

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

**Statement on the Medical Implications of Use of the
TASER X2 Conducted Energy Device System**

Key points:

- *Conducted energy devices (CEDs) are one of several less-lethal options available to the police and other authorised users in the UK. CEDs exert their effects on people by delivering brief electrical pulses that stimulate nerves running underneath the skin. Pulses may be delivered in several ways, but the most commonly used mode of pulse delivery (fired probes) produces two effects: disruption to voluntary movement and pain.*
- *The overwhelming majority of CEDs presently in service in the UK are TASER X26 devices. However, the manufacturer has ceased production of this device.*
- *The TASER X2 CED is being considered as a possible addition to, and eventual replacement for, the presently authorised CEDs.*
- *SACMILL has reviewed the various elements of the TASER X2 CED system from a medical perspective in order to inform a ministerial decision on whether to authorise the TASER X2 system for UK use. SACMILL's review considered the device itself, the electrical, ballistic and optical outputs of the device, the performance of the device in user handling trials, the training curriculum, the proposed roll-out plan, and the plans proposed to monitor the safety and effectiveness of the system should it be authorised for use.*
- *The TASER X2 CED is more complicated than the TASER X26 CED. In terms of potential medical implications, this added complexity may confer advantages and disadvantages when compared with the presently used CED.*
- *On balance, SACMILL is broadly satisfied by the evidence it has examined and is of the view that the medical implications of the TASER X2 system – when used by trained operators in accordance with UK policy and guidance – would be in line with those expected for a less-lethal system of this type. Certain functions of the TASER X2 CED are unique to this device and it is essential that the implications of this for system safety are closely monitored in the event that the new system is brought into service.*
- *The present medical statement on the TASER X2 system makes several observations and recommendations. Importantly, the medical implications predicted for the TASER X2 system must be validated through continuous review of data obtained from operational use. This review should continue until sufficient operational data has been collected to provide confidence that the system performs in the manner anticipated. It is suggested that usage and performance of the TASER X2 CED system should be closely monitored for twelve months in the first instance and that SACMILL should be involved in the monitoring process.*
- *Should the TASER X2 system become operational, it is essential that any substantive deviation from the medical predictions made in this statement is reflected in a revised statement. Importantly, this statement applies only to the TASER X2 CED system configuration reviewed by SACMILL for the purposes of the present statement. Any changes to the system, including changes to the device or user training curriculum, should be reviewed by SACMILL to assess their potential impact on this statement's validity.*

The role of SACMILL

1. The Scientific Advisory Committee on the Medical Implications of Less-Lethal Weapons (SACMILL) is an advisory Non-Departmental Public Body that provides independent advice to Ministers of Her Majesty's Government on medical aspects surrounding the use of less-lethal weapons (LLWs)¹ on members of the public by police and other authorised users in the UK.² SACMILL assumed this role in March 2012 when it replaced its predecessor committee, DOMILL.³
2. SACMILL neither endorses nor approves the LLW systems that it has been asked to review and acts only in an advisory capacity.
3. SACMILL is an independent committee that operates at arm's length from government. The committee is sponsored by the Surgeon General in the Ministry of Defence (MoD).
4. SACMILL is concerned with the safe use of LLWs. In addressing this remit, SACMILL considers aspects of a LLW system that have a bearing on the equipment's operational use. These aspects include: developing an understanding of the effects of the weapon's output on the human body; the 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.
5. 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.

Conducted Energy Devices (CEDs)

6. Since their introduction into policing in England and Wales in 2003, and subsequent take-up by police services in Scotland in 2005 and Northern Ireland in 2008, conducted energy devices (CEDs) have been increasingly adopted across the UK as less-lethal options for electronically incapacitating people threatening serious harm to the public, themselves or law enforcement officers.
7. The first type of conducted energy device authorised for use by UK law enforcement authorities was the TASER M26 CED. The TASER X26 CED was authorised for UK use in 2005 and this latter device has progressively replaced the TASER M26. Today, the device predominantly deployed in the UK is the TASER X26 CED.
8. CEDs are battery-operated, pistol-like devices that produce electrical pulses when activated by a trigger. The pulses can be delivered to people in a number of ways which are commonly referred to

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 Defence Scientific Advisory Council Sub-Committee on the Medical Implications of Less-Lethal Weapons (DOMILL).

as *probe mode*, *drive-stun mode* and *angled drive-stun mode*.

9. In probe mode, two metal probes (darts) are fired from a cartridge at the front of the CED handset. For an electrical circuit to be created, both probes must make contact with a person's clothing or skin. These probes remain electrically connected to the handset via fine wires. The intended effect of the pulses is to impair the ability of a person to move, thereby allowing officers to follow-up with conventional restraint methods. This effect is termed neuromuscular incapacitation (NMI) and lasts for as long as the pulses are applied. The pulse discharge also produces a widespread and severe pain sensation which may contribute to the overall effectiveness of the device. One limitation of probe mode is that there must be sufficient separation of the probes on the body for NMI to be induced. For this reason, the probes are designed to diverge as they leave the cartridge and the subject must be at a sufficient distance from the CED when the probes are fired for the system to be effective.
10. In drive-stun mode, pulse discharge is applied to the body by pushing the electrodes at the front end of the CED into the subject's skin. This produces localised pain at the region of application. NMI is not produced in this mode as the electrode separation is too small. The drive-stun method is, therefore, often referred to as a *pain compliance option*.⁴
11. Angled drive-stun mode is intended as a follow-up method for use when one of the probes misses its target or where there is insufficient probe separation because the probes were fired too close to the subject. Under these circumstances, pressing the front end of the handset into clothing or skin can create the separation required to produce NMI as the pulse discharge can conduct between the handset and the probe(s).
12. Home Office (HO) statistics for CED use in England and Wales in 2015 indicate that these devices were 'used' by police officers 10,329 times.⁵ About 80% of these uses did not involve the delivery of electrical discharge to the subject.⁶ The majority of the remaining discharge uses were in probe mode. Use in drive-stun mode or angled drive-stun mode each comprised about 1% of uses.

⁴ The Independent Police Complaints Commission (IPCC) has said that it has major concerns with the use of CEDs in drive-stun mode. Rather than inducing subject compliance, several cases reviewed by the IPCC indicated that drive-stun use had the opposite effect. *IPCC review of Taser complaints and incidents 2004-2013*: <https://www.ipcc.gov.uk/news/ipcc-review-taser-use-and-complaints-published> (accessed 7 Oct 2016)

⁵ <https://www.gov.uk/government/statistics/police-use-of-taser-statistics-england-and-wales-1-january-to-31-december-2015-data-tables> (accessed 7 Oct 2016)

⁶ Uses of CEDs in the UK are categorised as drawn, aimed, arced, red dot, drive-stun, angled drive-stun and probes fired.

The potential medical consequences of CED use

13. The medical consequences of CED use are broad-ranging and include:^{7,8}

- Muscular contraction or strain-related injury (including bone fractures, hernia rupture and dislocation).
- Injuries, particularly to the head, from falls or other uncontrolled movements. This risk may be exacerbated in people who are running or are located at height at the time the discharge is administered.
- Injury from probe penetration of the eye, blood vessels, genitalia, breast, neck, throat, thorax and other sensitive structures.
- People on anticoagulants or who have a disorder that impairs coagulation may be at increased risk of internal bleeding from penetrating injury or head injury.
- Adverse effects on the heart, circulation and respiratory system triggered by the physiological stress induced by CED discharge.
- Injuries (for example, abrasions, scars and electrical burns) from handset stun electrodes and fired probes.
- Cardiac capture from the electrical discharge, specifically linked to probes or electrodes in close proximity to the heart.
- Epileptic seizure (particularly in people with pre-existing epilepsy).
- Spontaneous abortion has been linked to the administration of CED discharge, although the strength of the association is uncertain.^{6,7}
- Rhabdomyolysis has been associated with CED use⁹ and is a rare side-effect associated with use of statins, which are widely prescribed to those over 40-years-old.¹⁰ Any risk of rhabdomyolysis associated with CED use may be elevated in persons taking statins. About 20% of uses of CED in the UK are on people in this older age group.
- Thermal burns from the discharge-induced combustion of flammable liquids (such as petrol or the solvent used in CS spray).
- Blast injury due to discharge-induced ignition of explosive vapour (for example, petrol vapour).
- Risk of drowning for people who are partially submerged in, or who are located next to, standing water due to loss of posture under the influence of electrical discharge.
- Psychological harm may be caused by the trauma associated with exposure to CED discharge. This aspect of CED use is under-researched. Such harm is not confined to CED use and applies to other forms of force employed by law enforcement officers.

⁷ DOMILL (2012). *Statement on the Medical Implications of Use of the Taser X26 and M26 Less-Lethal Systems on Children and Vulnerable Adults*. <http://data.parliament.uk/DepositedPapers/Files/DEP2012-0729/96605%20Library%20Deposit.pdf> (accessed 7 Oct 2016)

⁸ TASER International, Inc: *TASER® Handheld CEW Warnings, Instructions, and Information: Law Enforcement*. Dated 1 Mar 2013. https://prismic-io.s3.amazonaws.com/tasr%2Fa8e6e721-590b-459b-a741-cd0e6401c340_law-enforcement-warnings.pdf (accessed 7 Oct 2016)

⁹ Gleason JB and Ahmad I (2015). TASER® electronic control device-induced rhabdomyolysis and renal failure: a case report. *J Clin Diagn Res* 9:HD01-2.

¹⁰ Benes LB *et al* (*in press*). The risk of hepatotoxicity, new onset diabetes and rhabdomyolysis in the era of high-intensity statin therapy: does statin type matter? *Prog Cardiovasc Dis* doi: 10.1016/j.pcad.2016.08.001

Additionally, children and certain vulnerable persons have been highlighted as being at an elevated risk from the use of CEDs.⁷

The removal of skin-embedded probes also carries medical implications. In this regard, SACMILL endorses the advice offered by the Faculty of Forensic and Legal Medicine¹¹ from which the following has been adapted:

All persons subjected to CED discharge must ultimately be examined and assessed by a registered medical practitioner – a doctor – (e.g. a Forensic Physician or Emergency Department doctor) who is familiar with the nature of CED-associated risks and complications. If the doctor is unfamiliar with these unique risks and complications, he or she must be provided with a copy of these recommendations to inform them.

In most cases, initial first aid or dart removal (if not already done) may be undertaken by any appropriate healthcare professional (e.g. nurse or paramedic) and, where darts have not penetrated the skin, by police officers.¹² Darts that have penetrated the skin may be removed by stabilising the surrounding skin and, while firmly grasping the probe body, removing it with rapid traction.

Where darts have penetrated or are adjacent to sensitive and/or high risk areas, such as the eyes, ears, nose, mouth, face, neck, genitalia, spine, hands, feet or joints, doctors should use their clinical judgment and if necessary, seek specialist advice on dart removal.

The skin around the dart exit wound should be cleaned with an antiseptic wipe.

Approved local procedures for dart removal and wound treatment should be in place and should take precedence where they differ from those outlined above.

There appears to be no evidence for an infection risk from darts that have penetrated the skin.¹³ However, SACMILL considers that the risk of infection from tissue-penetrating darts should be borne in mind, especially in immunocompromised individuals (including those with diabetes).

Since the introduction of CEDs into British policing in 2003, the devices have been discharged operationally more than 13,000 times.¹⁴ Over this period, there have been seventeen fatalities in which the discharge of TASER CEDs featured as one of the uses of force.¹⁵ In two of these deaths, both of which occurred in 2013, the TASER CED discharge was concluded to have been a causal or contributory factor. One of these cases involved the discharge-induced ignition of petrol.¹⁶ In the

¹¹ Faculty of Forensic and Legal Medicine (2013). Taser®: Clinical Effects and Management of Those Subjected to TASER® Discharge. <http://www.fflm.ac.uk/wp-content/uploads/documentstore/1379584094.pdf> (accessed 7 Oct 2016)

¹² Police may remove skin-penetrating probes where there is an operational necessity (for example, where leaving the probes in place presents a risk of further avoidable harm to a detained subject).

¹³ Kroll MW *et al* (2016). Infection risk from conducted electrical weapon probes: What do we know? *J Forensic Sci* doi: 10.1111/1556-4029.13148

¹⁴ <https://www.gov.uk/government/collections/use-of-taser-statistics> (accessed 7 Oct 2016)

¹⁵ An eighteenth fatality, arising from a gun-shot wound to the head, involved the use of an unauthorised wireless electronic projectile device known as the TASER X-REP.

¹⁶ <http://www.bbc.co.uk/news/uk-england-devon-34414875> (accessed 7 Oct 2016)

other case, the inquest concluded that the TASER CED discharge was one of a number of factors that contributed towards the fatal outcome.¹⁷ The cause of death has yet to be determined in five of the seventeen UK fatalities in which the use of a CED featured. Two of these deaths were in 2014 and three have been recorded to date in 2016.

SACMILL is aware of two non-fatal serious adverse outcomes in the UK involving police use of the TASER CED. In 2012, a man required defibrillation following the application of 11 seconds of discharge to his chest delivered from a TASER X26.¹⁸ A subsequent High Court ruling in 2015 found the duration of the discharge to be “excessive and disproportionate” and that the police had been negligent in their failure to obtain timely treatment.¹⁹ More recently, a man was reported to have sustained a serious head injury following discharge of a TASER CED.²⁰

Despite the broad range of potential injuries that have been linked to the use of CEDs, the internationally reported incidence of serious injury – as judged by the relatively low number of published clinical case reports – appears to be low relative to the widespread use of CEDs. Notwithstanding the likelihood of under-reporting in the medical literature, the infrequency of reports of serious injury implies that most uses of CEDs result in unremarkable medical outcomes.

Background to the present medical statement

14. In December 2014, TASER International, Inc., stopped production of the type of CED available to UK police. In anticipation of the continued UK requirement for CEDs, the HO led a procurement competition for a new device to complement, and eventually replace, the UK’s current in-service CEDs. Of the responses received from potential providers, only the TASER X2 CED met the minimum mandatory technical requirements specified in the invitation to tender and is the sole device presently under consideration.
15. For any new CED system to be adopted in England and Wales it must be authorised for use by the Home Secretary, with the decision being informed by a medical assessment of the candidate system.
16. In light of this, SACMILL has been tasked by the HO to consider the TASER X2 CED system and to prepare a statement for Ministers summarising the committee’s opinion on the medical implications predicted to be associated with use of the candidate device.
17. This medical statement amends and supersedes SACMILL’s initial statement on the medical implications of the TASER X2 system (dated 30 August 2016), in which the committee highlighted a number of issues relating to the plans for the introduction of the system into operational service should it be authorised, the training curriculum and the technical assessment. The National Police Chiefs’ Council (NPCC), College of Policing (CoP) and the Home Office Centre for Applied Science

¹⁷ <http://www.bbc.co.uk/news/uk-england-manchester-33373531> (accessed 7 Oct 2016)

¹⁸ IPCC investigation (dated August 2013):

https://www.ipcc.gov.uk/sites/default/files/Documents/investigation_commissioner_reports/Final%20Report%20Merseyside%20Taser%20incident%2030%20September%202012.pdf (accessed 7 Oct 2016)

¹⁹ <http://www.bbc.co.uk/news/uk-england-merseyside-34705506> (accessed 7 Oct 2016)

²⁰ <http://www.bbc.co.uk/news/uk-wales-north-west-wales-36956135> (accessed 7 Oct 2016)

and Technology (CAST) subsequently responded to these issues. The present amended medical statement reflects SACMILL's opinion following the committee's review (on 29 September 2016) of the actions either proposed or already implemented by the NPCC, CoP and CAST in response to the issues identified in the initial medical statement.

Technical approach

18. In forming a view of the TASER X2 CED system, SACMILL has relied on the following evidence:

- a) A review by the Defence Science and Technology Laboratory (Dstl), entitled *Dstl opinion on the medical implications of the TASER® X2 system*. (Dstl/TR96283 version 1.0, dated 22nd July 2016.)
- b) [redacted] *CED Replacement Project. Assessment of the Taser X2 against the operational requirements*. (Report 057/16 version 2 from the HO Centre for Applied Science and Technology (CAST), dated July 2016.)
- c) CAST summary report entitled: *Taser X2 CED drop test (armed) and laser sight alignment check*. (Dated 26th September 2016.)
- d) Bray, JR and Cameron, F. *Electrical Testing of TASER X2 and TASER X26P Conducted Energy Weapons*. (Contract Report DRDC-RDDC-2014-C116, dated June 2014.)
- e) Draft TASER X2 CED user training and assessment documentation. (Prepared by the College of Policing (CoP) and dated 2016.)
- f) Implementation programme proposed for the TASER X2 CED system. (Prepared by the National Police Chiefs' Council and endorsed by the NPCC Lead for Less-Lethal Weapons; dated 15th September 2016.)
- g) Evidence supplied in 2016 by TASER International, Inc., in response to questions put to the company via the UK government's *Emptoris* procurement portal.
- h) A document entitled *SACMILL review of TASER X2/Omissions and inconsistencies: Dstl opinion on responses received from stakeholders*. (Dstl/LR098119, dated 26th September 2016.)
- i) Evidence from HO, NPCC, CAST, CoP and Dstl representatives at SACMILL meetings to review the TASER X2 CED system on 15th June 2016 and 29th September 2016.

The following opinion is based on SACMILL's review of the above evidence. Specifically, the present medical statement applies only to:

- The TASER X2 CED handset (Rev. E) running firmware Rev. 04.020 and fitted with the *SP Operational Smart Cartridge Rev. D* and *Automatic Shutdown Performance Power Magazine (APPM Rev. A)*.
- The TASER X2 CED configured to operate in semi-automatic mode.
- The TASER X2 CED and APPM configured in the *Trigger-Initiated Shut-Down Only* option.

The above configurations of the TASER X2 CED applied to the devices under test in the technical assessment and user handling trials and are those applicable to the training curriculum developed by the College of Policing.

Any changes to the device configuration must be reviewed by CAST and SACMILL to assess their potential implications and to confirm that the present medical statement remains applicable.

Medical implications of the TASER X2 CED system

The TASER X2 device

19. The TASER X2 CED differs from the TASER X26 and TASER M26 CEDs in several respects. One of the main differences is that the TASER X2 CED has two cartridge bays while the older devices have only a single bay. The single bay of the older devices, and each of the two cartridge bays of the TASER X2 CED, is capable of delivering pulse waveforms at a frequency of 19 Hz (pulses per second). However, under certain modes of use of the TASER X2 CED, notably drive-stun, angled drive-stun and an additional mode known as *X-Connect* (see para. 21), the subject may be exposed to discharges at a frequency of 38 Hz.
20. On the basis of an analysis by Dstl of CED use in the UK from 2010-2014, SACMILL is advised that officers reported failure to subdue a subject on some 30% of occasions when TASER CEDs were used in probe mode; half of these failures were attributed to one or both probes missing the subject. Under similar circumstances with the TASER X2 CED, the officer would be able to rapidly deploy the second cartridge without having to reload with a second unused cartridge, which is the case with the TASER X26. This has the potential to bring an individual under control more rapidly and reduce the likelihood of officers using other, possibly more injurious, force.
21. The *X-Connect* mode of the TASER X2 CED is unique to this two-cartridge device and refers to when probes from both cartridges have been deployed into a single subject. This mode is intended for use when one of the probes from the first deployed bay misses the subject, but may also be used when insufficient probe separation has been obtained. In *X-Connect* mode, any combination of the top and bottom probes from the TASER X2 CED's two cartridges can make a connection with the subject to induce NMI, provided that both bays of the device are electrically active. If any one top and one bottom probe are connected to the subject, then discharge will be delivered at 19 Hz. However, where three probes are connected to the subject, the discharge will be delivered at 38 Hz. When only two top probes or two bottom probes are in contact with the subject, no electrical current will flow into the subject. Where three probes are connected to the subject, one of the probes will deliver discharge at 38 Hz. Where this probe has penetrated the skin, local heating due to current flow into the body will be greater at 38 Hz than it would be at 19 Hz. SACMILL is unaware of any clinical or operational significance of the heating effect.
22. Pulses delivered by the TASER X2 CED at 38 Hz carry the same electrical charge per pulse as those delivered at 19 Hz. However, pulses at 38 Hz will induce a greater degree of muscle contraction and a greater sensation of pain than pulses at 19 Hz (although not double the amount). The greater muscle contraction may increase the risk of musculoskeletal injury, including sprains and spinal compression fractures. The greater muscle contraction may also influence the manner in which a subject falls when exposed to discharge and may alter the nature and frequency of fall-associated injuries compared with the TASER X26 CED.
23. The TASER X2 CED has pulse-generating circuitry that actively seeks to regulate the waveform charge at a constant level, irrespective of whether the probes are in the subject's clothing or whether they have penetrated the skin. Provided that the lower pulse charge of the TASER X2 CED is not reflected in a reduced NMI, SACMILL is of the opinion that the so-called 'charge metering' functionality of the candidate device constitutes a sensible technical progression from the passive

pulse-generating circuitry of the TASER X26 CED.

24. The electrical charge carried by the pulse waveform of the TASER X2 CED is rated at about half that of the waveform of the TASER X26 CED. Although presently speculation, one possible implication of the lower charge is that the degree of NMI – and possibly pain – induced by single cartridge discharge from the TASER X2 CED may be less than that from the TASER X26 CED. If this results in decreased effectiveness, this may lead officers to use alternative, potentially more injurious, forms of force or increase the frequency of deployment of the second cartridge bay. The latter may lead to an increase in the frequency of probe-associated injuries to the skin and underlying organs and tissues, as well as enhancing the risk of fall-associated injuries due to the augmented contraction caused by the 38 Hz discharge.
25. The lower pulse charge of the TASER X2 CED may present a lower cardiac hazard, particularly from probes that have penetrated the frontal chest overlying the heart (and particularly the region of the right ventricle as this is closest to the anterior chest wall). In such circumstances, there is evidence to indicate that cardiac capture can arise, albeit in rare circumstances.²¹ While the hazard may be less with the TASER X2 CED, SACMILL is of the opinion that a risk still remains. Furthermore, in *X-Connect* mode (in circumstances where a top probe has penetrated the chest overlying the heart and the two lower probes are connected to the subject), the top probe will deliver pulses at 38 Hz. In the single human study where cardiac capture was observed, the pulses were delivered at 19 Hz (equivalent to 1,140 pulses per minute) and the capture rate was 240 beats per minute. It is believed that the maximum rate of capture would be limited by the refractory nature of cardiac cycle. For this reason, it is speculated that the maximum rate of capture from 38 Hz stimulation would be similarly limited. SACMILL's concern with cardiac capture stems partly from the possibility that it could degenerate into a more serious dysrhythmia in certain vulnerable persons.²¹ During rapid cardiac capture the output of the heart is reduced; consciousness may be impaired if this period of capture is prolonged.
26. The electrical output of thirty TASER X2 devices has been independently tested by Defence Research and Development Canada (DRDC). The tests demonstrated that the waveform peak current, peak voltage, total charge, pulse repetition frequency and pulse duration were in line with the values stated by the manufacturer.
27. Should the TASER X2 CED system be authorised for UK use, SACMILL has been advised that the device would be equipped with a power supply known as the *Auto-shutdown Performance Power Magazine* (APPM). The APPM automatically limits the duration of discharge to 5-seconds, even when the trigger remains pressed. The APPM does not prevent the user from extending or repeating a discharge cycle, should this be judged necessary by the operator. However, the automatic 5-second limit offered by the APPM should help to avoid instances of inadvertent administration of prolonged discharge.

²¹ The evidence for, and implications of, cardiac capture were considered in DOMILL's last medical statement on CEDs: <http://data.parliament.uk/DepositedPapers/Files/DEP2012-0729/96605%20Library%20Deposit.pdf> (accessed 7 Oct 2016)

28. In addition to limiting the duration of discharge to 5-seconds, the APPM also provides an audible warning to the user that the pulse train is about to end. The APPM emits a series of beeps which start at 3-seconds into the train. It is felt that this facility may help to provide the user with enhanced situational awareness and, in this way, facilitate better control in an incident.
29. The design of the TASER X2 CED allows the user to display its twin warning arcs with the two cartridges loaded onto the device. This would allow the user to transfer quickly to deploying probes, should this be required. It is SACMILL's opinion that, as well as reducing the time required (and number of actions required) for the user to transition between arcing and firing, it would reduce the cognitive load on the CED operator and be of potential benefit in a rapidly-evolving event. The twin arcs of the TASER X2 CED are more visible than the single arc produced by the current devices which may provide an enhanced warning effect and, thereby, may reduce the need to escalate to firing the device.
30. The TASER X2 CED has separate laser sighting aids for the top and bottom probes. In principle, this facility should help to reduce the number of occasions on which one or both probes misses the subject on initial probe deployment. The twin laser sights may also be used to visualise the degree of probe separation that would be achieved when the probes are fired. Together, these should help to reduce the occasions on which other forms of force are required to restrain the subject and increase user confidence that NMI will be achieved.
31. The twin laser aiming aids of the TASER X2 CED emit radiation at a wavelength of about 650 nm (red) and the maximum output is claimed to be 5 mW. Four TASER X2 devices have been tested by Public Health England (PHE) who independently confirmed that the optical output of the tested units complied with the manufacturer's claims. PHE observed that the risk of ocular injury from exposure to the beam is extremely small. However, PHE advised that if a person is exposed to the beam at low ambient light levels, the beam illuminance would be sufficient to cause temporary visual impairment. The TASER X2 CED's laser sights are of the same power as that used in the TASER X26 CED, and SACMILL is not aware of any ocular injuries associated with exposure to this sighting beam.
32. The data captured on board the TASER X2 CED promises to improve the quality of forensically relevant information and to facilitate *post hoc* reconstruction of use. SACMILL is of the view that the data stored by the TASER X2 CED should be subjected to independent validation to determine their potential utility. Additionally, SACMILL has been advised that any devices involved in incidents where there is an adverse or unexpected outcome are suitably quarantined and removed from service pending investigation.
33. Should the TASER X2 CED be authorised for UK use, the device would be equipped with 7.62 m (25ft) range cartridges housing a new design of probe known as the SP probe. The dart of the SP probe is about 2 mm longer than that of the probe in the 6.40 m (21ft) cartridge presently used in the UK with the TASER X26 CED system. The SP probe therefore increases the risk of penetrating injury for darts that have fully penetrated skin and underlying tissue. At particular risk are the great vessels in the neck, under-arm and groin, although other tissues (such as the pleura) are also vulnerable. SACMILL also notes that the effective penetration depth of a CED dart entering

compressible tissue will be greater than the physical length of the dart. Moreover, the act of falling onto an embedded dart may further increase its effective penetration depth.

34. The dart of the SP probe has two opposing barbs while the dart of the present UK probe has only one barb. Therefore, the pattern of tissue injury, both from dart entry and dart removal, will differ from that seen with the TASER X26 CED probe. Whether any difference would be clinically significant is unknown. SACMILL has received an assurance from TASER International that the SP probe passed their (unspecified) medical tests, but detail is missing and the committee is unaware of any independent assessment. At the time of SACMILL's consideration of the TASER X2 CED system, no field data with the SP probe were available to inform the committee's view on the injury potential of the new probe design.²²
35. When fired, the SP probe is lighter but faster than the probe presently used in the UK. As a result of this the SP probe has higher kinetic energy and, it is to be assumed, would more efficiently penetrate clothing or skin when fired at targets from comparable distances. Based on information supplied by TASER International, SACMILL understands that the velocity of the SP probe falls off markedly between leaving the muzzle of the TASER X2 CED and striking a target at 7.62 m (25ft). Taken together, these characteristics may indicate that there would be a greater risk of deeper tissue penetration with the SP probe and that this risk would be exacerbated for probe shots at closer ranges. SACMILL notes that its predecessor, DOMILL, recommended in its last CED medical statement that studies should be undertaken to explore the differential penetration of probes at various firing distances. SACMILL re-affirms DOMILL's recommendation and takes the view that such studies should be undertaken in order that the ballistic behaviour and injury potential of both the TASER X2 CED system and the TASER X26 CED system are understood as fully as possible.
36. TASER International has supplied limited data to indicate that the SP probe is better retained in clothing and skin. SACMILL has not seen independent evidence to support this contention. However, it appears plausible given the twin-barb design of the SP probe. This design may improve electrical coupling and, thereby, could improve the likelihood of achieving NMI, facilitate more rapid control of a subject and reduce the need for further use of force (including the deployment of the second cartridge and alternative forms of force).
37. In firing trials using clamped devices, the accuracy and consistency of SP probes compared favourably with the accuracy and consistency of the probes currently used in the UK with the TASER X26 CED. Accuracy describes the deviation of the point of impact of fired probes from the point of aim, while consistency – sometimes called precision – describes the grouping (or scatter) of a series of impact points around the mean point of impact. When tested at the 7.62 m (25ft) limit of its range, however, the point of impact of the SP probe was nearly 30 cm below the point of aim. SACMILL notes that this vertical fall-off and mitigating tactics are addressed in training. SACMILL has been advised that an analysis of CED uses from 2009-2014 indicates that 92% of probe mode

²² SACMILL has been advised that many non-UK law enforcement agencies, including those in the United States, have adopted the XP probe. The XP probe is about 2 mm longer than the SP probe and about 4 mm longer than the TASER X26 CED probe presently in use in the UK. In the absence of field data with the SP probe, and under-reporting aside, the relative scarcity of published case reports of serious penetrating injury attributable to the 13.6 mm XP probe provides some degree of implicit reassurance that such injuries are unlikely to emerge with use of the 11.6 mm SP probe.

uses take place at ranges of less than 5 m, therefore engagement at greater distances will likely be infrequent.

38. Probes fired from the TASER X2 CED diverge at an angle of 7° while those fired from the TASER X26 CED diverge at 8°. In the case of both CEDs the top probe leaves the cartridge in line with the 'barrel' of the device, while the lower probe diverges downwards. The purpose of this divergence is to create the probe separation required to induce NMI once the probes have impacted on the subject. A minimum separation of the probes of about 23 cm (9 inches) is understood to be required to induce NMI, and this separation would be achieved at a firing distance (from the cartridge) of around 1.9 m (6.2ft) with the TASER X2 CED and 1.5 m (5ft) with the TASER X26 CED. The use of the TASER X2 CED at close range in probe mode may, therefore, be more constrained than has hitherto been the case. However, SACMILL has been advised that two options would be available to TASER X2 users to mitigate this apparent constraint: adoption of the 'braced hip' firing position or the deployment of a second cartridge in order to exploit *X-Connect* mode (para. 21).
39. SACMILL paid particular attention to the function of the trigger of the TASER X2 CED, which differs in one major respect from the trigger on the TASER X26 CED. On the TASER X26 CED, pressing the trigger momentarily when there is an unused cartridge attached to the device causes the probes to be fired and electrical discharge to be transmitted through the wires tethering the probes to the handset. The discharge cycle will continue for 5-seconds unless it is interrupted by the user. This initial discharge cycle may be extended or repeated on the TASER X26 CED by a second press on the trigger. With the TASER X2 CED, the initial activation of the trigger causes probes to be fired from one of the device's two cartridges and discharge to be administered (again, for a default cycle length of 5-seconds). To extend or repeat the discharge cycle on the TASER X2 CED, however, a separate button – termed the ARC switch – must be pressed. Moreover, in contrast to the TASER X26 CED, pressing the trigger of the TASER X2 CED a second time fires the probes from the device's second cartridge. The trigger functionality of the TASER X2 CED may result in an increased risk of unintentional probe discharge. The implications of this are considered further in para. 50.
40. Tests have been undertaken by CAST to check for the possibility of accidental discharge of probes when the TASER X2 CED is dropped from height. The tests were conducted on one device with the safety switch in the 'ARMED' position and one device with the switch in the 'SAFE' position. When subjected to a series of ten 2 m drops onto a steel plate, neither device discharged its probes. Additionally, the pre- and post-drop alignment of the laser sighting system of the 'ARMED' device was checked and found to remain in alignment.

User handling trials

41. CAST reported that the TASER X2 CED passed testing in the thirteen scenario-based exercises presented to participants in a user handling trial undertaken in April 2016. The three participating groups comprised six AFOs (all TASER X26 CED trained), six members of specially trained units (STUs; all TASER X26 CED trained) and six new users who had no CED training prior to the training on the TASER X2 CED received immediately before the trial.
42. A large proportion of participants commented on the shortness of the grip of the TASER X2 CED. Specifically, in response to the question "*The device fits well in the hand so it can be gripped firmly*"

to facilitate retention in the event of a struggle”, 4/6 of the AFOs and 3/6 of STUs either ‘tended to disagree’ or ‘strongly disagreed’. By contrast, only one 1/6 of new user group ‘tended to disagree’. As the new user group had no previous experience with the TASER X26 CED this may indicate that the negative comments from the other groups related to their previous experience with the TASER X26 CED coupled with a lack of familiarisation with the new device.

43. Other negative comments made by some trial participants were that the TASER X2 CED was more difficult to use with the non-preferred hand (because it is heavier than the TASER X26 CED) and that the cartridge eject button on the TASER X2 CED was difficult to operate.
44. Balanced against the negative comments, however, were positive comments concerning the two shot capability of the TASER X2 CED (paras. 19 and 20), the availability of *X-Connect* mode (para. 21), the ability to display a warning arc with the cartridges attached to the device (para. 29), the dual laser sights (para. 30) and the longer range cartridge (para. 37). Other positive comments received included the improved mechanical sight (for example, for covert use) and the detailed information display on the rear of the TASER X2 CED.
45. Of note, the participants fired a total of 756 TASER X2 CED cartridges as part of the 13 scenario-based exercises and there were no unintentional discharges over the course of the trial (see para. 39).
46. While the positive and negative comments are of interest and the absence of unintentional discharges reassuring, SACMILL notes that the size of the participating groups was small and that the findings from the trial should not be over-interpreted, especially given the necessarily artificial nature of the scenario-based exercises. This underlines the importance of monitoring the performance of the TASER X2 CED system in operational use and stresses the need for appropriate and robust mechanisms to be in place to collect, analyse and, when necessary, act on operationally-sourced data in the event that the TASER X2 CED system is authorised for use.

Review of the guidance and training documentation

47. The College of Policing’s guidance and training documentation has been reviewed and appears to be fit for purpose (although still subject to validation and potential modification as a result of operational experience). Mitigation for several of the issues identified elsewhere in this statement was seen to be in place. Furthermore, the majority of the issues identified by SACMILL during its initial review of the training curriculum are now deemed by the committee to have been satisfactorily resolved. For the few remaining issues, SACMILL has been assured that plans are in place to resolve them.
48. SACMILL noted that, in principle, a single TASER X2 device could be used in probe mode on two persons. However, the committee is of the view that use of the TASER X2 in this way would make it difficult to regulate the duration of the discharge received by each subject. This is due to the way in which the electrical outputs of the two cartridge bays are controlled by the ARC switch on the device. SACMILL has been advised that the training curriculum neither prohibits nor endorses probe discharge from a single TASER X2 device on two subjects. However, the training does emphasise that use against two subjects would be challenging and may make it difficult for the

officer to regulate the parallel discharges appropriately and proportionately.

49. Although the College of Policing's training curriculum and Authorised Professional Practice routinely apply to HO forces in England and Wales, SACMILL has been advised that non-HO forces in the UK voluntarily comply with the Home Office Code of Practice on Police Use of Firearms and Less-Lethal Weapons. This Code sets out the standards for the identification, delivery and quality assurance of training and the supporting curriculum identifies the training standards required for officers to be authorised to use less-lethal weapons. It is understood that the College of Policing's training curriculum is promulgated to non-Home Office forces by way of the latter's compliance with the Code, thereby assuring a consistent approach to less-lethal weapon use beyond England and Wales.
50. As stated in para. 39, SACMILL paid particular attention to the function of the trigger of the TASER X2 CED, which differs in one significant respect from the trigger on the TASER X26 CED. SACMILL perceives a particular risk of unintentional discharge by officers who were originally trained on the TASER X26 CED or who are conversant with firearms use. SACMILL has been advised that mitigation of these perceived risks will be achieved, partly by emphasis of this issue in training and, partly, by advising forces that TASER X2 CED users who are also former users of the TASER X26 CED must not revert to deploying with the older device. Whether the perceived risks of unintentional discharge with the TASER X2 CED are realised in operational use should be monitored, in the event that the TASER X2 CED system is authorised for use in the UK.
51. The accreditation of trainers is conducted through an established model using a three-tiered approach within the College of Policing, with the accreditation of personnel required annually. SACMILL believe this to be a sound approach, but given the increased complexity of the TASER X2 CED system, the differences of this system from the existing CEDs and the newness of the training, it is recommended that a review is undertaken by the College of Policing and other stakeholders on the effectiveness and applicability of the training and to address any issues identified.

Review of the proposed implementation plan for the TASER X2 CED system

52. The proposed plans for the introduction into service of the TASER X2 CED system, should it be authorised for UK use, have been reviewed. Users will be required to complete a form that captures aspects of use related to the expanded functionality of the candidate device. The data captured in this way will facilitate understanding of the safety and effectiveness of the system under operational conditions. SACMILL has been advised that the NPCC Less-Lethal secretariat will be responsible for collating completed TASER X2 use forms and that usage reports will be produced on a quarterly basis beginning 3-months after the introduction into service of the new CED system. **SACMILL requests that it is involved in this process.** This frequency of reporting should continue until sufficient confidence has been gained in the medical consequences of the new system. **SACMILL requests that it is involved in any decision to change the quarterly reporting process.**

In addition to the routine quarterly reporting process, SACMILL requests that it is notified, in a timely way, of any significant adverse events arising either operationally or during training. This is to include any events, including near-miss events, which might raise wider concerns around the

medical implications of the TASER X2 system.

53. SACMILL has reviewed a mature draft of the proposed 'TASER X2 CED Use Form' and believes it to be fit for purpose in terms of the range and types of medically relevant operational data that the form is designed to collect. The committee looks forward to the finalisation of the form.
54. SACMILL welcomes the inclusion of health care professionals as one of the groups identified in the NPCC's implementation plan for the TASER X2 system. It is important that this group is prepared for the introduction of any new CED system and is made aware of any differences from the presently authorised TASER X26 system, such as the increased probe length and differently designed probe dart. Should the TASER X2 system be authorised, SACMILL notes the NPCC's intention to issue an advice leaflet for health care professionals that will explain the primary differences between the currently used and new CEDs. SACMILL has reviewed the proposed advice leaflet and is satisfied with its content.

Conclusions

55. The TASER X2 CED is a more complicated device than the TASER X26 CED. In terms of medical implications, this added complexity appears to bring potential advantages and disadvantages. Overall, the evidence reviewed by SACMILL indicates that the injury mechanisms predicted for the TASER X2 CED system are similar to those for the TASER M26 and TASER X26 CEDs in UK police use.
56. Despite the broad range of potential injuries associated with the use of CEDs, together with the heightened level of threatening behaviour required to justify the necessary and proportionate use of such devices, the incidence of serious injury in the UK appears to be low relative to the number of times the devices are used. Notwithstanding the likelihood of under-reporting in the medical press, the relative infrequency of reports of serious injury implies that most uses of CEDs result in unremarkable medical outcomes. Nevertheless, a small number of deaths and serious injuries have occurred in the UK in association with the operational use of TASER CEDs.
57. SACMILL's review of the TASER X2 system, which included consideration of the electrical, ballistic and optical outputs of the TASER X2 CED, the user handling trials, the training and guidance and the proposed implementation plan, has resulted in a number of observations relating to various aspects of the system. These observations may be found in the main body of the present medical statement. Several issues are mitigated through training and guidance.
58. While SACMILL has endeavoured to predict the variety of potential injuries that might be associated with use of the TASER X2 system, other types of injury may arise in operational practice that could not have been forecast from the evidence reviewed for the present medical statement.

In the event that the TASER X2 system is authorised for UK use, it is essential that a robust review process is in place to permit SACMILL and other stakeholders to understand and respond to any trends or unforeseen events.

59. On balance, SACMILL is broadly satisfied by the evidence it has seen and is of the view that the medical implications of the TASER X2 system – when used by trained operators in accordance with UK policy and guidance – would be in line with those expected for an electronic less-lethal system of this type. Certain functions of the TASER X2 CED are unique to this device and it is essential that the implications of this for system safety are closely monitored in the event that the new system is brought into service.

Recommendations

60. The training, guidance and proposed plans for introduction of the TASER X2 system into UK police services are mature. However, confidence in the use of the system and the ability to identify at an early stage any unforeseen risks or trends, are reliant on an effective and responsive programme for monitoring operational use.

SACMILL therefore **recommends** that, alongside the introduction of the TASER X2 system, an audit of use is commenced that records system performance, including:

- The rate of unintentional discharge of TASER X2 CED cartridges.
- The rate of use of two cartridges, *X-connect*, drive-stun and angled drive-stun modes.
- Quantitative and qualitative information on neuromuscular incapacitation (especially with respect to injury).

SACMILL has been advised by the NPCC that these and other usage metrics will be incorporated into their routine quarterly reporting of the TASER X2 system performance.

61. SACMILL regards it as a condition of the continuing validity of this medical statement that monitoring of the system is begun with the first users of the TASER X2 CED. SACMILL **recommends** that it receives reports every three months with a comprehensive review of the system undertaken twelve months after its introduction into service. SACMILL expects to be notified immediately of any incidents that result in an adverse outcome or unexpected injury. SACMILL will offer assistance in identifying the information that requires collection. Immediate notification of SACMILL should also include near-miss events that may be deemed to have wider medical implications, whether these arise operationally or in training.

62. Additionally, SACMILL **recommends** that further investigation should be undertaken to examine the following features of the TASER X2 system:

- The validity and utility of the information captured by the data logging system of the TASER X2 in order to inform any forensic data gathering.
- The differences in probe penetration mechanics between the TASER X26 and the TASER X2 CEDs.

SACMILL has received assurances from CAST that the above studies will be undertaken in due course.

63. The system reviewed by SACMILL comprised the TASER X2 CED handset (Rev. E) running firmware Rev. 04.020, fitted with the SP Operational Smart Cartridge Rev. D and *Automatic Shutdown Performance Power Magazine* (APPM Rev. A). This is with the TASER X2 CED configured to operate in semi-automatic mode and the TASER X2 CED and APPM configured in the *Trigger-Initiated Shut-Down Only* option.

SACMILL **recommends** that any future changes to the TASER X2 CED configuration are evaluated by CAST and assessed by SACMILL for their potential to modify the medical implications of the system and to confirm the continued validity of the present medical statement.

64. SACMILL's review of the TASER X2 system has resulted in a number of changes to the training curriculum and the committee finds the proposed changes to be acceptable. In the event that the TASER X2 system is authorised, SACMILL **recommends** that it is given the opportunity to review the revised training curriculum in its entirety prior to its implementation by the College of Policing.

65. Finally, SACMILL has previously made known its strong support for the use of body-worn video cameras by CED officers and would like to take the opportunity to re-state its position here. Body-worn video imagery promises to provide medically relevant information from incidents in which an adverse outcome is associated with CED use.

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