

Scientific Advisory Committee on the Medical Implications of Less-Lethal Weapons (SACMILL)

**Statement on the Medical Implications of the
TASER 7™ Conducted Energy Device System**

Key points:

- This statement constitutes SACMILL’s response to a request from the Home Office for the committee to provide an opinion on the medical implications of the TASER 7™ system.
- The TASER 7™ is a Conducted Energy Device (CED) with twin cartridges that allow the user quickly to deploy a second shot after a failed first shot. While similar in many ways to the TASER X2™, the TASER 7™ has a number of notable differences, including having a green laser sighting system for the top probe and a probe design that radically departs from that used by the TASER X2™ and other older devices. The TASER 7™ also departs from earlier models of CED in that the TASER 7™ two cartridge options, one for close-range engagements, the other for when the subject is further away. It is understood that the guidance to TASER 7™ officers will be to load the device with a pair of cartridges of the same type.
- The electrical output of the TASER 7™, together with the way in which it is delivered, imply that the new device may be more effective than the TASER X2™ at inducing neuromuscular incapacitation and may be more painful for the subject.
- The two cartridge options available for the TASER 7™ make the system more complex than earlier CED systems. Depending on the subject’s distance, the TASER 7™ officer may be faced with a decision to change the cartridge to one more appropriate to the subject’s range or alter their position to bring the subject into the range of the pre-loaded cartridges.
- Other elements of the TASER 7™ system considered by SACMILL include the performance of the device in user handling trials, the proposed national training curriculum, the roll-out plan and how the CED system’s performance will be monitored should it be authorised for use.
- If the TASER 7™ system is authorised for use, it is essential that any significant deviation from the medical predictions made in this statement is reflected in a revised statement. Furthermore, should any substantive element of the system be changed, SACMILL must be informed.
- Should the TASER 7™ system be authorised, it is imperative that its operational performance is closely monitored to gain reassurance that the system performs in the manner anticipated. This monitoring should continue for a minimum of twelve months and SACMILL must be informed urgently of any adverse medical outcomes that may have a bearing on the opinion expressed in the present medical statement.

Preamble

1. SACMILL is a non-departmental public body that provides independent advice to Ministers of Her Majesty's Government. This advice concerns the medical aspects surrounding the use by the police and other authorised bodies of less-lethal weapons (LLWs)¹ on members of the public.² SACMILL is sponsored by the Surgeon General in the Ministry of Defence (MoD).
2. SACMILL acts only in an advisory capacity and neither endorses nor approves the LLW systems under review.
3. In addressing its remit, SACMILL considers all aspects of a LLW system that may have a bearing on the equipment's operational use. These include: developing an understanding of the effects of the weapon's output on the human body; the content and quality of the user guidance and training; how the equipment will be stored and maintained; the manner in which the system will be deployed and used; monitoring and learning from adverse outcomes arising in operational use of LLWs in the UK and elsewhere; assessing the implications of basic research into the medical effects of LLWs; and recommending avenues for further research. SACMILL also considers what information should be made available to personnel involved in the medical management of people subjected to a given LLW system.
4. In recognising that the use of LLWs is not free of medical risk, SACMILL will seek to understand and articulate the risk by systematically evaluating all elements of a less-lethal system and advising Ministers and other stakeholders accordingly.
5. This medical statement provides SACMILL's opinion on the medical implications of the TASER 7™ conducted energy device (CED) system. An annex to this statement lists the various injury types and mechanisms that have been associated with CED use in general. The annex will be maintained on the SACMILL website³ and will be updated as new information becomes available.

Evidence reviewed

6. In forming a view on the medical implications of the TASER 7™ system, SACMILL has in part relied on the following evidence:
 - a) A report by the Defence Science and Technology Laboratory (Dstl) entitled *Dstl opinion on the medical implications of the TASER 7™ system*. (DSTL/CR96283 v2.0, dated 8 July 2020)
 - b) A slide presentation by Dstl at a SACMILL teleconference on 24 April 2020. (DSTL/TR123006 v1.0, dated 24 April 2020)
 - c) A joint report by SACMILL and Dstl entitled *TASER 7™ probe removal evaluation*. (DSTL/TR123653 v1.0, dated 1 June 2020)
 - d) A report by Dstl entitled *Physical assessment of TASER 7™*. (DSTL/TR117685 v1.0, dated 13 March 2020)

¹ LLWs are sometimes referred to as non-lethal weapons or less-than-lethal weapons.

² The health and safety implications for users of less-lethal systems will be routinely assessed by law enforcement agencies. SACMILL will take these user-related aspects into account when forming a view on medical implications for the public.

³ www.gov.uk/government/organisations/science-advisory-committee-on-the-medical-implications-of-less-lethal-weapons

- e) A report from the College of Policing entitled: *T7 supplementary accuracy testing report*. (v1.0, dated 26 March 2020)
- f) Draft TASER 7™ user training and user assessment documentation prepared by the College of Policing.
- g) A draft training plan from the College of Policing entitled *Next generation conducted energy device (Taser 7)*. (v0.6, dated 16 April 2020)
- h) A draft document from the National Police Chiefs' Council entitled *Implementation Programme for the TASER 7™*. (dated 01 May 2020)

A report on the independent assessment of the electrical output of the TASER 7™ report by Defence Research and Development Canada (DRDC) had been anticipated in advance of preparation of this medical statement. Unfortunately, DRDC's scheduling was affected by COVID-19 site access restrictions. SACMILL has, therefore, relied on the data supplied by the manufacturer but will revisit this medical statement when the DRDC report becomes available.

Overview of the TASER 7™

7. The TASER 7™ was launched by Axon Enterprise, Inc (formerly TASER International) in November 2018. Earlier CEDs from the company include the TASER M26™ (introduced into the United Kingdom in 2003), the TASER X26™ (introduced in 2005) and the TASER X2™ (introduced in 2017). The TASER M26™ is no longer in service in the UK while the TASER X26™ is being progressively phased out in favour of the TASER X2™ but is still in service with some agencies.
8. While the TASER M26™ and TASER X26™ have only one cartridge and a single laser sight serving the upper probe, the TASER 7™ is similar to the TASER X2™ in that both devices have twin cartridge bays and separate laser sights for the upper and lower probes. The medical implications of the TASER X2™ system were reviewed by SACMILL in 2016.⁴
9. The TASER 7™ differs from the TASER X2™ in a number of ways, including: (a) the pulse waveform of the TASER 7™ is markedly shorter but carries a similar electrical charge; (b) the TASER 7™ pulses are delivered at a higher rate; (c) the probe design of the TASER 7™ marks a major departure from that used for the TASER X2™ and earlier models in that the tethering wire uncoils from within the probe body and the probe has a novel 'breakaway' design; (d) probes fired from the TASER 7™ have a higher kinetic energy and momentum; (e) the TASER 7™ has two cartridge options offering probe divergences of 3.5° and 12° while the TASER X2™ has a single 7° option (similar to the 8° options for the TASER X26™ and TASER M26™); (f) the TASER 7™ has a green laser for sighting the upper probe and a red laser for the lower probe; the TASER X2™ has two red lasers.
10. The above characteristics of the TASER 7™, together with SACMILL's opinion on the medical implications of these and other aspects of the TASER 7™ system, are discussed below.

⁴ SACMILL Statement on the Medical Implications of Use of the TASER X2 Conducted Energy Device System: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/595242/Medical_Statement_on_the_TASER_X2_system.pdf.

The electrical output of the TASER 7™

11. Like other TASER® CEDs, the TASER 7™ is a battery operated, pistol-like device that generates repetitive electrical pulses that may be delivered to the targeted subject in a number of ways. In the United Kingdom, CED use of force divides into non-discharge and discharge modes of use, such that even drawing a device from its holster is seen as a use of force. The various types of CED use are categorized in the following way:

Non-discharge mode	Draw	CED drawn from holster
	Aim	CED aimed at subject
	Arc display	Display of high voltage arc
	Laser dot	Aiming the laser dot at the subject
Discharge mode	Drive-stun	Front electrodes used to apply discharge
	Fire	Probes fired at subject
	Angled drive-stun	Drive-stun follow-up to complete circuit after firing probes

The firing of probes is the most frequent way in which CEDs are used in the UK to administer an electrical discharge to a subject.⁵

12. When the trigger of the TASER 7™ is pressed, the bay on the left (from the officer's perspective) is the first to deploy probes unless the device detects a fault in the left cartridge, in which case it will deploy the right bay. If these probes make suitable contact, a default five-second cycle of discharge is administered to the subject. This cycle may be interrupted by switching off the device. Pressing the trigger a second time will deploy the probes from the second cartridge bay.
13. A safety feature of the TASER 7™, which first appeared on the TASER X2™, is that the five second cycle will end even when the trigger remains depressed. To extend the cycle beyond five seconds a separate 'Arc' switch must be pressed. This means that the officer is required to make an active decision to prolong the discharge cycle. The discharge will continue for as long as the 'Arc' switch is pressed. Although the TASER X26™ also delivers a default five-second cycle when the trigger is momentarily pressed, if the trigger remains depressed the discharge will continue to be delivered beyond five seconds.
14. The pulse discharge from each cartridge bay of the TASER 7™ consists of short waveforms said to be delivered at a typical rate of 22 pulses per second (PPS). Hence, if the probes from both cartridge bays are fired and all four probes are in electrical contact with the subject, the subject will be exposed to pulses at 44 PPS. These pulse rates are higher than those applicable to the TASER X2™, where the analogous rates are typically 19 and 38 PPS.
15. The electrical charge carried by each pulse is an important determinant of efficacy. Charge is the arithmetic product of current and time. The pulse charge of the TASER 7™ is said to be typically about 63 microcoulombs (µC), which is the same as the pulse charge of the TASER X2™. The pulse duration of the TASER 7™ is, however, markedly shorter than that of the TASER X2™. Therefore, for

⁵ Home Office police use of force statistics, England and Wales: April 2018 to March 2019: <https://www.gov.uk/government/statistics/police-use-of-force-statistics-england-and-wales-april-2018-to-march-2019>

the two devices to achieve the same pulse charge the average current carried by each TASER 7™ pulse must be higher. It is an established electrophysiological principle that shorter pulses are more efficient than longer pulses at producing excitation of nerve and muscle: a shorter pulse requires less charge than a longer pulse to produce excitation. Combined with the increased average current carried by the TASER 7™, this implies that the discharge from the new device will be as effective, and possibly more effective, than that delivered from the TASER X2™. There is also separate evidence that the TASER 7™ may be more effective than the TASER X2™ and may approach the effectiveness of the TASER X26™ (see paragraph 43).

16. A feature of the TASER 7™, which the manufacturer terms *Adaptive Cross Connect*, promises to improve upon the *Cross Connect* feature implemented on the TASER X2™. *Adaptive Cross Connect* comes into play when both cartridges of the TASER 7™ have been fired and is claimed by the manufacturer to “*maximise effectiveness of the probe deployment and to help compensate for close probe spreads or clothing disconnects.*”⁶ The importance of probe spread and how it is achieved are explained in paragraph 19 *et seq.*
17. When both cartridges of the TASER 7™ are fired, the subject will be exposed to less than 44 PPS when fewer than four probes are in electrical contact. As a minimum, the subject will be exposed to 22 PPS (for example, when the upper probe from the first cartridge bay and the lower probe from the second bay are in contact with the subject). As with all the electrical parameters cited in this medical statement, SACMILL has not seen the results of independent testing to confirm the manufacturer’s claims.
18. Like the TASER X2™, the TASER 7™ is able to produce a warning arc display with cartridges *in situ*. Both of these devices improve upon the TASER X26™ where a warning arc may only be displayed with the cartridge removed or with a spent cartridge *in situ*. The arc display, along with the laser, may exert a deterrent effect.⁷

Ballistic considerations

19. The relationship between probe spread and the induction of NMI was first demonstrated in human subjects in a study published in 2012.⁸ The study showed that a spread of at least 23 cm (9 inches) was required to stop most subjects from advancing forward to complete a set task.
20. At the point of ejection from the cartridge, the flight of the upper probe of all TASER devices is in line with the ‘barrel’. The lower probe, however, is ejected at a downward angle, and it is this, combined with the distance from the target, that determines the probe spread on impact.
21. The lower probe divergence angle of the TASER X2™ cartridge is 7° while that of the TASER X26™ is 8°. This results in the 23 cm minimum probe spread for the two devices being achieved at target distances of 1.9 m and 1.5 m, respectively.

⁶ Axon website: <https://global.axon.com/products/taser-7>

⁷ <https://www.app.college.police.uk/app-content/armed-policing/conducted-energy-devices-taser/#visual-deterrents>

⁸ Ho J *et al.* (2012). *Forensic Sci Med Pathol* (<https://doi.org/10.1007/s12024-012-9346-x>)

22. In contrast to the older devices, the TASER 7™ has two cartridge options, which Axon refer to as the Close Quarter (CQ) and Standoff (SO) cartridges.
23. The CQ cartridge has a divergence angle of 12° which achieves the required minimum probe spread at a subject distance of slightly under 1 m. The SO cartridge, which has a divergence angle of 3.5°, requires a subject distance of nearly 2.5 m.
24. The high divergence angle of the CQ cartridge is designed for close-range engagements, which is where most CED probe discharge events reportedly occur.^{9,10} The small divergence angle of the SO cartridge is designed for longer distance engagements.
25. SACMILL has been advised that the TASER 7™ national training package, designed and overseen by the College of Policing, will teach engagement ranges for the CQ and SO cartridges of 3-11 ft (0.9-3.35 m) and 11-20 ft (3.35-6.1 m), respectively.
26. The information display on the rear of the TASER 7™ indicates which of the two cartridge bays is active. The display does not, however, provide the user with information on the cartridge type installed in each bay.
27. The design of the TASER 7™ probe departs radically from that used on earlier CED models in a number of ways. Firstly, while on earlier models the ejected probe dragged out the electrically conducting tethering wire from its cartridge bay, on the TASER 7™ the wire is contained within the probe and uncoils as it flies towards its target. Secondly, the probe has a so-called 'breakaway' design whereby the probe body is designed to detach from the front dart assembly when it strikes the skin or clothing obliquely or impacts in hard tissue, such as bone. SACMILL has been informed that the breakaway design is intended to limit the tendency for the momentum of the probe to drag it away from its initial point of impact, which is said to improve the likelihood of achieving a successful two-probe electrical connection to the subject.
28. A third way in which the TASER 7™ probe differs from its predecessors is that it is designed to separate from its tethering wire when the wire reaches its maximum length, which is 7.62 m (25 ft) for both the CQ and the SO cartridge.
29. In independent testing by Dstl, the kinetic energy and momentum of probes fired from the TASER 7™ were found to be about twice that of probes fired from the TASER X2™ and the TASER X26™. Furthermore, the accuracy and consistency of probes fired from TASER 7™ devices clamped in a rigid mount was found to be similar to probes fired from clamped TASER X2™ devices.
30. The independent testing also demonstrated that, in contrast to probes fired from the TASER X2™ and TASER X26™, the trajectory of probes fired from clamped TASER 7™ devices does not

⁹ Dstl has undertaken a UK-centric analysis of nearly 900 one- and two-bay probe discharges of the TASER X2™ based on information returned by CED officers (see footnote 10). The analysis found that 88% of probe discharges were at officer-reported subject distances of ≤4 m, 73% at ≤3 m and 41% at ≤2 m.

¹⁰ Sheridan RD and Hepper AE (2019). *The United Kingdom operational experience of the TASER® X2™*. Proceedings of the 10th European Symposium on Non-Lethal Weapons, Brussels, Belgium, May 20-23, 2019.

appreciably fall off at longer target engagement ranges.

31. The testing of the TASER 7™ identified an issue whereby a plastic component of the cartridge, known as the ejector, became trapped around the dart of the probe with the result that the depth of dart penetration into the target was reduced. Between the clamped weapon testing and the Dstl user handling trial (see below), a total of 1,332 TASER 7™ operational cartridges were fired. There were 28 instances in which one probe displayed a trapped ejector and four instances where both probes were affected. Trapped ejectors, therefore, affected 2.4% of the cartridge firings.

Laser sighting system

32. In contrast to previous devices which only had red laser sighting systems, the TASER 7™ has a green laser to aid visualisation of the point of aim of the upper probe. The TASER 7™ has two red lasers for the lower probe with only one of them being illuminated at any given time (depending on which type of cartridge it relates to).

Mechanical sighting system

33. In common with other CEDs, the TASER 7™ has a conventional non-laser (mechanical) sighting system that can be used for covert operations or when the laser sighting system cannot be used, as can happen in bright sunlight or in the event of the laser failing.

Cartridge clip and probe removal

34. TASER 7™ cartridges are shipped in pairs in a plastic cartridge clip. The clip additionally functions as a tool to be used for the removal of probes from skin or clothing. The clip may be used either on intact probes or on probes where the front dart assembly has separated from the probe body.

User handling trials

35. A user handling trial was conducted by Dstl as part of the UK assessment of the TASER 7™ system. The trial consisted of a series of exercises undertaken by police officers experienced with the older types of CED. The trial included comparisons of the TASER 7™, TASER X2™ and TASER X26™.
36. Of note, the trial identified a higher rate of probe misses with the TASER 7™ compared with the TASER X2™ or TASER X26™. The misses with the TASER 7™ were mainly associated with the lower probe of the high divergence CQ cartridge and were attributed to the probe missing the narrower area presented by the target's limb.
37. As a result of the above finding, a supplementary user trial was undertaken which was supervised by the College of Policing with SACMILL and Dstl observers present. The supplementary trial was specifically designed to establish whether the participants could fire the TASER 7™ accurately at a vertically orientated target and included comparisons with the TASER X2™.
38. The trial found that the participants could accurately fire both the TASER 7™ and TASER X2™ but noted that the probe dispersion around the point of aim was greater for the TASER 7™ than the

TASER X2™.

39. The outcome of one of the exercises in the Dstl trial is particularly noteworthy. In this exercise, participants were required to fire the TASER 7™, with a CQ cartridge fitted, at a horizontal target while using the mechanical sight for aiming. Under these conditions, the miss rate was 57.6%, with the most misses being associated with the lower probe. In the equivalent exercise conducted with the TASER X2™ and TASER X26™ the miss rates were 2.8% and 8.3%, respectively.

Draft training documentation from the College of Policing

40. SACMILL has reviewed and commented upon the College of Policing's draft guidance and training documentation for the TASER 7™. The committee is satisfied that these comments have been addressed. SACMILL has one further recommendation to make [paragraph 86].

Proposed NPCC implementation plan for the TASER 7™ system

41. The draft implementation plan has been reviewed by SACMILL and a number of comments and suggestions have been returned to the NPCC.

SACMILL opinion on the medical implications of the TASER 7™ system

42. Taken together, the pulse characteristics of the TASER 7™ (charge, duration and rate of delivery) and *Adaptive Cross Connect* function imply that the discharge from the new device will produce a more robust neuromuscular incapacitation (NMI) than the TASER X2™ [paragraphs 14-17].
43. SACMILL understands from Dstl that the officer-reported single-shot effectiveness of the TASER X26™ appears to be greater than that of the TASER X2™.¹¹ SACMILL has also seen a non-peer reviewed paper that offers support to the above conclusion that the TASER 7™ provides a more robust NMI than the TASER X2™ and which suggests that the efficacy of the TASER 7™ is more similar to the TASER X26™.¹² SACMILL is advised that the apparent effectiveness advantage of the TASER X26™ over the TASER X2™ disappears when the comparative effectiveness of the two devices is analysed at an incident level rather than at a single-shot level, and that this is a reflection of the two-shot capability of the TASER X2™. SACMILL is further advised that Dstl's analysis of TASER X2™ use indicated that both cartridge bays were fired 35% of the time the device was used in probe mode. If the effectiveness of the TASER 7™ is truly more akin to the TASER X26™, then SACMILL would anticipate seeing a reduction in the proportion of two-bay firings relative to that seen with the TASER X2™. Should this occur, this would reduce the number of probes fired at subjects with a corresponding reduction in probe penetration injuries.

¹¹ The analysis by Dstl was based on publicly available use of force data for FY17/18 and FY18/19 published by the Metropolitan Police Service (MPS) at <https://data.london.gov.uk/dataset/use-of-force>. SACMILL understands that the original data files used for the analysis indicated which type of CED was used in an incident, but that this information was subsequently removed for these two financial years. While the type of CED used by MPS officers was reinstated in the data files for FY19/20 and the current FY, SACMILL understands that there are too few uses of the TASER X26™ to undertake a reliable analysis.

¹² Ho J *et al.* (2019). *A model for conducted electrical weapon safety and effectiveness evaluation – the TASER 7*. Proceedings of the 10th European Symposium on Non-Lethal Weapons, Brussels, Belgium, May 20-23, 2019.

44. If the NMI induced by the TASER 7™ is more robust than it is with the TASER X2™, then this may elevate the risk of skull and other bony injuries associated with uncontrolled falls and may increase the risk of musculoskeletal injury due to a more forceful muscle contraction. Injuries of this nature may become more prevalent with the TASER 7™, particularly when *Adaptive Cross Connect* is active and three or four probes are in electrical contact with the subject.
45. The suggestion that the pulse characteristics of the TASER 7™ will be more painful than that from the TASER X2™ is supported by anecdotal evidence cited in a recent peer-reviewed paper.¹³ Pain, which is an unavoidable consequence of the way in which CEDs work and which may contribute to effectiveness, can induce increases in blood pressure and heart rate.¹⁴ Heart rate during the application of TASER X2™ discharge, measured using echocardiography, has been shown to be elevated relative to the pre-exposure rate.¹⁵ Unfortunately, the most recent study into the effects of TASER 7™ discharge¹³ did not employ echocardiography but it is reasonable to assume that an increase in heart rate would have been observed had this technique been used.¹⁶ There are practical reasons why blood pressure cannot be measured during the relative short period during which the discharge is applied. Although animal studies have found little effect of CED discharge on blood pressure, the interpretation of these studies is confounded by the fact that the animals were anaesthetised and, therefore, unable to sense painful stimuli.
46. With regard to safety, one concern relates to the potential for CED discharge to exert a direct effect on heart rhythm. Specifically, the concern lies with the possibility of discharge-induced ventricular capture from probes that have penetrated the frontal chest over the heart.¹⁷ The findings from one large animal study, reported in a non-peer reviewed paper¹², suggest that the TASER 7™ has a similar cardiac safety profile to the TASER X2™, and that both of these devices showed a better cardiac safety profile than the TASER X26™. SACMILL awaits publication of this study in a peer-reviewed journal. Irrespective of the cardiac safety profile of the TASER 7™, and in the absence of any follow-up human studies of ventricular capture risk since the issue was first highlighted ten years ago¹⁸, SACMILL remains of the view that this type of dysrhythmia should be considered a risk associated with all CEDs.
47. A further cardiac concern is the potential for CED discharge to induce ventricular fibrillation (VF), a dysrhythmia that could arise via indirect and direct mechanisms. VF could arise indirectly as a result of ventricular capture degenerating into a serious sustained ventricular dysrhythmia.¹⁷ Should this happen, it is most likely to occur in a diseased heart or where cardiac function has been compromised by certain recreational drugs or drugs of dependence.¹⁷ VF may also be induced in an uncompromised heart through a direct electrical action, although this requires at least a ten-fold higher current than that needed to induce ventricular capture.¹⁹ In relation to CED discharge, VF

¹³ Ho JD *et al* (2020). *Forensic Sci Med Pathol* (<https://doi.org/10.1007/s12024-020-00249-w>)

¹⁴ Kyle BN and McNeil DW (2014). (<https://doi.org/10.1155/2014/536859>)

¹⁵ Ho JD *et al* (2013). *J Emerg Med* (<https://doi.org/10.1016/j.jemermed.2013.08.069>)

¹⁶ Electromagnetic interference produced by the discharge precludes the use of conventional electrocardiography.

¹⁷ DOMILL Statement on the Medical Implications of Use of the Taser X26 and M26 Less-Lethal Systems on Children and Vulnerable Adults:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/443842/DOMILL14_2012_0127_TASER06.2.pdf

¹⁸ Ho JD *et al* (2011). *Forensic Sci Int* (<https://doi.org/10.1016/j.forsciint.2010.05.003>)

¹⁹ Kroll MW *et al* (2019). *Hum Factors Mech Eng Def Saf* (<https://doi.org/10.1007/s41314-019-0021-9>)

induced in this direct way would require the dart tip of the CED probe to be in close proximity to the outer wall of the heart – based on extrapolation from large animal studies, this distance in humans has been estimated to be about 4 mm.¹⁹ In one echocardiographic study of 150 subjects, skin-to-heart distance was shown to range from 10-57 mm and was positively correlated with body mass index.²⁰ As the darts of the TASER 7™ and TASER X2™ probes are 11.6 mm long, there may be a risk of VF from discharge delivered by darts that have penetrated the frontal chest over the heart for subjects with a lower body mass index. The region of the chest of greatest concern is understood to be located at the 4th or 5th left parasternal intercostal space, which is where the right ventricle is closest to the skin surface.^{19,20}

48. A volunteer study examined the effects of TASER 7™ discharge on a broad range of physiological markers.¹³ Probe discharge was applied for ten seconds from either one or both cartridge bays. The authors considered that the physiological effects of the discharge were modest, consistent with electrically-induced muscle contraction and similar to those seen with earlier TASER® devices. In this same study, one participant experienced vasovagal syncope during the application of TASER 7™ discharge. This type of adverse event is viewed as a novel injury mechanism that could increase the risk of fall injury during the application of discharge.
49. SACMILL has been advised by Axon that in volunteer testing “no appreciable difference” was observed in the profile of electrically-induced skin burns between the TASER 7™ and the company’s earlier devices. SACMILL has not seen any independent data to confirm or refute this claim.
50. The availability of two cartridge options for the TASER 7™ catering for two subject engagement distances brings a complexity not present with the TASER X2™ and TASER X26™ systems [paragraphs 22-25]. In the event that a subject is not at an appropriate range for the type of cartridge loaded, SACMILL has been informed that prospective TASER 7™ officers will be trained either to reload with range-appropriate cartridges or to alter position to bring the subject into the range of the pre-loaded cartridges. SACMILL has been advised by Dstl that, in relation to uses of the TASER X2™, officers reported that subjects were ‘moving slowly’ or ‘moving quickly’ in 85% of the incidents in which probes were fired – the subject was described as ‘not moving’ in only 15% of incidents. This observation may have implications for the TASER 7™ system.
51. SACMILL is of the opinion that the system complexity introduced by the two cartridge options has the potential to be exacerbated by the absence of feedback in the information display of the TASER 7™ showing which type of cartridge is installed in each bay [paragraph 26]. The current guidance is that officers will be trained only to load their devices with a pair of cartridges of the same type, which goes some way toward mitigating any scope for confusion brought about by the lack of feedback in the display.
52. Another aspect of the TASER 7™ system that adds to its complexity is the detachment of the probes from their tethering wire when the wire reaches its maximum extent [paragraph 28]. SACMILL has been informed that probe detachment is a feature designed with officer safety in mind, so that when a probe misses the subject and travels to the full extent of its wire, it does not rebound to

²⁰ Wu J-Y et al (2007). *IEEE Trans Biomed Eng* (<https://doi.org/10.1109/TBME.2006.888832>)

cause injury. Probe detachment, with the hazard presented from free-flying probes, introduces a new injury risk as it is not present with probes fired from the TASER X2™ and TASER X26™. SACMILL understands that detached probes have the potential to fly up to 25 m before striking the ground, although much will depend on local topography. Despite probe detachment reportedly being a safety feature for the officer, SACMILL is unaware of reports of officers being injured by probes rebounding after having been fired from the older devices. Probe detachment, and the need for officers to maintain awareness of its implications, is one of several factors adding to the complexity to the TASER 7™ system [paragraph 74].

53. To gain a better understanding of the potential hazard from free-flying probes, SACMILL asked Dstl to interrogate its database of TASER X2™ uses and report back on the frequency of probe misses. The database contains records of 2,820 cartridges having been fired. Of these, the officer reported that one or both probes had missed the subject on 17.3% of cartridge firings. Allowing for rounding error, these misses break down in the following way: upper probe miss - 1.9% of cartridge firings; both probe miss - 7.8%; lower probe miss - 7.7%.
54. SACMILL understands that the risk of injury to bystanders posed by free-flying probes will be included in the TASER 7™ training curriculum and that officers will be trained to mitigate the risk by maintaining a heightened awareness of the area behind the subject.
55. The breakaway design of the TASER 7™ probe and the way in which the tethering wire uncoils from within the probe body are features that may improve the performance of the system over its predecessors [paragraph 27]. This remains to be verified in practice but SACMILL does not currently believe there are medical implications associated with these novel design features.
56. The higher kinetic energy and momentum of the TASER 7™ probe should improve the interaction of the dart with clothing and mean that there will be a higher proportion of darts penetrating the skin. SACMILL understands that Dstl's analysis of TASER X2™ uses showed that the officer-reported effectiveness of the discharge from this device was greater than 90% when both darts had reportedly penetrated the skin. Where one dart had reportedly penetrated the skin while the other was said to be in clothing, the effectiveness was reported to be about 70%, while effectiveness dropped to about 40% when both darts were reportedly in clothing. By inference, if the higher kinetic energy and momentum of the TASER 7™ probe increases the proportion of firings in which one or both probes enters the skin, there should be a corresponding increase in effectiveness of the new device compared with the older devices. If this transpires to be the case, there should be a corresponding decrease in the need for officers to resort to other, potentially more injurious, forms of force and a faster resolution of an incident.
57. A second consequence of the higher kinetic energy and momentum of the TASER 7™ probe is an anticipated increase in the incidence of darts penetrating the body to their full depth. Moreover, injuries to deeper-lying organs and tissues may become more common due to elastic deformation of the body wall as the probe strikes. The design of the dart assembly of the TASER 7™ probe is identical to that used for the TASER X2™ probe, with both being 11.6 mm in length. One study of

civilian subjects used ultrasound to assess skin-to-organ distances.²¹ The findings imply that organs potentially at heightened risk are the anterior and lateral pleurae, the anterior and lateral liver, the spleen and pericardium. Another study analysed computerised tomography scans of male military service personnel to assess the skin to organ distances of the lung, heart and liver.²² The findings of the latter study indicate that none of these three organs would be breached by an 11.6 mm dart, notwithstanding the uncertainty introduced by the elastic deformation of the body wall.

58. Unlike earlier CEDs, SACMILL notes that there is very little fall-off in the trajectory of fired probes over their operational range [paragraph 30]. Therefore, officers should not compensate at longer subject distances in the way they might have done with previous devices. This advice has already been communicated to the College of Policing for their consideration.
59. Trapped ejectors [paragraph 31] may interfere with the electrical coupling of the probes with the subject and reduce effectiveness. The risk of occurrence for a single cartridge firing is 2.4%. Assuming that trapped ejectors are random events and not, for example, associated with a faulty batch of cartridges, the likelihood of both cartridges on the same device being affected is 0.06%.
60. SACMILL has been advised that the power outputs of the green and red lasers of the TASER 7™ have been independently verified by Dstl and all lasers were found to lie within the Class 3R band [paragraph 32]. While ocular exposure to the beam should be avoided, the risk of harm is low for short or unintentional exposures.²³
61. The utility of using the cartridge clip for probe removal [paragraph 34] was confirmed in tests involving a member of SACMILL. The use of the clip in this way is viewed by SACMILL as the preferred method of probe removal unless otherwise clinically indicated, for example where probes have penetrated vulnerable areas or have embedded in bone and are difficult to extract. SACMILL is of the opinion that it would be beneficial for some form of instruction to be present on the cartridge clip to inform medical staff who may be unfamiliar with the use of the clip in this way.
62. The change in the TASER 7™ to a green upper probe sighting laser [paragraph 32] is likely to improve laser dot visibility due to the greater sensitivity of the eye to this colour. SACMILL understands from the College of Policing that the adoption of a green laser may prove advantageous for officers with a protan colour vision deficiency, where red vision is weak or absent. SACMILL further understands that deutan observers, where green vision is weak or absent and which is the most common form of colour vision deficiency, would be relatively unaffected by the change to a green laser.
63. The UK technical assessment of the TASER 7™ and other CEDs routinely includes tests that measure where fired probes impact upon a target relative to the position of the laser sighting dot. These tests are designed to confirm that the accuracy of the device, when using the laser sight, is within an acceptable tolerance. Equivalent tests are not conducted, however, to assess the utility of the

²¹ Bleetman A and Dyer J (2000). *Injury Int J Care Injured* ([https://doi.org/10.1016/s0020-1383\(00\)00061-9](https://doi.org/10.1016/s0020-1383(00)00061-9))

²² Breeze J et al (2020). *Int J legal Med* (<https://doi.org/10.1007/s00414-020-02256-6>)

²³ *Laser radiation: safety advice*. Public Health England guidance. (<https://www.gov.uk/government/publications/laser-radiation-safety-advice/laser-radiation-safety-advice>)

mechanical sight [paragraph 33]. Although the laser is considered to be the primary sighting system, there are times when the mechanical sight would be used. For this reason, SACMILL is of the view that consideration should be given to exploring ways in which firing accuracy using the mechanical sight can be evaluated.

64. In user handling trials, the dispersion of probes fired from the TASER 7™ was found to be greater than the dispersion of probes fired from the TASER X2™ [paragraphs 35-38]. By contrast, the dispersion of probes fired from the clamped devices was found to be comparable [paragraph 29]. This indicates that, in the hands of the user, the point of impact of TASER 7™ probes may have a tendency to stray further from the point of aim than they would with the TASER X2™. The reason for the difference between the two devices is not known, but two candidate mechanisms seem likely: ergonomics and the force required to pull the trigger of the TASER 7™. In relation to the latter, SACMILL has been advised by Dstl that the trigger pull force of the TASER 7™ is higher than that of the TASER X2™ which, in turn, is higher than that of the TASER X26™.
65. Whatever the reason for the greater dispersion of probes of the TASER 7™, SACMILL is of the opinion that this is something that should be emphasised in training. The increased probe dispersion has two medical implications. Firstly, the dispersion of the upper probe may increase the risk of probe strikes to the vulnerable areas of the head and neck if the point of aim of the upper probe is too high. Secondly, the dispersion of the lower probe may increase the risk of missing the target if the point of aim is on a part of the limb presenting a smaller targeted area. The CQ cartridge may be particularly affected in this way because the high probe divergence of this cartridge means that the limb becomes engaged at relatively small subject distances.
66. SACMILL has been assured by the College of Policing that the issues associated with the greater dispersion of the TASER 7™ probes will be covered in training.
67. A positive aspect of the higher trigger pull force of the TASER 7™ is that it may lead to a reduction in unintentional discharge of the second cartridge bay after discharge of the first. The risk from an unintentional discharge was first raised by SACMILL when we considered the TASER X2™ system.⁴ The injury risk from the unintentional discharge of an un-aimed probe is self-evident. SACMILL has been advised by Dstl that the unintentional discharge rate for the TASER X2™ was just over 2%, which is to say that the second bay was accidentally discharged twice for every 100 discharges of the first bay. The real incidence of unintentional discharge may be higher as the analysis relied upon the officer highlighting in their report that an accidental discharge had occurred.
68. A very high lower probe miss rate was observed in the Dstl user handling trial when the TASER 7™ was fired against a horizontal target using the mechanical sight for aiming [paragraph 39]. The exercise was undertaken with the TASER 7™ fitted with a CQ cartridge, so one possible explanation is that the trial participants, all of whom were qualified users of the older devices, lacked familiarity with the ballistic implications of the much higher divergence angle of the CQ cartridge.
69. SACMILL has reviewed the proposed training curriculum for the TASER 7™ [paragraph 41] and is satisfied that the actions that the College of Policing propose to take in response to feedback from this committee are appropriate. SACMILL has one further recommendation to make (see

[*paragraph 86*]).

70. In relation to the NPCC plans for implementation of the TASER 7™ and, in particular, how the new system will be integrated with the CED systems already authorised for use in the UK [*paragraph 41*], the committee has returned a small number of comments and look forward to seeing the NPCC's response together with sight of the finalised plan.
71. SACMILL is reassured that the implementation plan advises that officers migrating to the TASER 7™ system from other CED systems should not revert to using their former device. SACMILL views this as an important safeguard and would like to reinforce the advice in this medical statement.
72. In common with other CED systems authorised for use in the UK, SACMILL understands that the operational performance of the TASER 7™ system will be closely monitored by way of a bespoke form that the officer will be required to complete after each use. Analysis of the returned data will provide insights into the safety and efficacy of the TASER 7™ system and provide an early warning mechanism should the new system behave in an unanticipated way. SACMILL views this monitoring to be an essential component in understanding the system's safety and effectiveness.

Conclusions

73. The electrical and ballistic outputs of the TASER 7™ point in the main to the device being more effective than the devices currently authorised for use in the UK. If this transpires to be the case, then situations requiring the use of probe discharge may be resolved more rapidly and may result in the avoidance of potentially more injurious forms of force.
74. Balanced against this, however, are the increased system complexities arising from several design features introduced in the new device. These are: the availability of the two cartridge options, the absence of feedback in the TASER 7™ information display on the type of cartridge installed, and the free-flying probes that present a hazard to bystanders and officers located down-range of the subject in the event of a probe miss. These complexities are not present in the CED systems currently authorised for use in the UK.
75. Further balancing the potentially increased effectiveness of the TASER 7™ system are the higher kinetic energy and momentum of fired probes compared with earlier devices and their increased dispersion relative to the point of aim. The higher kinetic and momentum may lead to an elevated risk of internal injury while the increased probe dispersion has the potential to raise the risk of upper probe strikes to the vulnerable areas of the head and neck in the event that the point of aim of the upper probe is inadvertently set too high.
76. How the above factors manifest themselves in operational use must be closely monitored in the event that the system is authorised for use.
77. Finally, SACMILL will work together with the Faculty of Forensic and Legal Medicine of the Royal College of Physicians and other relevant national bodies to ensure the availability of an updated and coherent set of guidance for people subjected to CED discharge, custody officers responsible

for the safety of those exposed to discharge, and health care professionals involved in the review and treatment of those people.

Recommendations

78. Recommendation 1

SACMILL has relayed to the College of Policing that the committee would like prospective TASER 7™ officers to be instructed in the dispersion characteristics of probes fired from the new device. SACMILL welcomes the fact that the College is looking at including this in the TASER 7™ training curriculum and recommends that an awareness of probe dispersion characteristics could usefully extend to other types of CED.

79. Recommendation 2

In the event of the TASER 7™ system being authorised for use, it is essential that any significant deviation from the medical predictions made in this statement is reflected in a revised statement.

80. Recommendation 3

Should the TASER 7™ system be authorised, it is imperative that its operational performance is monitored closely to gain reassurance that the system performs in the manner anticipated. This close monitoring should continue for a minimum of twelve months and SACMILL must be informed urgently of any adverse medical outcomes that may have a bearing on the opinion expressed in this medical statement. SACMILL also looks forward to finalising an information sharing agreement with the Independent Office for Police Conduct to serve as an additional early warning mechanism in cases where police use of a less-lethal weapon system, including the TASER 7™, has resulted in an adverse outcome.

81. Recommendation 4

The medical community must be informed in advance of any operational roll-out of the TASER 7™ system. In particular, medical practitioners should be made aware that the preferred method of probe removal involves use of the cartridge clip unless other methods of extraction are clinically indicated. Practitioners should be aware that tissue-embedded probes may present in an intact form or in a form in which only the dart assembly at the front of the probe remains.

82. Recommendation 5

Police officers and the medical community must be advised that, where the cartridge clip has been used to remove tissue-embedded probes, both clip and probe should be treated as biohazardous materials.

83. Recommendation 6

Where subjects with tissue-embedded TASER 7™ probes are transferred from the incident scene to a hospital, a cartridge clip should accompany the subject in case it is required for probe extraction. It is further recommended that Axon is advised that it would be appropriate to print some form of instruction on the cartridge clip to assist those unfamiliar with the use of the clip in this manner.

84. Recommendation 7

Accuracy of the laser sighting system of the TASER 7™ and other CEDs is routinely evaluated in independent technical assessments conducted as part of the systems approach taken by UK authorities prior to adoption of new police less-lethal weaponry into operational service or where there are “*significant changes to pre-approved less lethal weapons systems.*”²⁴ The accuracy of the mechanical sight of CEDs, however, is not routinely assessed. Although the laser is considered to be the primary sighting system, there are times when the officer resorts to the mechanical sight (for example, in bright sunlight). SACMILL recommends, therefore, that consideration is given to the assessment of mechanical sight accuracy as part of routine pre-authorisation testing.

85. Recommendation 8

Opinion expressed in this medical statement is predicated on the configuration of the TASER 7™ system as it stood at the time of SACMILL’s review. The system includes, not only the TASER 7™ device, but also all the other elements outlined earlier [paragraph 3]. Should any element of this system be changed substantively, it is important that SACMILL is afforded the opportunity to consider whether the committee’s medical opinion should be revised.

86. Recommendation 9

Finally, SACMILL notes that NPCC guidance on use of force monitoring mandates the following:²⁵

“[W]here severe injury or death has occurred and a less lethal weapon has been used – currently only CED (TASER) or Attenuating Energy Projectile (AEP) – the Scientific Advisory Committee on the Medical Implications of Less Lethal Weapons (SACMILL) must be advised. This referral should be carried out by your constabulary’s Professional Standards Department via email to: lesslethalweapons@westmercia.pnn.police.uk.”

Despite this mandatory advice, SACMILL has seen no referrals since the NPCC guidance and the national use of force reporting system were implemented in April 2017. SACMILL recommends, therefore, that the NPCC advice is incorporated into the training curricula for CEDs and other LLW systems in order to raise awareness of the requirement for referral.

[signed on original]

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²⁴ Code of practice on armed policing and police use of less lethal weapons. January 2020. (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/857699/CCS207_CCS012_0853800-001_Code-of-Practice-on-Armed-Policing_web.pdf)

²⁵ <https://www.npcc.police.uk/documents/Guidance%20on%20Use%20of%20Force%20master%20V2Jan17.pdf>