the data available, there is again no reason to amend the DSAC statements provided to Ministers on the comparison of the medical implications of use of the L21A1 and L5A7 Baton Rounds.

The SC, DSAC is pleased to note that:

- the L21A1 Baton Round has not been fired in Northern Ireland since September 2002;
- its use in Great Britain has led to resolution of violent incidents, without serious or life threatening injuries to the subject from the system;
- the Government has taken forward SC, DSAC's recommendation to undertake research into systems to reduce the clinical severity of an impact to the head;
- the Government is undertaking the development of the Attenuating Energy Projectile, a possible replacement for the L21A1 Baton Round.

The SC, DSAC requests that the performance and medical consequences of use of the L21A1 remains under review and that a further review is conducted to consider the period 1 June 2003 to 31 Aug 04.

Chairman, CBRN and Human Sciences Board, DSAC.

Statement of DOMILL on medical implications of the use of the M26 TASER®

Review of the research undertaken

The research requested by DOMILL was undertaken by Biomedical Sciences Department of Dstl. Dstl adopted a two-fold experimental approach to clarifying the risks of adverse cardiac effects arising from use of the M26 TASER®:

- **Effect of drugs of abuse on cardiac function.** This approach was predicated on empirical observations made in the United States that many of those involved in confrontations in which TASER® was used were under the influence of drugs. The hypothesis tested was that the drugs per se could predispose an individual to an adverse cardiac event, irrespective of TASER® use. Seven drugs of abuse were tested for their ability to modify the electrical properties of cardiac ventricular conduction tissue in vitro⁴⁰.
- **Direct application of electrical pulses to isolated beating hearts.** The pulses represent the current predicted to flow in the heart during discharge of the M26 TASER®. The assessment is designed to investigate the effect of the pulses on heart rhythm, the threshold for any effects observed and the effects of selected drugs of abuse upon this threshold. These studies necessitated the development of novel, complex computer models of the interaction of M26 TASER® pulses with the human body, in order to predict the shape and magnitude of current flowing in the heart.
- **Effect of drugs of abuse on cardiac function.** Seven recreational drugs, or their active metabolites, were examined in the sheep isolated cardiac Purkinje fibre preparation. MDMA (Ecstasy) and phencyclidine (PCP) produced effects on the action potential suggestive of an increased risk of development of torsades de pointes arrhythmia. Although cocaine, cocaethylene (a psychoactive metabolite formed when cocaine and alcohol are concurrently abused) and (+)-methamphetamine did not induce action potential prolongation, a critical review of the scientific and clinical literature revealed that these drugs still have the potential to compromise cardiovascular function in a way that could precipitate a life-threatening cardiac event. The clinical literature suggested that morphine (the principal metabolite of heroin) and Δ^9 -tetrahydrocannabinol (the principal psychoactive component of cannabis) are likely to be relatively benign in terms of cardiovascular toxicity at doses likely to be employed by abusers.

The results from the study, together with evidence gleaned from the literature, suggest that some frequently abused drugs have the potential to contribute to any cardiac-related morbidity or mortality that may arise in the context of TASER® use. Furthermore, it seems reasonable to assume that this conclusion could be generalised to other emotionally charged and possibly violent confrontations with law enforcement personnel.

The adverse cardiac effects produced by any individual drug are likely to be dependent on several risk factors, including dose consumed, co-use with other drugs (including pharmaceutical drugs and ethanol) and pre-existing heart disease. This complex interplay of multiple risk factors could conceivably contribute to any cardiac-related morbidity or mortality associated with TASER® use against drug-intoxicated persons. Officers should be aware that the risk of any adverse response in the aftermath of TASER® deployment may be higher in drug-impaired individuals and, accordingly, they should be vigilant of any unusual behaviour displayed by the apprehended person that may signal the need for early medical intervention.

DOMILL has reviewed the paragraph in its first statement that discussed pro-arrhythmic factors and concludes that it does not require modification on the basis of the current work. The current work provides experimental evidence to support the original statement.

⁴⁰ The assay addressed the effect of drugs on the cardiac action potential (the electrical basis for cardiac conduction, contraction and relaxation) in sheep isolated Purkinje fibres. Prolongation of the action potential duration is thought to be a possible marker for a potentially lethal type of ventricular arrhythmia known as torsades de pointes.

Direct application of electrical pulses to isolated beating hearts. The complex mathematical modelling underpinning the second experimental approach has never been undertaken before and has challenged the limits of current knowledge. Early setbacks with the modelling have been overcome and the quantitative modelling of the M26 TASER® current flow in the heart will be completed shortly. This will enable the studies on the isolated beating heart to commence.

Vulnerability of pacemakers and other implantable electronic devices

The implanted devices examined in the review included cardiac pacemakers, cardioverter defibrillators, cochlear implants and other implantable neurostimulatory devices, such as phrenic and vagal nerve stimulators. Published material on the construction of the devices was consulted to assess the likely consequences of TASER® barb impact on the device. An assessment of available published information on the observed interaction of external electromagnetic fields with active implantable devices was also undertaken. The review also addressed the probability of a person wearing an active implantable device being present in a situation where a TASER® may be deployed and used; this drew upon a comparison of the age profiles of the frequency of use of pacemaker and implantable cardioverter defibrillator wearers in the UK, and data on the age profile of persons arrested by the police.

It was concluded that the probability of direct impact and physical damage to implanted electronic devices was very low. The effects of M26 TASER® electrical fields on the function of cardiac pacemakers are unlikely to be permanent. The limited number of studies that have been reported on devices similar to TASER® indicate that effects are likely to be limited to reversion to asynchronous pacing mode, and that these effects are temporary. The effects of TASER® output on implantable cardioverter defibrillators are likely to be similar to those on cardiac pacemakers. The nature of the cardiac rhythm sampling process indicates that application of a TASER® for a period of 5 seconds is unlikely to result in inappropriate therapy delivery. The effect of TASER® outputs on other active implantable devices, such as cochlear implants and nerve stimulators, has not been reported. The interaction with nerve stimulators could produce deleterious effects but the risk of such interaction occurring is low, and it is unlikely that the effects will be long-term or life threatening.

The age profile of cardiac pacemaker recipients is significantly different from the overall population and that of persons arrested in situations where a TASER® may be deployed. The probability of an individual wearing a pacemaker being present in such a situation is therefore likely to be considerably lower than the overall incidence of pacemakers in the population.

It is concluded that there is no requirement to undertake experimental studies on the vulnerability of active implantable medical devices to the output of the M26 TASER®.

Ocular hazard of the laser sight

The output of the sighting laser has been tested and is a Class 3R according to the British Standard BS EN 60825-1. Class 3R exceeds the internationally agreed maximum permissible exposure values, but due to the safety factors in these values, devices of this Class are unlikely to cause ocular injuries for accidental exposures. Intentional viewing or deliberate exposure of the eyes of a subject must be avoided.

Overall conclusion

The risk of life-threatening or serious injuries from the M26 TASER® is very low.

Recommendations

DOMILL reaffirms its view that it does not consider it essential from a medical perspective that the experimental studies are completed before approval is considered for the extension of the M26 TASER® trial under the terms of the ACPO Guidance. This DOMILL statement will be reviewed when the results of the study on the isolated beating heart are available. The studies by Dstl on the effects of drugs on isolated Purkinje fibres should be published in the medical press.

Six months after the commencement of the extended operational trial, the Home Office should provide DOMILL with a report outlining the circumstances of every use of the M26 TASER®, the post-incident medical assessments undertaken by the FME, and the clinical consequences noted by the FME or clinical staff. DOMILL should be advised as soon as practical of any primary or secondary injury that could be classed as life-threatening, unexpected, or potentially leading to disability.

DOMILL should be advised of any changes in:

- the specification or performance of the M26 TASER®;
- the guidance to users, and training practices;
- the policy and practice of deployment, use and audit.

DSAC Sub-committee on the Medical Implications of Less-lethal Weapons (DOMILL)

Statement on the comparative medical implications of use of the X26 TASER® and the M26 Advanced TASER®.

Background

1. This statement has been produced by the Defence Scientific Advisory Council (DSAC) subcommittee on the Medical Implications of Less-Lethal Weapons (DOMILL). It provides an independent view for the UK Government on the medical implications of the use of the X26 TASER® in the UK, within the policy and guidance of the Association of Chief Police Officers (ACPO). Specifically, this statement compares the predicted principal medical risks associated with the X26 TASER®, and the M26 Advanced TASER® (referred to subsequently as the M26).
2. On 30th January 2003, the Home Secretary gave authority to proceed with an operational trial of the M26 as a less-lethal option in incidents at which authority to use firearms had been granted. The M26 would be used by police officers already trained in the use of firearms. The operational trial commenced on 21st April 2003 for an initial duration of 12 months. Five police forces took part in the trial, employing a joint policy, operational guidance and training strategy developed by ACPO.
3. Prior to the start of the trial, DOMILL provided an independent statement on the medical implications of the use of the M26 within the ACPO Policy and ACPO Operational Guidance⁴¹. The statement was based primarily on an assessment of the medical risks undertaken on behalf of DOMILL by the Defence Science and Technology Laboratory (Dstl). The DOMILL statement concluded that: "From the available evidence on the use of the device, the risk of life-threatening or serious injuries from the M26 Advanced TASER® appears to be very low."
4. DOMILL recommended that research be undertaken to clarify the cardiac hazards associated with use of the M26 on individuals who could be considered to be at greater risk of adverse effects. The main thrust of the investigations addressed the possible cardiac hypersusceptibility to M26 currents arising from drugs commonly used illegally in the UK and a review of the vulnerability of pacemakers and other implanted devices.
5. A report on the operational trial of the M26 was produced by PricewaterhouseCoopers. The report concluded that use⁴² of the M26 "helped secure a positive outcome to an incident, minimising the potential need for officers to deploy other, possibly more lethal technologies". ACPO proposed that, subject to a review of the medical assessment and Ministerial approval, the trial should be extended: With Chief Officer agreement, the trial should be extended to all forces for use by existing firearms officers, in situations where an authority for firearms would be granted in accordance with criteria presently laid down within the ACPO Manual of Guidance on the Police Use of Firearms.

41 DSAC Sub-committee on the Medical Implications of Less-lethal Weapons (DOMILL). Statement on the medical implications of the use of the M26 Advanced Taser. DSTL/CBS/BTP/PAT-ACPO/MAN/REP/4/ dated 9 Dec 02.

42 "Use" by ACPO's definition is the: (i) drawing of a device in circumstances where any person perceives the action as a use of force or a threat of use of force; (ii) discharging the darts at a subject; (iii) application and discharge in "touch stun" mode.

6. Consequently, DOMILL issued a second statement⁴³ subsequent to a review of:
 - revised and reviewed ACPO policy, operational guidance and training;
 - the outcome of the research addressing the recommendations in their first statement;
 - the data presented to them by ACPO on the outcome (to date) of the initial trial then proceeding.

The second statement also concluded that: *"The risk of life-threatening or serious injuries from the M26 TASER® is very low"*

7. On the basis of the second DOMILL statement and other evidence, the Home Secretary agreed to ACPO's proposal and the Parliamentary Under Secretary of State at the Home Office (Caroline Flint MP) announced the decision to Parliament in a Written Answer on 15th. September 2004. The Home Secretary's decision applies only to the M26 Advanced TASER®.
8. In May 2003, the manufacturers of the M26 introduced another TASER® weapon - the X26. ACPO expressed the view that the X26 may have operational benefits over the M26 and requested that the Home Office Scientific Development Branch (HOSDB) conduct a handling trial with users on the X26, similar to the trial undertaken on the M26 before its introduction. Subsequent to the X26 handling trial, in which the X26 showed some potential operational benefits, the Home Office requested that DOMILL prepares this statement on the medical implications of the use of the X26.

Comparison of M26 and X26 TASER® outputs

9. The manufacturers claim that the direct incapacitating effect of the X26 is 5% greater than that of the M26⁴⁴. They claim that the X26 is 60% smaller, 60% lighter and consumes one fifth of the power. The electrical pulses from the two weapons have a different shape, magnitude and pulse repetition frequency. The X26 pulse has a lower peak voltage and a longer duration than the M26; it also has a lower pulse repetition frequency.
10. The evidence from the electro-physiological literature is that the threshold for stimulation of excitable tissues reduces as pulse duration is extended, and as the number of pulses is increased⁴⁵. Although the implied reduction in peak current for the X26 would suggest a lower risk of adverse cardiac events from currents that may flow in the heart, the extended duration may offset some of that benefit. Because of the complex shape of the TASER® waveforms, the overall effect of this trade-off cannot be assessed from the literature, which has been developed using simple waveforms such as rectangular or sinusoidal pulses.

Technical approach to compare risks from X26 and M26

11. DOMILL requested that Dstl undertake the following modelling and experimental work:
 - a. Characterisation and comparison of the electrical output of the X26 and M26 TASER® (in conjunction with HOSDB).

43 DSAC Sub-committee on the Medical Implications of Less-lethal Weapons (DOMILL). Statement on the medical implications of the use of the M26 Advanced Taser. DSTL/CBS/BTP/PAT-ACPO/MAN/REP/4/ dated 9 Dec 02.

44 "Use" by ACPO's definition is the: (i) drawing of a device in circumstances where any person perceives the action as a use of force or a threat of use of force; (ii) discharging the darts at a subject; (iii) application and discharge in "touch stun" mode.

45 DSAC Sub-committee on the Medical Implications of Less-lethal Weapons (DOMILL). Second statement on the medical implications of the use of the M26 Advanced Taser (July 2004). DSTL/CBS/BTP/PAT-ACPO/MAN/REP/4/ dated 27 Jul 04.

- b. A comparison of the currents predicted to flow in the human heart from the M26 and X26 TASER®. This would require the use of a computer model of electromagnetic interactions of applied TASER® pulses with the superficial tissues of the body, and the flow of currents to the heart.
- c. Application of the predicted currents to isolated, spontaneously beating hearts to establish the threshold for any potentially adverse effects on cardiac rhythm.

Additionally, DOMILL requested a review of: (i) experimental work undertaken by, or on behalf of the manufacturers to support the introduction of the X26; (ii) operational and training data compiled by the manufacturers and global police forces; (iii) medical assessments undertaken by organisations and individuals unconnected with the manufacturers.

Review of the modelling and experimental work undertaken by Dstl

Prediction of TASER® currents in the human heart.

12. Computational electromagnetic modelling of M26 and X26 TASER® currents flowing in the human heart was achieved using a digital mannequin of the human body, in which the electrical properties of human tissues were represented.
13. Studies on the effect of dart separation on the predicted current density (mA/mm²) flowing in the heart from the M26 showed that a vertical separation of 225 mm, with the upper dart overlying the heart, gave the maximum cardiac current of the scenarios modelled⁴⁶. In this most severe scenario, about 20% of the applied current from the M26 was predicted to pass through the heart during the M26's 2_ cycle, 50 _s pulse. The peak predicted current density was about 0.66 mA/mm². With regard to the X26, initially about 10% of the applied current from the X26 was predicted to pass through the heart, rising to about 20%. During the X26's 4 cycle, 160 _s pulse, the peak current predicted was about⁴⁷ –0.11 mA/mm².
14. Thus, the model predicted that the peak current density flowing in the human heart from the X26 pulse was about one sixth that of the M26. The current duration of the X26 in the heart was about 3-4 times that of the M26.

Effects of the predicted Taser currents on cardiac rhythm.

15. **Method:** Excised, spontaneously beating guinea-pig hearts (the Langendorff preparation) were used to determine if the predicted M26 and X26 waveforms in human heart could induce either or both of two phenomena:
 - Ventricular ectopic beats (VEBs) – cardiac contractions outwith the normal inherent rhythmicity of the heart;
 - Ventricular fibrillation (VF) – chaotic, asynchronous contractions of the heart muscle fibres that result in no effective heart output. If uncorrected, this would lead rapidly to death in the human.

46 Taser International Inc. use a rating scale entitled "Muscular Disruption Units". The M26 is used as the baseline of 100 units. The X26 has 105 units. The rationale and method for determining these values is not stated, but is believed to have been based upon the Taser-induced contractile force in the muscles of a pig limb.

47 Reilly JP. Applied Bioelectricity: From Electrical Stimulation to Electropathology. Springer - Verlag, 1998, ISBN 0-387-98407-0. Chapter 6 – Cardiac sensitivity to electrical stimulation. Pages 220-225.

16. The modelled cardiac M26 and X26 TASER® waveforms were applied to the ventricular outer surface of the isolated hearts. Both the absolute values of the peak currents predicted from the modelling, and higher magnitudes, were applied to determine the thresholds for the two phenomena. Rectangular pulses were also applied to hearts to determine the relationship between current density and pulse duration for a well-characterised, simple waveform, and to ensure that the heart preparations were capable of eliciting VEBs or VF.
17. **VEB induction:** When applied during the most vulnerable phase of the heart's electrical cycle (the T-wave of the electrocardiogram) at peak current densities predicted in the human heart during TASER® discharge, neither the simulated M26 nor X26 waveforms evoked VEBs. However, VEBs could be elicited by both TASER® waveforms by increasing the peak current density of the applied waveforms above those predicted to arise in the human heart. The threshold current density for generation of VEBs for both the M26 and X26 TASER® waveforms was greater than 60-fold the modelled current density predicted to occur at the heart, implying a wide safety margin for this particular type of potentially pro-arrhythmic response.
18. **Ventricular fibrillation:** In an attempt to evoke ventricular fibrillation, trains of simulated M26 or X26 TASER® waveforms (designed to mimic the discharge patterns of the respective TASER® devices) were applied to the ventricular muscle. When the simulated waveforms were applied in this way, neither the M26 nor X26 waveforms elicited ventricular fibrillation at peak current densities up to the maximum output available from the laboratory electrical stimulation system. The threshold peak current density for generation of ventricular fibrillation for the simulated M26 waveform was greater than 70-fold the modelled current density predicted to occur at the heart during TASER® discharge. In the case of the simulated X26 waveform, the threshold peak current density was greater than 240-fold the modelled current density. That this failure of the simulated M26 and X26 TASER® waveforms to induce ventricular fibrillation was not a function of the biological test system was demonstrated in each experiment by the generation of VF using the rectangular stimulation pulses.
19. **Conclusions:** The results show that the simulated M26 and X26 waveforms, *when amplified*, are capable of eliciting VEBs, but not VF, when applied to the ventricular muscle of spontaneously beating guinea-pig isolated hearts. The guinea-pig heart is more susceptible than hearts of larger animals (e.g. dog, calf and pig, and presumably human) to VF induced by extrinsic electrical stimulation⁴⁸. The present findings provide indirect evidence for a wide margin of safety in relation to induction of this type of lethal arrhythmia in man. A broadly similar conclusion was reached in a study in the US, in which trains of simulated X26 waveforms of varying intensity, applied across the thorax of anaesthetised pigs, induced ventricular fibrillation only at intensities 15- to 42-fold that of the standard X26 waveform⁴⁹.
20. On the basis of the present study, it is considered unlikely that the electrical discharge from the M26 and X26 TASER® devices will influence cardiac rhythmicity by a direct action on the heart of healthy individuals.
21. **Contributing factors to cardiac susceptibility:** The possibility that other factors, such as illicit drug intoxication, alcohol abuse, pre-existing heart disease and cardioactive therapeutic drugs may modify the threshold for generation of cardiac arrhythmias cannot be excluded. Similarly, other indirect responses to TASER® deployment (e.g. arrhythmias precipitated by stress- or exercise induced catecholamine release) may, in themselves, predispose to an adverse cardiac outcome independently of the primary (electrical) action of the TASER® devices.

48 The dart separations modelled were those determined in M26 user trials undertaken by HOSDB.

49 The minus term indicates that this was flowing out of the heart (measured at the peak of the second half cycle).

22. DOMILL's first statement on the M26 Advanced TASER® concluded that (paragraph 28):

"There is no experimental evidence that the aforementioned pro-arrhythmic factors increase the susceptibility of the heart to low- or high-power Tasers specifically, sufficient to cause an arrhythmic event. Nevertheless, there is sufficient indication from the forensic data and the known electro-physiological characteristics of the heart (and the effects of certain drugs on this) to express a view that excited, intoxicated individuals or those with pre-existing heart disease could be more prone to adverse effects from the M26 Taser, compared to unimpaired individuals. The ACPO Guidance to Users reflects this view."

Experimental work reported in DOMILL's second statement¹² on the effects of drugs on cardiac function supported this view. The view expressed above is also applicable to the X26 TASER®.

Falls to the ground

23. The claim that the X26 is more effective than the M26 in stimulating skeletal muscle implies that falls following X26 application may be less controlled. This will increase the risk of head injury. It is anticipated therefore that there may be a greater likelihood of head contact with surfaces following use of the X26. Overall, the risk of serious head injury is considered to be low.

Overall conclusion

24. The risk of a life-threatening event arising from the direct interaction of the currents of the X26 TASER® with the heart, is less than the already low risk of such an event from the M26 Advanced TASER®.

Recommendations

25. The Home Office should continue to provide DOMILL with reports outlining the circumstances of every use of the M26, the post-incident medical assessments undertaken by the Forensic Medical Examiner (FME), and the clinical consequences noted by the FME or clinical staff. This audit should include the X26 TASER® if this system is made available for use. DOMILL should be advised as soon as practical of any primary or secondary injury that could be classed as life-threatening, unexpected, or potentially leading to disability.
26. DOMILL should be advised of any changes in:
- the specification or performance of the M26 and X26 TASER® devices;
 - the guidance to users and training practices;
 - the policy and practice of deployment, use and audit.

[signed]

Chairman, DSAC Sub-Committee on the Medical Implications of Less-Lethal Weapons

STATEMENT ON PAVA SPRAY FROM THE COMMITTEES ON TOXICITY, MUTAGENICITY AND CARCINOGENICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT.

COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

STATEMENT ON THE USE OF PAVA (NONIVAMIDE) AS AN INCAPACITANT SPRAY

(COT/04/6 - November 2004)

Introduction

1. In 2001 the Home Office requested advice from COT on the health effects arising from the use of a chemical incapacitant spray containing pelargonyl vanillylamide (PAVA or Nonivamide). PAVA is the synthetic equivalent of capsaicin the active ingredient of natural pepper. It is a potent sensory stimulant. It is also used both as a food flavour (at up to 10 ppm in the diet) and in human medicine (topical application as a rubifacient). In the USA it has been given GRAS (Generally Regarded as Safe) status by the FDA as a food flavour.
2. The Sussex Police Force have now been using PAVA spray since 2001, following a pilot exercise in 2000. It is now being used by 2 other police forces in the UK, as well as by police forces in other European Countries and in North America.
3. The COT considered this use in 2001 and agreed a statement in April 2002, which incorporated the advice of the COM on the available mutagenicity data. A copy is attached as part of this Appendix (page B8). This gives details of the structure of PAVA, its use and a summary of the available toxicity data at that time.
4. The following conclusions were reached:
 - (i) We consider that it is not possible to make a complete assessment of the likely adverse health effects that could arise from the use of PAVA spray as a chemical incapacitant in view of the limited data available.
 - (ii) We recognise that exposures would be low and for a short period. It is impossible to calculate exposure with any accuracy but we note that dermal exposure would be of the order of 30 mg PAVA from a 1 second burst, with about 3 mg being absorbed. Any systemic exposure is likely to be low (of the order of 0.04 mg/kg bw).
 - (iii) The animal model data and experience in use do not give rise to any concerns regarding long term harm to the skin or eyes. However consideration needs to be given as to whether those wearing contact lenses might experience increased irritant effects. It is also noted that no data are available on the potential of PAVA to induce skin sensitisation.
 - (iv) The *in-vitro* mutagenicity data, and consideration of metabolites, indicate that PAVA has some mutagenic potential; although negative results were obtained in an *in-vivo* study to investigate mutagenic effects in the bone marrow, data from a further study are needed to provide adequate assurance that this activity cannot be expressed *in vivo*. An *in-vivo* study to investigate the induction of unscheduled DNA synthesis (UDS) in the liver would be appropriate in this regard.

- (v) No data are available to assess whether PAVA has any effects on the reproductive system. In particular the lack of any developmental toxicity studies is of concern as it is possible that pregnant women may be exposed to the spray.
- (vi) The data from inhalation studies in volunteers, including those with mild asthma, indicate that there are unlikely to be any adverse respiratory reactions in normal individuals. Some respiratory effects may well occur in asthmatics, particularly since effects were observed in asthmatic volunteers at 0.1% PAVA, which is lower than the 0.3% used in the spray, and given the conditions of increased stress likely when the spray is used.
- (vii) Further monitoring of experience in use, including the police officers using the spray, is recommended with particular consideration being given to eye irritancy in those wearing contact lenses and to effects in those with asthma or hay fever and in women who may be pregnant.

New data

5. In response to the conclusions in the COT statement Sussex Police have commissioned further studies to provide information on the data gaps highlighted. These comprise a further *in-vivo* mutagenicity study (the liver UDS assay),¹ an investigation of skin sensitisation potential using the local lymph node assay,² and an investigation of effects on reproduction using a developmental toxicity study.^{3,4} In addition they have provided some information on experience in use since the COT last considered the issue.⁵⁻⁸ PAVA is now being used as an incapacitant spray by 3 Police Forces in the UK.
6. The COM considered the new *in-vivo* mutagenicity data at their meeting on 5th February 2004. They concluded that the *in-vivo* liver UDS assay was done to the current OECD guideline (No 486) and was adequate. There was no evidence for the induction of DNA repair, as measured by unscheduled DNA synthesis, in the assay. The COM concluded that the information sought by the Committee had now been provided and that it was possible to conclude that PAVA would not be expected to be an *in-vivo* mutagen.⁹ No further mutagenicity data were required.
7. The COT considered the new data on skin sensitisation, reproductive toxicity and experience in use at their meeting in May 2004.
8. The ability of PAVA to induce skin sensitisation has been investigated in mice using the local lymph node assay.² The methodology was consistent with that given in the OECD guideline (No 429). Dose levels of 0.8, 2.1 and 4.1% PAVA were employed. Negative results were reported. However there was a high level of inter-animal variability, with for example, very low individual scintillation counts in 2/5 animals treated at the highest dose level. In addition it was felt that a concurrent positive control should have been carried out, as the laboratory concerned appeared to be relatively inexperienced in this assay. No conclusions could therefore be drawn from this study.
9. The potential of PAVA to induce adverse effects on development following exposure *in-utero* has been investigated in the rat in a study that conformed to OECD test guideline (No 414) with oral dosing (gavage). Dose levels used in the main study were selected following a preliminary developmental toxicity study in which no effects were seen on embryo-fetal development at doses up to 1000 mg/kg (the maximum dose level recommended in the OECD guideline (No 414)).³ In the main study animals were dosed at 100, 500 and 1000 mg/kg on day 5-19 of gestation.⁴ They were then killed and their uteri and contents examined in the usual way. The only significant effect seen was a slight but statistically significant, reduction in fetal weight at the top dose level. The no observed adverse effect level (NOAEL) was 500 mg/kg. This was not of concern in view of the large margin of safety.
10. Further data provided by Sussex Police did not indicate any significant adverse effects arising from the use of this spray either in the general public or in officers using the spray.⁵ Experience in use has not identified any groups that are particularly sensitive to the spray.

11. Regarding the COT conclusions in 2002, the only outstanding data related to skin sensitisation, in view of the inability to draw any conclusions from the local lymph node assay on mice. As an alternative to repeating this study, consideration was given to obtaining information on the experience in use of PAVA as a topical medicine. As noted earlier it is used, at up to 0.4%, in topical medicines, sometimes under occlusion. Information on whether there was any history of skin sensitisation arising from such use was considered by the Committee at their September 2004 meeting. Data provided by industry and also by the Medicines Healthcare products Regulatory Agency (MHRA) were considered.⁶⁻⁸ Products containing up to 0.4% PAVA have been used in human medicines for topical application in many countries, including the UK, for over 50 years. They are generally well tolerated with an insignificant number of adverse reactions. In the UK there have been reports of only 2 adverse reactions (both involving a rash) over the last years. It can be concluded that PAVA does not have any significant skin sensitisation potential in practice.

Revised conclusions

12. Following consideration of these new data the COT agreed the following revised conclusions on the health effects of the use of PAVA incapacitant spray:
 - (i) We recognise that exposures would be low and for a short period. It is impossible to calculate exposure with any accuracy, but we note that dermal exposure would be of the order of 30 mg PAVA from a one second burst, with about 3 mg being absorbed. Any systemic exposure is likely to be low (of the order of 0.04 mg/kg bw).
 - (ii) The animal model data and experience in use do not give rise to any concerns regarding long term harm to the skin and eyes, arising from irritant effects. Although no conclusions can be drawn from the one available animal study to investigate skin sensitisation, experience in use, including in human medicines for topical application, indicates that PAVA is not a skin sensitising agent.
 - (iii) The new *in-vivo* mutagenicity data provided (negative results in an *in-vivo* liver UDS assay conducted to internationally accepted guidelines) in conjunction with previously evaluated studies allow the conclusion to be drawn that PAVA is not an *in-vivo* mutagen.
 - (iv) The ability of PAVA to induce adverse effects on the developing offspring following *in-utero* exposure has been investigated in a prenatal developmental toxicity study in the rat using oral exposure (by gavage). The compound had low toxicity by the oral route, with no significant effects being seen in the maternal animals at doses up to 1000 mg/kg/day. The only effect seen in the developing offspring at this dose level was a small reduction in fetal weight. There was no evidence of any malformations, skeletal anomalies, or any other adverse effects at this dose level. The NOAEL for effects on the offspring was 500 mg/kg/day. This NOAEL is about 4 orders of magnitude above the expected exposure level arising from use of the spray; there are thus no concerns regarding developmental toxicity.
 - (v) The data from inhalation studies in volunteers, including those with mild asthma, indicate that there are unlikely to be any adverse respiratory effects in healthy individuals. It is possible that some respiratory effects may occur in asthmatics, particularly since effects were observed in asthmatic volunteers at 0.1% PAVA, which is lower than the 0.3% used in the spray, and given the increased stress likely when the spray is used.
 - (vii) The available information, both from the toxicity data in experimental studies, and experience in use, indicates that the low exposures arising from the use of PAVA incapacitant spray would not be expected to be associated with any significant adverse health effects. However we recommend that monitoring of experience-in-use be continued.

COT Statement 2004/06 November 2004

References

1. Clay P. Nonivamide (PAVA) In-vivo rat liver Unscheduled DNA synthesis assay. Central Toxicology Laboratory report CTL/SR1166, 13 June 2003.
2. PAVA (nonivamide); Local lymph node assay. Inveresk Report No 22133 (2003). Unpublished report. Commissioned by Sussex Police.
3. PAVA (nonivamide); Preliminary oral gavage pre-natal developmental toxicity study in the rat. SafePharm Laboratories Project No 1833/001 (2003). Unpublished report. Commissioned by Sussex Police.
4. PAVA (nonivamide); Oral gavage prenatal developmental toxicity study in the rat. SafePharm Laboratories Project No 1833/002 (2003). Unpublished report. Commissioned by Sussex Police.
5. Experience of use of PAVA incapacitant spray. Unpublished information; Sussex Police (2004).
6. Letter from Boehringer Ingelheim on human clinical experience of dermal preparations containing nonivamide (2004).
7. Letter from Beisdorf AG on human clinical experience of dermal preparations containing nonivamide (2004).
8. Letter from the Medicines and Healthcare Products Regulatory Agency Pharmacovigilance service on reported suspected adverse reactions associated with nonivamide and skin disorders. (2004).
9. Committee on Mutagenicity conclusions on mutagenicity data. February 2004. Available at <http://www.advisorybodies.doh.gov.uk/com/index.htm>

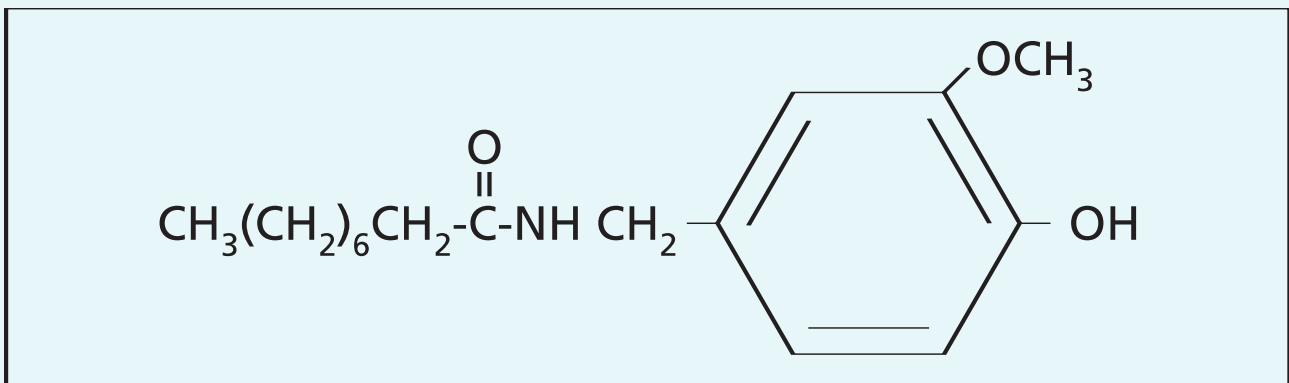
STATEMENT ON THE USE OF PAVA (NONIVAMIDE) AS AN INCAPACITANT SPRAY

(COT/02/2 - April 2002)

Introduction

1. The Home Office has requested advice from the COT on the health effects arising from the use of a chemical incapacitant spray, containing pelargonyl vanillylamide (PAVA or Nonivamide) as the active ingredient. PAVA is the synthetic equivalent of capsaicin the active ingredient of natural pepper. It is a potent sensory stimulant. It is also used both as a food flavour (at up to 10 ppm in the diet) and in human medicine (topical application as a rubifaciant). In the USA it has been given GRAS (Generally Regarded as Safe) status by the Food and Drug Administration as a food flavour.
2. Following a pilot exercise last year the Sussex Police Force is now using PAVA spray as an alternative chemical incapacitant to CS spray. Recently Northamptonshire Police Force also started to use the spray. It is used by police forces in other European countries and in North America.

PAVA has the following chemical structure:



Use of PAVA as incapacitant spray

3. The spray used by Sussex Police consists of a 0.3% solution of PAVA in 50% aqueous ethanol. It is dispensed from hand held canisters (containing nitrogen as propellant) as a coarse liquid stream; the spray pattern is stated to be directional and precise. The canisters contain 50 ml of solution. The instructions are to aim directly at the subject's face, especially the eyes, using a half second burst (still air) or one second burst (moving air), repeating if necessary. The maximum effective range is 8-15 feet and the instructions are not to use at a distance of under 3 feet because of the risk of pressure injury to the eye. The effectiveness of the spray depends on eye contact with small amounts reaching the eyes producing the desired effect. In some cases officers will miss and use more than one burst.
4. Studies on the particle size of the spray indicate that the bulk of the droplets are over 100 mm but a small proportion (1-2%) is in the range 2-10 mm, and there may be traces below 2 mm. Thus it is unlikely that large amounts of PAVA will reach the respiratory system, although the possibility of some reaching the lungs cannot be excluded. It is not possible to estimate the respirable dose.

Toxicity of PAVA

Absorption, Metabolism, Elimination and Excretion

5. Only limited data are available to assess oral absorption of PAVA; the compound shows higher acute toxicity by the parenteral rather than by the oral route suggesting relatively poor oral absorption. More extensive data are available regarding skin absorption, particularly from ointments designed for topical medical use. PAVA has been shown to be well absorbed through the rabbit skin (50-70% in 14 hours) when applied in such ointments (hydrophilic, oil-water emulsions) under an occlusive dressing.⁽¹⁾ More limited skin absorption (12% over 72 hours) was reported in the rat using an aqueous vehicle (phosphate buffered saline) and a non-occlusive dressing.⁽²⁾ The only data available on skin absorption from aqueous ethanol are from in-vitro studies using rat skin when the rate of absorption from 50% aqueous ethanol was shown to be considerably faster than that when phosphate buffered saline was used as vehicle.⁽²⁾ It should therefore be assumed that there will be some absorption of PAVA following skin or eye contact with the spray.
6. Once absorbed PAVA is distributed throughout the body, extensively metabolised and rapidly excreted (most within 24 hours). The main route of metabolism is hydrolytic cleavage of the amide bond which occurs in liver and other tissue including the skin.⁽²⁾ There is some evidence for aliphatic hydroxylation, as also occurs with capsaicin.⁽³⁾

Experimental studies in animals

7. Only very limited data are available on PAVA itself; it has a comparable toxicity, as measured by the LD50 value, to capsaicin when given by the intra-peritoneal route to mice (8 mg/kg).^(4,5) Capsaicin has moderate toxicity by the oral route with LD50 values being reported as 119 and 97 mg/kg in male and female mice and 161 and 148 in male and female rats.⁽⁶⁾ Data were provided on an acute inhalation study on PAVA in the rat using exposures of up to 3.6 mg/l for 4 hours, but the report is difficult to follow and no conclusions could be drawn.⁽⁷⁾
8. The skin irritancy of a 3.2% (v/v) solution of PAVA in polyethylene glycol has been investigated in the rabbit using an occlusive dressing and 4 hour exposure.⁽⁸⁾ Animals were then observed for up to 3 days post exposure; no signs of irritancy were noted.
9. The ability of the in-use formulation (0.3% in 50% aqueous ethanol) to produce eye irritation has been investigated in the rabbit using the standard OECD test method.⁽⁹⁾ Signs of significant irritation were seen from instillation until 3 days post-dose (including some evidence of opacity of the cornea and damage to the iris). However the eyes of all the animals had recovered by 7 days post exposure. These data indicate that the solution should be regarded as irritating to the eyes, but they do not suggest that any long term effects are likely.
10. No data are available on the potential of PAVA to cause skin sensitisation.
11. Few data are available on the effects of repeated exposure to PAVA. These consist solely of the results of a limited 90 day dietary study in the rat.⁽¹⁰⁾ Only a single dose level was used, equivalent to about 10 mg/kg body weight/day. This produced no evidence for any toxic effects and can be regarded as a no observable adverse effect level (NOAEL).

Reproductive toxicity

12. No data are available on reproductive toxicity studies on PAVA. Nor are any data available from fertility or developmental toxicity studies using standard methods for either PAVA or capsaicin. There is one report of the treatment of neonatal rats (2 day old) with a relatively high dose level of capsaicin (50 mg/kg using the subcutaneous route) resulting in retardation of sexual development and reduced fertility.⁽¹¹⁾ The dose level used resulted in growth retardation throughout adulthood. No conclusions can be drawn from this study regarding any effects of PAVA on the reproductive system. There are no reported investigations of developmental toxicity (teratogenicity), nor of any multigeneration studies to investigate effects on fertility.

Mutagenicity studies

13. The advice of our sister committee, the Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment (COM) was sought on a package of mutagenicity data on PAVA that had been commissioned by the Sussex Police Force.^(12,13,14,15) Its conclusions are given below:
 - i. The structure of PAVA suggests the possible formation of reactive oxygen species from the phenol moiety, and other possible active metabolites which may be mutagenic.
 - ii. Data are available from 3 in-vitro studies done to current standards. The assay for gene mutation in bacteria gave negative results. Equivocal weakly positive results were obtained in the mouse lymphoma assay. A clear positive result was however obtained in the assay for chromosome damage in CHO cells in the presence of the exogenous metabolic activation system which was not limited to concentrations producing excessive toxicity. These in-vitro data indicate that PAVA has mutagenic potential.
 - iii. Negative results were obtained in a bone marrow micronucleus test, PAVA being given orally at up to dose levels that produced marked toxicity (some lethality).
 - iv. As noted in the COM guidelines, in the case of substances positive in vitro a negative result in a single tissue will not provide sufficient data to conclude that the chemical is inactive in vivo. Thus data from a second in-vivo assay are necessary to provide adequate reassurance that the mutagenic potential identified in the in-vitro studies cannot be expressed in vivo. In this regard members felt that data from an in-vivo liver UDS assay would be appropriate in this case and that negative results in this assay would provide the necessary reassurance.

Effects in humans

Studies in volunteers

14. A series of studies have been carried out in volunteers to investigate the effect of inhalation of PAVA on the respiratory and cardiovascular system by measuring effects on heart rate, blood pressure, oxygen saturation and airways (FEV1, Forced Expiratory Volume in 1 second).^(16,17) These included studies in mild asthmatics. In order to maximise any response an aerosol of respiratory sized particles was produced using a nebulizer, rather than the coarse spray that is used by the police. Subjects (10 'normal' and 10 with mild asthma) were exposed to a range of concentrations, in the case of the normal subjects up to 0.3% PAVA in 50% aqueous alcohol to mirror the in-use condition. In the case of the asthmatics the maximum concentration used was 0.1%. Transient coughing was noted in normal subjects on exposure to the PAVA spray. Minimal effects were seen on FEV1 heart rate and blood pressure (bp) in the normal subjects at the in-use concentration (1% reduction in mean FEV1, 15% increase in mean heart rate and 8% increase in mean systolic bp compared to baseline). Similar effects were noted in the asthmatics exposed to 0.1% PAVA (mean reduction in FEV1 3%, increase in heart rate 5% and increase in systolic bp 5%), although a

transient but clinically significant reduction in FEV1 (>0.5 l) was noted in 2 subjects; these were judged to have somewhat more severe asthma on the basis of their greater methacholine responsiveness. These data suggest that exposure to the coarse 'in-use' PAVA spray is unlikely to have any significant respiratory effects in normal subjects although some bronchospasm could be induced in asthmatics. It was noted that under operational use the subjects would be likely to be experiencing a high level of stress, and this could lead to clinically significant bronchospasm.

Experience in use

15. Data provided by Sussex Police did not indicate any significant adverse effects arising from the use of this spray. There did not appear to be any persistent harm to skin or eyes in those exposed. The Committee noted that the animal data indicated that it is an eye irritant and there is the possibility that more marked effects could occur in subjects wearing contact lenses.

Quantification of exposure

16. It is extremely difficult to estimate accurately actual exposure levels in use due to the dynamics of the confrontation. The advice given to officers of the Sussex Police Force is to use a one second spray burst, and to repeat only if the first spray does not affect the eyes. However it is theoretically possible to discharge the whole of the container in a 6 second burst and this would be the most extreme (very unlikely) scenario. Assuming that half of this comes into contact with the skin, eye or mouth, this is equivalent to exposure to about 85 mg PAVA ie an external dose of the order of 1 mg/kg for an adult - some of which may be ingested. It was noted that the total exposure is about 150 times less than the estimated oral LD50 in the rat. A more realistic exposure scenario is to assume that all of a 1 second discharge comes into contact with the skin (ie about 28 mg PAVA). Assuming 10% absorption this will give a systemic dose of the order of 0.04 mg/kg (compared to a NOAEL of 10 mg/kg/day in the sub-chronic rat study referred to in para 11). However it was noted that it was not possible to compare directly the dermal dose to that obtained orally, due to differences in systemic exposure to PAVA arising from the different routes. Any systemic exposure resulting from the use of PAVA spray was however likely to be low.

Conclusions

- i. We consider that it is not possible to make a complete assessment of the likely adverse health effects that could arise from the use of PAVA spray as a chemical incapacitant in view of the limited data available.
- ii. We recognise that exposures would be low and for a short period. It is impossible to calculate exposure with any accuracy but we note that dermal exposure would be of the order of 30 mg PAVA from a 1 second burst, with about 3 mg being absorbed. Any systemic exposure is likely to be low (of the order of 0.04 mg/kg bw).
- iii. The animal model data and experience in use do not give rise to any concerns regarding long term harm to the skin or eyes. However consideration needs to be given as to whether those wearing contact lenses might experience increased irritant effects. It is also noted that no data are available on the potential of PAVA to induce skin sensitisation.
- iv. The in-vitro mutagenicity data, and consideration of metabolites, indicate that PAVA has some mutagenic potential; although negative results were obtained in an in-vivo study to investigate mutagenic effects in the bone marrow, data from a further study are needed to provide adequate assurance that this activity cannot be expressed in vivo. An in-vivo study to investigate the induction of unscheduled DNA synthesis (UDS) in the liver would be appropriate in this regard.

- v. No data are available to assess whether PAVA has any effects on the reproductive system. In particular the lack of any developmental toxicity studies is of concern as it is possible that pregnant women may be exposed to the spray.
- vi. The data from inhalation studies in volunteers, including those with mild asthma, indicate that there are unlikely to be any adverse respiratory reactions in normal individuals. Some respiratory effects may well occur in asthmatics, particularly since effects were observed in asthmatic volunteers at 0.1% PAVA, which is lower than the 0.3% used in the spray, and given the conditions of increased stress likely when the spray is used.
- vii. Further monitoring of experience in use, including the police officers using the spray, is recommended with particular consideration being given to eye irritancy in those wearing contact lenses and to effects in those with asthma or hay fever and in women who may be pregnant.

References

1. Fang JF, Wu PC, Huang YB, Tsai YH. In vivo percutaneous absorption of capsaicin, nonivamide and sodium nonivamide acetate from ointment bases: pharmacokinetic analysis in rabbits. *Int. J. Pharmaceutics*. 128 169-77 (1996).
2. Kasting GB, Francis WR, Bowman LA, Kinnett GO. Percutaneous absorption of vanilloids: In vivo and in vitro studies. *J. Pharm. Sci.* 86 142-6 (1997).
3. Surh YJ, Ahn SH, Kim KC, Park JB, Sohn YW, Lee S. Metabolism of capsaicinoids: evidence for aliphatic hydroxylation and its pharmacological implications. *Life Sciences* 56 PL305-311 (1995).
4. Janusz HM, Buckwalter BL, Young PA, LaHann TR, Farmer RW, Kasting GB, Loomans ME. Vanilloids I. Analogues of capsaicin with anti-nociceptive and anti-inflammatory activity. *J. Med. Chem.* 36 1595-2004 (1993).
5. Glinsukon T, Stitmunnaithum V, Toskulkao C, Buranawisti T, Tangkrisanavinont V. Acute toxicity of capsaicin in several animal species. *Toxicol* 18 215-20 (1980).
6. Saito A and Yamamoto M. Acute oral toxicity of capsaicin in mice and rats. *J. Toxicological Sciences*, 21 195-200 (1996).
7. Confarma AG. Report No 21101618C. Test of inhalation toxicity of Nonivamide/Nonyl acid capsaicin. Report for Swiss Police Technical Commission (1996).
8. Confarma AG. Report No: 21101618. Primary Dermal Tolerance of Intact and Scarified Skin Against Nonivamide. Report for Swiss Police Technical Commission (1995).
9. Chevarne FE. Technical/toxicological back up data to synthetic capsaicin solution (PAVA). Report by Analysis SA. Spain for IDC systems Switzerland.
10. Posternak JM, Linder A, Voduz CA. Toxicological tests on flavouring matter. *Food Cosmetic Toxicol.* 7 405-7 (1969).
11. Traurig H, Saria A, Lembeck F. The effects of neonatal capsaicin treatment on growth and subsequent reproductive function in the rat. *Naunyn-Schmiedeberg's Archives of Pharmacology* 327 254-9 (1984).
12. Nonivamide (PAVA). Testing for mutagenic activity with *Salmonella typhimurium* TA 1535, TA 1537, TA 98, TA 100 and *Escherichia coli* WP2 UvrA. Inveresk Report No 19490 (2001). Commissioned by Sussex Police.

Annex 9

13. Nonivamide (PAVA). Chromosomal aberration assay with CHO cells in vitro. Inveresk Report No 2039 (2001). Commissioned by Sussex Police.
14. Nonivamide (PAVA); mouse lymphoma cell mutation assay. Inveresk Report No 20250 (2001). Commissioned by Sussex Police.
15. Nonivamide (PAVA). Micronucleus test in bone marrow of CD-1 mice. Inveresk Report No 20903 (2002). Commissioned by Sussex Police.
16. Effects of high concentrations of inhaled nonivamide (PAVA) in normal subjects. Report by Dr P Ind et al. Imperial College School of Medicine, London for Sussex Police (2001).
17. Effect of inhaled Nonivamide (PAVA) in subjects with asthma. Report by Dr P Ind et al. Imperial College School of Medicine, London for Sussex Police.

STATEMENT ON CS SPRAY FROM THE COMMITTEES ON TOXICITY, MUTAGENICITY AND CARCINOGENICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT.

COMMITTEES ON TOXICITY, MUTAGENICITY AND CARCINOGENICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

STATEMENT ON 2-CHLOROBENZYLIDENE MALONONITRILE (CS) AND CS SPRAY

Introduction

1. The advice of the Committees on Toxicity, Mutagenicity and Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COT, COM, and COC), on ortho-chlorobenzylidene malononitrile (CS), specifically in the context of the use of CS spray as a chemical incapacitant, was sought by the Department of Health, with the support of the Home Office.
2. CS spray has now been used by some police forces in England and Wales since March 1, 1996 when it was introduced for a trial period which was followed by approval in September 1996. Although the use of CS as an aerosol or 'smoke' was reviewed following its use in Londonderry in 1969,^{1,2} the spray itself has not been subjected to scrutiny by independent expert advisory committees. It was for this reason, and because of the potential public health concerns, that the Department of Health was of the opinion that such a referral was appropriate.
3. This statement incorporates the conclusions of each of the three Committees and is divided into sections concerned with a) the physical and chemical properties of the spray, b) the toxicological data on the compound CS, c) the toxicological data on the solvent, methyl isobutyl ketone (MIBK), and d) the toxicological data on CS spray. The COT considered toxicological data on CS itself and the solvent MIBK itself and then the very limited animal and human data on the combination, CS spray. Professor K.E. Donaldson of Napier University assisted the Committee in its deliberation and Dr V.S.G. Murray and her colleagues from the Chemical Incident Response Service (CIRS) and the National Poisons Information Service (NPIS), London Centre described cases of putative toxic effects of CS spray reported to their service.

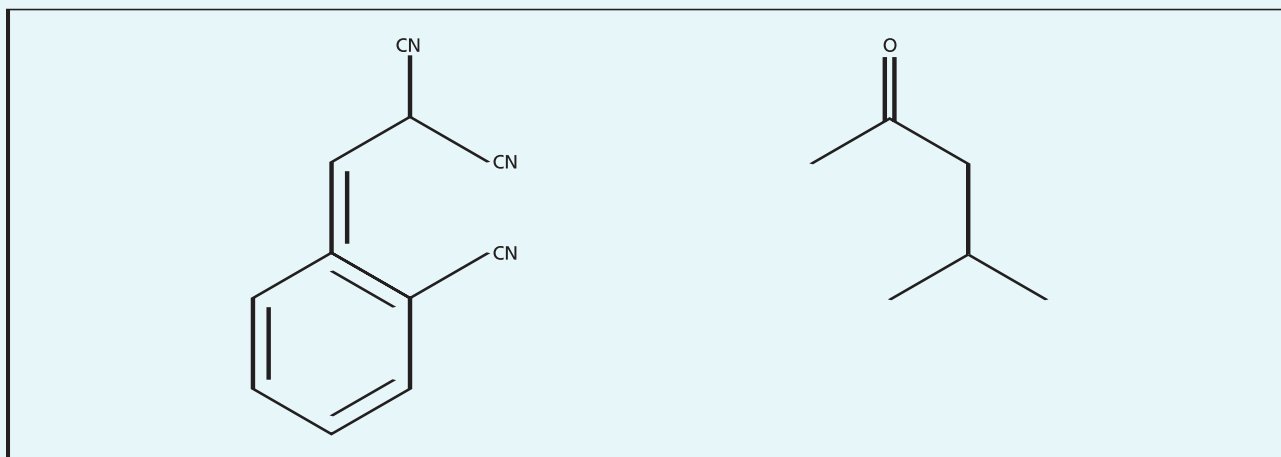
Annex 10

The nature of CS spray and its components

4. The CS spray used by police forces in the UK consists of a 5% (w/v) solution of CS in MIBK, comprising 1.5 grams (g) of CS dissolved in a total volume of 30 millilitres (ml), contained in a canister with nitrogen as a propellant. The chemical structures of CS and MIBK are given in the Figure below.

2-Chlorobenzylidene malononitrile (CS)

Methyl isobutyl ketone (MIBK)



Exposure to CS spray

5. The COT noted that, although there are reports and studies which describe the effects of CS spray on humans, these do not provide data in respect of individuals who have been sprayed which allow any estimation of their exposure to the constituent chemicals. The guidelines for the use of CS spray that have been provided to police forces for the training of officers were available³ but, in the absence of quantitative evidence relating to operational use, the Committee was unable to estimate exposure in the field.*
6. However, to address this question the Home Office Scientific Development Branch (HOSDB) of the Home Office carried out a study of 500 canisters that had been used operationally in the UK by police officers in the course of arrests of individuals. The Committee has been informed that it is standard practice to replace a canister after it has been used once. By comparing the weights of the used canisters with the mean weight of unused canisters it was possible to estimate the quantities of CS spray that had been used during each incident. At the maximum flow rate permitted in the specifications, 10% of the canisters had been discharged for a total calculated period of more than 3 seconds and had weights corresponding to the release of between 12.0 and 23.7 g of the CS solution in MIBK. The peak of the exposure distribution corresponded to the release of 4 to 6 grams of the solution of CS in MIBK, of which 0.28 to 0.35 g is calculated to have been CS.⁴
7. The nature of the toxic effects of the spray will depend upon the extent to which exposure occurs to the eyes, to the skin and via inhalation or ingestion. The mass and size of the droplets of the CS solution in MIBK produced during spraying will determine how far the droplets can penetrate into the respiratory tract. In response to the COT's enquiries about the physical properties of the spray released from the canisters, the HOSDB commissioned a study, undertaken by AEA Technology, to address the question of the size distribution of droplets produced under conditions simulating operational use.
8. The results of this study indicate that, when the CS spray is used at distances of 2 to 3 metres from a detector, the median diameter of the spray particles is between 417 to 441 micrometres (μm). There are,

* Short Term Exposure Limit (STEL): An occupational exposure limit defining a level of exposure over a 15 minute reference period which should never be exceeded.⁶ Such values are typically set to protect workers against effects that occur rapidly after exposure eg irritation of the eyes, nose and throat.

however, some particles with diameters of less than 100 µm and a few with diameters of less than 50 µm. When the spray was used at distances of less than 0.1 m, (a shorter distance than that recommended for operational use), the proportion of the smaller droplets decreased. When the spray was allowed to impinge on, and be scattered back from, a solid target the proportion of smaller diameter droplets increased. In a further study with 5 canisters of CS spray in which the diameter of the smaller particles was measured, none were found to have diameters of less than 28 µm.⁵

9. The Committee was of the view that, although the CS canisters release, for the most part, a coarse spray, there is a proportion of droplets with diameters of less than 100 µm which, in the event of full discharge of the can, could transport a maximum of 20 mg of the spray solution into the upper respiratory tract the smallest droplets of which (diameter 28 to 50 µm), could reach the large- and medium-sized airways of the lung. This proportion will be increased if the spray is scattered from any nearby surface. Since these are the airways that are affected in bronchial asthma, it is possible that an asthmatic attack could occur in susceptible individuals. It was also recognised that the increased rate and depth of respiration occurring in an individual under stress might, in addition, result in a greater dose of the CS spray being inhaled.
10. In a separate study with CS canisters the vapour concentration of the solvent MIBK was measured at 6 positions placed either as close as could be achieved or up to 0.5 m from a target. The target was sprayed from a distance of 2.0 m for periods of 1 or 3 seconds or until the canister was empty. The resultant MIBK vapour concentration at each position was then measured at one second intervals for a period of 15 minutes. In these trials the Short Term Exposure Limit (STEL)¹⁹ for MIBK of 100 ppm time-averaged over a 15 minute reference period⁶ was exceeded on four out of eighteen occasions. However, static air conditions were used in these trials in order to achieve a greater reproducibility,⁴ such conditions would reduce dispersion and increase average measured concentrations.
11. Because of the nature of this trial, and the differences in circumstances from operational use where static air conditions would be unlikely, the Committee felt that these results probably did not represent a cause for concern, provided that the spray is used in accordance with the operational guidelines.

Toxicity of CS

12. Most of the data on the toxicity of CS derive from studies which have used either CS aerosols or pyrotechnically-generated 'smokes'. In both cases respirable particles were produced. Data have been obtained on the size of droplets resulting from the use of CS dissolved in an organic solvent and delivered in the form of a spray; these are discussed in paragraphs 7 to 9 above.

Metabolism

13. Studies of the metabolism of CS have been conducted on the compound itself and not in the form in which it would be used as an incapacitating agent by police officers. It is readily hydrolysed in aqueous mixtures^{7,8} and reacts readily with plasma proteins and glutathione *in vitro* and *in vivo*.^{9,10} It undergoes rapid metabolism and chemical breakdown *in vitro* and *in vivo*, initially to 2-chlorobenzaldehyde and malononitrile, each of these then undergo further rapid reactions. The half lives (t_{1/2}) of CS and the metabolites, 2-chlorobenzaldehyde and 2-chlorobenzylmalononitrile in one *in vivo* experiment involving the administration of compounds by intra-arterial injection into cats were 5.4, 4.5 and 9.5 seconds respectively.¹¹ After oral administration CS is metabolised and eliminated largely (circa 70%) via the urine as 2-chlorohippuric acid and 2-chlorobenzoic acid.¹² Other metabolites have been identified but there is no evidence of dechlorination. It was noted however that the available data were not as comprehensive as would have been obtained if modern techniques had been used. In addition, no data were available on the kinetics of CS administered as a solution in MIBK.

Experimental studies in animals

14. The acute toxicity of CS following exposure via inhalation is characterised by sensory irritancy followed by prompt recovery. Acute studies in rodents and guinea pigs using pyrotechnically generated CS smokes indicated that short term exposure (10 to 20 minutes) to concentrations of CS of around 4 grams/metre³ (g/m³), or longer exposure (several hours) to levels of around 30 to 40 mg/m³, resulted in deaths. Death was due to severe lung damage (comprising haemorrhages and oedema).¹³ Animals that survived showed no pathological abnormalities when examined 14 days later.
15. Studies to investigate skin irritancy in rats, rabbits and guinea pigs indicated that a 12.5% (w/v) solution of CS in corn oil or acetone applied for 6 hours without occlusion produced mild skin irritation.⁷ No conclusions can be drawn with regard to its potential to induce skin sensitisation from the two animal studies available due to limitations in the methodology used.^{14,15} There are, however, some data in humans to indicate that CS can provoke skin sensitisation (see paragraph 30).
16. The eye irritancy of CS has been shown to be dependent upon the solvent used. A 5% (w/v) solution in PEG-300 (polyethylene glycol) produced severe irritant effects in the rabbit (mild or moderate keratitis lasting for 2 weeks or more after a single application) whereas a 10% (w/v) solution in trichloroethane produced some conjunctivitis but no corneal damage and no effects were seen after 7 days.^{16,17} Results of eye irritancy studies in rabbits using a 7% (w/v) solution in MIBK are given in paragraph 44; signs of severe irritation were seen initially with recovery after 8 days.
17. Repeated dose inhalation studies involving exposure for 1 hour a day for 120 days, indicated a NOAEL[†] of about 30 mg CS/m³ in a range of species (mice, rats, guinea-pigs).¹⁸ At around 200 mg/m³ in mice and guinea pigs, deaths of 23% and 48% respectively of the exposed animals occurred in the first month of the experiment.

Mutagenicity

18. The mutagenicity data on CS were considered by the Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment (COM). Their conclusions are given in the following paragraphs.

In vitro studies

19. The mutagenicity of CS has been extensively studied *in vitro*. Negative results were obtained in *Salmonella* assays, but there were reservations regarding the suitability of the standard protocols used in these tests with respect to CS in view of its very short half life.¹⁹⁻²³ Positive results were noted in assays in V79 cells for gene mutation and also in the mouse lymphoma assay.^{20,24,25} Positive results were documented also in metaphase analysis for clastogenicity in V79 and CHO cells.^{20,26} In addition, CS has been shown to induce SCEs (Sister Chromatid Exchanges) in CHO cells.²⁰ These data indicate that CS has clastogenic potential.
20. There is evidence from *in vitro* studies to indicate that CS has aneugenic effects. It has been shown to interfere with the spindle machinery and cell division in mammalian cells resulting in Cmitosis and metaphase block.²⁷⁻³² CS has also been shown to induce micronuclei in mammalian cells *in vitro*.²⁵ These data suggest that CS has aneugenic potential.
21. The clastogenic effects seen appear to be due to CS itself, or an unknown short-lived intermediate.²⁶ The mechanism of aneugenicity appears to differ from the clastogenicity with 2-chlorobenzaldehyde being the important metabolite regarding aneugenicity but not in respect of clastogenicity.²⁹

† No Observable Adverse Effect Level

In vivo studies

22. Negative results were consistently obtained in bone marrow or peripheral blood assays for micronuclei induction using high dose levels and both the oral and intraperitoneal routes.^{23,33} (These assays are capable of detecting clastogens and aneugens if the active metabolite reaches the bone marrow.) It was noted that no data were available to indicate if adequate amounts of CS or short lived reactive metabolites reached the target organ. Data from DNA binding studies in the liver and kidney did not help in this regard as no relevant analysis of tissues of initial contact (ie skin or nasal mucosa) were undertaken.²¹ Studies using *Drosophila* (fruit flies) did not provide any meaningful data as the experimental design was unlikely to result in exposure of *Drosophila* to biologically active CS.²³ It was felt prudent for complete reassurance on the lack of mutagenic activity of CS *in vivo* to have data from a study to investigate genotoxicity to measure potential mutagenicity at a site of contact, for example in the nasal mucosa. However, some members of COM recognised that the design of such an animal study would be difficult both from practical and ethical standpoints and were of the opinion that these studies were not necessary.

Carcinogenicity

23. The carcinogenicity data on CS were considered by the Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC). Their conclusions are given in the following paragraph.
24. The US National Toxicology Program carcinogenicity studies provide no evidence that CS had any carcinogenic effects in adequately conducted inhalation bioassays in rats or in mice following 2 year exposure at up to 0.75 mg/m³ and 1.5 mg/m³ respectively.²⁰ These data provide reassurance that CS does not have mutagenic activity *in vivo* at site of contact tissues, a concern raised by the COM. No further work relating to CS is therefore needed in this area.

Reproductive toxicity

25. Developmental toxicity (teratogenicity) studies using the inhalation route and an aerosol of CS (1- 2 µm mass median diameter) did not indicate any teratogenic or foetotoxic effects in rats or rabbits exposed to 60 mg/m³ CS (5 minutes per day) on days 6 to 15 of pregnancy.³⁴ Similar results were obtained when CS was given by the intraperitoneal route at 20 mg/kg as a single dose on day 6, 8, 9, 10, 12 or 14 of pregnancy.

²⁰ Threshold Limit Value (TLV): Occupational exposure limit, for an 8 hour time weighted exposure, recommended by the American Conference of Government Industrial Hygienists in the USA.

26. There were no data available relating to single or multigeneration reproductive toxicity studies.

Effects in humans

27. Most of the data available relates to studies involving CS smoke or aerosol and exposure via inhalation. Aerosols were generated by thermal dispersion (particle size about 0.5 µm) or from a solution in methylene chloride (particle size about 1 µm). Studies on volunteers indicate that exposure to about 0.5 to 1 mg/m³ CS for 90 minutes in an exposure chamber produced profuse tears (lachrymation), involuntary repeated closure of eyes (blepharospasm), a burning sensation in the mouth, nasal irritation and symptoms of tightness in the chest; in some cases difficulty in breathing was experienced, particularly upon initial exposure.^{35,36} Subjects were able to tolerate exposure at these levels throughout the 90 minute duration of this experiment. In general exposures of about 2.5 mg/m³ could be tolerated only for a few minutes. These data relate to subjects not previously exposed to CS. There is evidence for the development of some tolerance if exposures are built up slowly with 7/8 (88%) subjects then being able to

tolerate 2.5 mg/m³ for 60 minutes.³⁶ Once exposure ceased all symptoms and signs, apart from headache, disappeared within a few minutes. No biologically significant effects were seen on respiratory function, blood chemistry nor in the pattern of electrocardiograms (ECG). However, the observation of effects on the ECG would be very dependent on the time after exposure at which they were measured and it is not clear from the published paper how long a delay occurred after exposure had ceased.³⁶ Dermal exposure of volunteers, by body drenching whilst only lightly clothed, with very dilute aqueous solutions of CS (up to 0.0005% w/v) resulted in marked transient skin and eye irritation.³⁷ During this period a rise in both systolic (30 to 59 mm Hg) and diastolic (15 to 30 mm Hg) blood pressures was noted which took 2 to 25 minutes to fall to within 10 mm Hg of the controls. This was not dose-related and was not exacerbated by exercise.

28. Data from volunteer studies and experience in use, both in the manufacture of CS and its use in riot control, indicate that CS itself is a skin irritant. Volunteers whose forearm skin was exposed to dry powder experienced a mild, transient skin reaction.³⁸ The effects were more pronounced if the powder was moistened, when erythema lasted for between 1 to 2 days. Studies have also been carried out on volunteers whose forearm skin was exposed to high concentrations of CS under simulated tropical conditions.³⁹ Marked irritant effects could be produced although there was much variability in response depending on the individual and on local conditions (heat and moisture). A high incidence of dermatitis on the arms and neck has been reported at the industrial site in the USA that manufactured CS in the past.³⁹ Occupational hygiene standards at this plant were poor, with airborne CS concentrations of levels up to 12 mg/m³ (much greater than the Threshold Limit Value TLV at the time of 0.4 mg/m³).
29. Skin problems were common in individuals exposed to CS from grenades when these were used in Hong Kong during rioting at a Vietnamese detention camp, under circumstances where the rioters were not able to disperse.^{40,41} A subsequent review of case records of 184 patients with symptoms consistent with CS exposure revealed a high incidence (52%) of skin problems including contact dermatitis and minor burns, most of which resolved within 2 weeks. Some of the skin injuries were caused by contact with hot canisters or grenades.
30. There is some evidence that CS can also produce skin sensitisation. At the CS manufacturing site referred to in paragraph 28, 8% (2/25) of the individuals who were patch tested with CS showed skin reactions consistent with allergic contact dermatitis.³⁹ There are also case reports of CS induced allergic contact dermatitis in four individuals who were also exposed to CS from tear gas grenades.⁴²⁻⁴⁴ There is, however, no information on the sensitisation potential of CS in solvent formulations.
31. Data on eye irritancy are available from studies in volunteers. Exposure of young male volunteers to 0.1 or 0.25% CS as a slurry in 0.5% polysorbate, either directly (0.25 ml drop) or as a spray (hand-held disperser from 15 feet), resulted in a severe pain response for a few minutes, profuse tears and redness of the conjunctiva for about 10 minutes.⁴⁵ Comparable effects were seen in volunteers exposed to up to 1% CS in an organic solvent (trioctyl phosphate) using identical methodology.⁴⁶ There was complete recovery after about 30 minutes. Similar effects were seen in volunteers exposed to CS powder (0.8 µm mass median diameter) at up to 6.7 mg/m³ for 10 minutes.⁴⁷ There were no effects on visual acuity several minutes after exposure ceased. Data from experience in use indicates similar effects with transient pain, profuse tears and conjunctival reddening. There is no evidence from these studies of any permanent damage.
32. The question as to whether subjects being treated with neuroleptic drugs are likely to be more sensitive to CS spray has been raised.⁴⁸ There are no experimental data to allow any conclusions to be drawn on this aspect of the toxicity of CS.
33. The only data on the effects of repeated exposure to CS derived from case reports of workers occupationally exposed.² These do not indicate any effects other than local irritant effects seen after acute exposure, but no conclusions can be drawn from these very limited data.

Toxicity of MIBK

34. MIBK is readily absorbed and widely distributed in various tissues of rats and mice following oral or inhalation exposure.^{49,50} The major metabolites in rodents are 4-hydroxy-4-methyl-2-pentanone (4-OHMIBK) and 4-methyl-2-pentanol (4-MPOL) which may be further conjugated, or metabolised and eliminated as carbon dioxide, or incorporated into tissues.^{50,51} Data on elimination of MIBK are incomplete. Studies in humans suggest that absorbed MIBK is rapidly cleared from blood and that very little unchanged MIBK is eliminated in the urine.⁵²
35. Studies using hens have indicated that MIBK has the potential to induce microsomal metabolism carried out by cytochrome P450 enzymes in the liver after repeated exposure for 3 months. MIBK would thereby potentiate the effects of other chemicals (including drugs) that undergo activation via cytochrome P450-mediated metabolism.⁵³ These data, however, derived from studies involving prolonged, repeated exposure and are not relevant to single exposure, as is the case in the use of CS spray in the field.
36. MIBK is of low acute toxicity in rats or mice both by inhalation (4 hour LC5021 circa 12 g/m³) or by ingestion (oral LD5022 2 to 5 g/kg b.w.).⁵⁴⁻⁵⁶ Studies in rabbits to investigate skin irritancy using an occlusive dressing and 10 to 24 hour exposure resulted in minor transient effects, indicating that MIBK has a low skin irritant potential.^{57,58} Repeated exposure produced drying and flaking of the skin due to the defatting action of MIBK. Eye irritancy studies in the rabbit using neat MIBK (0.1 ml) resulted in transient effects.⁵⁴ These results indicate that MIBK has low eye irritant potential.
37. Repeated dose (90-day) studies by inhalation showed effects on the liver and kidneys.⁵⁹ In mice the only effect seen, apart from lachrymation, at the top dose (4100 mg/m³) was a small increase (11%) in liver weight, not accompanied by histopathological abnormalities. A similar effect was seen in the liver of rats. In addition, nephrotoxicity was seen in the proximal tubules of the rat kidney at concentrations of 1025 and 4100 mg/m³ of MIBK. Nephrotoxicity was limited to the male rat and was associated with hyaline droplet deposition. It may have been due to binding to alpha-2 urinary microglobulin, a male rat specific protein; this mechanism is believed to be specific to the male rat.⁶⁰ The NOAEL was 205 mg/m³ in the rat and 1025 mg/m³ in the mouse.
38. In an unpublished 90-day oral study in the rat, histological evidence of kidney damage was reported at doses of 250 mg/kg and above, both in male and female animals. There was increased liver weight, not accompanied by histopathological damage, at 100 mg/kg.⁶¹ The NOAEL for this study was estimated to be 50 mg/kg.
39. There is no evidence that MIBK or its major metabolite 4-OHMIBK have any genotoxic properties. Negative results were obtained with MIBK in the *Salmonella* assay, a metaphase analysis for clastogenicity in hepatocytes, a mouse lymphoma assay, an unscheduled DNA synthesis (UDS) assay in hepatocytes and also *in vivo* in a bone marrow micronucleus assay.^{62,63} Negative results were obtained for the metabolite in the *Salmonella* assay and metaphase analysis in hepatocytes.⁶²
40. The developmental toxicity (teratogenicity) of MIBK in rats and mice has been assessed following exposure between 300 and 3000 ppm by inhalation on gestation days 6-15.⁶⁴ Maternal toxicity and foetotoxicity were observed in both species at 3000 ppm, but not at 1000 ppm. Significant reductions in foetal weight and ossification in the rat at 300 ppm were probably related to litter sizes and were not treatment-related. Contrary to the statement in some reports (which have relied on secondary sources and not the original article), there was no evidence of teratogenicity in either species, even at the maternally toxic exposure concentration of 3000 ppm.
41. It was noted that no carcinogenicity bioassays nor any single or multigeneration reproductive toxicity studies have been carried out on MIBK.

42. The characteristic effects noted in humans relate to local irritant effects and non-specific central nervous system (CNS) effects (eg headache, nausea) at occupational exposures of about 100 ppm and above.^{52,65,66} The odour threshold is low (0.4 ppm) and the irritant effects can be detected at about 2 ppm.⁶⁷

Data on the combination of CS and MIBK

43. The Committee noted the sparsity of data on the combination of CS dissolved in MIBK. There are no data available on the metabolism, kinetics, acute toxicity, or skin irritancy of CS when administered in MIBK as solvent.
44. The only experimental data specifically on this combination consist of a study on the eye irritancy of 7% CS in MIBK (w/v) in rabbits.⁶⁸ This indicated that spraying 7% CS directly into the eyes of rabbits from close range produced severe irritant effects, including a degree of corneal opacity, which had cleared by day 8 and was not followed by irreversible damage.
45. Information was available from experience arising from the use of the spray from studies carried out by NPIS London Centre and the CIRS.^{69,70} These indicated that there were cases of dermatitis following the use of CS spray: the effects produced were noted 6 hours after the exposure. No longer term follow-up studies have been carried out. There are also case reports of marked dermatitis following the use of CS spray in France. The report describes eleven subjects of whom five had multiple exposures to CS. The authors considered that a direct irritant effect was responsible, although an allergic dermatitis could not be ruled out. It is not clear from the published information whether exposure was to CS in MIBK or to another formulation. In addition, no information is available on the ethnicity of the exposed individual who developed dermatitis.⁷¹
46. Literature searches did not reveal reports of serious eye damage caused by CS spray. Furthermore such cases were not identified as a consequence of exposure to CS spray in the data provided by NPIS London Centre.

Conclusions

47. The Committee noted that there are considerable data available to assess the toxicity of CS itself, and to a lesser extent, the solvent MIBK itself. CS is a potent sensory irritant, particularly to the skin and the eyes. It is rapidly hydrolysed and therefore tissue exposure to CS itself is transient. Experience in use indicates that it is a skin irritant and there are some reports of skin sensitisation occurring. There are no concerns relating to the mutagenicity, carcinogenicity or teratogenicity of CS itself. The toxicity of the solvent MIBK is characterized by transient local irritant effects and central nervous system (CNS) effects (particularly headache, nausea) resulting from occupational exposures of about 100 ppm and above. Negative results were obtained in mutagenicity tests and there was no evidence of teratogenicity in developmental toxicity studies. There is no information from carcinogenicity or multigeneration reproductive toxicity assays.
48. There are very few data on the formulated material. A 7% (w/v) solution of CS in MIBK produced severe irritant effects in rabbit eyes followed by recovery in 8 days. This is consistent with the absence of evidence of serious permanent eye damage in humans. Experience in use indicates that it has skin irritant properties, and can cause dermatitis.
49. The Committee's conclusions regarding the health effects of CS spray were based on consideration of the toxicity data on CS and MIBK. As noted above there was very little information on the formulated product. The Committee's advice applies to all individuals exposed to CS spray during its use as a chemical incapacitant.

50. The Committee considered that the *available* data did not, in general, raise concerns regarding the health effects of CS spray itself. Local irritant effects are short term and there exists the possibility of skin sensitisation occurring in some individuals. It must be noted that no comprehensive investigation of the effects of CS spray in humans was available, nor has there been any systematic follow-up of individuals who have been sprayed with CS spray. The Committee has concerns regarding exposure to CS spray in susceptible groups. These are:
- Individuals with bronchial asthma or chronic obstructive airways disease whose condition could be aggravated by the irritant effects of CS spray on the respiratory tract.
 - Individuals suffering from hypertension or other cardiovascular disease because of the transient effects of CS spray in increasing blood pressure.
 - It was not possible, on the basis of the available data, to comment on whether individuals being treated with neuroleptic drugs are more likely to be sensitive to the effects of CS spray.
51. The Committee noted that adherence to the operational guidelines for the use of CS spray was of particular importance since at the time of exposure it would be exceedingly unlikely that the medical status of those exposed would be known. These concerns, and the uncertainties noted earlier, lead to the conclusion that particular care needs to be taken to follow the recommended aftercare guidelines for *all* persons exposed to CS.
52. The Committee considered that further information needs to be obtained on the effects of CS spray in humans. In this regard it was noted that systematic studies in volunteers to investigate the toxicity of CS spray may present insurmountable difficulties. The Committee thus *recommended* that follow-up studies be carried out on individuals treated for the immediate effects of CS spray in order to obtain data on whether delayed effects occur. Information should also be collected in these studies relating to the previous medical history of the individuals involved, particularly with regard to respiratory or cardiovascular disease, or treatment with neuroleptic drugs.

September 1999

COT Statement: COT/1999/06

COM Statement: COM/98/S2

COC Statement: COC/98/S4

References

1. Himsworth H, Dornhorst HC, Thompson RHS. *Report of the enquiry into the medical and toxicological aspects of CS (ortho-chlorobenzylidene malononitrile). Part I. Enquiry into the medical situation following the use of CS in Londonderry on the 13 and 14 August 1969*, London: HMSO, 1969.
2. Himsworth H. *Report of an enquiry into the medical and toxicological aspects of CS. Part II. Enquiry into the toxicological aspects of CS and its use for civil purposes*, London:H MSO, 1971.
3. National Police Training Personal Safety Programme. *Module Four 'Incapacitant Sprays', Version 7/97*, 1997.
4. Lacy R, Hewlett D. *Evaluation of o-chlorobenzylidene malononitrile (CS) and methyl isobutyl ketone (MIBK) exposure during CS spray use*. Report submitted to the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment by the Home Office Home Office Scientific Development Branch, St Albans, UK:Home Office Scientific Development Branch, 1999.
5. Parker R, Knight D. *CS spray droplet sizing. Report AEAT-4596 by AEA Technology plc, Abingdon, Oxfordshire, UK, with additional data reported to the Home Office Scientific Development Branch in February 1999*. Submitted to the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment by the Home Office Scientific Development Branch, 1998.
6. Health and Safety Executive. *EH40 Occupational Exposure Limits*, 1999.
7. Ballantyne B, Swanston DW. The comparative acute mammalian toxicity of 1-chloroacetophenone (CN) and 2-chlorobenzylidene malononitrile (CS). *Arch Toxicol* 1978; 40:75-95.
8. Patai S, Rappoport Z. Nucleophilic attacks on carbon-carbon double bonds. Part II. Cleavage of arylmethylenemalononitriles by water in 95% ethanol. *J Chem Soc* 1962; 383-392.
9. Boyland E, Chasseaud LF. Enzyme-catalysed conjugations of glutathione with unsaturated compounds. *Biochem J* 1967; 104:95-102.
10. Cucinell SA, Swentzel KC, Biskup R, Snodgrass H, Lovre S, Stark W, Feinsilver L, Vocci F. Biochemical interactions and metabolic fate of riot control agents. *Fed Proc* 1971; 30:86-91.
11. Leadbeater L. The absorption of ortho-chlorobenzylidenemalononitrile (CS) by the respiratory tract. *Toxicol Appl Pharmacol* 1973; 25:101-110.
12. Brewster K, Harrison JM, Leadbeater L, Newman J, Upshall DG. The fate of 2-chlorobenzylidene malononitrile (CS) in rats. *Xenobiotica* 1987; 17:911-924.
13. Ballantyne B, Callaway S. Inhalation toxicology and pathology of animals exposed to ochlorobenzylidene malononitrile (CS). *Med Sci Law* 1972; 12:43-65.
14. Rothberg S. Skin sensitization potential of the riot control agents BBC, DM, CN, and CS in guineapigs. *Mil Med* 1970; 135:552-556.
15. Chung CW, Giles AL,Jr. Sensitisation of guinea pigs to alpha-chloroacetophenone (CN) and orthochlorobenzylidenemalononitrile (CS), tear gas chemicals. *J Immunol* 1972; 109:284-293.
16. Ballantyne B, Gazzard MF, Swanston DW, Williams P. The ophthalmic toxicology of o-chlorobenzylidene malononitrile (CS). *Arch Toxicol* 1974; 32:149-168.

Annex 10

17. Gaskins JR, Hehir RM, McCaulley DF, Ligon EW, Jr. Lachrimating agents (CS and CN) in rats and rabbits. Acute effects on mouth, eyes, and skin. *Arch Environ Health* 1972; 24:449-454.
18. Marrs TC, Colgrave HF, Cross NL, Gazzard MF, Brown RF. A repeated dose study of the toxicity of inhaled 2-chlorobenzylidene malonitrile (CS) aerosol in three species of laboratory animal. *Arch Toxicol* 1983; 52:183-198.
19. Rietveld EC, Delbressine LPC, Waegemaekers THJM, Seutter-Berlage F. 2-Chlorobenzylmercapturic acid, a metabolite of the riot control agent 2-chlorobenzylidene malonitrile (CS) in the rat. *Arch Toxicol* 1983; 54:139-144.
20. National Toxicology Program. Toxicology and carcinogenesis studies of CS2 (94% CS) in rats and mice. US National Toxicology Program Technical Report No 377. Unknown 1983;
21. Von Daniken A, Friederich U, Lutz WK, Schlatter C. Tests for mutagenicity in *Salmonella* and covalent binding to DNA and proteins in the rat of the riot control agent CS. *Arch Toxicol* 1981; 49:15-27.
22. Meshram GP, Malini RP, Rao KM. Mutagenicity evaluation of riot control agent CS in the Ames *Salmonella* microsome test. *J Appl Toxicol* 1992; 12:377-384.
23. Wild D, Eckhardt K, Harnasch D, King MT. Genotoxicity study of CS in *Salmonella*, *Drosophila* and mice. *Arch Toxicol* 1983; 54:167-170.
24. McGregor DB, Brown A, Cattanaach P, Edwards I, McBride D, Caspary WJ. Responses of the L5178Y tk+/tk- mouse lymphoma cell forward mutation assay. II. 18 coded chemicals. *Environ Mol Mutagen* 1988; 11:91-118.
25. Ziegler-Skylakakis K, Summer KH, Andrae U. Mutagenicity and cytotoxicity of 2-chlorobenzylidene malonitrile (CS) and metabolites in V79 Chinese hamster cells. *Arch Toxicol* 1989; 63:314-319.
26. Bauchinger M, Schmid E. Clastogenicity of 2-chlorobenzylidene malonitrile (CS) in V79 Chinese hamster cells. *Mutat Res* 1992; 282:231-234.
27. Schmid E, Bauchinger M, Ziegler-Skylakakis K, Andrae U. 2-Chlorobenzylidene malonitrile (CS) causes spindle disturbances in V79 Chinese hamster cells. *Mutat Res* 1989; 226:133-136.
28. Salassidis K, Schmid E, Bauchinger M. Mitotic spindle damage induced by 2-chlorobenzylidene malonitrile (CS) in V79 Chinese hamster cells examined by differential staining of the spindle apparatus and chromosomes. *Mutat Res* 1991; 262:263-266.
29. Schmid E, Bauchinger M. Analysis of the aneuploidy inducing capacity of 2-chlorobenzylidene malonitrile (CS) and metabolites in V79 Chinese hamster cells. *Mutagenesis* 1991; 6:303-305.
30. Nusse M, Recknagel S, Beisker W. Micronuclei induced by 2-chlorobenzylidene malonitrile (CS) contain single chromosomes as demonstrated by the combined use of flow cytometry and immunofluorescent staining with anti-kinetochore antibodies. *Mutagenesis* 1992; 7:57-67.
31. Weller EM, Kubbies M, Nusse M. Induction of cell cycle perturbations by the tear gas 2-chlorobenzylidene malonitrile (CS) in synchronously and asynchronously proliferating mammalian cells. *Cytometry* 1995; 19:334-342.
32. Miller BM, Nusse M. Analysis of micronuclei induced by 2-chlorobenzylidene malonitrile (CS) using fluorescence in situ hybridization with telomeric and centromeric DNA probes, and flow cytometry. *Mutagenesis* 1993; 8:35-41.

33. Grawe J, Nusse M, Adler ID. Quantitative and qualitative studies of micronucleus induction in mouse erythrocytes using flow cytometry. I. Measurement of micronucleus induction in peripheral blood polychromatic erythrocytes by chemicals with known and suspected genotoxicity. *Mutagenesis* 1997; 12:1-8.
34. Upshall DG. Effects of o-chlorobenzylidene malononitrile (CS) and the stress of aerosol inhalation upon rat and rabbit embryonic development. *Toxicol Appl Pharmacol* 1973; 24:45-59.
35. Punte CL, Owens EJ, Gutentag PJ. Exposures to CS. *Arch Environ Health* 1963; 6:72-80.
36. Beswick FW, Holland P, Kemp KH. Acute effects of exposure to orthochlorobenzylidene malononitrile (CS) and the development of tolerance. *Br J Ind Med* 1972; 29:298-306.
37. Ballantyne B, Gall D, Robson D. Effects on man of drenching with dilute solutions of ochlorobenzylidene malononitrile (CS) and dibenz(b.f)-1:4-oxazepine (CR). *Med Sci Law* 1976; 16:159-170.
38. Holland P, White RG. The cutaneous reactions produced by CS and chloroacetophenone when applied directly to the skin of human subjects. *Br J Dermatol* 1972; 86:150-154.
39. Shmunis E, Taylor JS. Industrial contact dermatitis. Effect of riot control agent CS. *Arch Dermatol* 1973; 107:212-216.
40. Zekhri AMB, King WWK, Yeung R, Taylor WRJ. Acute mass burns caused by CS tear gas. *Burns* 1995; 21:586-589.
41. Anderson PJ, Lau GSN, Taylor WRJ, Critchley JAJH. Acute effects of the potent lacrimator ochlorobenzylidene malononitrile (CS) tear gas. *Hum Toxicol* 1996; 15:461-465.
42. Gollharsen R, Holzmann H, Ring J. Contact dermatitis through tear gas. *Munch Med Wochenschr* 1988; 130:680-683.
43. Such Y, Lee CW. Tear gas dermatitis; allergic contact sensitisation due to CS. *Cameo* 1991; 30:576-577.
44. Kanerva L, Tarvainen K, Pinola A, Leino T, Granlund H, Estlander T, Jolanki R, Forstrom L. A single accidental exposure may result in a chemical burn, primary sensitisation and allergic contact dermatitis. *Contact Dermatitis* 1994; 31:229-235.
45. Rengstorff RH, Mershon MM. CS in water. II. Effects on human eyes. *Mil Med* 1971; 136:149-151.
46. Rengstorff RH, Mershon MM. CS in trioctylphosphate: effects on human eyes. *Mil Med* 1971; 136:152-153.
47. Rengstorff RH. The effects of the riot control agent CS on visual acuity. *Mil Med* 1969; 134:219-221.
48. MIND. *Letter to the COT Secretariat from MIND, the Mental Health Charity, 7th October 1998, 1998.*
49. Duguay AB, Plaa GL. Tissue concentrations of methyl isobutyl ketone, methyl n-butyl ketone and their metabolites after oral and inhalation exposure. *Toxicol Lett* 1995; 75:51-58.
50. Granvil CP, Sharkawi M, Plaa GL. Metabolic fate of methyl n-butyl ketone, methyl isobutyl ketone and their metabolites in mice. *Toxicol Lett* 1994; 70:263-267.
51. DiVicenzo GD, Kaplan CJ, Dedinas J. Characterization of the metabolites of methyl n-butyl ketone, methyl iso-butyl ketone, and methyl ethyl ketone in guinea pig serum and their clearance. *Toxicol Appl Pharmacol* 1976; 36:511-522.

Annex 10

52. Hjelm EW, Hagberg M, Iregren A, Lof A. Exposure to methyl isobutyl ketone: toxicokinetics and occurrence of irritative and CNS symptoms in man. *Int Arch Occup Environ Health* 1990; 62:19-26.
53. Abou-Donia MB, Lapadula DM, Campbell G, Timmons PR. The synergism of n-hexane-induced neurotoxicity by methyl isobutyl ketone following subchronic (90 days) inhalation in hens: induction of hepatic microsomal cytochrome P-450. *Toxicol Appl Pharmacol* 1985; 81:1-16.
54. Smyth HF, Carpenter CP, Weil CS. Range finding toxicity data: list IV. *Arch Ind Hyg Occup Med* 1951; 4:119-122.
55. Batyrova TF. Substantiation of the maximum permissible concentration of MIBK in air of workrooms. *Gig Tr Prof Zabol* 1973; 17:52-53.
56. Zakhari, S., Levy, P., Liebowitz, M. and Avia, D.M. Acute oral, intraperitoneal and inhalation toxicity of MIBK in the mouse. In: *Isopropanol and ketones in the environment*. Part 3, edited by Golberg, L. Cleveland, Ohio: CRC Press, 1977, p. 93-133.
57. Krasavage, W.J., O'Donoghue, J.L. and DiVincenzo, G.D. Unpublished data on MIBK cited in: *Patty's Industrial Hygiene and Toxicity*, edited by Clayton, G.D. and Clayton, F.E. 1994,
58. Weil CS, Scala A. Study of intra- and inter-laboratory variability in the results of rabbit eye and skin irritation tests. *Toxicol Appl Pharmacol* 1971; 19:276-360.
59. Phillips RD, Moran EJ, Dodd DE, Fowler EH, Kary CD, O'Donoghue J. A 14-week vapor inhalation toxicity study of methyl isobutyl ketone. *Fund Appl Toxicol* 1987; 9:380-388.
60. US Environment Protection Agency. *Alpha-2u-globulin. Association with chemically induced renal toxicity and neoplasia in the male rat*. Risk Assessment Forum (EPA-625-3-91-019F), Washington DC:US Environment Protection Agency, 1991.
61. Microbial Associates. *Subchronic toxicity of methyl isobutyl ketone in SD rats. Preliminary report*. Research Triangle Park, North Carolina, Study No. 5221.04. Cited in IPCS, Environmental Health Criteria Document 117. Methyl isobutyl ketone, 1990.
62. Brooks TM, Meyer AL, Hutson DH. The genetic toxicology of some hydrocarbon and oxygenated solvents. *Mutagenesis* 1988; 3:227-232.
63. O'Donoghue JL, Haworth SR, Curren RD, Kirby PE, Lawlor T, Moran EJ, Phillips RD, Putnam DL, Rogers-Back AM, Slesinski RS, Thilagar A. Mutagenicity studies on ketone solvents: methyl ethyl ketone, methyl isobutyl ketone, and isophorone. *Mutat Res* 1988; 206: 149-161.
64. Tyl RW, France KA, Fisher LC, Pritts IM, Tyler TR, Phillips RD, Moran EJ. Developmental toxicity evaluation of inhaled methyl isobutyl ketone in Fischer 344 rats and CD-1 mice. *Fund Appl Toxicol* 1987; 8:319-327.
65. Dick RB, Krieg EF,Jr., Setzer J, Taylor B. Neurobehavioral effects from acute exposures to methyl isobutyl ketone and methyl ethyl ketone. *Fund Appl Toxicol* 1992; 19:453-473.
66. Cagon P, Meigler D, Lapere J. Olfactory adaption, threshold shift and recovery at low levels of exposure to MIBK. *Neurotoxicology* 1994; 15:637-642.
67. Ruth JH. Odor thresholds and irritation levels of several chemical substances: a review. *Am Ind Hyg Assoc J* 1986; 47:A142-A151.

68. Bouchet Study Centre. *Comparison of ocular irritation in the New Zealand rabbit of two products CAP-STUN and CS (7% in MIBK)*. Unpublished report for the French authorities. Bouchet study centre report RT 93009, 1993.
69. Wheeler H, MacLehose R, Euripidou E, Murray V. Surveillance into crowd control agents [Correspondence]. *Lancet* 1998; 352:991-992.
70. Euripidou E. *A pilot investigation into the short/medium term health impacts of Crowd Control Agents. A follow-up of patients reported to NPIS*. MSc Thesis (London School of Hygiene and Tropical Medicine), 1998.
71. Parneix-Spake A, Theisen A, Roujeau JC, Revuz J. Severe cutaneous reactions to self-defense sprays [Letter]. *Arch Dermatol* 1993; 129:913.

DSAC Sub-committee on the Medical Implications of Less Lethal Weapons (DOMILL)

Statement on the medical implications of the use of the Somati RCV9000 Vehicle Mounted Water Cannon

Introduction

1. This statement addresses the use of the Somati RCV9000 Vehicle Mounted Water Cannon as a less-lethal option for dealing with unlawful protest, disorder and threats of violence in the United Kingdom. The statement supercedes an interim statement that considered the medical implication of use in Northern Ireland of the Mol CY NV MSB 18 water cannon⁵⁰; the interim statement was placed in the Library of the House of Commons in July 2002.

Background

2. The role of the DSAC⁵¹ Sub-committee on the Medical Implications of Less Lethal Weapons (DOMILL) is to provide the Secretary of State for the Home Department and the Secretary of State for Northern Ireland with:
 - d. Advice on the medical implications of generic classes of less lethal (LL) weapon systems (which includes biophysical, pathological and clinical aspects);
 - e. Independent statements on the medical implications of use of specific LL systems, when used according to the formal guidance provided to users;
 - f. Advice on the risk of injury from identified LL systems striking specific areas of the body, in a format that would assist users in making tactical decisions, and developing guidance to users to minimise the risk of injury.
3. This advice is in support of the UK Government's requirements arising from:
 - a. Recommendations 69 and 70 of the Patten report into policing in Northern Ireland⁵²: (i) a research programme to find an acceptable, effective and less potentially lethal alternative to the Baton Round, (ii) provision of a broader range of public-order equipment to the police;
 - b. The desire of the Association of Chief Police Officers (ACPO) to have a wider range of options in conflict management scenarios, including those most commonly associated with self-defence and restraint, maintenance of public order, and the police use of firearms.

In Summer 2000, the Secretary of State for Northern Ireland set up a UK-wide inter-departmental Steering Group to co-ordinate a programme to address both requirements.

4. The second report of the Steering Group described the various classes of LL weapon systems being evaluated to address the requirements. The report categorised the technologies according to the requirement for research and evaluation. Within Category A (devices which may be subject to research

50 DSAC Sub-committee on the Medical Implications of Less Lethal Weapons (DOMILL). Interim statement on the medical implications of the use of vehicle-mounted water cannon in a public-order role. DSTL/CBS/BTP/DOC/592/1.0 dated 13 May 02.

51 Defence Scientific Advisory Council.

52 Report of the Independent Commission on Policing in Northern Ireland; September 1999.

and evaluation immediately) were vehicle-mounted and portable water cannon. The third report of the Steering Group concluded that portable water cannon did not merit further study, and were unsuitable for use as a less-lethal option in a public-order role. The Steering Group took forward the assessment of commercially available vehicle-mounted water cannon.

5. DOMILL was invited to provide, by March 2002, the interim statement on the medical implications of the use of water cannon in a public-order role. Prior to and during this period, the Police Service of Northern Ireland (PSNI) were deploying the Mol CY NV MSB 18 water cannon. These cannon had been borrowed from the Belgian police authorities. The interim statement was required to facilitate the consideration of future water cannon use and in particular, the proposal for purchase of water cannon for use by the PSNI.
6. On 18 July 2002, the Northern Ireland Office Minister of State announced that the PSNI - following discussions with the Northern Ireland Policing Board and the Association of Chief Police Officers (ACPO) - would shortly place an order for six new vehicle-mounted water cannon. Upon the announcement, a PSNI, ACPO and Home Office project team took forward the procurement, and following an objective review of the specifications of water cannon from two manufacturers that had responded to a technical requirement, a contract was negotiated with Somati of Belgium to supply six water cannon – the Somati RCV9000 Vehicle Mounted Water Cannon. The first two of these vehicles were accepted by the PSNI in August 2003, subject to a medical statement by DOMILL. ACPO produced guidance on the deployment and use of the water cannon in the UK. The water cannon are a new design, and there is no history of operational use.
7. DOMILL was requested to produce a statement on the medical implications of the use of the Somati RCV9000 within the ACPO Guidance. The Defence Science and Technology Laboratory (Dstl) developed and implemented a technical strategy to gather experimental data to underpin DOMILL's statement. The strategy was based on the recommendations presented in para 14 of the interim DOMILL statement. Dstl undertook tests on the Mol CY NV MSB 18 water cannon in October 2002, and on the first two Somati RCV9000 vehicles in Belgium in early September 2003.
8. A DOMILL statement was prepared in October 2003. However, familiarisation trials undertaken by PSNI identified technical problems in the first two vehicles that required modifications by the manufacturers. DOMILL withheld its statement until additional tests could be undertaken by Dstl to ensure that the modifications had not increased the injury potential of the systems. The additional tests on the first and second vehicles took place in February 2004; the water jet outputs of the third and fourth vehicles were also determined at the same time. This statement encompasses these data.

Technical approach

9. The approach was two-fold: a comprehensive review of the literature pertinent to water jets, and a comparison of the water jet output and its effect on responding structures selected to predict the principal hazards. The potential injuries from a jet of water are defined thus:
 - Primary injuries are those caused directly by the energy of a water jet impacting the human body (including rotational injuries to the head and neck).
 - Secondary injuries are those caused by the impact on the human body of street furniture or other debris, energised by the water jet.
 - Tertiary injuries are caused by impact of the body with other items, as a result of the initial event, such as being thrown against a wall or falling.

10. For the literature review, over 500 references and web-sites were reviewed. The documents and web-sites addressed the use of water cannon, and injuries attributed to that use, the physics of water jets, and injuries reported from the impact of water in other scenarios, such as water sports. Dstl reviewed the technical specifications of some of the water cannon used recently in Northern Ireland, Belgium and Germany, and the nominal specification of the Somati water cannon to be purchased. Dstl updated the review to gather any new information published between the interim DOMILL statement (May 2002) and February 2004.
11. The technical assessment comprised the following activities on the Mol and Somati water cannon:
 - c. Measurement of the gross fluid output;
 - d. Definition of the biologically effective loading within the jets;
 - e. Measurement of the contact velocity and acceleration of the head with a rigid object such as a wall or the ground;
 - f. Measurement of the initial linear and rotational acceleration of the head/neck assembly following direct or sweeping interaction of the jet with the head, and with the torso;
 - g. The distribution of representative debris accelerated by the cannon directed to the ground, and the risk of specific injuries such as ocular trauma;
 - h. The risk of primary injury to the torso and head assessed using physical models.
12. Vehicle-mounted water cannon are less accurate than those LL options that are designed to strike specified individuals. However, they can be used in a variety of modes that reduce the energy transferred to the body by the water: spray or diffused output; short bursts of water jets; continuous water jets. The technical assessment used continuous water jets; uses of lower forces, such as spray output, were considered to be less hazardous. Specifically designed force plates of five different diameters were used to measure the force and the pressure (force per unit area) from the jets. Hybrid III automotive dummies and other injury assessment models were exposed to the jets to assess the hazard. The force and pressure from the jets, and the responses of the injury assessment models were determined at a number of ranges, and cannon output pressure settings. The tests in February 2004 to check the output of the first two vehicles after the modifications, and the tests on the third and fourth vehicles, only employed force plates. The ACPO Guidance was reviewed to assess how the risks were to be controlled in operational use.

Conclusions

Literature review

13. On the basis of the review of a diverse body of literature - little of which had direct, substantiated relevance to the medical consequences of the operational use of water cannon or its use in training - the following conclusions are offered.
14. **Deaths:** There was no evidence in the peer-reviewed journals, press, police or fringe literature reviewed that any person has been killed by the direct or indirect effects of the impact of a jet from a water cannon in appropriate operational use. This conclusion encompasses injuries directly from the jet impact (primary injury), penetrating or blunt impact injuries from debris and street furniture accelerated by the jet (secondary injury) and the impact of the accelerated human body against solid objects or the ground (tertiary injury).

15. **Life-threatening injuries:** In the world-wide literature, there was an extremely low incidence of injuries that could be classed as life-threatening attributable to, or actually caused by water cannon jets. The Belgian and German police authorities, and the PSNI have no reports of serious or life-threatening injuries to the public that could be attributed to the jet of the Belgian Mol CY NV MSB 18 or the German Ziegler water cannon. It should be recognised however that the use of force of any nature carries a risk of injury.
16. In public order incidents in which water cannon may be deployed, it may be difficult to differentiate injuries arising directly from the use of water cannon, as opposed to those caused by other LL weapons such as batons, kinetic energy projectiles, physical assaults or chemical irritants, in cases where such approaches are also used. This clouded the review of all sources of published information on the use of water cannon, and will have implications for assigning injuries arising from future deployments and use, in the subsequent audit.

Technical assessment

17. **Water jet dynamics:** The measured forces and pressures were very variable; this was principally a consequence of the natural structure of water jets, and the difficulties in directing water jets to small experimental targets. Overall, the forces and pressures from the Somati water cannon at maximum pressure were greater than those of the Mol at the same range, although this was not reflected in the variable response of the principal injury model deployed. There was no significant difference between the water output of the four examples of the Somati water cannon.
18. The pressures measured by the force plates were predicted to be sufficient to displace personnel at medium range. At short range, the predicted pressures to the ocular area exceeded a threshold developed from the medical review, and could result in ocular injury.
19. **Response of the injury models:** Unsurprisingly, the responses of the models were also variable. Jets from both types of water cannon directed to the head/neck area could result in high forces that directly accelerate the head/neck assembly. Using a Hybrid III dummy restrained at the torso, the accelerations, forces and moments indicated that according to criteria developed for automotive impact, serious injuries would not be expected, although there was undoubtedly a risk of injury.
20. An unrestrained Hybrid III dummy was accelerated and displaced by the jet, and struck either the ground, or a barrier placed 2 m behind the dummy. The peak accelerations to the head upon the secondary impact were high, and in some cases exceeded the automotive thresholds for serious injury. The high accelerations were observed with the Mol and Somati water cannon. The loads in the neck were also high, and were close to but did not exceed the automotive criteria for serious injury. The loads indicated that there was a risk of injury ("moderate" as defined by the Abbreviated Injury Scale). The Hybrid III dummy does not model the controlled fall of a human; in practice, it is likely that in a human, forces on the head and neck would be less.
21. There was no evidence from the models deployed that there was a significant risk of direct thoracic injury from the jets, arising from body wall deflection. However, in a few of the instances when the dummy was displaced by the jet, high accelerations to the rear of the thorax were observed, as a result of impact with hard surfaces.
22. The application of the water jets to the ground resulted in the acceleration of small pieces of debris to a height that resulted in the risk of non-penetrating impact to standing and seated personnel. The principal risk was impact to the eye.

Overall assessment

23. The hazards identified in the trials have been reviewed in the context of the ACPO Guidance, and the information acquired from the literature survey. It is concluded that the use of the Somati RCV9000 Vehicle Mounted Water Cannon within the ACPO Guidance is unlikely to result in serious or life threatening injuries.

Recommendations

24. Any modifications to the vehicles relevant to the jet output or use of the jest, or any changes to the ACPO Guidance, should be reported promptly to DOMILL.
25. The output of the jest from the two remaining Somati vehicles should be determined prior to operational deployment and use.
26. The maintenance schedule and routine review of the suitability for service of the vehicles should include a check of the calibration of the water pressure sensors in conjunction with the control system.
27. The training syllabus for Water Cannon Commanders, Operators and Drivers should be reviewed by DOMILL to ensure that the medical risks of the use of the systems (declared in the ACPO guidance) are clear and understandable.
28. DOMILL should be advised immediately of any injuries specifically attributable to the operational use of the water cannon, or in training.
29. DOMILL request a joint report from ACPO, the Home Office and the Northern Ireland Office on the operational performance of the Somati water cannon, and the frequency and type of injuries directly or indirectly attributed to the water cannon. It is requested that this report is provided within one year of the formal acceptance of the first four Somati water cannon by PSNI.

Chairman, DSAC Sub-committee on the Medical Implications of Less Lethal Weapons 3rd March 2004

