

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) sub-committee 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 injuries¹;
 - b. recommendations 69 and 70 in the report of the Independent Commission on Policing for Northern Ireland (the Patten report)² 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-site³.

¹ "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.

² "A New Beginning: Policing In Northern Ireland". The report of the Independent Commission on Policing for Northern Ireland. September 1999.

³ "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

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.
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 Audit⁴, 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.

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/

⁴ "Patten Report recommendations 69 and 70 relating to public order equipment: A research programme into alternative policing approaches towards the management of conflict". Second Report by the Steering Group led by the Northern Ireland Office, in consultation with the Association of Chief Police Officers. Pages 40-44. November 2001.

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 L21A1¹, 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.