Dstl opinion on the medical implications of the TASER 10™ system

s40(2); **s40(2)**; **s40(2)**

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The circulation of version 1.0 of this report, along with several preceding drafts, was restricted to the Scientific Advisory Committee on the Medical Implications of Less-Lethal Weapons (SACMILL) in order to give the independent committee a private space in which to deliberate.

The intention of this report was to assist the committee in its consideration of the medical implications of the TASER 10™ system. These deliberations completed on 12/03/2025, which is the date on which SACMILL finalised its medical statement on the system.

Version 1.1 of this report now opens up the report's circulation to the Home Office, which is the government department that tasked SACMILL with the production of a medical statement on the TASER 10™ system.

Version 1.1 retains the same publication date as version 1.0.

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Executive summary

The TASER 10™ is the fifth generation Conducted Energy Device (CED) to be considered for police use in the UK, having been preceded by the single cartridge devices (the TASER M26™ and TASER X26™) and the twin cartridge devices (the TASER X2™ and TASER 7™).

Launched by Axon Enterprise in January 2023, the TASER 10™ marks a radical departure from its predecessors in several ways:

- All earlier devices adopted in the UK fired a pair of diverging probes upon pressing the trigger, the divergence angle being determined by the cartridge design. This divergence is needed to create the probe spread required for neuromuscular incapacitation (NMI). The TASER 10™, on the other hand, fires single probes from its ten-cartridge magazine when the trigger is pressed. Therefore, at least two trigger presses are required to create an electrical circuit. The probe spread is determined by the firer.

- Due to a brief very high voltage component at the start of the pulse waveform, the electrical output of all earlier TASER devices was able to:

    - generate an arc warning display designed to reinforce verbal warnings and assist in de-escalation;

    - arc across a small air gap to complete an electrical circuit when the probes are in clothing;

    - administer discharge in contact and three-point contact mode, commonly referred to as drive-stun and angled drive-stun.

  The lower voltage TASER 10™ waveform, however, precludes use of the above three options. The warning display is now delivered by way of an electronically synthesised tone combined with a strobing LED. A corollary to the lack of an arcing waveform is that **penetration of the skin with at least two probes having a sufficient spread** is essential for the induction of NMI.

  Dstl has been advised that Axon have mooted that the lower voltage of the TASER 10™ waveform constitutes less of an ignition hazard around flammable liquids and explosive vapours than was the case with previous devices. While plausible, no confirmatory data have been made available to Dstl.

- The polarity of the probe pairs fired from the earlier devices was fixed, with the top and bottom probes being positive and negative, respectively. With the TASER 10™, probe polarity is dynamically determined. This means that a circuit is not reliant on a positive and negative probe making contact. The device will assign the probe polarity to achieve a current path. The TASER 10™ has ten probes, which means that at the point of firing of a fully-loaded magazine, there are a possible 45 probe-probe connections and, therefore, up to 45 probe-pair combinations with which to induce NMI.

- Despite the large number of probes, the manufacturer states that a maximum of only four (skin-embedded) probes can be energised at any one time.

- The TASER 10™ has an increased range when compared to its predecessors. The nominal maximum range is 13.7 m (45 ft), but at ranges above 10 m (33 ft) there is a graceful degradation of accuracy. Earlier CEDs had maximum operational ranges of up to 7.62 m (25 ft)

- The TASER 10™ has many features in common with earlier devices, such as being able to project a laser dot to warn individuals of impending escalation to probe discharge, an audible alert and strobing LED (to replace the warning arc display), a torch, a safety and arming switch, and a Central Information Display. The complexity of the TASER 10™ is, in some respects, greater than the previous models, however, some design features make usage simpler (such as the single probe firing to allow more appropriate probe placement and reducing the burden of aiming two probes simultaneously). The operation of the device is through the multi-function selector switch (the safety and arming switch) – this has multiple other functions which will require substantial familiarisation.

- The TASER 10™ is also able to track the deployment of the device from its holster, recording this as an ‘event’ in its event logging system, providing additional information around the timeline of an operational deployment.

The device has undergone substantial testing, both technical testing of the device in isolation and in user handling trials to see how it operates in the hands of the user as part of a system:

- The technical testing assessed the intrinsic accuracy and consistency of the device firing both operational and training (‘hook and loop’) probes. This showed that both probe types had similar accuracy and consistency properties over the ranges expected and, therefore, that the training probe will serve as a suitable substitute for the operational probe.

- The technical testing measured the mass and velocity of the probes (allowing the calculation of probe momentum and kinetic energy). The momentum and kinetic energy of the TASER 10™ probes were greater than for probes fired from previous devices.

- The technical testing also assessed the relative penetration into skin and skull surrogates. The TASER 10™ probe penetrated the skin surrogate to a similar extent as the TASER X2™ probe (the penetration of the TASER 10™ probe was slightly greater but with no statistically significant difference). The testing into the skull surrogate showed that the dart of the TASER 10™ probe could deform in a different manner to the dart of the TASER X2™ probe. Moreover, the TASER 10™ dart deformed to a greater degree than the TASER X2™ dart, indicating the potential for greater tissue damage if due caution is not exercised during probe removal. The greater kinetic energy of the TASER 10™ probe meant that, on isolated occasions, the probe body embedded into the skull bone surrogate.

- Technical testing also examined the ability of the dart of the TASER 10™ probe to penetrate selected types of clothing. The clothing selected was not particularly challenging and routine penetration was achieved into a skin surrogate through the clothing. There is an intention to conduct further testing with more challenging clothing, but this had not reported at the time of writing.

- Additional tests were conducted to measure the electrical output, laser output, the noise output of the device and the robustness of the TASER 10™ when dropped. The electrical output, laser output and noise output were found to be within limits. The device showed damage when dropped from 2 m onto an unforgiving surface. Devices that have had such impacts will need to be removed from service whilst they are checked for serviceability; this is already covered in the College of Policing Authorised Professional Practice for CEDs.

- The user handling trials examined:

    - how easy the device was to train (for new users and experienced users of other models of CED),

    - user opinion on the acceptability of the device, and

    - how accurate the device was in the hands of users.

  The overall conclusion was that it was possible to train non-CED qualified officers to use the TASER 10™ as well as convert existing CED officers. The TASER 10™ was relatively well accepted by the trial participants who managed to target probes with reasonable accuracy (including in simulated challenging operational scenarios).

The present report has explored UK operational data for earlier CEDs in an attempt to estimate the number of TASER 10™ probes that would need to be fired to induce NMI. Assuming no probe misses, the analysis predicted that an average of four probe firings would be needed in summer and six in winter to achieve two skin-embedded probes with a probability of 95% or greater. This is broadly consistent with limited anecdotal data from [redacted] who reported that [redacted] when the TASER 10™ was used to deploy probes.

The College of Policing training documentation has been reviewed although, at the time of writing, this was still at the draft stage. Similarly, the National Police Chiefs' Council TASER 10™ Implementation Programme, also in draft form, has been reviewed. The medical implications emerging from these documents are discussed in the main body of this report.

The medical implications of the TASER 10™ system emerge, in part, from the observations set out above. For the system to serve its purpose when probes are fired, there needs to be a high degree of confidence that NMI will be achieved. This is in order to bring an incident to a swift conclusion and minimise the risk of resorting to other, potentially more injurious forms of force, ranging from unarmed defence techniques and baton strikes up to the use of lethal firearms.

The electrical output of the TASER 10™ is similar to that produced by previous devices whose subdual effectiveness has been well-documented in the field. One unknown, however, is how successfully the dart of the TASER 10™ probe will overcome clothing and embed in skin, in the absence of which the electrical discharge will not be effective. Mitigating this uncertainty is the higher energy of the TASER 10™ probe coupled with their floating polarity and the large number of potential probe-pairing possibilities that a full magazine provides.

Given the broad similarities between the electrical output of the TASER 10™ and that of earlier twin-cartridge devices, and provided that a maximum of only four TASER 10™ probes can be energised at any one time, then a change in the injury potential of the discharge itself is not anticipated.

The higher kinetic energy and momentum of the TASER 10™ probe compared with the probes of previous devices, points towards a greater risk of blunt and penetrative injury. Moreover, the deformation of the dart of the TASER 10™ probe seen in the skull surrogate testing implies probe extraction following penetration of bony tissue has the potential to be more complicated than it was hitherto.

While some features of the TASER 10™, such as the individually targeted probes, appear to reduce system complexity, other aspects of the device may work in the other direction, perhaps with knock-on effects on system effectiveness. These latter aspects include:

- The need to secure at least two skin-embedded darts, which may be particularly challenging when the subject is moving quickly;
- The multi-function selector switch which serves more device functions than the ARM/SAFE switch on previous models;
- The amount of data conveyed to the user by the multi-colour Central Information Display;
- The range of audible alerts that serve to convey device status to the user; and
- The potential for a free-flying hazard to be created when probes reach the limit of their tethering wires in the event of a probe miss.

These and other aspects relating to the medical implications of the TASER 10™ system are discussed in detail in this report, along with a number of recommendations intended for SACMILL consideration.

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1 General introduction

The purpose of this report is to provide the independent Scientific Advisory Committee on the Medical Implications of Less-Lethal Weapons (SACMILL) with a grounding in the TASER 10™ system, as viewed from the perspective of Dstl. This report also draws on UK operational data from earlier devices to see how that may inform aspects of the TASER 10™ system. The report is designed to provide a launch pad for the committee to undertake its own deliberations on the medical implications of the system which will ultimately be presented to Home Office ministers in the form of a SACMILL medical statement.

SACMILL is undertaking its consideration of the TASER 10™ system after the committee's Executive Officer (MOD Surgeon General) received a tasking request from the Policy Lead for Armed Policing and Police Use of Force at the Home Office Police Powers Unit (APPENDIX A).

s31(1)(a) [redacted]

However, at the point of tasking, a major element feeding into the authorisation process – namely, the technical assessment exercise – had not begun. Previously undertaken by the Home Office Centre for Applied Science and Technology (CAST) and, latterly by Dstl, for the first time this technical assessment has been contracted out to an independent commercial concern (independent of the manufacturer). The technical testing began in earnest in the first week of October 2024 and the test house reported their final results in mid-January 2025, after which Dstl reviewed the report for its technical content and briefed SACMILL accordingly.

The timeline for delivery of SACMILL's medical statement was subsequently relaxed by the Home Office and the current aspiration is for the statement to be delivered to the Home Office in time for them to prepare a Home Secretary briefing by mid-March 2025.

The TASER 10™ is the fifth conducted energy device (CED) to be considered by the UK for use by police and other authorised personnel, it being preceded by the TASER M26™ (authorised in 2003), the TASER X26™ (2005), the TASER X2™ (2017) and the TASER 7™ (2020).

The TASER 10™, however, represents a major shift in the concept of use underpinning all previous CEDs in five principal ways:

- Instead of firing two probes of opposite polarity from a cartridge when the trigger is pulled, the TASER 10™ fires only a single probe from its ten-cartridge magazine, meaning that at least two trigger pulls are required to achieve neuromuscular incapacitation (NMI);

- The probes of the TASER 10™ can assume either polarity which, in principle, means that there are initially 45 combinations of probe pairings possible from a ten-cartridge magazine, although a maximum of only four probes will be electrically active at any one time.

- Whereas the higher voltage pulse waveforms of earlier devices could arc across a small air gap when probes are in clothing, the darts of the TASER 10™ probes must pierce the skin to form an electrical circuit with the subject and induce NMI.

- The lower voltage of the TASER 10™ waveform means that arc warning displays and drive-stun are no longer options.

- The nominal maximum range of the TASER 10™ is 13.7 m (45 ft), considerably longer than the maximum range of 7.62 m (25 ft) achieved by earlier devices.

The present report will review these and other aspects of the TASER 10™ system and offer Dstl's opinion on their medical implications. This report is structured as follows:

- Section 1 General introduction
- Section 2 Introduction to the TASER 10™
- Section 3 System specification and acceptance for UK police use
- Section 4 Technical testing of the TASER 10™
- Section 5 User handling trials
- Section 6 On the predicted performance of the TASER 10™ – insights from the TASER X2™ and TASER 7™
- Section 7 NPCC implementation plan for the TASER 10™ system
- Section 8 Human factors considerations
- Section 9 Operational reporting
- Section 10 Additional testing
- Section 11 Medical implications of the TASER 10™ system
- Section 12 Conclusions and recommendations

At the time of finalisation of the present report, SACMILL has held three meetings to discuss the TASER 10™, in advance of which earlier drafts of this report were shared with the Committee. SACMILL's first meeting was in-person at MOD Main Building on 22nd November 2024, while the second and third were virtual meetings on 16th December 2024 and 23rd January 2025. A further in-person meeting is planned for 25th February 2025. Amongst other things, this meeting will give SACMILL an opportunity to obtain hands-on experience with functional TASER 10™ devices and allow the Committee to further finesse their medical statement.

2 Introduction to the TASER 10™

2.1 Externally identifiable parts

The external parts of the TASER 10™ are shown in Figure 1:

Figure 1. External features of the TASER 10™. Images are screenshots captured from a 3D model.[1]

The following are the verbatim descriptions provided by Axon for the various external components.[1]

[1] Model available at https://sketchfab.com/3d-models/taser-10-7c804723dfe3431bb8e9f48d83d3dd23 (accessed 29/10/2024)

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TRIGGER (1)

- First trigger pull discharges a single probe without electrical output
- Second trigger pull will discharge the second probe
- If a connection is established between the first and second probe, electrical output will begin (22 pulses per second for 5 seconds)
- Subsequent trigger pulls will discharge probes 3 - 10
- Shift the multi-function selector switch down (SAFE) to stop a discharge (e.g., if accidentally discharged)
- Holding the trigger continuously beyond the 5-second cycle will continue the electrical discharge until the trigger is released *[authors' note: the Auto-Shutdown configuration will be implemented for the UK which will automatically stop delivery of discharge after 5-seconds, even with continued pressure on the trigger]*

SELECTOR SWITCH (2 and 10)

The ambidextrous selector switch serves multiple functions.

Selector Switch Up = ARMED

- Activates CID, laser and illumination
- Begins entries in the logs to be viewed in Axon Evidence

Momentary Up (moving switch upwards past the ARM position) = Warning Alert / Re-Energize

- Warning Alert: Prior to cartridge deployment, moving the selector switch up (past the ARMED position) and releasing the switch will initiate a warning alert sound
- Re-energize: After cartridge deployment, moving the selector switch up (past the ARMED position) will re-energize deployed connected probes for 5 seconds

Selector Switch Down = SAFE / DISARM

Momentary Down = Function Test Mode/Stealth Mode

NOTE: TASER 10's new electrical output wave form does not produce an electrical arc. That arc has been replaced with a Warning Alert. When activated, it will produce up to 1000 Lumens of strobing light and loud alert sound to warn of the potential use if subject does not change their behavior.

RECHARGEABLE BATTERY PACK (3)

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The removable battery pack is rechargeable through the docking station and will allow for approximately 100 trigger pulls or 50 warning alerts on a full charge.

- Disconnect Battery Pack - the optional disconnect battery pack has extra circuitry to shutoff the power supply to the TASER 10 when disconnected from its lanyard.
- Haptic Battery Pack - the optional haptic battery pack has an extension on its grip and extra circuitry to vibrate the handle when the user unholsters TASER 10 and when a connection to the subject is sensed *[authors' note: this will not be implemented in the UK at this time as it is still in development at the manufacturer]*

NOTE: TASER Training recommends docking the rechargeable battery pack once every 30 days or when the weapon indicates 20% of power remaining. TASER 7 battery packs are compatible with TASER 10.

BATTERY PACK RELEASE BUTTON (4 and 9)

To remove the battery pack:

- Press both battery pack release buttons (one on each side of the battery pack)
- Hold the release buttons and pull down on the battery pack

REAR SIGHT (5)

[No additional description]

FRONT SIGHT (6)

[No additional description]

RAIL SIDELIGHT (7)

LED side lights illuminate based on the weapons mode or to display a critical error condition

- Blue = Training Mode or Functional Test
- Yellow = Weapon Mode or "Duty Mode"
- Red = Duty Mode with Critical Error[2]

[2] The critical errors recorded by the device do not align directly to the CAT A critical faults defined for the user handling trials (discussed later in this report) [1].

CENTRAL INFORMATION DISPLAY (CID) (8)

The CID is positioned on the back of the TASER 10 and faces the operator. TASER 10 uses a larger display than previous models and features a color display that provides the operator with critical information about the energy weapon.

- Blue = Training Mode or Functional Test
- Yellow = Weapon Mode or “Duty Mode”
- Red = Duty Mode with Critical Error

WARNING: If the trigger is pulled at any time while the weapon is armed a probe will be deployed.

MAGAZINE (11)

Houses 10 single probe cartridges.

MAGAZINE BAYS (12)

The TASER 10 uses 10 cartridges. Previous models used cartridges that contained compressed nitrogen to deploy two probes simultaneously. TASER 10 cartridges do not contain a gas capsule. Instead, when a TASER 10 cartridge primer is ignited, it pushes a captive piston forward which provides the energy to propel one probe forward at a time.

FLASHLIGHT (13)

In normal operation, the flashlight will illuminate at ~200 lumens. When Warning Alert is activated the flashlight will strobe and illuminate up to 1000 lumens.

GREEN LASER (14)

A bright green laser indicates the approximate impact location of each probe.

SPEAKER PORT (15)

When activated by the user, Warning Alert will produce a very loud alert sound to serve as an auditory warning of the potential use if a subject does not change their behavior.

2.2 TASER 10™ magazines and cartridges

Table 1 lists the four types of magazine are available for the TASER 10™:

Model	Model No.	SKU No.	Type	Color
Live	T01076-1	100393	Duty	Black
HALT	T01076-3	100394	Training	Blue
Live	T01076-4	100395	Training	Purple
Inert	T01076-6	100396	Training	Red

Table 1. Magazine types available for the TASER 10™ [2]

2.2.1 Duty (black) magazine and cartridge

The live cartridges, which carry a black sleeve, are designed for operational use but can also be loaded into the purple training magazine (see 2.2.2).

Figure 2. Black duty (operational) magazine and cartridge.

2.2.2 Live training (purple) magazine

Figure 3. Live training (purple) magazine and (black) cartridge.

Axon state that the duty (black) cartridges can be loaded into the purple training magazine for the purposes of target practice [3]. Probes fired from duty (black) cartridges loaded into the purple training magazine will be energised in the same way as if they are fired from the black duty magazine. The difference is that the purple magazine is recognised as such by the TASER 10™ handle, which records details of all deployments and, therefore, that the deployment has been made in a training environment. For this reason, Axon cautions not to use purple training magazines for duty use.

Axon further cautions not to deploy a TASER 10™ device with a purple training magazine at a person, even in a training scenario, even if the person is wearing TASER Simulation Training Suit, HALT Suit or other protective gear [3].

The purple training magazine will be introduced into UK use.

2.2.3 Hook-and-loop training (HALT, blue) magazine and cartridge

Figure 4. HALT (blue) magazine and blue-sleeved HALT cartridge.

HALT (blue) cartridges are designed for use with the HALT suit. According to Axon [3] : "Instead of having barbs on the ends of their probes, HALT cartridges are tipped with hook fasteners that enable them to stick to the loop fasteners on the training suit. The HALT cartridges contain non-conductive line and will not transmit electrical pulses to the probes. When a blue training magazine is loaded into a TASER 10 energy weapon, the weapon records all deployments and other actions as training events."

2.2.4 Inert (red) magazine and cartridge

Figure 5. Inert (red) magazine and cartridge.

Axon states [3] that the "inert (red) cartridges do not contain propellant, probes, or wire. They are intended for use with an inert (red) magazine to practice loading cartridges into a magazine. When a red training magazine is loaded into a TASER 10 energy weapon, the weapon records all actions as training events." These magazines have a randomised connection alert, which results in the trigger having to be pulled 2 to 5 times before the connection alert sounds. The intention of this is to reinforce that the TASER 10™ may need more than two trigger pulls to make a connection and incapacitate a subject.

2.3 Loading and unloading of the magazine

2.3.1 Cartridge loading

Axon's instructions for the loading of cartridges are as follows [3]:

- Point the magazine in a safe direction at all times.
- Slide the cartridge with the front facing away from you, front-first into the back of the chamber until the cartridge is seated.
    - Load one cartridge at a time.
    - It is not necessary to force a cartridge into the chamber.

  - When fully chambered, part of the cartridge will protrude from the magazine as shown.

- Repeat until all cartridges are loaded.

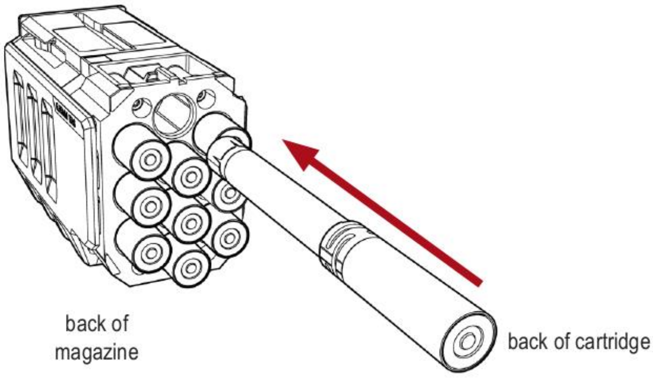

Figure 6. Loading cartridges into the magazine.

2.3.2 Cartridge unloading

Where one or more cartridges have been deployed, Axon gives the following instructions for the removal of the expended cartridges from the magazine [3]:[3]

- Check your surroundings to ensure the situation is safe.
- Ensure the selector switch is in the down (SAFE) position.
- Remove the magazine.
- Holster the weapon.
- Break the wires, and remove the cartridges as needed.
- Unholster the weapon.
- Re-insert the magazine.
- Move the selector switch to the up (ARMED) position to confirm the cartridges display properly on the CID.
- Move the safety switch to the down (SAFE) position.
- Holster the weapon.

[3] The College of Policing teach a different order of actions, whereby [redacted].

2.4 Fitting the magazine into and removal from the TASER 10™ handle

2.4.1 Loading the magazine into the handle

Axon advises that for both operational and training scenarios, ensure that the magazine is fully loaded with un-deployed cartridges before inserting the magazine into the device. Their instructions for loading the magazine into the handle are as follows:

- Ensure the selector switch is in the down (SAFE) position.
- While gripping the magazine from the bottom, align the guides on the magazine with the rails on the weapon.
- Slide the magazine approximately halfway towards the back of the weapon before pushing upward.
- Push the magazine horizontally into the TASER 10 energy weapon.
- Ensure the magazine is properly aligned with the rails in the magazine well.

  TASER 10 magazines are designed to prevent being loaded into the weapon backwards. Nevertheless, ensure the magazine is oriented properly before attempting to insert it into the weapon.
- Slide the magazine backward until you hear a click.
- If the magazine does not latch to the weapon, remove the magazine and confirm that the correct type of cartridges are loaded.
- Move the selector switch to the up (ARMED) position.
- Confirm the CID displays a loaded magazine.
- Move the selector switch to the down (SAFE) position.

2.4.2 Unloading the magazine from the handle

Ensure the selector switch is in the down (SAFE) position. Do not put your hands in front of the magazine.

Holding the magazine on the sides, pull the magazine horizontally out of the TASER 10 energy weapon.

2.5 The TASER 10™ probe

The probe of the TASER 10™, in comparison with probes for earlier devices, is shown in Figure 7:

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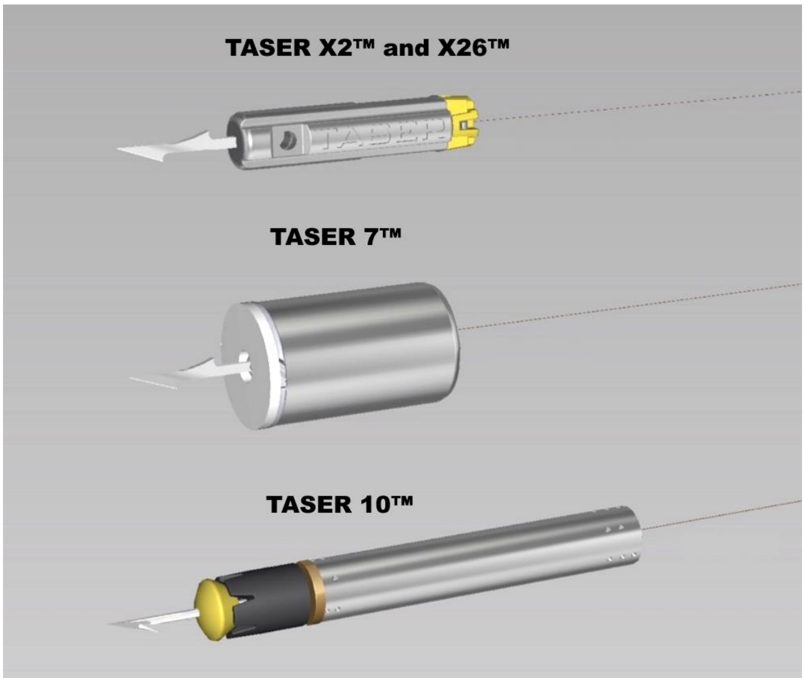

Figure 7. The probes of the TASER 10™, TASER 7™, TASER X2™ and the TASER X26™.

Although the design of the dart of the TASER 10™ probe has changed from the design used by the older devices, the length of the dart is similar, this being 11 mm for the TASER 10™ (but see below) and 11.5 mm for the TASER X2™, TASER 7™ and TASER X26™.[4]

The black collar behind the mustard-coloured bumper towards the base of the dart of the TASER 10™ probe is an impact absorber, as shown in Figure 8:

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Figure 8. Cutaway illustration of a TASER 10™ probe inside its cartridge case.

Figure 8 also illustrates that, like the TASER 7™ probe, the tethering wire is wound in the probe body rather than spooled out from the cartridge body (as is the case with TASER X2™ and TASER X26™).

The TASER 10™ dispenses with the traditional blast door fitted to the cartridges on earlier devices. Previously, the door would be pushed open by an ejector sitting at the front of the expelled probe (hence, the phenomenon of ‘trapped ejectors’ noted with the TASER 7™ [4]). Instead, the expelled TASER 10™ probe simply pierces through a thin

[4] Ref to SACMILL review of X26 SP probe change.

metal foil covering at the front end of the cartridge assembly. There are no reports in UK use of the foil being ejected from the front of the cartridge with the potential to cause injury.

With regard to the impact absorber, Axon state:

> "TASER 10's probes are tipped with a dual polymer impact absorber that expands upon contact, creating more surface area for a more reliable connection while decreasing the chance of injury from impact."[5]

Compression of the impact absorber will effectively increase the dart length relative to its length with an uncompressed absorber. An example of a compressed impact absorber is shown in Figure 9:

Figure 9. Example of a compressed impact absorber observed in user handling trials.

Removal of the bumper and impact absorber reveals that the physical length of the underlying dart is about 18 mm (Figure 10):

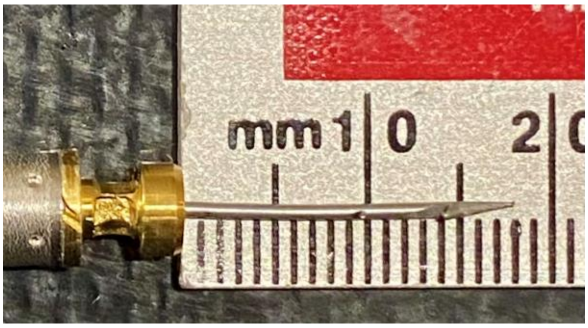

Figure 10. TASER 10™ dart after removal of the bumper and impact absorber.

Therefore, the true depth of the tip of a TASER 10™ dart that has fully penetrated into tissue is likely to be greater than 11 mm in instances where the impact absorber has been compressed. Such a situation would seem most likely after full penetration of the dart in a rigid structure, such as the skull or a rib.

Axon have been asked to advise on the length of the exposed dart after full compression of the impact absorber and a response is awaited.[6] Separately, Dstl asked the test

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[5] https://www.axon.com/resources/one-giant-leap-towards-reducing-fatal-police-public-shootings
[6] Email **s40(2)** to **s40(2)** (Senior Product Manager, TASER Devices) 30/10/2024.

house to measure the length of the dart after full compression. The test house reported back that the effective length of the dart with full compression is about 15 mm:

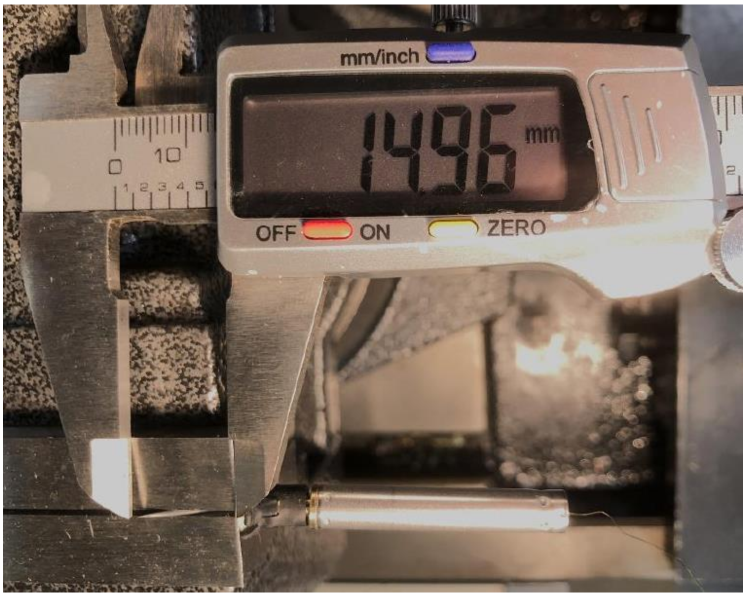

Figure 11. Length of dart after full compression of the probe's impact absorber.

The ballistic properties of the TASER 10™ probe are covered in section 6.5 of this report, while the medical implications of the probes are considered in section 11.

2.6 Probe firing sequence

The cartridge chambers in the TASER 10™ magazine are designated as follows:

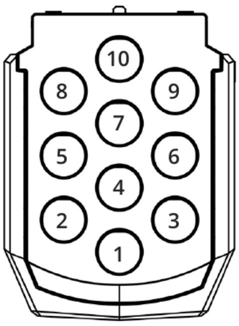

Figure 12. Cartridge number designation viewed from the front of the magazine.

According to Axon [3]:

> "The TASER 10 energy weapon is designed to distribute cartridge deployments across the magazine over time. The device remembers which chambers have been used. Because the TASER 10 is designed to deploy cartridges in order, if cartridges one and two are deployed, the weapon is made SAFE and then ARMED again in the future, the third and fourth chambers will be the first and second chambers to deploy cartridges. This reduces wear on the chambers and thus extends the weapon's useful life."

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Axon refers to this incremental cycling of probe deployment chambers as 'Intelligent Deployment Distribution'.

2.7 The trigger

Axon describe the TASER 10™ trigger and its function in the following way [3]:

> "Unlike a firearm trigger, the TASER 10 trigger is a momentary electrical switch. The trigger is operational only when the safety is in the up (ARMED) position. Pulling the trigger will deploy a cartridge. Pulling the trigger a second time will result in an approximately 5-second discharge cycle if the weapon detects a connection between the probe pairs. If only one probe is deployed, a second trigger pull and cartridge deployment is necessary for NMI to be possible."

Like the TASER X2™ and TASER 7™, the TASER 10™ will be configured for UK use with the Automatic Shutdown feature enabled, meaning that a manual intervention is required by the officer to extend the discharge cycle beyond the 5-second default period, irrespective of whether the trigger is depressed. This intervention involves pressing-up the multi-function selector switch (see 2.8), whereas on earlier devices the cycle may be extended using the arc switch. On the single cartridge devices, pressing and releasing the trigger launches probes and initiates a 5-second discharge cycle which can be extended by pressing the trigger again. Pressing the trigger on the TASER 10™ will result in the firing of another probe and recommencement of the 5-second discharge.

Figure 13. The triggers of the TASER 10™ *(left)*, TASER X2™ *(middle)* and TASER 7™ *(right)* compared.

2.8 The multi-function selector switch

The multi-function selector switch on the TASER 10™ augments the functionality of the safety switch on previous models of Axon CED (Figure 14):

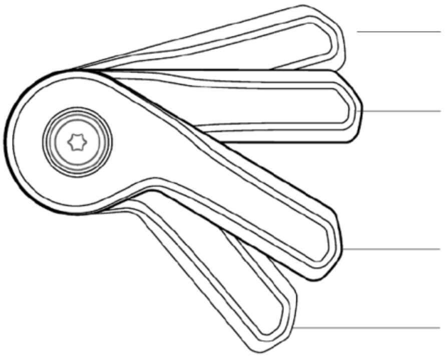

Figure 14. The multi-function selector switch of the TASER 10™.

It may be seen that the selector switch gives access to six functions whereas, on the TASER X2™, the safety switch served only to turn the weapon on (ARMED), off (SAFE) or to engage stealth mode (flashlight, side lights, laser off and CID dimmed). The safety switch on the TASER 7™ was even simpler, with stealth mode being engaged by a separate control (simultaneously pressing the two ARC switches).

The multi-function selector switch on the TASER 10™ is, therefore, more complex than on earlier models and was one of the features of the new device that attracted some negative comment in user handling trials (see sections 5 and 8).

2.9 Audible alerts

The audible alerts of the TASER 10™ are transmitted from the speaker port located at the front of the device. There are several alerts that serve to indicate device status (see Table 2):

Notifications	Warnings	Alerts
Low level beep • Low battery • Mode changes	Medium level beep • Automatic shut-down warning	Loud sound • Armed Alert • Warning Alert High-pitched sound • Connection alert

Table 2. Device status audible alerts.

2.9.1 Warning alert

Because the TASER 10™ cannot generate the high-voltage arc warning display available on earlier devices, the subject-directed warning is now generated by a “loud” alert sound in combination with a flashlight strobe display. The flashlight normally produces a continuous 210 lm output, but this rises to “up to 1000 lm” (alternating at 20 Hz) when the warning alert is activated.

The warning alert is activated under two conditions [3]:

- Subject-directed warning (with strobing of flashlight): The device has not deployed a cartridge and the multi-function selector switch is briefly moved to the press-up position.
- Officer-directed warning (no strobing and normal flashlight intensity): The device has deployed cartridges and the multi-function selector switch is moved to the press-up position with the intention of re-energising the deployed probes but there is no electrical connection with the subject.

Like the multi-function selector switch, the subject-directed warning alert attracted some negative comment in user handling trials, partly because of its perceived lack of effectiveness and partly due to ergonomic aspects related to the multi-function selector switch action required to activate the feature (see section 5).

2.9.2 Connection alert

This alert sounds when cartridges have been deployed and there is an electrical connection with the subject. A connection alert also sounds when probes have been deployed and the selector switch is momentarily pressed up to re-energise deployed probes and there is an electrical connection with the subject. This can be disabled, however the intention is to ensure it is enabled for UK use and monitor its utility.

2.9.3 Automatic shutdown warning

In addition to the warning alert, the speaker port emits beeps to alert the user to the impending shutdown of the default 5-second discharge cycle. This is the same feature as implemented on the TASER X2™ and TASER 7™ where the beeping initiates during the final 2-seconds of a cycle. The actions to reinitiate the cycle are given in section 2.7.

2.9.4 Other alerts

The remaining two audible alerts are for low battery charge and device mode, with the latter being determined by the cartridge fitted to the device (training or duty – see 2.2)

2.10 Sighting laser

The TASER 10™ is labelled as being fitted with a class 3R green (510 nm) with a stated maximum output of 5 mW. The sight provides an indication of the point of probe impact on the subject and is said by Axon to be zeroed at 33 feet or about 10 m: “The laser sight is said to coincide with the centre of the dart grouping at 33 ft.”[7]

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[7] Email [redacted] (Axon UK) to Dstl (dated 19/10/2023).

Figure 15. Laser classification label.

According to the UK government's safety advice for laser radiation [6]:

> "Class 3R laser products are higher powered devices than Class 1 and Class 2 and may have a maximum output power of 5 mW or 5 times the AEL *[accessible emission limit]* for a Class 1 laser product. The laser beams from these products exceed the MPE *[maximum permissible exposure]* for accidental viewing and can potentially cause eye injuries, but practically the risk of injury in most cases is relatively low for short and unintentional exposure. The risk is limited because of natural aversion behaviour for exposure to bright light for the case of visible radiation and by the response to heating of the cornea for far infrared radiation."

The stated power and wavelength of the TASER 10™ laser are identical to those of the green (upper) laser of the TASER 7™ [7].

Confirmation of the output of the TASER 10™ laser formed part of the work undertaken in the independent technical testing (see section 4).

2.11 Rail sidelights

The lights on each side of the TASER 10™ indicate the device mode, which changes depending on which type of magazine is installed in the weapon [3]:

Color	Mode
Yellow	Duty
Blue	Training
Red	Error

Figure 16. Rail sidelight colours.

2.12 The TASER 10™ battery

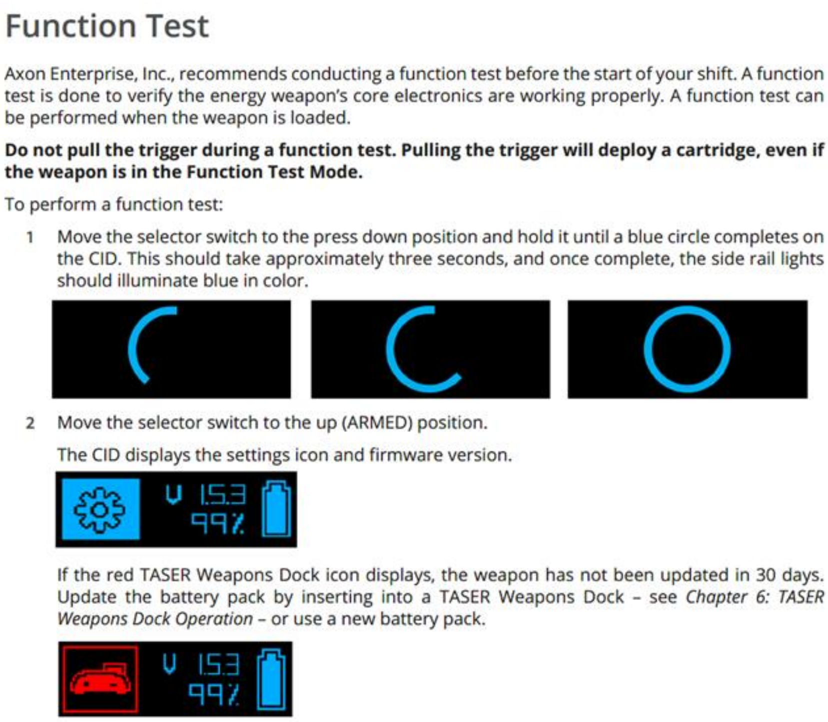
The TASER 10™ is powered by a rechargeable lithium cell battery pack. Axon state that a fully charged battery pack will support approximately 100 five-second trigger pulls and that battery capacity will vary depending on temperature, use of the flashlight and other factors [3].

The TASER 10™ user manual describes two battery options [3]: the standard Rechargeable Battery Pack and a Haptic Rechargeable Battery Pack, with the latter option said to "provide feedback *[vibration]* when the weapon is drawn from a holster, when a circuit is completed, when the energy cycle shuts down, when the battery is low, and when there is a device error." The UK user handling trials, described in section 5 of this report, were undertaken using the standard battery pack.

Despite the information in the TASER 10™ manual, it is understood from Axon that they "haven't finalised the spec and we will gauge interest before submitting for DSTL etc testing and approval."[8] NPCC have no plans at the time of writing to introduce the haptic battery [5].

2.13 Function test

The function test is described in the TASER 10™ user manual [3]:



Function Test

Axon Enterprise, Inc., recommends conducting a function test before the start of your shift. A function test is done to verify the energy weapon's core electronics are working properly. A function test can be performed when the weapon is loaded.

Do not pull the trigger during a function test. Pulling the trigger will deploy a cartridge, even if the weapon is in the Function Test Mode.

To perform a function test:

1 Move the selector switch to the press down position and hold it until a blue circle completes on the CID. This should take approximately three seconds, and once complete, the side rail lights should illuminate blue in color.

2 Move the selector switch to the up (ARMED) position.

The CID displays the settings icon and firmware version.

If the red TASER Weapons Dock icon displays, the weapon has not been updated in 30 days. Update the battery pack by inserting into a TASER Weapons Dock – see *Chapter 6: TASER Weapons Dock Operation* – or use a new battery pack.

Figure 17. TASER 10™ function test (continued over page).

[8] Email Axon UK to [redacted] (College of Policing), dated 07/11/2024.

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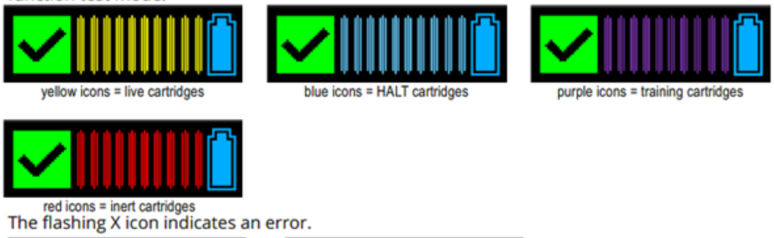
3 Wait for the weapon to conduct the test.

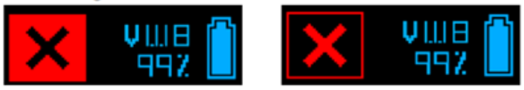
The check mark icon indicates the weapon is functioning properly. The CID also displays which magazine type is loaded and how many cartridges are detected.

Note: If an inert magazine is loaded, it will show 10 cartridges loaded on the CID even if 0 cartridges are in the magazine.

The next time the selector switch is moved to the up (ARMED) position, the weapon will exit the function test mode.



The flashing X icon indicates an error.



In this case, follow these steps:

4 Put the battery pack in the TASER 10 Dock until the battery pack is updated. See the *TASER Weapons Dock Quick Start Guide* for more information.

5 Put the battery pack back in the TASER 10 energy weapon.

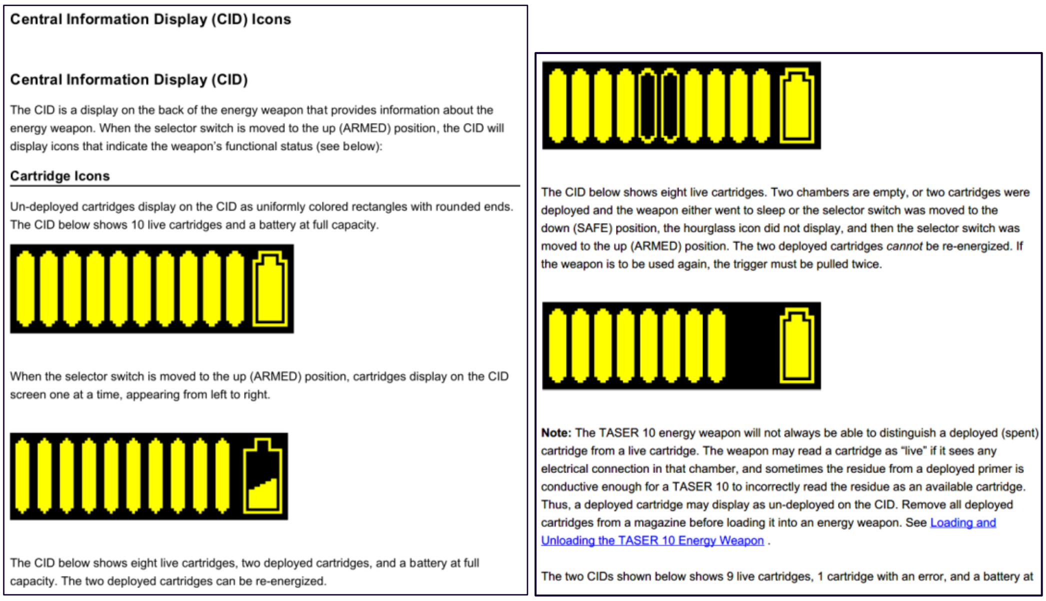
6 Perform the function test.

If the error icon still displays, contact your agency's TASER Program Coordinator.

2.14 The Central Information Display (CID) and speaker port

2.14.1 The CID icons[9]

Figure 18. CID icons.



Central Information Display (CID) Icons

Central Information Display (CID)

The CID is a display on the back of the energy weapon that provides information about the energy weapon. When the selector switch is moved to the up (ARMED) position, the CID will display icons that indicate the weapon's functional status (see below):

Cartridge Icons

Un-deployed cartridges display on the CID as uniformly colored rectangles with rounded ends. The CID below shows 10 live cartridges and a battery at full capacity.

When the selector switch is moved to the up (ARMED) position, cartridges display on the CID screen one at a time, appearing from left to right.

The CID below shows eight live cartridges, two deployed cartridges, and a battery at full capacity. The two deployed cartridges can be re-energized.

The CID below shows eight live cartridges. Two chambers are empty, or two cartridges were deployed and the weapon either went to sleep or the selector switch was moved to the down (SAFE) position, the hourglass icon did not display, and then the selector switch was moved to the up (ARMED) position. The two deployed cartridges *cannot* be re-energized. If the weapon is to be used again, the trigger must be pulled twice.

Note: The TASER 10 energy weapon will not always be able to distinguish a deployed (spent) cartridge from a live cartridge. The weapon may read a cartridge as "live" if it sees any electrical connection in that chamber, and sometimes the residue from a deployed primer is conductive enough for a TASER 10 to incorrectly read the residue as an available cartridge. Thus, a deployed cartridge may display as un-deployed on the CID. Remove all deployed cartridges from a magazine before loading it into an energy weapon. See Loading and Unloading the TASER 10 Energy Weapon .

The two CIDs shown below shows 9 live cartridges, 1 cartridge with an error, and a battery at

[9] These are screen captures from https://my.axon.com/s/article/Central-Information-Display-CID-Icons-TASER-10?language=en_US (accessed 01/11/2024). The screenshots should be read left to right, top to bottom.

full capacity. The error icon (the second cartridge from the left) will flash, alternating between the two icons shown.

The CID below shows that a live simulation magazine with 10 cartridges loaded in the energy weapon. None of the cartridges has been discharged, and the battery is at full capacity. It is important to note that although the side lights display blue, the CID icons are yellow See the Cartridge, Mode, Lighting, Logging Reference Chart for more information.

When the icons are blue as shown below, the weapon is loaded with an inert (red) magazine.

In this case, the 10 cartridges have all been expended. In this case, cartridges may be re-energized by moving the selector switch to the press up position.

This CID displays in one of three situations:

- The magazine is empty or not loaded into the energy weapon.
- All 10 cartridges were expended and the weapon has gone to sleep.
- All 10 cartridges were expended and the selector switch was moved to the down (SAFE) and up (ARMED) positions.

Log Synchronization

When a battery pack is inserted, the selector switch is moved to the down (SAFE) position, or the device is holstered, the CID will display a series of vertical bars one at a time, from left to right until ten bars are displayed. This indicates the logs are syncing from the device to the battery, or that firmware is syncing from the battery to the device. The progress bars will blink periodically to indicate activity. Do not remove the battery pack from the energy weapon or move the selector switch until ten bars are displayed. This may take 5–7 minutes (sometimes more). Once complete, the CID will go blank.

System Status Icons

The system status icons are designed to inform you of a fault in the energy weapon. It is a fault indicator only. It is the user's responsibility to heed the fault indicators, conduct proper maintenance and repair, and ensure that the energy weapon is working properly before any use. Failure to heed the system status icons could cause serious injury or death.

All faults are recorded in the energy weapon's log.

Critical Fault Indication. The CID cycling between the two icons below indicates a system failure.
Critical faults are rare. Do NOT attempt to use the energy weapon. The energy weapon may need to be repaired or replaced.

Battery Error. If you see a blinking battery icon with an X through it, this indicates that the energy weapon did not recognize the battery correctly. Remove the battery pack and reinsert it. If the error is still present, try another battery pack. If the icon still displays, the energy weapon should be serviced.

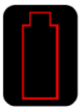
Battery Level Icons

This battery is fully charged.

This battery has a significant amount of charge remaining.

This battery has a low level of charge remaining and should be recharged.

A red, blinking icon means the battery should be recharged as soon as possible.



Sample CID Displays

These icons alternating on the CID indicate a magazine error.

The CID below is dimmed because the energy weapon is in Stealth Mode.

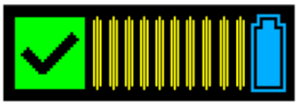
When a function test is initiated, a circle forms on the CID.

The icon below displays at the beginning of a function test.

The CID below indicates the battery pack has not been docked in 30 days. The battery pack should either be updated or swapped for a new one. This red dock icon will display during the Function Test Mode when the conditions for its appearance are met.

After the selector switch is moved to the up (ARMED) position, the check mark icon indicates

the
energy weapon passed the function test. With firmware version 1.5.3, the CID will now display which
magazine is loaded and how many cartridges are detected (live = yellow cartridge icons, HALT = blue,
training = purple, and inert = red).



If the X icon alternates after a function test, the energy weapon did not pass.

The CID below displays in different circumstances:

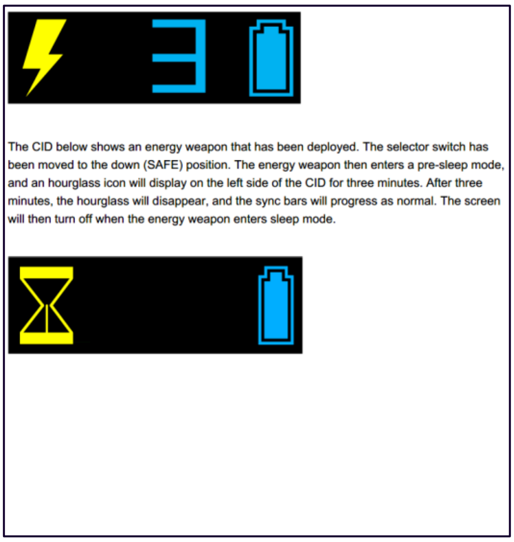
- The energy weapon has a full battery and a Warning Alert in progress. No cartridges have been deployed.
- The energy weapon is deploying HALT cartridges.

The CID below shows the firmware version used in the energy weapon.

The CID below displays an energy weapon with a full battery and a probe deployment three seconds into the cycle.

The CID below displays an energy weapon with a full battery. A probe deployment has been in progress for three seconds, but the probes have not connected with the target. The lack of connection is indicated by the lightning bolt being missing from the CID.

The CID below shows an energy weapon with inert cartridges and a previous trigger pull. A Connection Alert has been in progress for three seconds.



2.15 Stealth mode

Stealth mode may be initiated using the multi-function selector switch by depressing the switch down three times in quick succession. This mode temporarily turns off the flashlight, the laser and the side lights. Stealth mode also dims the CID. The device will remain in stealth mode for 10 minutes after being switched on before going to sleep. It will remain in stealth mode until the multi-function selector switch is put to the SAFE position. If the trigger is pulled, the TASER 10™ will exit stealth mode and return to normal mode.

2.16 Mechanical sight

The TASER 10™ has mechanical (or 'fixed') sights that can be used when the device is operating in stealth mode or, if needed, in bright sunlight if the laser dot is poorly visible. This is a simple sight system along the top of the main body with white dots to make sight alignment easier. The location of the sights is shown in Figure 1 (items 5 and 6) and in Figure 19.

Figure 19: Location of mechanical sights on top of TASER 10™ body.

2.17 Holster tracking

The TASER 10™ can track when it is holstered and unholstered from the appropriate type of holster (these are being recommended for UK use). This information is uploaded to the Axon *Evidence.com* service and weapon logs and could provide an audit trail on timing information for incidents. This functionality has not been assessed in UK testing.

2.18 Timeout/sleep

If cartridges have been deployed and the multi-function selector switch has been moved to the SAFE position, but the device has not been holstered, the weapon will enter low power mode and remember which cartridges have been deployed. It will go to sleep after three minutes. If the multi-function selector switch is moved to the ARMED position before the three minutes have elapsed, the deployed cartridges can be re-energised. If the device has gone to sleep (i.e. after three minutes) the deployed cartridges will register as having been fired and cannot be re-energised.

If the weapon is left in the ARMED position and there is no movement after five minutes, the weapon will go into a power saving state, dimming the flashlight and turning off the laser sight. If there is no movement, after 20 minutes the weapon will go to sleep, turning off the flashlight, laser sight and side lights. To reactivate the weapon the multi-function selector switch needs to be reset.

2.19 Operational and tactical considerations

As a result of many of the changes to the system, some of the tactics required by users of extant devices will not be necessary for TASER 10™ users, for example:

- There is no need to cant the weapon to get two laser dots on a subject in an ‘unconventional position’ (for example someone laying down): two probes can be fired from an uncanted weapon.
- There is no need for the stances that are promoted to provide additional stand-off to increase probe separation, because each probe is individually aimed with the officer determining the probe spread.
- Operational re-load is not possible due to the complexity of the device, therefore, the maximum number of probes that can be realistically operationally deployed in most circumstances is ten per device.

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3 System specification and acceptance for UK police use

The Code of Practice controlling the introduction of less-lethal weapon systems into police use [9] specifies the need for an operational requirement and appropriate testing. Adherence to the prescribed process is now documented through a three-stage NPCC process by which the NPCC record and approve their requirements and acceptance. These stages are:

1. An ‘Operational Requirement’ is written and endorsed (i.e. a set of statements articulating what the police want to achieve).

2. A set of endorsed ‘System Requirements’. These are statements of how the system (i.e. the equipment etc) should perform and which start to identify what information or evidence is necessary to provide sufficient confidence that the equipment and the system as a whole meet the systems requirements.

3. A ‘System Acceptance Document’ that records the acceptance evidence.

Different types (or levels) of information or evidence are identified to meet the systems requirements:

- Level 1 (supplier information): taking the manufacturer’s product information.

- Level 2 (user judgement): operator judgement on whether they can achieve some of the requirements (such as whether they can carry the equipment without too much difficulty or whether officers will routinely recognise it is a less-lethal option).

- Level 3 (independent testing): detailed independent testing, such as measuring the intrinsic accuracy of the weapon at different ranges (the so called ‘Technical Testing’) or measuring the accuracy in the hands of UK police officers (the ‘User Handling Trials’).

These pieces of information then feed into the final stage of the process, which is the ‘System Acceptance Document’ which, if deemed satisfactory, is completed and approved by the NPCC. This document also provides confidence levels on which the system should be accepted to identify any mitigations or limitations with the use of the system.

The above assessments of the TASER 10™ system have been independent of the SACMILL assessment and, in an ideal world, would be completed well in advance of SACMILL’s deliberations. This has not been possible due to delays in the testing, so this opinion on the TASER 10™ has been completed in a compressed timescale, whilst still waiting for the NPCC endorsement of the system via the System Acceptance Document.

The Level 3 (independent testing) has not been limited to testing framed by the requirements set out in the System Requirements Document. Rather, it has been expanded in an effort to address issues that Dstl believe may be of concern to SACMILL, such as the skull surrogate penetration testing.

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Whilst the Operational Requirement Document and System Requirement Document for TASER 10™ have been finalised, at the time of writing of the present report the System Acceptance Document has yet to be signed-off by the NPCC.

4 Technical testing of the TASER 10™

4.1 Background

In a first for the UK, the technical testing of a CED was put out to tender by the Home Office, whereas previously it was done within government. The technical testing of the TASER 10™ was subsequently undertaken by an established test house sub-contracted by a management consulting agency (PA Consulting, Melbourn, Herts).

The testing undertaken followed a test plan constructed by the Home Office Science, Innovation and Technology (SIT) Delivery unit, formerly known as the Home Office Commissioning Hub. The final test plan was produced following consultation with others, including Dstl.

This section of the present report summarises the test findings and draws upon the report prepared by PA Consulting on behalf of the test house [10]. A substantive draft of the PA report was sent on 15/12/2025 to SACMILL for its consideration.

4.2 The TASER 10™ test programme

The testing covered the following:

- Probe ballistics
    - Accuracy of operational (duty) and hook-and-loop training (HALT) probes
    - Maximum range of the probes (including extended range tests to determine probe behaviour at the length limit of the tethering wire)
    - Probe mass, velocity, momentum and kinetic energy
- ‘Skin’ penetration of the probe dart
- Clothing (and underlying skin) penetration of the probe dart
- Skull fracture/penetration potential
- Robustness (drop-testing)
- Sound levels
- Laser power
- Electrical output

The ‘skin’ and clothing penetration testing has never before been undertaken in UK CED testing and was included because of the requirement for the dart of the TASER 10™ probe to pierce the skin in order to create an electrical circuit and bring about NMI. The skull fracture/penetration work has similarly never been undertaken before and followed an understanding that the TASER 10™ probes have a greater kinetic energy and momentum than probes fired from earlier models of CED. These skull fracture tests were therefore undertaken to advise SACMILL.

4.3 Probe ballistics

4.3.1 Intrinsic accuracy of TASER 10™ duty and HALT probes

The accuracy of the duty and HALT probes was examined at firing distances ranging from 1.5 m (5 ft) to 13.7 m (45 ft). Additionally, inter- and intra-magazine variation was examined at two firing distances: a range of 4.6 m (15 ft) "considered a typical operational distance"[10] and a range of 10.1 m (33 ft) which is the claimed zeroing point at which the point of aim of the laser dot should coincide with the mean point of impact of the probes. All intrinsic accuracy tests were conducted with a single TASER 10™ handle clamped in a fixed firing rig.

4.3.1.1 Inter-magazine variation (duty magazines and duty cartridges)

This looked at the variation in dispersion of probes fired at 4.6 m and 10.1 m from cartridges fitted to six magazines. Although the number of magazines used was limited, this was undertaken to obtain at least some level of assurance that there was no unexpected variation between magazines.

More detail, including graphics and tables, may be found in section 2.3.1 of the PA Consulting report [10] which concluded that *"[n]o significant accuracy variation between duty magazines was observed in this testing".* Visual appraisal of the outcomes in Figure 2 of the PA report appear to support the conclusion that no noteworthy differences were found between the six duty magazines tested.

4.3.1.2 Intra-magazine variation (duty magazine and duty cartridges)

Intra-magazine variation addressed the question of whether probes fired from different cartridge bays of a single magazine showed any meaningful differences in their points of impact. Five probes were fired from each of the ten cartridge bays at target distances of 4.6 m and 10.1 m.

The original intent of this testing was to select the two extreme cartridge bays: one showing the most deviation of the point of impact from the point of aim and that showing the least deviation). These two extremes cartridge bays would then be used in subsequent accuracy testing.

The results are presented graphically in Figure 3 and Tables 3 and 4 of the PA report [10]. Given the relative paucity of data points – five shots from each cartridge bay at each firing distance[11] – it is difficult to determine how much weight should be placed on the outcome of this testing. Notwithstanding this, and based on a straightforward

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[10] Exercise 6 in the first user handling trial conducted by the College of Policing involved a threatening role actor approaching the TASER 10™ firer from a distance of 15 m. The mean engagement distance at the point of the first probe firing was 8.2 m (range: 2.9 to 11.3 m).

[11] In one shot from cartridge bay 9 at a range of 10.1 m, the tethering wire broke at the device end and the wire failed to deploy. This data point was justifiably excluded from PA's data analysis leaving only four data points for analysis.

objective appraisal of the data (at the 10.1 m firing range), cartridge bays 3 and 10 were determined to represent the bays displaying the highest and lowest probe dispersion characteristics, respectively.

4.3.1.3 Inter-magazine variation (HALT magazines and HALT cartridges)

This followed a similar approach to that described in section 4.3.1.1 for the duty magazines and duty cartridges, the exception being that the HALT probes were fired at a single target distance of 10.1 m. The outcome is shown in Figure 4 and Table 5 of the PA report. PA concluded that the variation in the dispersion characteristics of the HALT probes was "broadly similar" across the six magazines tested.

PA noted that the mean point of impact for each HALT magazine was "below and to the left" of the point of aim. The average of the six mean *x* values in Table 5 of the PA report is -38.1 mm (i.e. the distance the global mean point of impact was displaced to the left of the point of aim). The global mean of the *y* displacement was -67.5 mm, reflecting the drop-off in the trajectory of the HALT probes at the 10.1 m target distance. The equivalent *x* and *y* displacements of the duty probe at 10.1 m (from Table 2 of the PA report) were -11.8 mm and -68.4 mm, respectively.

There appears to be no meaningful difference between the vertical drop-off pattern of the duty and HALT probes. The HALT probes at the 10.1 m target distance landed about 26 mm to the left of the duty probes, but it is considered that this small difference is unlikely to have any meaningful consequences for the trainee firing the HALT probes.

4.3.1.4 Accuracy of duty and HALT probes across the operational range

The dispersion behaviour of the duty and HALT probes across the operational range of the TASER 10™ is shown in Figure 6 of the PA report and reproduced below:

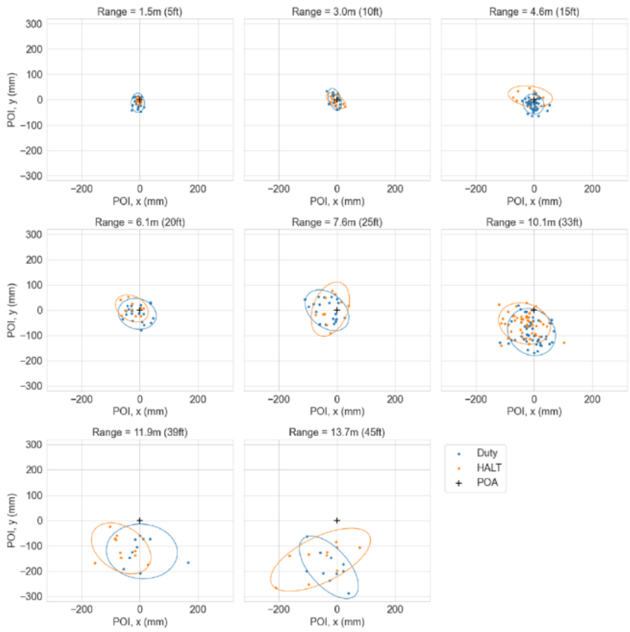

Figure 20. Points of impact (with 95% confidence ellipses) for duty and HALT probes across the operational range.

PA usefully summarise the point of impact data for the two types of probe in the form of box and whisker plots (Figures 7 and 8 of the PA report):

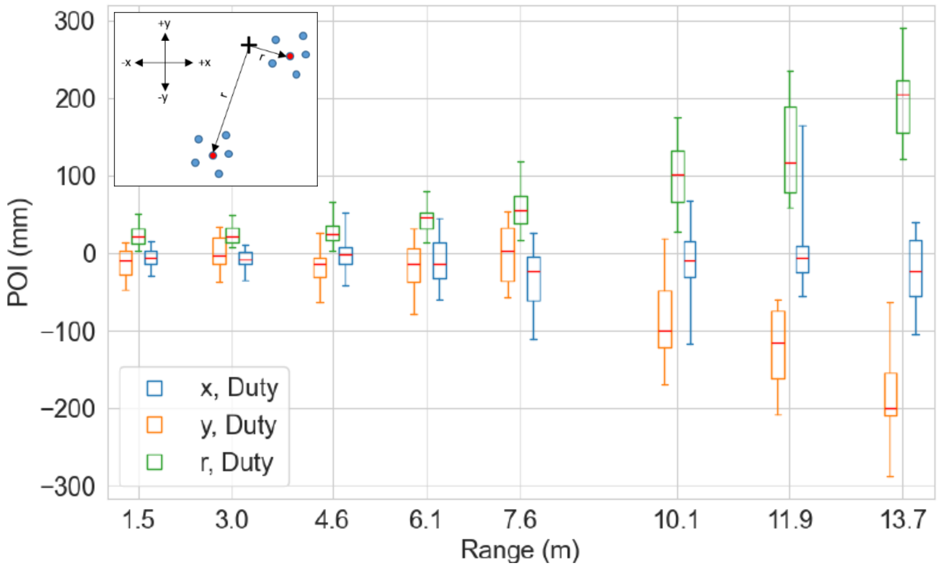

Figure 21. Box and whisker plots for duty probes showing median, minimum, maximum and interquartile range for the points of impact across the operational range. The radial distance (r) of the mean point of impact from the point of aim is also shown. The inset (added by Dstl) is for orientation purposes and shows two identical hypothetical groupings with the same dispersions and mean point of impact (indicated by ●) but demonstrating two different radial distances from the point of aim (indicated by **+**).

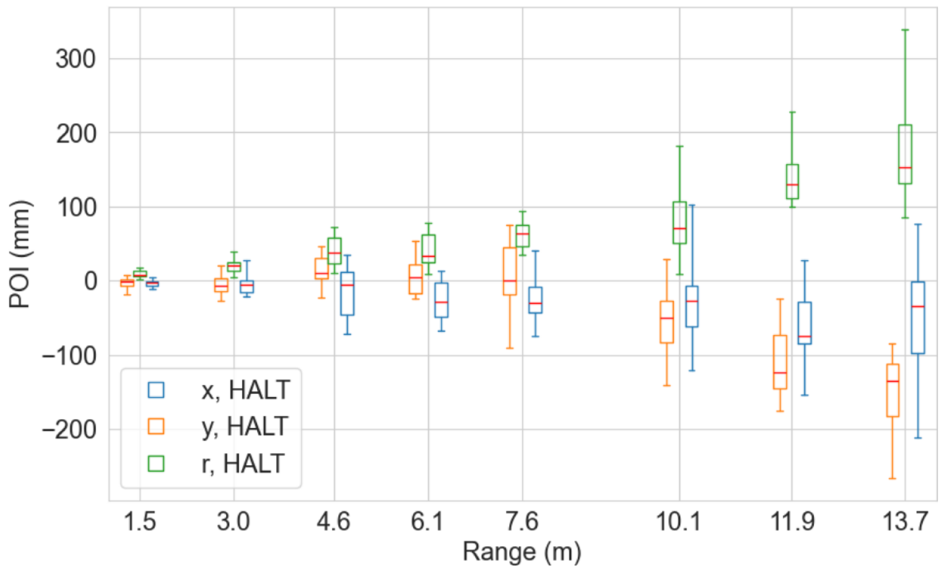

Figure 22. Box and whisker plots for HALT probes across the operational range.
(See Figure 21 legend for further detail.)

The above plots indicate that the (intrinsic) accuracy and dispersion of both duty and HALT probes out to a target range of 7.6 m (25 ft) may be considered acceptable for the devices tested, with deviations in the *x* and *y* axes being around 100 mm and the *r* value showing a similar deviation from the point of aim at 7.6 m.

The trend to a reduced accuracy (i.e. an increase in *r*) continues as the target range increases out to 13.7 m (45 ft), which is the *nominal* maximum range of the TASER 10™ probe (but see section 4.3.2).

The decreasing accuracy of both types of probe at 10.1 m and beyond appears to be reflective of the progressive drop-off in the trajectory of the probe as well as a tendency for the probes to deviate to the left of the point of aim.

Despite the progressively reduced accuracy with distance, the drop-off in trajectory at longer firing distances implies a reduced threat of probe injury to vulnerable superior regions (face/head/neck). The current draft of the TASER 10™ training material does not allude to the drop-off in probe trajectory with distance [11] or teach people to aim off to account for the drop.

One factor involves the TASER 10™ officer's ability to estimate distance, with one study indicating that people tend to underestimate egocentric distance by some 30% [12]. Does range underestimation matter? The current draft of the TASER 10™ training curriculum states that the probe has:

> **s31(1)(a)** [redacted]

Range underestimation, should it apply to TASER 10™ officers, could mean that an officer perceives a subject at a physical distance of 15 m to be closer to 10 m, **s31(1)(a)** [redacted]. This subject is discussed in more detail in section 8.

However, in addition to the progressively deteriorating accuracy and dispersion at longer distances, the technical testing found that at distances of 15 m or more, the TASER 10™ probe tended to detach from its tethering wire (see section 4.3.2). These two factors, in combination with range underestimation, **s31(1)(a)** [redacted].[12]

A further point emerging from the above discussion, is whether an awareness of errors in distance estimation should be highlighted in training. Distance underestimation is considered further in section 8.

4.3.2 Maximum range of the duty probe and probe detachment

While the nominal maximum range of the TASER 10™ probe is 13.7 m (45 ft), the true distance that the duty probe will travel is governed by the length of its tethering wire. The testing to establish the true maximum range of the duty probe, as well as its behaviour once all the wire has been spooled out from the probe, is described in section 4 of the PA report.

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12 **s31(1)(a)** [redacted].”

For this testing, the test house took advantage of its 20 m facility and fired duty probes from a rigidly fixed handle with no target board or other obstruction in the line of flight. Table 3 reproduces the test house findings (presented in Table 9 of the PA report):

Range	Number of shots fired	Number of shots detached	Number of shots not detached	% of shots detached
17 m	2	2	0	100%
15.35 m	10	10	0	100%
15.2 m	4	2	2	50%
15.1 m	2	1	1	50%
15 m	7	2	5	29%
15 m*	40	7	33	18%

Table 3. Range at which probes did or did not detach from their tethering wire. The shaded row incorporates data acquired in clothing penetration tests described elsewhere in section 4 of the present report.

The data clearly demonstrate the propensity of the TASER 10™ probe to detach from its wire once the limit of its length is reached. It is understood that when the probe detaches it is likely to become ballistically unstable.[13]

This phenomenon, and the hazard it may present to bystanders in the event of a probe missing its intended target, was previously noted by SACMILL in relation to the TASER 7™ probe and the potential hazard (and its contribution to system complexity) is commented upon in the committee's TASER 7™ medical statement [4]:

> "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."

It is argued in section 4.3.1.4 of the present report that free-flying TASER 10™ probes represent a potential hazard, not only to those down-range of the subject, but also to subjects located beyond the range at which there is a risk of detachment but whose actual range is underestimated by the TASER 10™ officer.[14] Such a situation would be much less likely to arise with the TASER 7™ as the firing range is effectively capped by the need to place two divergent laser dots on the subject.

[13] Personal communication PA-Dstl, 09/12/2024.

[14] [redacted] **s31(1)(a)** [redacted].

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4.3.3 Probe mass, velocity, momentum and kinetic energy

The output from this testing is contained in section 5 of the PA report. As shown in Figure 12 and Table 10 of the PA report, probe mass decreased from a mean of 3.73 g close to the point of ejection from the cartridge to a mean of 2.88 g at 13.7 m from the point of ejection. The PA report also indicated that, for probes that had detached from their wire at the end of their travel (see section 4.3.2), the mean mass was 2.83 g. Figure 13 and Table 11 of the PA report describe the probe velocity over distance. The probe mean velocity close to point of ejection from the cartridge was 62.2 m/s, dropping to a mean of 49.7 m/s at 13.4 m from the point of ejection.[15] The mean velocity of detached probes (at 15.35 m) was 36.1 m/s. The momentum and kinetic energy of the probe were then calculated from the above and reported in Table 12 of the PA report and shown graphically in Figure 23:

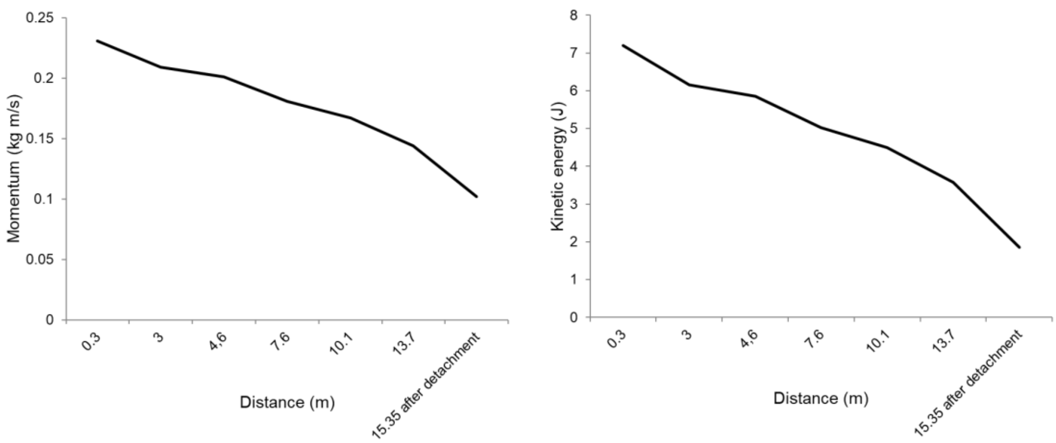

Figure 23. Mean values for momentum *(left)* and kinetic energy *(right)* reported by the test house.

How these momentum and kinetic energy parameters compare with those of the TASER X2™ and TASER 7™ probes is shown in Figure 50 on page 79 of this report and discussed in section 6.5.1.

4.4 ‘Skin’ penetration of the probe dart

Comparative testing was conducted of the skin penetration potential of probes fired from the TASER 10™ and TASER X2™ into a ‘skin pack’. This pack was designed under a collaborative programme between the national defence departments in Australia, Canada, New Zealand, the United Kingdom and the United States [13]. The pack consists of a multi-layer foam pack made of three well-specified materials respectively representing the epidermis (thin neoprene rubber), the dermis (a soft foam), and soft tissue (a stiffer foam). Selection of the material thicknesses can be varied to provide a pack that represents average adult human tissue or extremes (for example, child skin). The materials selected for the present testing resulted in packs where penetration would be expected to indicate ~20% risk for adult thorax or thigh and a ~50% risk for child thorax or thigh. Whilst these were designed to assess fragment-penetration potential, they were used for the present testing as the energy densities are similar.

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[15] The velocity-measuring equipment was located 0.3 m in front of the 13.7 m target board.

It was accepted that there was a risk with the use of CED probes against these packs that the initial incision of the dart may affect the response of the pack, however, given that they would be used as a comparator between the TASER 10™ and the TASER X2™ they would give some indicative results. The selection of a low probability of penetration (~20% adult thorax/thigh penetration) was also seen as a level that it was understood to be unlikely that the TASER X2™ probe would penetrate.

During the tests, however, the TASER X2™ top probe (which hit the skin pack orthogonally) penetrated the 'epidermis' layer; the lower probe (which hit the skin pack at an angle) tended to ricochet off, with only three of fifteen being retained (two of which penetrated the skin).

The full testing is reported in section 6 of the PA Consulting report which concluded that "*the T10 was observed to penetrate skin and be retained in the skin more repeatably than the X2, with a slightly higher average penetration depth*". This was not statistically significant.

No confirmed reported penetrations of the body of the TASER X2™ probe into the skin have been reported operationally to the authors' knowledge (however, one anecdotal ambiguously worded report is provided in section 9 relating to the TASER 10™ probe), so whether these observations have clinical significance cannot be determined. However, limited operational data may provide some insight (see section 9).

4.5 Clothing penetration of the TASER 10™ probe dart

The outcome of the clothing penetration testing may be found in section 7 of the PA report. Probes were fired at a modified skin pack (as used in the skin penetration testing) with a clothing cover. The modification consisted of a thin conductive layer inserted underneath the outermost 'epidermal' layer, thereby allowing 'skin' penetration to be assessed by measuring the electrical resistance between fired probes. Various clothing samples were then placed over the skin pack:

- A single layer cotton t-shirt
- A hoody
- A single layer denim jeans material
- A hoody over a t-shirt

Probes were fired at ranges of 2, 8 and 15 m at the clothing-covered modified skin packs. The test house findings are reported in Table 15 of the PA report which essentially shows that electrical connectivity (i.e. 'skin' penetration) was achieved for virtually all probe pairs fired.

Given these results, the test house has asked if further work is required to test against more challenging items of clothing, especially after questioning from a visit by police forces to the testing. Since the clothing for testing was specified by the NPCC (in accordance with the specification and acceptance process described in section 3), the

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Home Office is considering testing with more challenging clothing but, at the time of writing, the testing has not been undertaken.

4.6 Skull fracture/penetration potential

Given the reported increased energy and momentum of the TASER 10™ probe, and in an attempt to pre-empt questions from SACMILL, comparative firing of the TASER X2™ and TASER 10™ probes into a skull surrogate was conducted as part of the technical testing. This is reported in section 8 of the PA Consulting report [10] and a supplementary report by Dstl [14].

The model used in the skull fracture/penetration testing is a model using a bovine scapula – the infraspinous fossa of the bovine scapula can be used to represent areas of the human calvarium (apart from the squamous temporal region).[16] This model is constructed using a layer of ballistic gelatin and chamois leather to represent the scalp over the impact surface, with further gelatin behind the scapula to represent brain and head mass. The scapulae were obtained from a local butcher and were screened to ensure there was no damage to the bone caused by the separation during processing of the animal.

The extent of damage to the model is classified according to the following regime:

1. No visible fracture of scapula
2. Linear fracture
3. Depressed intact fracture
4. Depressed detached fracture
5. Total fracture

Given the size of the TASER probes, 20 scapulae were prepared as above and each was shot twice: once with a TASER X2™ and once with a TASER 10™ - these were alternated.

One feature of the TASER 10™ probe that does not apply to all earlier types of probe is the presence of an impact absorber at the base of dart. When completely compressed, the effective length of the dart can increase from 11 mm (in the uncompressed state) to 15 mm when fully compressed (see Figure 11 in section 2.5). It seems plausible that some compression of the impact absorber is most likely to arise in circumstances where the dart fully enters a rigid structure, such as the skull or other bony structure.

None of the TASER probes caused fracture to the model. Examination of the scapula surface revealed pin-prick damage to the surface of the bone in 60-65% of cases. There

[16] Since the model was originally developed by Dstl, the age at which cattle are slaughtered has reduced, resulting in thinner scapulae. This is likely to result in an overestimation of the risk of skull fracture.

was no statistical significance in this type of damage between devices. Two tests were of note from the contact of the probe with the bone (both with TASER 10™ probes):

- One in which the dart deformed, fragmented and stuck in the bone (shown in Figure 24).
- One in which the dart perforated the bone so that the end of the dart had penetrated the full depth of the bone and hooked back on itself (Figure 25). This could not be removed by hand.

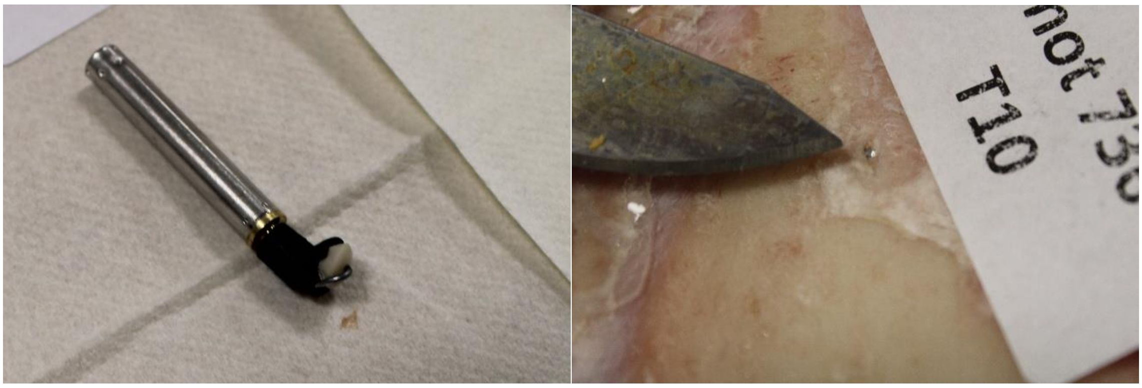

Figure 24: TASER 10™ probe removed from target *(left)*. The remaining part of the dart when the probe had been removed *(right)*.

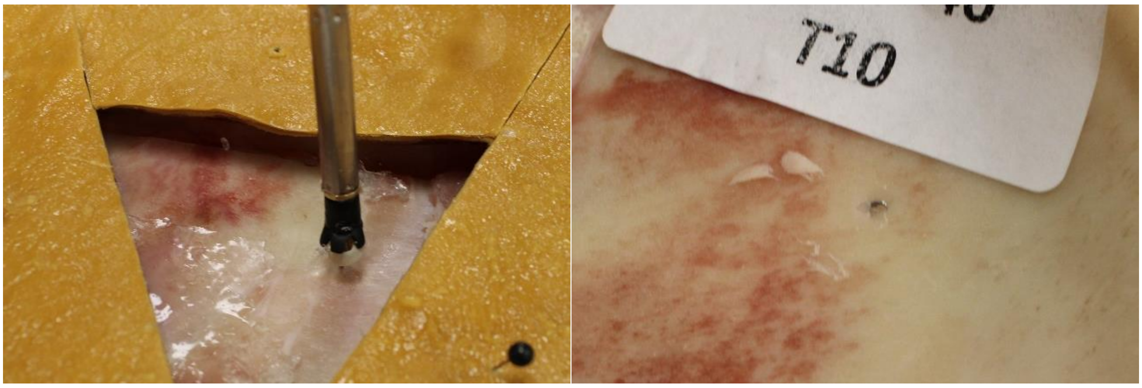

Figure 25: TASER 10™ probe embedded in skull surrogate. Normal side of model, showing probe embedded into bone *(left)*. Internal face of the model, showing dart perforating through *(right)*.

Whilst the risk of skull fracture (to all regions apart from the squamous temporal region; which cannot be considered with this model) would appear to be low, the risk of dart fracture or dart embedding in bone cannot be discounted, especially as several case reports of CED darts perforating the skull have appeared in the medical literature [15] and under-reporting of such events seems probable. One recently published case of a CED probe causing a head injury has been highlighted to SACMILL [16]. This resulted in an intracranial penetration of 4 mm from a TASER X26™ probe (the TASER X26™ has a probe kinetic energy near the muzzle of approximately 2.2 J and the TASER 10™ has a probe kinetic energy near the muzzle of approximately 7.2 J).

A further feature of note related to the crumple behaviour of the darts, which bent and deformed in these tests. The TASER X2™ darts routinely bent into simple shapes (see Figure 26), however, the TASER 10™ darts had a tendency to bend back on themselves (see Figure 27), raising concern on the ability to remove the dart without causing greater soft tissue damage. This was most noticeable, both in number and severity, with the TASER 10™ probes; the only TASER X2™ dart that crumpled mid-shaft is shown in Figure 27, however the model used in this case had a void directly underneath the point of impact and was therefore excluded from the analysis (this was the only case excluded from the analysis). Fourteen of the TASER 10™ probes crumpled on impact (two of which formed a hook shape); none of the TASER X2™ probes showed this type of deformation in valid tests (n=19).

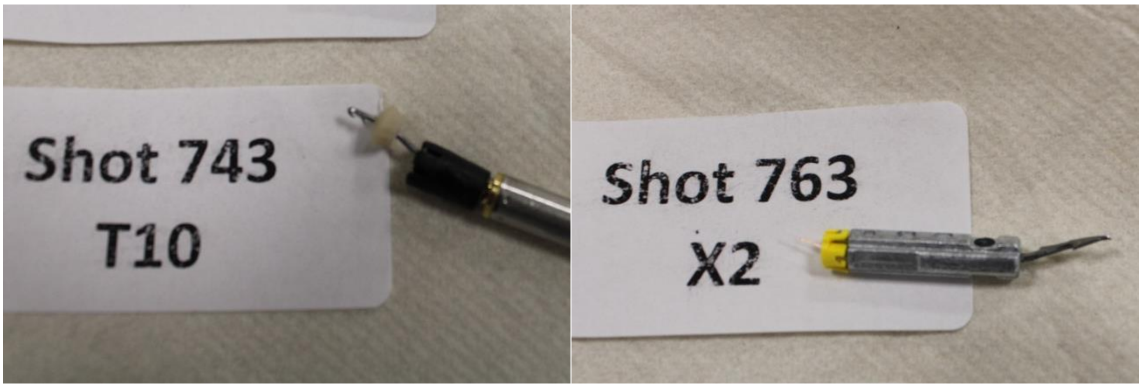

Figure 26: Barbs with simple bent shapes from skull surrogate fracture tests.

Figure 27: complex deformed shapes from skull surrogate fracture tests.

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4.7 Robustness (drop-testing)

To assess the ability of the device to tolerate rough handling, drop tests were conducted with a TASER 10™ handle fitted with a magazine loaded with ten duty cartridges. The device was dropped from a height of 2 m onto a 12 mm thick steel plate on the floor. The device was dropped in different orientations in an armed condition. After the drop, the device was examined for damage and checked to ensure the ARMED condition had not changed. A function test was conducted, and the device was test fired, to ensure it would discharge a probe and to check the alignment of the laser sight. This was repeated for a total of ten orientations of the device.

After some of the tests, the device reported an error which disappeared once the function tests were completed.

After two of the test conditions, the two plastic mouldings forming each side of the handle had separated slightly. In addition, the magazine ejected in one drop condition: this test was repeated with a different handle and the magazine again separated under this test condition.

In two test conditions, the battery ejected.

In none of the testing with the ARMED device was a probe discharged from its cartridge.

Additional tests were conducted, including dropping the device top-down in the SAFE condition. When dropped in this manner, the device set itself to the ARMED state on six of the twelve drops conducted. This effect could also be achieved in the more benign condition when the device was dropped from 1 m onto a thinly carpeted concrete floor. This self-arming effect was attributed by PA to movement of the selector switch on impact and was confined to one specific orientation of the device (being dropped top-down).

A change in the laser alignment was noted after the first drop test.

The summary from the PA testing report [10] concluded that the TASER 10™ is formed from robust, well-moulded, but still quite thin plastic components. Drops can cause parts to separate, the laser pointer to change alignment, the magazine and/or battery to be ejected and the device to self-arm. They therefore recommend that any device that has been dropped should be removed from service until it has been checked for damage.

A statement in the Authorised Professional Practice for CED use states [17]:

"Forces should have procedures in relation to the maintenance and inspection of CEDs and cartridges. This should be documented in a standard operating procedure (SOP) that articulates the following:

- *…*
- *Quarantining and labelling of CEDs, cartridges and batteries that are:*

- *faulty or suspected to be faulty (including those identified during routine testing by users),*
- *damaged*
- *subject to significant physical impact (for example dropped or involved in a road traffic collision)*
- *…*
- *subject to doubt as to whether the device, cartridge or battery is serviceable"*

This should therefore be covered in use.

4.8 Sound levels

Tests were conducted to compare the sound output from the TASER 10™ with that from the TASER X2™. The purpose of these tests was to provide some level of guidance to users on the need to assess the impact of individual and repeated exposures to the emission of noise from the new device.

The sound level was recorded at a distance of 50 cm from the device at an angle of 45° to the front right of the device: 50 cm to reflect the typical distance from the device to the operator's ear and to the front to capture the worst of the probe ejection blast.

Apart from the ejection blast, the TASER 10™ produces a number of sounds during operation (a warning alert, a firing alert and a connection alert); the TASER X2™ produces fewer alerts (when arcing or firing). These sounds were also measured.

The firing sound from the TASER 10™ was the loudest noise (at 97.5 dB(A)) which was 2.28 dB louder than for the TASER X2™ (i.e. a 69% greater sound pressure level) [10]. All other sounds were quieter than this (although it should be noted that the sound produced from the probe impacting the target board was not measured). This does not exceed the peak impulsive sound pressure level to which someone should be exposed, however it could exceed the daily exposure limits for an individual if they are subjected to repeated exposures (for example during training and qualification).

Since it is not possible to replicate all environments in which the device will be used, the conclusion is that it is necessary for users to conduct sound level measurements in their training environments to ensure people are not subjected to excessive noise.

4.9 Laser power

CED systems with sighting lasers have previously been assessed in UK where the power output of the laser had been incorrectly marked on the hazard warning label. This typically occurred with lasers of approximately 5 mW power output and small beam diameters: the border between the Class 3R and Class 3B lasers. Class 3R and 3B lasers can potentially cause eye injuries. Practically, the risk of injury in most cases from Class 3R lasers is relatively low for short and unintentional exposure. The risk is limited because of the natural aversion to bright light. Class 3B laser products may have sufficient power to cause an eye injury, both from the direct beam and from reflections.

The higher the radiant power of the device the greater the risk of injury. Class 3B laser products are therefore considered hazardous to the eye.

It was therefore decided that the power output of the lasers of the handles used in the technical testing should be measured to confirm the power output and classification of the laser. All measurements fell below the 5 mW threshold [10] and, therefore, the classification of the TASER 10™ aiming laser had been correctly assessed by the manufacturer as being a Class 3R laser. This is no different from the classification of other sighting lasers on CEDs in use in the UK.

4.10 Electrical output

Axon provide a specification of the pulse parameters for the TASER 10™ and have a test method for assessing the electrical output into a 600 Ω load [18], which is understood to reflect the typical load that two probes would encounter when embedded in human skin. The Axon methodology prescribes the use of a custom magazine (supplied by Axon) and involves measurement of pulse parameters across two of the output of the possible forty-five paths of the device.

When tested in this way, pulse parameters were within the Axon specifications for pulse rate, pulse charge and peak loaded voltage [18].[17]

Although not specified in the Technical Test Plan, the test house thought it would be interesting to look at the pulse parameters "under more representative conditions". This involved the firing of two probes into a target at approximately 2 m range and then measuring the pulse parameters as before. The additional load presented by the tethering wire meant that the total load measured was now 684 Ω. This resulted in an increase in pulse charge (from a mean of 68.8 µC to a mean of 73.4 µC) and an increase in peak loaded voltage (from 870.2 V to 904.7 V). The test house did not report the pulse rate in this extemporaneous testing.

The pulse charge of the TASER 10™ between any two connecting probes is understood to vary according to the resistive load sensed by the device, with a higher load being met with a higher pulse charge. The results from the extemporaneous testing are in line with this.

The waveform itself is much simpler than that generated by earlier models, partly because of the absence of an initial high voltage (ca. 50 kV) spike. The TASER 10™ waveform is approximately rectangular with a rise time of about 3 µs and a decay time of about 5 µs.

4.11 Technical testing summary

The accuracy, dispersion and trajectory of duty and HALT probes were very similar across the operational and training ranges over which they may be fired, indicating that

[17] The parameters specified by Axon were: pulse rate (21-23 Hz), pulse charge (52-95 µC) and peak loaded voltage (653-883 V). Pulse duration does not form part of the Axon specification although the Axon document shows an example of the waveform where the duration is 65 µC (across the 600 Ω load). Pulse peak current may be derived from the peak voltage and the resistive load ($I = V/R$). This was found to be 1.45 A in the technical testing.

the HALT probes would provide a suitable surrogate for duty probes in the scenario-based training environment. Focusing on operations, the accuracy, dispersion and trajectory of the duty probe appear acceptable out to a range of 7.6 m (25 ft); beyond that, accuracy and dispersion continue to degrade and this is accompanied by a drop-off in the point of impact of the probe and a small tendency to strike the target towards the left of the point of aim.

One further factor to consider in relation to the underestimation of distance is when a subject is at a distance beyond the limit of the probe's tethering wire. Probes start detaching at a distance of 15 m (see section 4.3.2). Taking into account the potential 30% range underestimation, the officer may perceive the subject to be only 10 m away, which is within the Axon's "maximum effective range" of 12.2 m.[18] An officer, therefore, may fire probes at a person perceived to be within a safe range but who, in reality, is at a range where that person, and potentially bystanders, are possibly at risk of being struck by a ballistically unstable detached probe. The range estimation of officers and the lack of range indication previously provided by two divergent sighting lasers is one area that SACMILL may wish to consider. It may be prudent to request the firing ranges of the device in operational use to understand how frequently probes are deployed at distances close to (or exceeding) the maximum range of the probe.

The kinetic energy and momentum of the probes will be considered further in section 6.5.1, however, they may be regarded as a measure of the probe's propensity to penetrate or perforate clothing and skin. Testing with a skin penetration pack has shown that the TASER 10™ probes tend to penetrate the pack deeper than the TASER X2™ probes (this was not statistically significant). Dstl are unaware of any instances where the TASER X2™ probe body has perforated the skin, but absence of evidence is not evidence of absence. There have been no validated reports of the TASER 10™ probe body perforating the skin in the very limited anecdotal data that the authors have been party to (although one yet to be confirmed case is noted in section 9).

The mass and velocity of the probe appear to be sufficient to cause skin penetration of the dart of the probe through clothing (necessary for NMI with this device). However, whether the probe dynamics are sufficient against more challenging clothing has yet to be determined. Testing is awaiting to be started on more challenging clothing (understood to be a thick padded jacket).

In addition to skin penetration, comparative testing was conducted with TASER 10™ and TASER X2™ probes fired at a skull surrogate model. The model was developed to assess the risk of skull fracture. Skull fracture was not seen in these tests, however, three unexpected outcomes occurred:

1. A TASER 10™ dart embedded into the bony representation of the skull model and could not be removed by simply pulling the probe body. This probe had hooked back on itself within the bone.

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18 The College propose to teach [redacted] **s31(1)(a)** [redacted].

2. A second TASER 10™ dart embedded into the bony representation of the skull model and fractured off, leaving part of the dart embedded in the bone.

3. Several TASER 10™ darts deformed in a ductile manner due to buckling; some of these deformed sufficiently to bend back on themselves to form a hook-like shape.

Should these findings be replicated in the field, all are likely to result in complications during removal – the first two requiring detailed medical consideration and the third may increase the severity of the injury if removed using the recommended probe extraction technique[19]: the hooked nature could cause much greater damage to the soft tissue. SACMILL should consider the implications of this type of injury, not just for impacts to the skull, but also other areas of the body with superficial bone, especially in the light of reported embedded probes for other designs of CED.

Drop testing of the TASER 10™ revealed that damage, component separation, laser sight misalignment and change to the SAFE/ARMED state is possible through dropping (some of which is possible under relatively benign conditions – for example a 1 m drop onto a thinly carpeted floor). SACMILL need to be satisfied that appropriate process is in place to deal with devices that may have been subjected to accidental damage. The current College of Policing Authorised Professional Practice relating to CEDs specifies that damaged devices should be quarantined [17].

The measurement of sound pressure levels did not produce any results of immediate concern (i.e. anything different from current devices), although there is a need for police forces to ensure that the repeated use of the device (for example, in the training environment) does not mean officers exceed their daily noise exposure levels. This will need to be assessed for each training establishment.

The laser output levels were within the guidelines stated on the devices tested.

The electrical output was within manufacturer specifications.

[19] The technique is to support the body part with a flat hand a few centimetres distant from the probe, followed by a quick extraction of the probe.

5 User handling trials

5.1 Introduction

User handling trials are conducted not only to gain insight into how a new device might behave in the hands of potential future users and to solicit trial participants' opinions on the device, but also to understand any technical or other issues that might emerge that need to be considered in order that an informed decision may be made on whether the new device, as part of a system, is authorised and adopted into policing.

The initial user handling trial for the TASER 10™ took place in October 2023, some eight months after the TASER 10™ was launched by Axon in January 2023 [19]. During this first trial, however, a plethora of faults manifested themselves with the result that the College of Policing, in consultation with other TASER 10™ stakeholders, decided that further trials were necessary. A total of three user handling trials (UHTs) were eventually conducted by the College of Policing:

- UHT1 – Weeks commencing 9 and 16 October 2023
- UHT2 – 7/8 February 2024
- UHT3 – 2/3 April 2024

UHT2 was a cut-down version of UHT1 that primarily focused on the reliability issues uncovered in UHT1. UHT3 was a similarly cut-down version which focused on the faults manifested in UHT2.

In between successive trials, the College engaged with Axon to share the fault findings with the intention that the company was appraised of the various issues and could then proceed to seek fixes in the form of firmware updates and other measures.

The College's final report on the trials was published in October 2024 [20] and it is understood that this has been shared with SACMILL.[20]

The need to conduct multiple user handling trials shifted the timeline for the UK's assessment of the TASER 10™ system to the right by nearly seven months and will have contributed, in combination with contracting delays, to the late start of the technical testing phase (covered in section 4).

This section of the present report will initially consider the performance of the TASER 10™ in terms of the weapon system's practical accuracy in the hands of the trial participants as explored in an extensive series of exercises in UHT1. The 27 trial participants in UHT1 were all serving police officers drawn from three groups: ten TASER X2™ officers, nine TASER 7™ officers and eight officers who had no previous experience with CEDs (so-called 'New Users'). More information on the make-up of the participants (gender, eye dominance and so on) may be found on page 59 of the College's report.

[20] [redacted] email correspondence with SACMILL Chair and secretariat on 30/10/2024.

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This section then covers the residual reliability issues manifested in UHT3, since this final trial reflects any issues remaining after those that manifested in UHT1 and UHT2 had been largely (but not entirely) addressed.

Finally, this section will address the subjective opinions of the trial participants.

Readers interested in the evolution of the reliability issues over the course of the three trials should consult the College's report [20].

5.2 Practical accuracy of the TASER 10™ (UHT1)

Practical accuracy of the device in the hands of the user is distinct from the intrinsic (i.e. weapon-only) accuracy examined in the technical testing (covered in section 4).

Practical accuracy was explored in a series of exercises in the first UHT, as detailed in Table 5 of the College's report (pp. 49-55). This table also summarises the rationale behind the design of each exercise.

The exercises involved a mix of firing probes at target boards set at various distances from the firer and firing probes at a role actor wearing protective clothing.

The target board design (used in exercises 1-5) is explained on page 56 of the College's report and is shown in Figure 28:

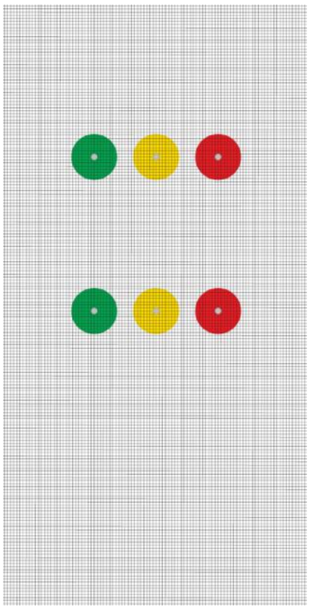

Figure 28. Target design for trial exercises 1-5.

The role actor was involved in exercises 6 and 7.[21]

[21] Note that there is an error in the description for exercise 6 in the College's report (on page 53). This reads "Subject advances from 12m to 3m…". This should read "Subject advances from 15 m to 3 m…". (Correspondence with **s40(2)** on 15/11/2024.)

This section will focus on the report's key findings as they relate to the outcomes of the various exercises.

5.2.1 Key finding 1 (Exercises 1 and 2)

> The Taser 10 is more accurate, and has lower probe dispersion, than extant CEDs at 3 to 5m with the laser sight. This may be as result of improved intrinsic accuracy but also assisted by the relatively low complexity of aiming one probe at a time.

Exercises 1 and 2 used a target board and were designed to assess practical accuracy at firing distances of 3 m and 5 m, respectively. The accuracy of three devices was compared (TASER 10™, TASER 7™ and TASER X2™). The laser sights were used for aiming and only the accuracy of the top probes of the older devices was reported.

Dstl concurs with the College's interpretation of the accuracy outcomes of these exercises and this is evidenced in the distribution of the points of probe impact for the three devices tested, particularly at the 5 m firing distance (Figure 29):

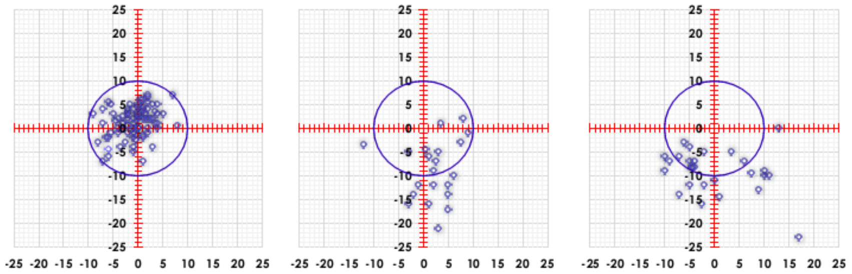

Figure 29. Probe dispersion at 5 m for the TASER 10™ *(left)*, TASER X2™ top probe *(centre)* and TASER 7™ top probe *(right)*. Numbers shown are centimetres and the point of aim was at 0,0. The 20 cm diameter circle was added to the figure by the College to aid visual comparison between devices. (Graph 2 on page 67 of the College's report.)

The better accuracy of the TASER 10™ at 5 m appears mainly due to the absence of drop-off in the trajectory of the probes compared with the older devices. This drop-off is not evident at 3 m, although the dispersion of points of impact of the TASER 7™ at this shorter distance appears worse than it is for the other two devices (Graph 1 on page 65 of the College's report).

The speculation that the accuracy outcome for the TASER 10™ may have been assisted by the "relatively low complexity of aiming one probe at a time" appears plausible but is a matter for discussion.

5.2.2 Key finding 2 (Exercise 2A)

> Notwithstanding other factors, such as thick clothing, it is reasonable to conclude that a Taser 10 has sufficient practical accuracy to be used at distances up to 10m with the laser sight. Being able to operate a CED from further away has several benefits, including the ability to give a subject more 'space' to aid de-escalation and, where deployed alongside firearms, reduce

the likelihood of resorting to conventional firearms where extant CEDs would be outside their effective range.

In addition, the T10, on average, was more accurate and consistent at 10m than both the X2 and T7 were at half that distance.

Exercise 2A (laser sight, target board, TASER 10™ only) was designed to establish the practical accuracy of the TASER 10™ at an extended firing distance of 10 m, which is beyond the range of the older devices:

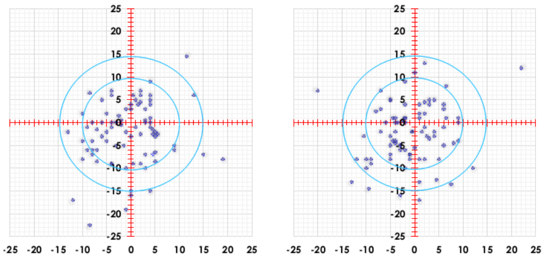

Figure 30. TASER 10™ probe dispersion at 10 m showing the points of impact on the upper *(left)* and lower *(right)* target zones shown in Figure 28. Numbers are centimetres and the point of aim was at 0,0. The 20 and 30 cm diameter circles were added to the figure by the College to aid visual interpretation.

Exercise 2B (laser sight, target board, TASER 10™ only) established the practical accuracy of the TASER 10™ at the nominally maximum distance of 13.7 m. While at a range of 10 m there appears to be little or no drop-off in the trajectory of the TASER 10™ probes, at 13.7 m drop-off of the probes is readily apparent (Figure 31):

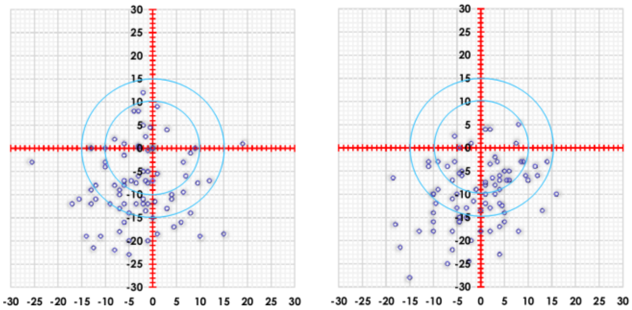

Figure 31. TASER 10™ probe dispersion at 13.7 m. (See Figure 30 legend for further information.)

To gain insight into what the probe dispersion findings at 10 m and 13.7 m may mean in practice, the images in Figure 30 and Figure 31 have been superimposed upon scaled human forms of height 177.1 cm (5 ft 10 in) and 167.6 cm (5 ft 6 in) and doing the appropriate scaling (see Figure 32 and Figure 33).[22]

[22] To maximise the number of data points, the dispersion patterns for the upper and lower target zones were combined for each of the two firing distances.

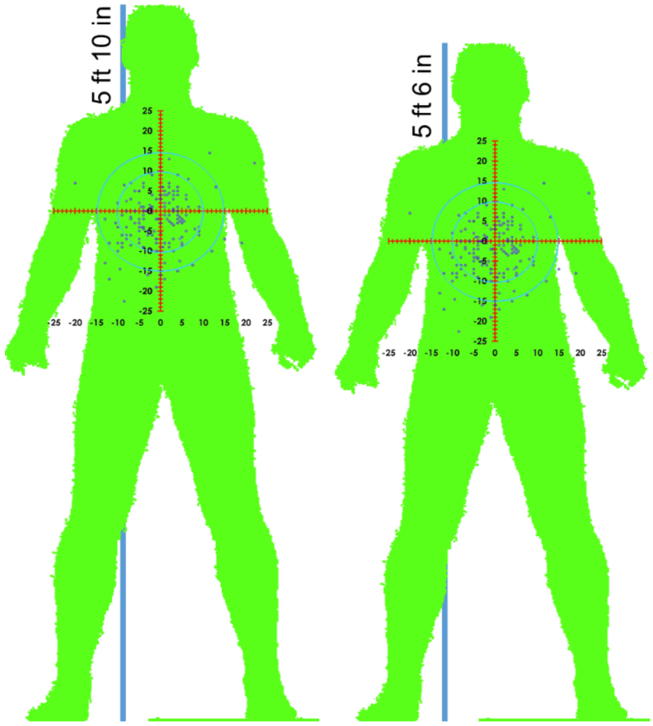

Figure 32. Points of impact at 10 m mapped onto a human male form.

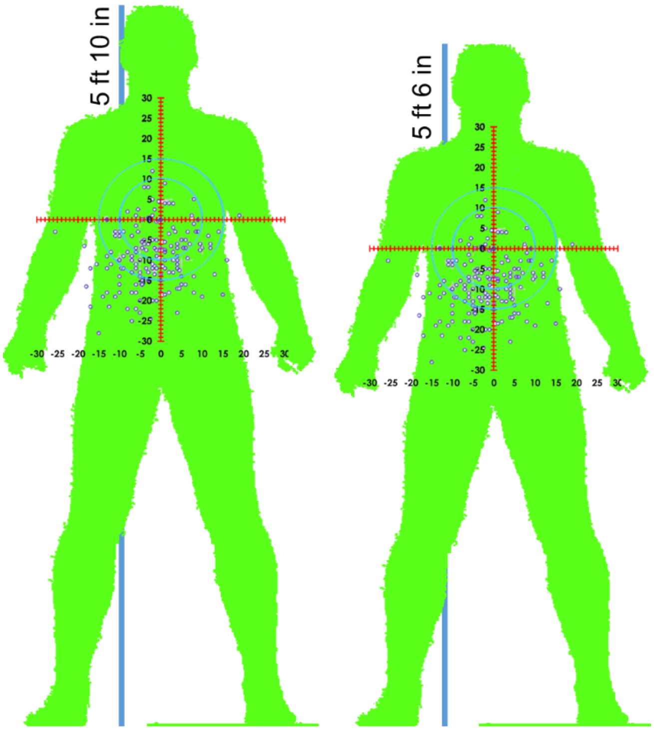

Figure 33. Points of impact at 13.7 m mapped onto a human male form.

This testing at the longer range found that a proficient user can still be accurate, but the success rate decreased noticeably. The College of Policing concluded that at 13.7 m, most leg shots would have missed and only about two-thirds of torso shots would have hit the subject. Nevertheless, they found (Key finding 5):

> At the time of writing the intrinsic accuracy of the device has yet to be examined but based on these data it would appear the practical accuracy of the device at or near its maximum range (13.7m), with both sight systems, was more limited in comparison to 10m or less. However, accuracy was seen to improve when New Users were excluded from the analysis, suggesting the device remains accurate in the hands of proficient users.

5.2.3 Key findings 3 & 4 – Use of mechanical (fixed) sights

A series of tests were conducted comparing TASER 10™, TASER T7™ and TASER X2™ at 5 m using the mechanical (fixed) sights (with the devices in stealth mode). Only the accuracy of the top probe was analysed for the older devices. The College found:

> Consistent with the findings in relation to the laser sight, the T10 again proved to be the most accurate device of the three with fixed sights at 5m.

Similarly, at longer ranges the College found:

> In the hands of a proficient user using the fixed sight, the device remains accurate at 10m, although greater accuracy would be achieved using the laser sight.

5.2.4 Key finding 6 – unconventional postures

Exercise 4 examined the practical accuracy when firing at a supine target from a fixed range. This compared TASER 10™, TASER 7™ and TASER X2™ firings. Not surprisingly the ability of the TASER 10™ to provide probe placement at chosen locations was seen as a major benefit – the older devices placed the probes at non-ideal locations for supine firing and required canting of the weapon. The College of Policing found:

> Given the nature of individually aimed probes of the T10 system, one could contend it is far easier to deliver probes to subjects in a supine, or other unconventional posture, than with the fixed probe spread of extant systems. In addition, in this test, the probes were delivered with greater accuracy and consistency than with either an X2 or T7.

5.2.5 Key finding 7 – practical accuracy with supplementary drills

Exercise 5 examined the ability to deliver a warning display and further probes should the first attempts fail. Officers were required to deliver six probes as accurately and quickly as they could. This required them to move their point of aim as required by the exercise. They were also required to extend and re-energise the cycle.

The examination of the time taken to discharge the probes offers a comparison of the speed and utility of the TASER 10™ in comparison with extant CEDs. The accuracy data of the probes was consolidated for all six probes. The mean radial distance from POA to POI was 33 mm for the TASER 10™, 45 mm for the TASER X2™ and 63 mm for the TASER 7™.

The College found:

> The T10 can deliver probes rapidly and accurately. Should the first four probes fail in their attempt to create incapacitation, an officer with a T10 can swiftly deliver further probes where their colleagues with an X2 or T7 would have to reload. Often this may not be an available option, due to the rapidly evolving nature of the incident and/or significant time taken to complete such an action. It also should be recognised that probes must be in the skin for T10 to create effective NMI and relevant training strategies are required to embed this concept.

5.2.6 Practical accuracy – unknown subject distance

Exercise 6 was conducted with HALT cartridges. A subject wearing a HALT suit and other protection walked at the officer from 15 m. The officer was required to engage with the subject when they thought they could successfully deliver the probes, i.e. they were within range and believed they could achieve accurate probe placement. The range of firing distances for the TASER 10™ is shown in Figure 34. This showed that no shots were fired beyond the maximum effective range of the TASER 10™ (but some were with the TASER 7™ and TASER X2™).

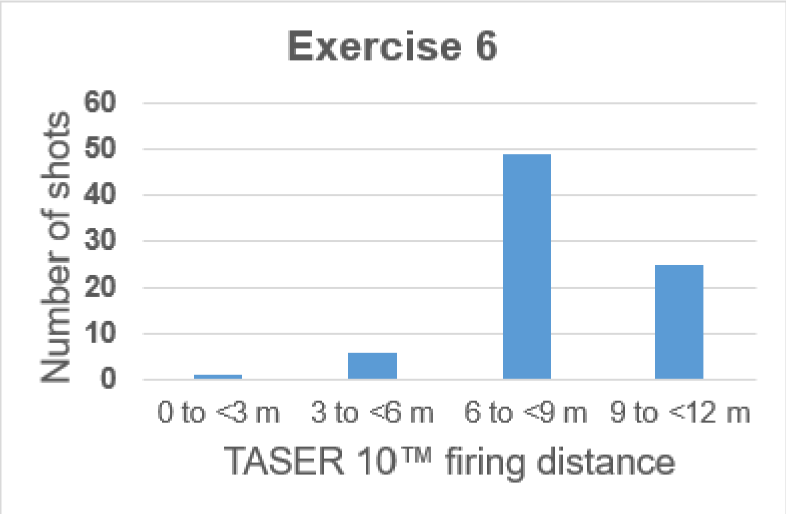

Figure 34: TASER 10™ firing distance in 'unknown distance' trial (Exercise 6).

The College concluded from this exercise:

> The T10, in exercise 6, had a low rate of missed shots. The rate of shots to sensitive areas was less when comparing the T10 to the X2.

> Although the T7 had no shots to sensitive areas, its high probe miss rate (two or three times that of the X2 and T10) makes unsafe any comparison with the other two devices. (See exercise 7 below)
>
> The need for officers to avoid shots to sensitive areas, where possible, must remain a key requirement in training.

The College was also able to find in the same set of tests:

> Where confronted with an approaching subject, officers, on average engaged the subject at 8.2m. Notwithstanding the limitations of this exercise, these data may inform training design.

These tests are also assumed to inform the stand-off utility of the TASER 10™, since 8.2 m is outside the range of the majority of current devices.

5.2.7 Accuracy during scenarios

Tests were conducted where there were six scenarios. Officers had to react appropriately. Probe location was measured and the rate of impacts to vulnerable areas measured. The College observed:

> During exercise 7 (mini scenarios), the frequency of shots that missed or hit a sensitive area was low for the T10 and broadly similar to that of extant devices, and lower than such rates in operational use.

5.3 Other observations

A number of other observations were made in the user handling trials, predominantly relating to the training methods, material or practices. The TASER 10™ was found during the first set of trials to register a high number of faults. Discussions with Axon proposed fixes, which were undertaken, and the second set of trials was conducted with a reduced number of participants (who were all experienced CED users). This second set was purely to see if the fixes had worked.

The second set of user handling trials also demonstrated a high rate of faults. These were not the same faults as the first user trials. Further remedial work was conducted by Axon, leading to another configuration of the device and a third set of trials under the same conditions as the second set of trials.

During the subsequent technical testing [10] (with a different configuration of the device), the error rate was further reduced, with some of the errors reported during the user trials apparently eliminated.

Whilst the fault rate remains a concern, ensuring the device has an acceptable fault rate is part of the acceptance criteria for the device. At the time of writing, the residual fault rate has been considered by the NPCC and deemed to be tolerable.

6 On the predicted performance of the TASER 10™ – insights from the TASER X2™ and TASER 7™

The inability of the TASER 10™ waveform to arc across an air gap means that piercing of the skin by at least two darts is *mandatory* for NMI to be induced. This may raise concerns over the anticipated subdual effectiveness of the TASER 10™, the answers to which may be informed by our knowledge of the operational performance of the TASER X2™ and TASER 7™. The purpose of this section of the report is to explore the UK field data for these earlier devices and how this may carry across to the TASER 10™.

6.1 Effectiveness of the TASER X2™ when probes are fired

The probe discharge dataset for the TASER X2™ contains data extracted from the *TASER X2™ Use Forms* received by Dstl from September 2017 to March 2020. These forms cover 1,966 one-bay firings and 1,041 two-bay firings (a total of 4048 cartridge firings). An analysis of the data has been presented by Sheridan and Hepper (2022) [21].

Probe discharge effectiveness was assessed in terms of whether or not the subject was 'subdued', with the officer's response options being 'Yes', 'No' or 'Unsure'. 'Unsure' responses were excluded from the analysis. When assessed in this way, the subdual rate after firing the first cartridge bay was 52.5% (95% CI: 50.7–54.3%; 2850 firings) while that for the second cartridge bay was 55.1% (95% CI: 51.9–58.3%; 929 firings). These cartridge-wise subdual rates were not significantly different (two-tailed Fisher's exact test; P = .173).

To estimate the overall operational effectiveness of the TASER X2™, the approach taken was to examine whether a subject was 'subdued' by probe discharge in an incident, irrespective of whether the discharge was delivered from one or two cartridge bays. To simplify the analysis, only incidents involving a single TASER X2™ officer and a single subject were considered. This produced 2,656 incidents in which subjects were reportedly subdued on 1,819 occasions by probe discharge. The overall subdual effectiveness estimated in this way was 68.5% (95% CI: 66.7–70.2%).

As well as including successful subdual events, the above subdual rate estimates take into account all possible reasons for failure. When TASER X2™ officers were asked to select a reason for the failure, the following responses were returned (Figure 35):

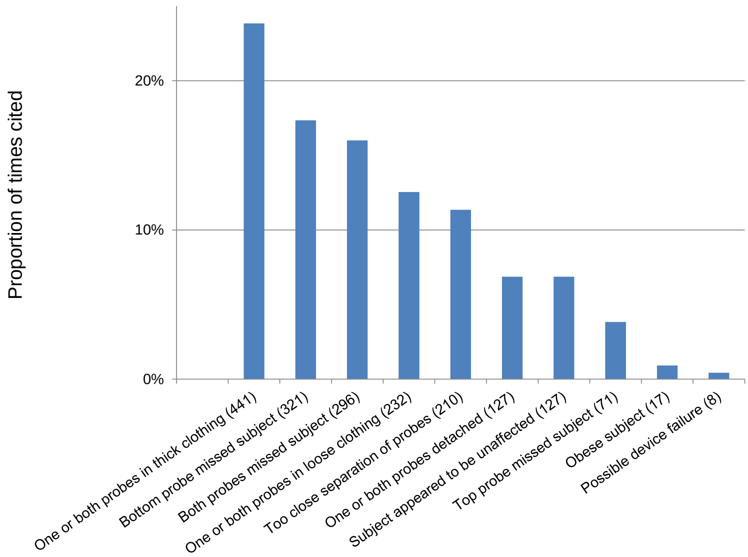

Figure 35. Officer-reported reason why probe discharge failed to subdue. Numbers in parentheses indicate the number of times a given failure reason was cited. Data are from 1850 cartridge firings where the subject was reportedly not subdued.

To assess how effectiveness varied with probe spread and whether probes were in clothing or skin, the next stage of the TASER X2™ analysis looked at the effectiveness of probe discharge when both probes were reportedly in contact with the subject (Sheridan and Hepper, 2022 [21]). In this way it was shown that wider probe spreads were associated with higher reported subdual rates and that the highest subdual rates were achieved when the darts of both probes had perforated the skin (Figure 36). The progressive decline in subdual rates when clothing is interposed in the signal path is entirely consistent with the ability of the pulse waveform to arc a short distance in air [22].

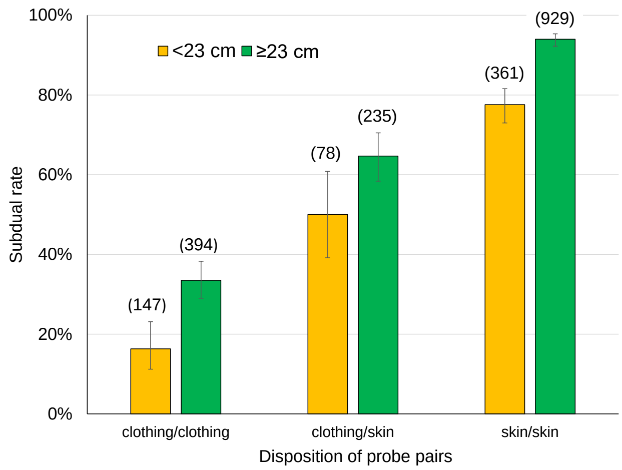

Figure 36. Relationship between officer-reported subdual rate, probe spread and probe disposition in clothing and/or skin. The vertical bars are the 95% CIs for the subdual rate point estimates. Numbers in parentheses refer to the number of probe pairs contributing to each point estimate. The probe spread cut-off values are based on the findings from a volunteer study in which participants were subjected to discharge delivered from a TASER X26™ [24].

6.2 On the requirement for skin penetration/perforation by TASER 10™ probes

6.2.1 Insights from the TASER X2™

Because the TASER 10™ probes must embed in the skin for NMI to be induced, the effectiveness of the new device would correspond to the right-most two columns in Figure 36. Based on UK operational data, the present authors have previously reported that the subdual effectiveness of the TASER 7™ is similar to that of the TASER X2™ [25]. More recently, a human volunteer study has provided evidence to indicate that the ‘stopping power’ of the TASER 10™ discharge in a goal-directed task is similar to that of the TASER 7™ [23]. Taken together, then, these two reports lead to the suggestion that the subdual effectiveness of the TASER 10™ might be expected to be 90% or more with an adequate probe spread.

But given that skin perforation by the darts of at least two probes is obligatory for the TASER 10™ to induce NMI, is there anything to be learned from the UK operational data that have been acquired for the TASER X2™?

The UK CED training curriculum (reference [26] slide 31) teaches the differential subdual effectiveness achieved depending on probe location in skin and clothing (see Figure 36). [redacted] **s31(1)(a)** [redacted].

To explore how this advice translates into operational practice, the TASER X2™ data set was interrogated to examine the proportion of TASER X2™ probes that had reportedly pierced the skin. Where officers have fired probes, they are asked in the *TASER X2™ Use Form* to report whether the probes striking the subject were located in clothing or skin, the response options being 0% if in clothing or 25-100% to signify the depth of the dart of the probe in skin (Figure 37):

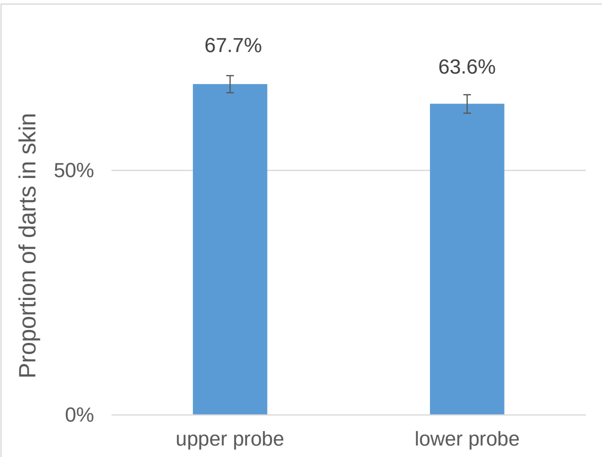

Figure 37. The proportion (±95% confidence interval) of 2684 upper probes and 2417 lower probes reported by TASER X2™ officers to be located in skin (versus clothing). The proportions of upper and lower probes in skin were significantly different (2-tailed Fisher’s exact; $P = .0026$).

Why the proportion of darts in skin was greater for the top probes is a matter for speculation. One possible factor might be that the officer, when engaged in tactical communication with the subject, has a greater situational awareness of the location of the sighting laser for the top probe, which emerges from the CED in line with the 'muzzle' of the device. In this way, the officer may be better able to target the upper probe around any obstacles to skin contact, such as areas obscured by thick or loose clothing.[23] Alternatively, or additionally, the difference between the upper and lower probe skin piercing rates may be due to the ballistic properties of the probes, with the downwardly diverging lower probe presenting a less favourable (oblique) angle of attack as it strikes the subject.

To explore how the skin piercing rates for the TASER X2™ probes might inform the expected performance of the TASER 10™, a decision was made to focus on the top probe of the older device as it seemed more akin to the situation with the TASER 10™, where the officer's attention would be on the placement of probes propelled from the device in line with 'muzzle'.

Given that the proportion of all TASER X2™ top probes reported to have pierced the skin was 67.7% (Figure 37), it was then hypothesised that this overall figure may be subject to seasonal variation. This was explored in the analysis depicted in Table 4:

	Dec-Feb	**Mar-May**	**Jun-Aug**	**Sep-Nov**
Top darts in skin	509	296	510	501
Top darts in clothing	362	143	151	212
Proportion in skin	58.4%	67.4%	77.2%	70.3%
95% confidence interval	55.1–61.7%	62.9–71.6%	73.8–80.2%	66.8–73.5%

Table 4. Seasonal variation in the proportion of TASER X2™ top darts reported to have perforated the skin (versus clothing) for TASER X2™ database entries from September 2017 to March 2020.

The four 3-month periods shown in Table 4 were selected on the basis of Met Office data for one region of the UK – the Midlands – which indicates that the Dec-Feb period brackets the coldest months of the year while the Jun-Aug period brackets the warmest months [27]:

[23] There are several possible alternative reasons for this, including the officer may have concern about upper probe placement since that is likely to be close to vulnerable superior areas of the body, but that is not a matter for this analysis.

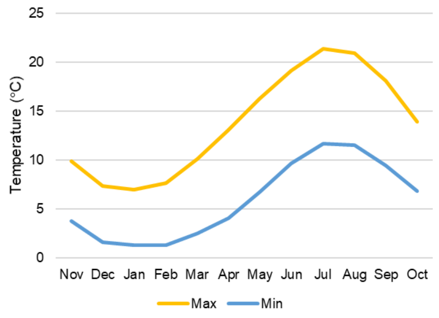

Figure 38. Met Office average monthly temperature data for the Midlands (1991-2020).

The difference in the proportions of TASER X2™ top darts reportedly in skin in the December-February and June-August periods was statistically significant (two-tailed Fisher's exact test; $P < .0001$). The most parsimonious explanation for this seasonal variation lies in the different types of clothing worn by the subjects during the winter and summer months, although other explanations are conceivable. Amongst the latter, the smaller number of daylight hours in the winter period may mean that a greater proportion of probe discharges occurs in the hours of darkness in the Dec-Feb period, resulting is less favourable targeting conditions. This was investigated by filtering the environmental information data field of the TASER X2™ data set for any records where the word 'dark' or 'darkness' featured (e.g. dark hallway). Records where street lighting was mentioned were included in the analysis. This yielded 249 records. Of these, the top probe reportedly pierced the skin on 161/249 occasions, or 64.7%. This was not significantly different from the global 67.7% skin perforation rate reported above (two-tailed Fisher's exact test; $P = .358$).

The winter/summer 'worst case'/'best case' data for the skin perforation rates were then used to estimate the number of TASER X2™ top probes that would need to be fired in order to achieve two skin-perforating darts. The probability of skin perforation of the top probe of the TASER X2™ was estimated to be 0.584 for the period December-February and 0.772 for the June-August period (Table 4). Using these values, it is then possible to estimate the cumulative probability of successive probe firings reaching the point at which the darts of two probes will have pierced the skin. This is illustrated in Figure 39:

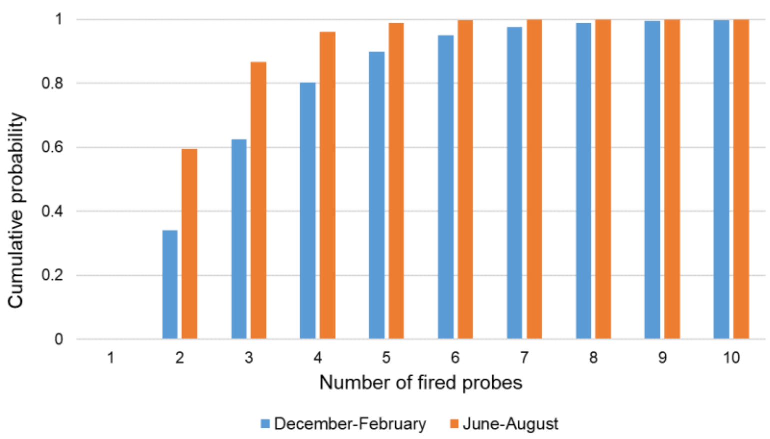

Figure 39. Cumulative probability of two TASER X2™ top probes piercing the skin given an initial probability for any one probe of 0.584 and 0.772, respectively, for the three-month winter and summer epochs.

Probabilistic modelling of the behaviour of the top probe of the TASER X2™ indicates that, on aggregate, four probes in summer and six probes in winter would need to be fired to achieve two skin-perforating probes with a probability of 95% or more.[24]

The seasonal variation in skin perforation rates was also reflected in the overall subdual rates reported by officers. Thus, combining the reported subdual rates for bays 1 and 2 of the TASER X2™, the subdual rate for the winter epoch was 61.9% (95% CI: 58.3-65.3%) while that for the summer period was 74.2% (70.4-77.7%).[25] The seasonal subdual rates were significantly different (two-tailed Fisher's exact; $P < .0001$).

For the TASER X2™, the probability of achieving two skin-piercing probes, as depicted in Figure 39, should not be conflated with the probability of achieving NMI due to the ability of the TASER X2™ pulse waveform to arc across clothing (Figure 36). Because of this, an overlay of the probability of achieving NMI on the skin-piercing data in Figure 39 would lie to the left of the skin-piercing probability columns. This would not be the case for the TASER 10™, the pulse waveform of which is unable to arc in air.

Another aspect of the TASER X2™ that could inform how the TASER 10™ will perform is how the proportion of darts in skin versus clothing varies with the officer-reported distance of the subject from the firer. This is shown for the TASER X2™ in Figure 40:

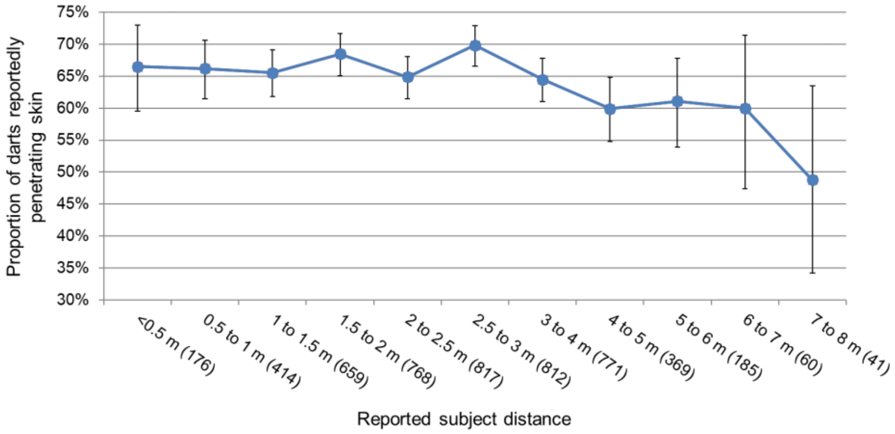

Figure 40. Relation between officer-reported subject distance and the proportion of TASER X2™ darts reported to be in skin versus clothing. The number of darts contributing to each data point is shown in parentheses. The dart disposition data for the upper and lower darts for Bays 1 and 2 are pooled. Vertical bars are the 95% confidence intervals of the point estimates at each distance.

Pooling the data for subject distances in the three closest distance bands and comparing them with the pooled data for the three furthest bands yielded skin penetration proportions of 65.9% (95% CI: 63.2-68.5%) and 59.1% (53.3-64.6%), respectively. These proportions were significantly different (two-tailed Fisher's exact test; $P = .0335$).

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24 Assuming that seasonal variation is due to clothing, these estimates should be understood to reflect the average skin piercing rates, which will encompass unclothed subjects at one extreme and subjects wearing clothing that will impair CED probe perforation to greater or lesser extents.
25 Analysis applies only to probe discharges where both probes were in contact with the subject.

The trend towards a reduction in the proportion of darts reportedly penetrating the skin with increased firing distance, is consistent with the progressive decay in the kinetic energy and momentum of the probe, resulting in fewer darts being able to overcome a clothing barrier at longer distances.

6.2.2 Insights from the TASER 7™

As with the TASER X2™, Dstl has been collating, processing and analysing operational data retrieved from *TASER 7™ Use Forms* since the first reported operational use of the device in the UK in February 2021 [25]. Despite the first use being some 3.5 years ago, the size of the data set is still relatively small compared with that of the TASER X2™ data set and any inferences drawn on the operational performance of the TASER 7™ should be viewed in that context. With that caveat in mind, at the time of writing the TASER 7™ has been used in probe discharge mode on 286 occasions, comprising 174 one-bay firings and 112 two-bay firings. Of these 286 records, 220 contained data on the disposition of the top probe in skin or clothing and, of these, 146/220 (66.4%) were reported to be located in the skin. This is very close to the global 67.7% proportion for the top dart of the TASER X2™ (see 6.2.1).

Despite the comparatively few data points for the TASER 7™, using the same seasonal analysis approach as that taken earlier for the TASER X2™, the proportion of top probes reportedly located in skin was 33/58 (56.9%; 95% CI: 44.1-68.8%) for incidents in the December-February period and 54/67 (80.6%; 95% CI: 69.6-88.3%) for those in the June-August period. As was found for TASER X2™, this difference in the proportion of TASER 7™ top darts reportedly in skin in winter versus the summer periods was statistically significant (two-tailed Fisher's exact test; *P* = .006).

Probabilistic modelling of the behaviour of the top probe of the TASER 7™ gave the same outcome as the TASER X2™ for the summer period, namely, four top probe firings were required to achieve two skin-perforating probes with a probability of 95% or more. During the winter period, however, the slightly lower proportion of TASER 7™ top darts reported in skin (compared with the TASER X2™) translated into a requirement for seven top probe firings (compared with six for the TASER X2™).

As with the TASER X2™, the proportion of TASER 7™ darts reportedly in skin declined at longer subject distances, as shown in Figure 41:

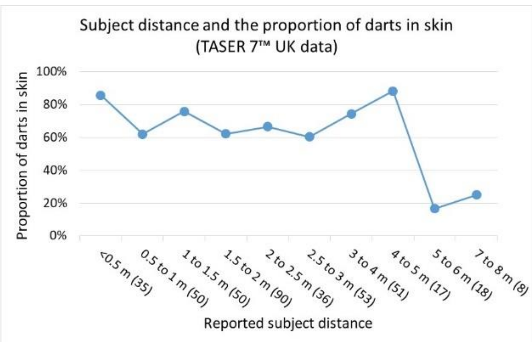

Figure 41. Relation between officer-reported subject distance and the proportion of TASER 7™ darts reported to be in skin. The number of darts contributing to each data point is shown in parentheses. (95% confidence intervals not shown due to the paucity of data points.)

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Although comprising a much smaller data set, the TASER 7™ data demonstrate qualitatively similar outcomes to the TASER X2™ data both in terms of the seasonal variation in the proportion of darts reported to have penetrated the skin and the reduction in skin penetration rates at longer firing distances.

6.2.3 TASER X2™ and TASER 7™: subject distances at the point of probe discharge

The operational usage forms for the two older devices ask the officer to estimate the subject's distance when probes were fired. This yielded the following responses for the TASER X2™ (Figure 42):

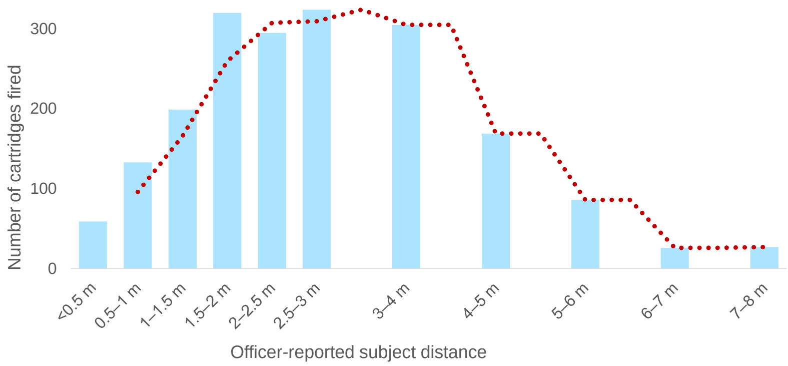

Figure 42. Officer-reported subject distances for the TASER X2™ when a single cartridge bay was discharged. The data are for 1,943 Bay 1 firings. The dotted line is a two-point moving average.

The bulk of the reported subject distances spanned a range of 1.5 to 4 m, which is consistent with the probe spread imposed by the 7° cartridge divergence of the TASER X2™ device.

The equivalent data set for single cartridge bay firings for the TASER 7™ is much coarser, consisting at the time of writing of only 74 Close Quarter (12°) cartridge firings and 109 Stand Off (3.5°) cartridge firings. Nevertheless, bimodal distributions of the officer-estimated subject distance are apparent (Figure 43):

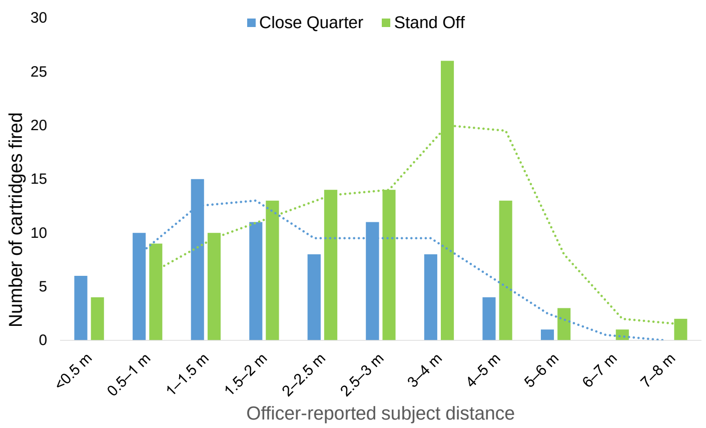

Figure 43. Officer-reported subject distances for the TASER 7™ when a single cartridge bay was discharged. The dotted lines are the two-point moving averages for the two cartridge variants.

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6.3 Implications for the TASER 10™

The foregoing analyses of the data sets for the TASER X2™ and TASER 7™ led to the following observations:

- The proportion of probe darts reported to have punctured the skin (versus clothing) was significantly higher in the hottest months (June-August) than in the coldest months (December-February). This was considered most likely attributable to the different types of clothing worn by subjects. The differential skin perforation rates in summer and winter were reflected in the respective subdual rates for these periods.

- Probabilistic modelling of the reported skin perforation rates of the top probe darts indicated that a minimum of four probe firings would be required in the summer months to achieve a >95% probability of two darts perforating the skin. During the winter months, this increased to a minimum of six and seven probe firings for the TASER X2™ and TASER 7™, respectively.

- The proportion of probe darts reported to be in the skin tended to decrease with increasing subject distance, a finding consistent with the progressive decline in energy of the probe after ejection from the cartridge.

- The subject distance at which probes were fired demonstrated patterns consistent with the differing cartridge divergence angles of the earlier devices.

What implications might these observations have for the TASER 10™?

6.3.1 Clothing and seasonal variation in the proportion of skin-piercing probes

The TASER 10™ user has from two to ten trigger-pull attempts to achieve at least two skin-perforating darts, without which NMI will not result. The modelling of the data for the older devices (see, for example, Figure 39) brings a high degree of confidence that the ten shots available on the TASER 10™ are likely to achieve at least two skin-piercing darts.

The modelling of the earlier data also leads to the suggestion that the ten shots available on the TASER 10™ may mitigate the seasonal variation in both the proportion of skin-perforating darts and reported subdual rates seen with the earlier devices.

Certain types of clothing are understood to impair the ability of the earlier devices to form an electrical circuit with the subject. For example, Dstl's analysis of the operational performance of the TASER X2™ noted that thick and/or loose clothing styles were not infrequently cited by the officer as the reason for subdual failure (see Figure 35 and [28]).

When the firing of probes failed to subdue subjects, the types of clothing cited by officers in the *TASER X2™ Use Form* included:

s31(1)(a) [redacted]

s31(1)(a) [redacted].

Overcoming challenging clothing may be easier with the TASER 10™ for several reasons:

- The TASER 10™ user has greater control over the point of impact of *each* fired probe.
- The kinetic energy and momentum of probes fired from the TASER 10™ are higher and preserved over a greater distance than probes fired from earlier devices.
- Probes fired from the TASER 10™ show greater accuracy and consistency than probes fired from the earlier devices.
- The TASER 10™ uses a single green laser sight while the TASER 7™ has a green laser sight for the upper probe and a red laser sight for the lower probe. The TASER X2™ has two red laser sights. This single probe firing allows for more selective probe placement.
- Up to 45 probe-probe combinations.

These various features of the TASER 10™ are considered in more detail below.

6.3.2 Greater control over the probe point of impact

With the TASER X2™ and TASER 7™ the user is constrained by the fixed divergence angle of the cartridge that determines, in combination with the subject's distance, the point of impact of the lower probe (the upper probe is always ejected in line with the 'muzzle' of the device).

To achieve NMI with the earlier devices, the officer needs to consider a number of factors with Dstl's 2021 report on the performance of the TASER X2™ [28] recommending a hierarchical approach which was subsequently incorporated into CED training [26]:[26]

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[26] **s31(1)(a)** [redacted].

s31(1)(a)

Figure 44. The hierarchy of factors to consider to optimise the likelihood of achieving NMI.

Probe misses are the leading cause of failure to achieve two-probe contact and, as seen in Figure 35 and discussed in section 6.2.1, misses with the lower probe of the TASER X2™ outnumbered upper probe misses by nearly five-fold.

One or both probes missing the subject was reported on 698/2992 occasions (23.3%) when the first cartridge bay of the TASER X2™ was fired. While it is not possible to determine their relative contributions, there are several potential reasons why probes miss, including poor aiming (possibly due to red laser dot visibility in bright sunlight) and partial physical obstruction (such as furniture or a hidden object in the subject's clothing).

Subject movement is also likely to be a factor in probe misses, with 46.7% of TASER X2™ subjects being described as "moving quickly" at the time of probe discharge [21][3]. The TASER 7™ data set indicates that 31.7% subjects were described as "moving quickly".

Rapid movement of subjects will similarly adversely affect successful probe placement with the TASER 10™, although this may be mitigated by the higher probe velocity of the new device relative to the earlier devices, as illustrated in Figure 45:

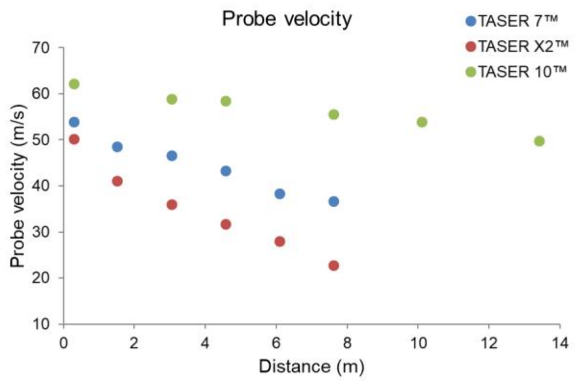

Figure 45. Probe velocity data for the TASER 10™, TASER 7™ and TASER X2™. The data for the older devices come from earlier testing undertaken by CAST and Dstl [7], while the TASER 10™ data come from [10]

Probe misses caused by rapid movement of the subject will likely also be a factor in subdual failures with the TASER 10™. However, in addition to its higher probe velocity, the TASER 10™ has a number of other features that may reduce the proportion of subdual failures caused by missed probes:

- Smaller probe dispersion around the point of aim
- Green sighting laser
- Up to ten individually targeted probes
- Flexible electrical polarity of probes

6.3.2.1 Greater kinetic energy, momentum, accuracy and smaller probe dispersion around the point of aim

The greater kinetic energy and momentum should result in more reliable skin penetration of the dart of the TASER 10™ probe compared with its predecessors given that the dart design is not dissimilar. The flip side to this is that it could also result in a greater risk of injury with the TASER 10™.

The accuracy and probe dispersion of the TASER 10™ compared with the older devices is usefully illustrated by the outcome of one of the exercises in the first user handling trial undertaken by the College of Policing (see section 5) (Figure 46):

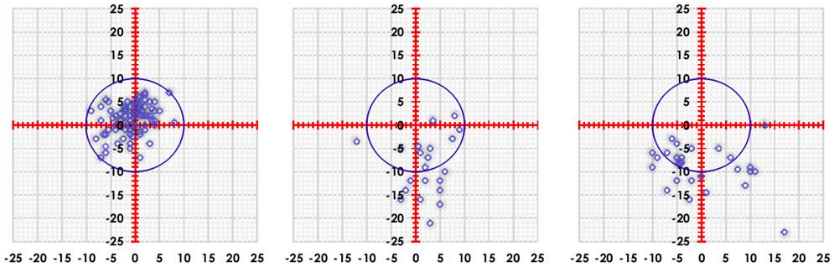

Figure 46. Probe impact points in Exercise 2 of the first user handling trial. Using the laser sight, participants fired at a target set at distance of 5 m. The TASER 10™ points of impact are shown on the left, TASER X2™ (top probe) in the middle and TASER 7™ (top probe) on the right. Numbers shown are centimetres and the point of aim was at 0,0.

The greater accuracy and smaller dispersion of the TASER 10™ probes, when fired by users, will likely result in a greater proportion of probes striking the intended point of aim, although this might not be the case at extreme firing distances where probe dispersion is greater.

6.3.2.2 Single green sighting laser

The TASER 7™ was the first Axon CED product to feature a green laser sight for the upper probe. All other products, including the sight for the lower probe of the TASER 7™, featured red lasers.

The wavelength response of the human eye has a peak sensitivity at 555 nm [29]. The green laser of the TASER 10™ has a wavelength of 510 nm while the two red lasers of the TASER X2™ and the lower red laser of the TASER 7™ have a wavelength of 650 nm. Hence, the green laser dot will be perceived to be brighter, which is something that is evidenced, albeit anecdotally, in comments left by users of the TASER X2™ and TASER 7™ in their respective usage reports:

TASER X2™ [30]:

"Dry and sunny day. Bright sunlight caused red dot system to be nearly useless."

"taser aimed then red dot challenge top dot on right side as male was side on male stood up red dot on lower chest no lower dot seen due to sunlight."

"Bright sunshine officer could not see red dots from laser sight"

TASER 7™ [25]:

"green laser was effective in the bright sunshine, the red one was very hard to see"

"green laser dot was very effective as the red one became hard to see in the bright sunshine."

"Visibility of lower sight not great in daylight against light background."

The utility of the green upper laser sight may be further evidenced in the TASER 7™ data set: of the 405 cartridges fired to date, subdual failure was attributed only to two instances in which the upper probe missed the subject, one of these being an unintentional discharge. In contrast, subdual failure was attributed to a lower probe miss in 27 instances.

In addition, the need to only concentrate on the positioning of one laser on the subject will eliminate any chance of confusion over whether the top or bottom probe is being targeted. This will also allow greater selection of placement areas of the probes because the relative impact locations of two probes is not fixed.

The green sighting laser of the TASER 10™ has the potential to improve probe placement accuracy due to its enhanced visibility relative to the red laser sights of the older devices. For the same reason, the green laser sight also has the potential to reduce the incidence of probe misses.

6.3.2.3 Up to ten individually targeted probes

The TASER X2™ and TASER 7™ have twin cartridges with each cartridge housing two vertically orientated probes of opposite polarity (top probe positive). At least two probes (of opposite polarity) from either or both cartridges must be in electrical contact with the subject for NMI to be induced. In ideal circumstances, when the first cartridge bay of these earlier devices is fired, both probes form an electrical connection with the subject. But, as indicated in Figure 35, there are several reasons why this may not occur (hence, the subdual rate reported after the firing of the first bay being little more than 50%). For the TASER X2™, one or two probe misses were given as the reason for failure in 37% of all reports received in which probe discharge failed to subdue the subject (Figure 35).

The earlier twin cartridge devices have a maximum of two probe pairs available to create an effective electrical connection with the subject. With the electrical crosstalk feature that allows positive and negative probes fired from separate cartridges to 'talk' to each other, this yields a maximum of five permutations of (+)/(-) probes (to include when all four probes are in electrical contact with the subject). The TASER 10™, with its 'Any Probe Connect' feature (see 6.3.2.4) and the potential to fire up to 10 probes, offers 45 probe pair permutations.[27] Figure 47 illustrates the number of potential electrical connections for the earlier devices versus two example cases for the TASER 10™:

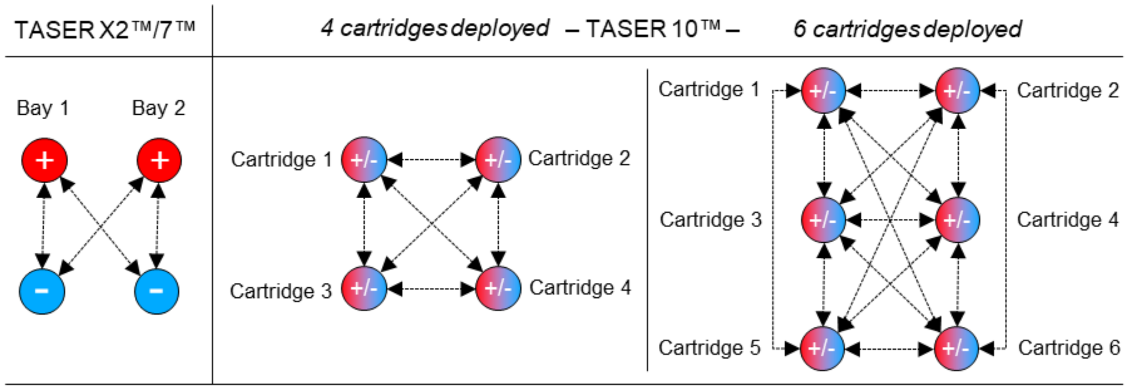

Figure 47. Potential electrical connections for the twin cartridge TASER X2™/7™ *(left)* and the TASER 10™ after 4 or 6 cartridge deployments (giving 6 or 15 potential pairings, respectively). Although the theoretical limit of probe pairings for all 10 probes of the TASER 10™ is 45, a maximum of only 4 probes can be electrically active at any one time.

For the TASER 10™, the high number of possible probe pairings not only has the potential to mitigate failures due to probe misses, but also failures due to clothing disconnects by giving the officer more opportunities to aim probes at less challenging areas of the subject's body. Clothing disconnects (i.e. non-skin piercings) with the TASER 10™ are functionally equivalent to probe misses.

One other advantage of individually targeted probes is that the officer has control over probe spread instead of being tied to the spread imposed by the combination of the probe divergence angle of conventional cartridges and the subject's distance. Compared with earlier devices, then, the mode of use of the TASER 10™ arguably confers a reduction in system complexity in this regard.

Furthermore, the individually targeted probes of the TASER 10™ give the officer greater flexibility when the subject is in a challenging posture or the subject's body is partially obstructed, as illustrated in this image taken from a slide in the training pack delivered to TASER X2™ and TASER 7™ officers (Figure 48):

[27] See combination calculator at https://www.statskingdom.com/combinations-calculator.html.

[redacted]

Figure 48. Image from a TASER X2™/7™ training slide illustrating potential aiming tactics when the subject's body is partially obscured [ref [26] J4.1, v6.2].

The ten individually targeted probes of the TASER 10™ free the officer from the constraints imposed by the fixed probe divergence angle of the cartridges on earlier devices. This arguably reduces system complexity in one respect and permits more flexibility when targeting partially obscured subjects, subjects in a non-standing posture (where tilting of device may have been previously necessary) or attempting to target around challenging clothing. The ten probes of the TASER 10™ give the officer up to 45 opportunities to secure an effective probe pairing on the subject compared with up to five on earlier twin cartridge devices. The ten probes of the TASER 10™ appear to provide an improvement over the older devices when it comes to compensating for probe misses and clothing disconnects.

[redacted]

When NMI fails to be induced after the first two TASER 10™ probes have been fired and both probes are in contact with the subject, the presumption must be that this is the result of one or both probe darts not having pierced the skin. [redacted]

[28] Email [redacted] to [redacted], subject line 'T10 scenario' (12:27 BST; 27/09/2024)

6.3.2.4 Flexible electrical polarity of probes

Newly implemented on the TASER 10™ is the so-called 'Any Probe Connect' feature (see section 6.3.2.3). This increases the electrical flexibility of deployed probes which can now be either positive or negative, depending on the connections the device senses. For all previous models of Axon CED, the upper and lower probes had fixed positive and negative polarities, respectively.

Given that the TASER 10™ has ten probes, before the first shot is taken there are up to 45 ways in which a *single pair* of skin-piercing probes could combine to form an electrical circuit with the subject and induce NMI.[29] Should the first probe miss or fail to pierce the skin, the nine remaining probes then offer up to 36 opportunities, with eight remaining probes offering 28, seven offering 21, and so on until the last two remaining probes offer the final opportunity to create a probe pairing. In reality, the picture is likely to be more complex, as there may be more than two skin-piercing probes and some connections may fail having been initially successful (e.g. a probe dislodged by the subject's movement).

The 'Any Probe Connect' feature is a novel departure from all previous Axon devices that permits individual probes to assume either a positive or negative polarity. By not permanently designating a probe's polarity, 'Any Probe Connect' brings a flexibility not present with earlier devices and would seem to be more forgiving in the event that one or more probes miss the subject. Probe misses with the TASER 10™ are functionally equivalent to the darts of the probes not piercing the skin, hence 'Any Probe Connect' would seem to mitigate the impact of both of these undesirable outcomes.

6.4 Subject distance considerations

Officers deploying probe pairs from the TASER X2™ and TASER 7™ are constrained by the subject's distance, the probe divergence angle imposed by the cartridge designs and the associated spread of the laser sighting dots on the subject. This constraint is broadly reflected in the subject distances reported by officers at the point that probes are fired from these earlier devices (see 6.2.3).

The concept of use of the TASER 10™, with its ten individually targeted probes, makes subject distance considerations all but redundant, the primary constraint now being that imposed by the maximum range of the probe tethering wires.

As speculated in section 6.3.2.3, the control over probe spread offered by the TASER 10™ arguably confers a reduction in system complexity as officers would now no longer need to adjust their position relative to the subject to ensure that the upper and lower laser dots are both appropriately positioned to enable an electrical pairing with the subject.

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[29] Combinations calculator: https://www.calculatorsoup.com/calculators/discretemathematics/combinations.php

6.5 Considerations around probe ballistics

This section seeks to compare what is known about the ballistic properties of the TASER 10™ probe and how they compare with earlier devices. A study from an independent research group which looked at the penetration of TASER 10™ and TASER 7™ probes (darts) into human skull simulants is also considered in this section but only from the perspective of observations made on the stability of the TASER 10™ probe in flight.

6.5.1 Mass and energy of tethered TASER 10™ probes

While the tethering wire of the TASER X2™ probe is spooled out from the cartridge bay, the wire of the TASER 10™ probe, like the TASER 7™ probe, is wound inside the probe body and spools out from there. This means that the TASER 10™ and TASER 7™ probes lose mass as they spool-out wire with range, as illustrated in Figure 49:

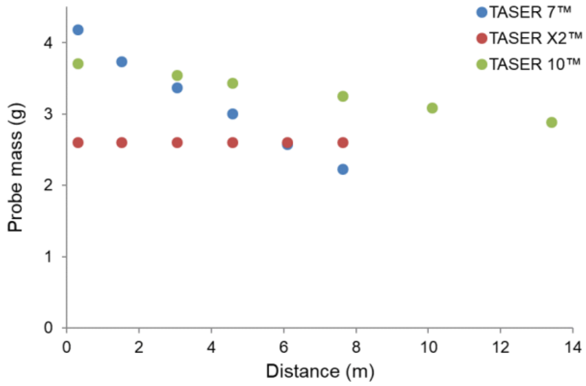

Figure 49. Probe mass with distance. Data for the TASER 10™ probe come from [10]. The data for the older devices come from [7]

The momentum and kinetic energy of the TASER 10™ probe, compared with the probes of earlier devices, are shown in Figure 50:

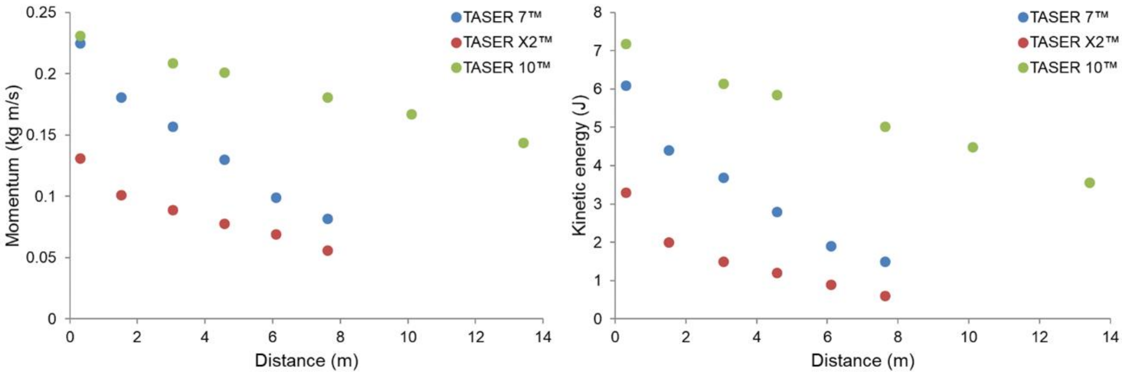

Figure 50. Momentum and kinetic energy of the TASER 10™ probe. Data for the TASER 10™ probe come from [10]. The data for the older devices come from [7]

The momentum of the TASER 10™ probe at the muzzle is similar to that of the TASER 7™ probe and nearly double that of the TASER X2™ probe. The kinetic energy of the TASER 10™ probe at the muzzle is some 18% higher than that of the TASER 7™ probe and more than double that of the TASER X2™ probe. Both the kinetic energy and momentum of the TASER 10™ probe are better preserved over distance from the muzzle.

The kinetic energy and momentum of the TASER 10™ probe may be viewed as surrogate indicators of the ease with which the dart of the probe will penetrate or perforate clothing and skin and both parameters for the TASER 10™ probe exceed those for the TASER 7™ and TASER X2™ probes and are preserved over a longer distance.

6.5.2 Stability of probes in flight

Khmara et al. [15] used human skull simulants, comprising gelatine-filled polyurethane spheres wrapped in buckskin, to explore the potential of TASER 10™ and TASER 7™ probes to penetrate the skull. While the darts of both types of probe were able to penetrate the skull simulant (discussed elsewhere in this report), an interesting finding was how the depth of penetration varied with firing distance (Figure 51):

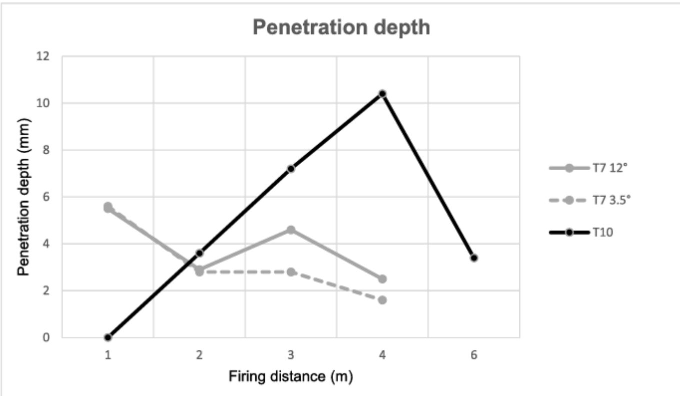

Figure 51. Skull simulant dart penetration depth vs firing distance. (From Khmara et al., [15])

The progressively increasing penetration depth of the TASER 10™ dart between 1 m and 4 m runs contrary to expectation given that the energy of the probe is higher at 1 m. Khmara et al. attributed this unexpected behaviour to the angle at which the dart struck the simulant, which they estimated using high speed videography [15]. They reported that the TASER 10™ darts failed to strike the skull model at a right angle over the first 2 m of flight but "*invariably struck at right angles over 3 to 7 m of flight, with the probe becoming instable in [sic] greater firing distances.*" In contrast, the TASER 7™ struck at an approximate right angle over the first 2 m of flight and *"showed a certain instability"* at firing distances beyond 2 m (striking the simulant at about 30° off the right angle).

Probe instability is not a new phenomenon and may be seen in an Axon high speed video comparison of TASER X2™ and TASER 7™ probes in flight as they leave the cartridge bay (Figure 52):

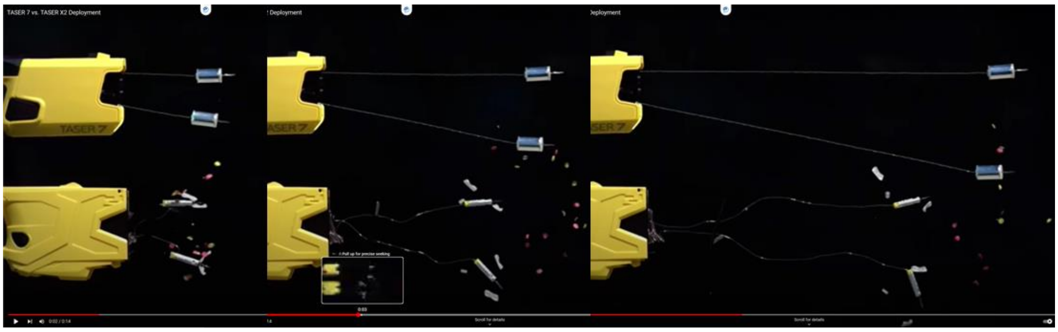

Figure 52. Screen shots from a high speed video of TASER 7™ *(top)* and TASER X2™ probes *(bottom)* in flight. (https://www.youtube.com/watch?v=f6o6BwCVWkg; published on YouTube in December 2020)

The instability of the TASER X2™ probes is clearly evident in Figure 52, the authors' understanding, based on a personal communication with Axon in 2018, being that the most difficult portion of probe flight stability is within the first metre of flight, but that probe stability continuously improves thereafter, reaching optimal stability at ranges of 1.5-2.0 m and beyond [30].

The concern with probe instability is that it may negatively influence how the tip of the dart interacts with clothing and skin, this being of particular concern for the TASER 10™ given that piercing of the skin is essential for the device to be effective. In the case of the TASER X2™, however, probe instability at short ranges does not appear to have adversely affected the proportion of darts reported by officers to be in the skin (see Figure 40).

Furthermore, the tethering wire of the TASER X2™ probe is of the traditional design, with the wire being dragged out from the cartridge bay by the probe. The tethering wire of the TASER 7™, on the other hand, is spooled out from the probe body, and it is presumed to be this design that contributes to the stable early flight of the TASER 7™ probe seen in Figure 52 (and borne out by the high speed video observations of Khmara et al. [15]).

The design principle of the TASER 10™ probe is the same as that of the TASER 7™ probe, with the tethering wire spooling out from the probe body. Despite this, however, the findings of Khmara et al. [15] indicate that the TASER 10™ probe is unstable at ranges up to 2 m, stable from 3-7 m, with instability returning beyond that (the videography of Khmara et al. is not available as supplementary data). It is possible that the unspooling of the wire from the TASER 10™ probe or, more likely, the 'muzzle jump' caused by the blast of the pyrotechnic propulsion gases past the probe as it leaves the barrel causes this instability. Whether the apparent instability is significant is unknown.

For the clothed aggressor, the sequence of clothing perforation followed by penetration or perforation of the skin, will be critical for the TASER 10™ to be effective when used in probe discharge mode. There is evidence from an independent study that the TASER 10™ probe is stable in flight from 3-7 m but exhibits some instability at ranges outside these limits. This ballistic behaviour may (or may not) influence the sequence of events required for the device to induce NMI.

6.6 Summary

The UK’s operational data sets for the TASER X2™ and TASER 7™ have been reviewed to seek insights into how the TASER 10™ system might perform in the field. The TASER X2™ data set contains information drawn from 3,044 instances in which officers fired probes (from either one or two cartridge bays). The TASER 7™ data set is still open to new data being returned by officers in the *TASER 7™ Use Form* and, at time of writing, contains information relating to 308 instances involving human subjects in which the officer discharged either one or two cartridge bays.

When probes were fired from the first cartridge bay, the older devices were effective in subduing subjects only about 50% of the time, the bulk of subdual failures for the TASER X2™ being attributed by officers to probe misses (37.2% of failure reports), clothing disconnects (36.4%) and narrow probe spreads (11.4%). For the TASER 10™, the contribution of probe misses to subdual failures may be lessened by a number of features of the new device:

- The higher velocity of the TASER 10™ probe which may mitigate misses due to subject movement;
- The smaller dispersion and greater accuracy of the TASER 10™ probes;
- The higher visibility of the green laser sight compared with the TASER X2™ (two red laser sights) and the TASER 7™ (red laser sight for the lower probe);
- The ten individually targeted probes of the TASER 10™ which:
    - allow the officer to focus on aiming probes that are ejected in line with the ‘muzzle’;
    - remove the constraint imposed by the divergence of the probe pairs fired from the cartridges of the older devices, meaning that the accuracy of placement of the lower of the probe pair would no longer be a concern;
    - permit greater aiming flexibility for subjects who are partially obscured or in an unusual posture (tilting of the device not required);
    - allow the officer to focus on targeting unclothed or lightly clothed areas and away from challenging clothing;
    - give the user up to 45 opportunities to obtain a probe pairing on the subject compared with up to five opportunities with the earlier devices.
- The ‘Any Probe Connect’ feature means that probes may adopt either electrical polarity instead of the predetermined upper (positive) probe and lower (negative) probe of the earlier devices. This should mitigate the effect of probe misses and, at one extreme, means there still remains one possibility of achieving an effective probe pairing even when the first eight probes have missed the subject or lodged in clothing and only two probes remain.

Rather than probe spread being a function of cartridge divergence angle and the officer-to-subject distance, the TASER 10™ user determines the probe spread, irrespective of subject distance (up to the tethering range limit of the probe). In theory, this may reduce the contribution of narrow probe spreads to subdual failures.

Unlike with earlier devices, the pulse waveform of the TASER 10™ does not carry the brief very high voltage component of earlier devices that was designed to enable it to arc across small air gaps, such as when probes land in thick or loose clothing. For this reason, the darts of at least two TASER 10™ probes must pierce the skin for NMI to be induced.

Given the above constraint, the UK data sets for the TASER X2™ and TASER 7™ were reviewed, with a focus on the skin-piercing rates of the top probes to see if they could shed light on how the TASER 10™ might perform in practice. The top probes were chosen because of the qualitative similarity with how the probes from the TASER 10™ are deployed in line with the 'muzzle', an approach indirectly supported by the observation that upper probe misses with the TASER X2™ were nearly five-fold less than lower probe misses and there have been no reported upper probe misses to date with the TASER 7™.

The analysis of the rate of skin piercing indicated that, on aggregate, four TASER X2™ probe firings in summer and six in winter were required to achieve a >95% chance of achieving two skin-piercing probes. The equivalent findings for the TASER 7™ were, respectively, four and seven probe firings. On the assumption that this seasonal variation is due to clothing, these estimates should be understood to reflect the average skin piercing rates, which will include unclothed subjects at one extreme and subjects wearing clothing that will impair, to greater or lesser extents, the ability of the TASER 10™ probes to perforate clothing and pierce the skin.

The data set for the TASER X2™ indicated a significant decline in reported skin-piercing rates at longer subject distances (5-8 m) and a similar observation was made for the smaller TASER 7™ data set. This is to be expected as the probe progressively loses kinetic energy and momentum with distance, these properties determining the interaction of dart of the probe with clothing and skin. A similar outcome may be anticipated for the TASER 10™.

The kinetic energy and momentum parameters of the TASER 10™ probe exceed those for the TASER X2™ and TASER 7™ probes and are preserved over a longer distance. These parameters provide a surrogate indication of the ability of the dart of the probe to perforate clothing and to penetrate or perforate the skin.

Finally, while the higher kinetic energy and momentum of the TASER 10™ probe appear to promise an improved interaction of the probe dart with the subject's skin, there is some evidence from an independent study that the probes of the TASER 10™ are stable in flight from 3-7 m but exhibit some instability at ranges outside these limits. Whether or not this reported instability has a knock-on effect on skin-piercing rates remains to be seen.

7 NPCC implementation plan for the TASER 10™ system

The NPCC Less Lethal Administration has recently sent a draft of the TASER 10™ Implementation Programme [31]. This states some of the concerns and policies that the NPCC are likely to hold, such as:

- The concern over the likely imminent removal of the TASER X26™ from UK police use. This will remove the dependence on devices that are outside their warranty period and are not supported, although does not directly address the issue of whether this is removal for all police roles, or whether the TASER X26™ will remain a tactical option for officers in a covert role.

- Concerns over the use and management of mixed CED capabilities held by forces. To mitigate this, officers will only be authorised to operationally carry one design of CED. This includes TASER instructors who may need to be competent in more than one design of TASER, but instructors will only be authorised to use one design operationally. Although not in the current draft of the implement plan [31], it is understood that the next revision will contain the instruction that anyone trained in the TASER 10™ who is already trained and qualified to use an earlier model of CED will not be permitted to revert to their former device except in exceptional circumstances.[30] One example of an exceptional circumstance would be if a major issue were to arise with the TASER 10™ that could not have been foreseen at the point of the system's authorisation for police use. The prohibition of reversion to a previous CED model was first introduced for those taking up the TASER X2™ from the TASER X26™ and the practice continued with the introduction of the TASER 7™. That the prohibition of reversion is included in the next revision of the NPCC implementation plan should be confirmed, given the major change in the concept of CED use that the TASER 10™ represents.

- The TASER 10™ has certain complexities in terms of wider system management. The implementation plan emphasises the need for good management of the system, especially as the firmware updates are managed through the battery system and docking and communicating with *Evidence.com* is necessary. Management will also be required to ensure preventative maintenance for cleaning and replacement of worn parts, such as the interposer bucket, which is a component that fits between the TASER 10™ handle and the rear end of the magazine/cartridges.

- All TASER Lead Instructors in forces introducing the TASER 10™ must undergo a TASER 10™ upskilling course [11]. This is a minimum of twelve hours training. Twelve hours training and qualification time will also be required for officers converting to TASER 10™ from other CEDs. *Ab initio* trainees will undergo a minimum of eighteen hours training including qualification tests.

This document was a draft – several aspects of which required clarification, such as whether the connection alert will be enabled for UK use and the specification of a 45' operational range for the device (please see sections 4.3.1.4 and 8.2.2 for why this may not be an appropriate range to quote). Since the initial draft, a decision has been made

[30] Email **s40(2)** - **s40(2)** 'RE: TASER 10 SAccD', 17:50 30/01/2025.

to enable the connection alert for UK use. However, it is understood that a behavioural change indicative of NMI will still take primacy over the connection alert, not least because a connection alert could occur with two probes having an insufficient spread.[31]

The implementation plan [31] also states:

> "We expect the new model to help with de-escalation rather than increasing the rate at which Taser is used."

This may be one item that SACMILL may wish to monitor for whether there is any evidence for this in operational practice. It is something that should be readily apparent through the national use of force reporting system and through any specific TASER 10™ use reporting.

[31] Email **s40(2)**- **s40(2)** 'RE: Further questions' 13:25 31/01/2025.

8 Human factors considerations

8.1 Requirement and approach

Due to the marked changes in the TASER 10™ in terms of how the CED operates, SACMILL requested additional human factors input from Dstl to consider potential implications of these changes for training and use of the TASER 10™ in a dynamic operational environment. In response to this request, a broad human factors assessment of the TASER 10™ was carried out taking a socio-technical systems approach exploring the people, technology and environment.

The methodological approach was limited to developing an understanding of relevant literature: TASER 10™ user handling trial [20] and technical assessment [10]; draft training material [8] and [26]; previous Dstl reports on extant CEDs in use with the police to understand potential differences to current in-service CEDs: TASER X2™ [21], [28] and [30] and TASER 7™ [7] and [25]; Independent Office for Police Conduct reporting on use of CEDs (2015-2020) [32] and recent deaths (in England and Wales) involving CEDs (2023/2024) [33]; as well as recent open publications considering effectiveness [23] and [22] and decision-making around CED use [24], [34], [35], [36], [38], [39], [40], [41] and [42]. Additionally, a demonstration of the TASER 10™ Virtual Reality system at the College of Policing supported an understanding of the form factor of the TASER 10™ and the key differences in comparison with previous devices.

In taking a socio-technical systems approach a number of key human factors were evaluated.

- **Trust in the system:**
  Trusting that the system will operate in the way expected and be able to deliver the effect expected in a dynamic operational situation is of utmost importance to the officer and will affect how the system is used. The level of trust in the system will be influenced by many factors including the technology (e.g. reliability and functionality of the system), individual experience and organisational factors (such as the experience of trainers).
- **Individual factors:**
  Human characteristics will affect the ease of interaction between the officer and the system e.g. due to anthropometrics such as hand size, vision etc., compatibility with other equipment/systems the officer is using, the cognitive load associated with the use of the system and the ability to maintain situation awareness.
- **Situation factors:**
  Finally, the situation factors are considered, including the context for CED deployment, such as the physical environment and wider societal factors. These situation or contextual factors may bear an impact on unintended consequences from the introduction of a new system into a specific social environment. It is important to consider these wider factors to ensure that we are "*alert to the possible consequences of unexpected as well as predicted outcomes of their*

work."[32] Therefore the potential unintended consequences of the deployment of TASER 10™ were also considered as part of this work.

The remainder of this section will consider each of these human factors in turn.

8.2 Trust in the system

8.2.1 Reliability

A number of reliability issues were identified during the iterative testing carried out through the TASER 10™ user handling trials conducted by the College of Policing. These are identified in detail in **s40(2)** and **s40(2)** [20] and categorised according to the risk and consequence from safety critical (Category A)[33] through to minor (Category E). As well as being an important part of the operational and system requirements[34] (*SR29: The system should be reliable in use and function as expected when activated,* threshold for reliability is 95%[35]*)*, the reliability of the system and frequency of faults experienced have a significant impact on the use of a system and how it is viewed both at an individual and organisational level. If there are reliability issues, knowledge of the issue will cascade through the organisation, from training through to deployment of the system, and could significantly affect the level of trust officers have in the TASER 10™.

During the three user handling trials [20] faults were recorded and logged, however, between the various trials, changes to the TASER 10™ firmware were made. For the purposes of this section of the report, the faults identified in the final user handling trial only will be considered. However, it must be noted that this makes the assumption that any device and firmware updates introduced following the initial trials, were made across all devices and will be applied for all TASER 10™ acquired in the future.

As the user handling trials progressed, the number of Category A (safety critical) faults decreased significantly from 4.3% of device uses in the first user handling trial to 1.9% in the third and final trial, however, the incidence of all categories of fault actually increased from the first user handling trial from 6.3% to 7.1% in the third and final trial. Although the severity of the issues was lower, in terms of the rates of Category A and B faults (Cat A = 1.9%, Cat B = 2.8%), these were still higher than the systems they were compared to in the first user trial (TASER 7™ Cat A = 1.5%, Cat B = 2.2% and TASER X2™ Cat A = 1.3%, Cat B = 0), and the overall level of faults was still higher than these devices (TASER 7™ = 3.7% of uses, TASER X2™ = 1.3% of uses). Despite the acknowledged improvements across the user trials, depending upon the interpretation of the data, one could argue that the decrease in reliability due to faults being reported in 7.1% of uses means the device does not appear to meet the 95% threshold for the systems requirement. However, it is not clear how the "threshold" requirement should be met due to the lack of clarity around the basis on which it should be calculated, as this is

[32] British Psychological Society Code of Research Ethics (2021) https://www.bps.org.uk/guideline/bps-code-human-research-ethics
[33] The critical errors recorded by the device (see section 2.1) do not align directly to the CAT A: critical faults defined in the User Handling Trials (discussed earlier in this report) [1].
[34] See section 3.
[35] It is not specified if this is across each trigger pull or incident/exercise, for the purposes of the user trial a pragmatic approach was taken in measuring faults each time the device was used.

not defined. If one focuses only on the Cat A and Cat B faults then the device does meet the 95% threshold with Cat A and B faults only being present in 4.7% of uses.

In the third user trial, the types of Cat A faults included: trigger being pulled and no discharge (1.1% of uses, 6 in total), probe detaching with no wire visible (0.4% of uses, 2 in total) and wire snapped mid-wire (0.4% of uses, 2 in total). Cat B faults included: warning tones extended past their expected timeframe (2% of uses, 11 in total) and cartridge bay errors (0.8% of uses, 4 in total). Experiencing these faults operationally could have significant consequences in terms of the device failing and possible safety implications, however, **s40(2)** and **s40(2)** [20] summarise that due to the fact that in the third user handling trial the officer could continue to operate the device (except for two exercises), the issue could be mitigated without serious consequence.

Reliability issues were also observed with the HALT system during the user trials, including cartridge jamming issues, however, these appeared to be easily rectified and can be flagged to instructors during training, so will not be discussed in any depth. Monitoring issues with the device and cartridges during training and operational use will be important to better understand the incidence and impact of any issues.

The technical testing also reported a number of issues the authors classified as “minor quality assurance issues” [10]. These included the laser sight producing a vertical stripe on one device as well as a dot on the target (1 of 6 devices) and wire failures (0.1% of cartridges, HALT and duty cartridges). “Deployment failures” are more concerning, these were rare (0.6% of cartridges, HALT and duty) and often accompanied by an error on the CID. There was also a handle that completely failed after circa 530 shots. Additionally, the trigger sensitivity was observed to alter over deployments with increased force on the trigger needed to fire the device. This was also reported to be notable to an experienced operator (although this appeared to have been tested with an *n* of one and was not tested blind). Although deployment failures were comparatively rare occurrences, these failures could obviously have significant implications in a live situation and will need to be monitored if the new device is authorised for police use.

At the time of writing of this report, the College of Policing and NPCC have reviewed the residual faults against their reliability requirements. They have accepted the system with the proviso to monitor reliability in service and to ensure the importance of maintenance, care and management of devices is included within the implementation pack and training.

Despite the reduction in Cat A faults across the user trials, the reliability of the TASER 10™ in comparison to previous devices, particularly the TASER X2™, still raises human factors concerns. In the user handling trial report, it is flagged that in the third user trial 35% of devices exhibited a Cat A fault at some point in the testing and, if Cat A and B faults are combined[36], this increases to 70% of devices [20]. If officers experience reliability issues during training, and/or operational use, this will significantly impact their trust in the system and how they view the system. Any anecdotal evidence of reliability issues is likely to be discussed widely amongst officers and spread across forces. It was

[36] Important to note that the fault recording during the user trial only captured the highest category of fault if more than one fault was noted simultaneously, so the overarching number of faults is arguably under-reported in the user trial findings.

clear from the testing that there was some uncertainty around the implications of the changes to the device through the revisions and firmware updates that Axon made. Therefore, there will need to be careful scrutiny by the College of Policing when revisions to the device and firmware updates are issued to understand the potential impact upon faults before they are released more widely. It is advised that the reliability of the updated device will need to be assessed by the NPCC to understand any wider implications that need to be addressed in training, and then carefully monitored to fully understand the extent of any faults and any remedial activities needed to address these. Our understanding of the current procedure[37] is that Axon provides notification of any firmware updates that will impact the user and a date for the update is given. Information is provided in a bulletin from Axon summarising the update which may allow for consideration of implications for training or policy. General updates and ones that have not been identified as having any user impact are likely to be accepted by default. If the implications of the update for the UK user are unclear, there is then opportunity to carry out further testing to better understand what the impact may be. One risk associated with this approach is that Axon may not have identified an update as having an impact on a user, or may not have fully understood the potential wider implications of the change for the UK user. An update could then be accepted as default without a full understanding of what this might mean for the UK user.

8.2.2 Accuracy

To trust the TASER 10™, the officer needs to have confidence in the accuracy of the device when fired. The accuracy of the system was assessed both during the first of the user trials (n = 27 participants, representative of potential end users of TASER 10™) carried out by the College of Policing and in the technical testing. The user trial compared officers using the TASER 10™ to the accuracy of officers using the device they were currently trained in: TASER X2™ (n = 10) or TASER 7™ (n = 9), there were eight new users (i.e. had never been trained in the use of a CED). Accuracy was recorded at 3 m, 5 m, 10 m and 13.7 m (these latter two distances are beyond the range of previous devices, so there was no comparative data) with the laser sight.

The user testing demonstrated higher accuracy and lower probe dispersion with the TASER 10™ (for both probe placements) than previous devices at 3 m and 5 m range with the laser sight. There was also no visible bias from the point of aim across either axis in accuracy. In terms of the greater distances, the accuracy was higher than the comparative data at 5 m for previous devices when TASER 10™ was tested at 10 m. At 13.7 m the impact of previous experience on accuracy became evident in the results and the results (in terms of the deviation from the point of aim to point of impact) were more variable. The accuracy at 13.7 m was much lower and the point of impact drifted lower from the point of aim due to a drop-off in the probe's trajectory.

Accuracy using the mechanical sight was also tested at 5 m using the stealth mode feature. The accuracy of the TASER 10™ in comparison to the TASER X2™ was the same in terms of the average distance between the point of aim and the point of impact for the first probe and this was better than with the TASER 7™.[38] When the data were

[37] Email communication from NPCC and College of Policing 20/01/2025.
[38] In stealth mode, the laser is off and the CID is dimmed. The laser switches on after the first shot is fired using the mechanical sight to assist the initial aiming.

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analysed to compare experienced users of the other CEDs only to their accuracy with their current device, their accuracy with the TASER 10™ was higher than the device they were trained in. The TASER 10™ was also tested at 10 m using the mechanical sight. Results showed the variability in accuracy increased with the mechanical sight at 10 m when compared with the laser sight (which was used to place the bottom probe). Given the difference in accuracy with the mechanical sight it will be important for new users to practise use of the mechanical sight during training, and to understand the likely decrease in their accuracy using the mechanical sight at increased range.[39] One of the participants commented on decreased accuracy at range:

- *Accuracy seriously diminishes at increased distance so would make it difficult to hit a moving target at distance. (T7 user)*

Technical testing [10] assessed the accuracy of the device without a human user involved (i.e. fired from a fixed clamp). Inter-magazine variation and intra-magazine variation was assessed at 10 m for standard and HALT shots as well as assessments at 1.5, 3, 6.1, 7.6, 10.1, 11.9 and 13.7 m for a single magazine. Results demonstrated that the variability around the mean point of impact is low and the accuracy of the device is high, however it does drop off (i.e. to a point of impact below the point of aim) between 7.6 m and 10.1 m, and beyond 13.7 m this is more pronounced. [redacted] [8]. However, an issue with the handle used in the (clamped) technical testing or an artefact of recoil cannot be ruled out (see 10.1). The Home Office have requested additional testing on this handle but this has not yet been conducted at the time of writing.

In general, user handling trials and demonstrated that the accuracy of the device (using both the laser and mechanical sights) was high, and this was confirmed in the technical testing; the TASER 10™ appears to be more accurate than previous devices. This also appears to be successfully maintained at greater range (10 m), noting the decrease in accuracy with the mechanical sight in comparison to the laser sight. The results demonstrate that the accuracy of the system when successfully deployed is high and will not impact negatively upon officers' trust in the system. Rather, the high accuracy is likely to inspire increased confidence in comparison with other systems up to a greater range. Therefore, it will be important to highlight the clear differences in accuracy between 10 m and 13.7 m to ensure that users understand the range at which there will be a drop-off ([redacted] [8]). They will also need to understand the limits of the system in terms of range (<15 m otherwise the probe may detach), drop-off and likely adjustment in point of

[39] The reduced accuracy with a mechanical (fixed) sight is mentioned in the (draft) Operational and Tactical Skills training [8].
[40] Email communication with College of Policing 14/01/25.

aim upwards at greater range and an expected reduction in accuracy using the mechanical sight at range.[41]

One of the challenges of the increased range of the device is that estimation of range tends to be inaccurate, particularly for estimation of egocentric distance[42], which is important for the officers' risk assessment to understand the limits of the device as well as changes in accuracy at increased range. Experimental work with untrained participants in outdoor environments shows that distances from the observer's line of sight tend to be compressed, underestimation increases with target distance and judgements are affected by the tasks people are asked to perform (e.g. see Norman et al. [44]). This egocentric range estimation has also been found to vary with age, for example Bian and Andersen [35] conducted studies outdoors with different aged participants (younger group mean age 23 years and older group mean age 70 years), looking at targets at distances between 4 m and 12 m (highly relevant to the range of the TASER 10™). The judgements of the older participants were significantly more accurate particularly at greater distances, e.g. they were able to judge (giving verbal estimates or pulling a rope to the distance of a target) when a target was 10 m from them, whereas younger participants were significantly less accurate and tended to underestimate egocentric distance (i.e. they think objects are closer than they are). The experimental work suggests that new TASER 10™ users may be inaccurate when judging distance to a target, particularly when the target is at greater distance, and that this inaccuracy may reduce with age (there is a lack of clear data on how and when this occurs)[43]. It is expected that experienced AFOs will have greater experience of range estimation due to their training, however, the author could not find clear data to support this. The assumption cannot be made that officers will be able to accurately judge when targets are reaching the limits of the device's range, or when a target is in the range where the accuracy of the device decreases (i.e. POI drops from the POA). This challenge is considered in more depth in the section on situation awareness.

If the inability to accurately estimate range applies to TASER 10™ officers, then, at longer ranges, the officer may witness a higher than anticipated drop-off in the impact points of fired probes. From the perspective of the subject, this potential underestimation will reduce the likelihood of probe impacts to vulnerable superior structures (head, neck, face) but may increase the risk of injury to structures in the groin region. From the perspective of the officer, however, a decreased ability to accurately target probes at extended ranges may adversely impact on effectiveness.

8.2.3 Functionality

8.2.3.1 Multi-function selector switch

Trust in the system is also dependent upon the functionality of the device and the ability to use the device with ease and without error. The user needs to be fully trained in all

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[41] Review of the (draft) Operational and Tactical Skills training [8] reveals all of these are considered in the descriptive text, but the associated powerpoint slides have not been available for review at the time of writing.
[42] Distance from the observer to a location in 3D space.
[43] The mean (range) age range of the user trial participants was female 32 years (28-38 yrs), male 40 years (25-55 yrs).

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procedural aspects to ensure they have laid down the procedural memory and psycho-motor skills needed to become skilled users of the new system, and are aware of any challenges they may face operating the system and how to mitigate these. Any differences between the new device and the device they may already be trained in also need to be clear so they understand how they need to change their procedures and develop new psycho-motor skills.

The TASER 10™ has a new multi-function selector switch which differs significantly from previous models. This lever on both sides of the device is used to arm the device (single movement up from the "off" / safe position), deliver a warning alert (double movement up from the "off" position) and function test the device (single movement down from "off" position, used to check the device is operating correctly at point of issue). The double movement up position also re-energises skin-embedded probes (said to be up to four) once deployed (once switched to safe the deployed probes cannot be re-energised) and the single movement down also enacts "stealth mode" (i.e. without the laser and warning alert functions). Previous devices (TASER 7™ and TASER X2™) separated the safety switch (similar switch to the TASER 10™ multi-function selector switch but only operates the safety on TASER 7™ so has just two positions "on" or "off", only operated the safety and the stealth mode on TASER X2™ so just had three positions), the arc switch (depressible button on both sides of the device in front of the trigger on the body of the device) which also re-energised probes, and the way in which stealth mode was enacted.

Despite sounding extremely complicated, [redacted]'s experience of physically using the switch and understanding the different positions was more straightforward than expected: moving the lever up is associated with arming, aiming, warning and firing, whereas down is preparatory, whether that is function testing or enacting stealth mode. However, in the user trial there were issues reported in terms of accidentally activating the warning alert and finding the lever difficult to operate (especially if the user had small or large hands, discussed further in section 8.3.1). In response to the statement: "The safety switch/selector is easy to operate" the rating for the TASER 10™ was lower than for the TASER 7™ and TASER X2™ (30% disagreed with this comment for the TASER 10™ in comparison to 11% strongly disagreed for the TASER 7™ and 0% for the TASER X2™). Additionally, 10% of trainers rated the TASER 10™ as "not so easy" to teach officers to manipulate the safety selector.

There is also a delay (reportedly 250-500 ms according to Axon) due to the boot-up process for the electronics between arming the device and activation of the warning alert (there is no delay if the device is fired without the warning alert). These challenges led to inadvertent triggering of the warning device by users as well as failures for the warning alert to activate. Users gave a lower rating for the question: "is it easy to perform a warning display with this device?" in comparison with the TASER X2™ and TASER 7™ (30% disagreed with this comment for the TASER 10™ in comparison with 11% who disagreed for the TASER 7™ and 0% for the TASER X2™). This could have serious implications for a user if they are unable to successfully operate the multi-function selector switch and select the mode they intended.

Understanding the procedures for using the multi-function selector switch, the pressure needed to switch between the positions (and the momentary pause needed once the device is armed before using the warning), will need to be laid down in training to develop the procedural memory and psycho-motor skills. This will take repeated experience of using the multi-function selector switch and practising stepping through the use of each mode until the operator can demonstrate skilled use. However, once an officer is trained significant issues are not envisaged (by this author). It just takes time to develop the user experience in the weapon handling and lay down the procedural memories through practice to progress to a skilled user. There are comments that support this from the user trial:

- *As a new user of Taser and never handled one before, I found this device very easy to operate. I found the 'safety switch/selector' took some time for me to get used to, however I think this is just down to the device being new, as towards the end I found it much easier to operate.* (new user)
- *The safety (return to safety) switch should be a standalone downward action (as with an X2 Taser) If the operator, with the drawn Taser is in a high adrenaline, operational environment, could reply on a single downward thumb action, I believe they would have more confidence that the device was safe and no unintentional discharge could occur (and that the device could not activate a safety check function).* (X2 user)
- *The safety switch is easy to operate as a conventional safety. The only issue I found was when doing a warning display, where the switch has to be pushed all the way up was awkward in comparison to X2.* (X2 user)
- *Warning display not easy to activate under stress as requires distinctive thinking due to being a selector switch. Also activate by accident if too positive a press on selector.* (T7 user)
- *Warning display/arc button easier than all on one button on T10.* (X2 user)
- *The selector switch has a positive feeling to it however there are too many functions that it does.* (T7 user)
- *T10 has more options to consider. X2 and T7 are just on/off, but still easy. Functionality of T10 safety – sees people doing all sorts of things!* (instructor)

How often this needs to be practised to maintain this discrete psychomotor skill[44] is a good question. Research has investigated competence retention for the Defence domain and produced a handbook for supporting analysis in this area (see Cahillane, Anderson and MacLean [36]). As far as the author is aware, analysis of the skills retention for the CED user has not been conducted, additionally the switch is a novel feature for the TASER 10™ so data on previous CEDs would not provide a clear evidence base to understand the training interval needed to maintain the skills of correctly operating the switch. When used under pressure in a live situation, the

[44] A discrete psychomotor skill combines higher motor and moderate cognitive demands and includes procedural skills such as those involved in weapon handling drills (HS 1.004 Revised Knowledge Skill and Attitude Domains Taxonomy v3.0 from Cahillane, Anderson and MacLean, 2022).

operation of the switch will be affected by the wider complexity of cognitive demands on the user at the time of operation. This will be considered in more detail in the section on situation awareness and cognitive load (section 8.3.5). It will be important to record possible challenges in using the switch during the training and in the data collected following use, to identify if there are any specific issues that need to be further addressed in training.

In comparison with previous CEDs, the way in which the device is armed and the warning alert is operated is significantly different, as noted already. This also means that the way in which the user steps through the stages of escalation differs somewhat. Previously this would involve: drawing the TASER to the ready position, aiming, laser "dotting" and arcing the device (as the "warning alert"), before firing. There is no "arcing" of the device with the TASER 10™ so this stage of escalation now involves activating the "warning alert" through the multi-function selector switch.

Additionally, as the warning has changed from the "arcing" of previous devices, perceived to be clear distinctive warning to potential targets that the device was ready to be used due to the "crackle" noise of electricity, to a combined warning sound (mean 89 dBA measured five times at 50 cm from device) described by AXON to be "sci-fi" in nature, and strobe lighting (1000 lumen). This was perceived by some previous CED users to be unsatisfactory in comparison with traditional "arcing":

- *I don't think the warning display is as effective as the X2. I prefer the ""crackle"" of the X2.* (X2 user)
- *I don't feel as though the warning display is as effective as the X2's 'ARC DISPLAY'.* (X2 user)
- *Warning display does not seem as effective as the X2 "arc display"*. (X2 user)
- *I feel the light/arc display is no longer a real deterrent compared to the visual electricity/sound on the T7*. (T7 user)
- *The sound was a lot quieter which I felt was better for public perception, but did not give me confidence as a user of a suspect's compliance.* (T7 user)
- *The ARC warning/light display is pretty much pointless and would be better if the sound mimics the ARC sound of T7*. (T7 user)
- *I did not like the lack of noise during an ARC display. A flashing torch and a toy-like noise I feel would not be effective. It is not showing the capabilities of the device should it be fired.* (X2 user)
- *The 'arc warning' feature with the flashing light wasn't intimidating.* (X2 user)
- *The arc display is more impactive in my opinion and the use of force will be less than firing multiple shots with the T10.* (T7 user)
- *T10 warning v poor its not loud enough I think there needs to be a better warning and a show of force.* (T7 user)

The comments made suggested the change in the warning mode could cause a lack of trust in the potential deterrent effect in comparison with previous devices. A user's lack of confidence and perceived decreased deterrence effect of the warning could have a number of impacts including the risk that escalation to aiming and firing the TASER 10™ is more rapid. Unfortunately, there is a lack of evidence from previous devices to better understand the deterrent efficacy of "arcing" in comparison with other steps of the escalation process. It is not possible to separate out the behavioural response to the laser "dotting" from the "arcing" in the data. Therefore, the potential difference in deterrence effect of this change, in the behavioural response of a subject being targeted, is unknown. Collecting data to better understand the deterrence effect specifically of the new warning alert would be useful for the future, this could then be used in the training so new users understand the likely deterrence effect from the use of the warning and trust this aspect of the system. It would also be advised to engage with and educate the public about the distinctive difference in the warning from TASER 10™ in comparison with previous devices. This would help to make them fully aware that the warning sound and strobe is the same step as "arcing" previous devices and could reduce the risk that they do not view the warning as the same level of threat of being targeted and change their behavioural response to the warning.

8.2.3.2 Central Information Display (CID)

The CID is distinctly different in terms of the information that is displayed and how it is displayed in comparison with previous devices. The location of the display is the same as previous devices although the display is larger. The CID is now a multi-colour display rather than the monochrome yellow of previous devices and the display makes use of more animation than previously (e.g. by flashing). Different colours are used on the display to distinguish between training mode/function test (blue, matches the side lights), weapon/duty mode (yellow, also matches side lights) and critical error in duty mode (red, matches side lights). Understanding the information imparted through the display is important for the user to trust the device and respond/react appropriately to the information on the display. The use of colours other than yellow could pose particular challenges in understanding the display for users with colour vision deficiency (CVD), this is considered further in section 8.3.2.

In terms of the icons, there are similarities to those used on previous devices which will help with the understanding for users who already trained in previous models. For example, loaded "live" cartridges (there are obviously more live cartridges than previous models) are the same and the device displays deployed cartridges in the same way (interior of cartridge icon is black and only the border remains yellow). The battery icon and indicator are the same to show capacity of charge that remains and when there is a low level of charge and should be re-charged. Stealth mode is indicated through a dimmed screen (i.e. the cartridge and battery icons are still yellow but are dimmed).

However, when armed (multi-function selector switch in the up position) the cartridges display on the screen one at a time from left to right, essentially blinking each cartridge individually. This could be distracting to the officer with the TASER 10™ raised in front of them when aiming. The officer should be looking at the subject, however, flashing information on the CID may distract their visual attention particularly in low light conditions.

Errors and issues are displayed using red icons e.g. when there is an error with a cartridge this displays as a red cartridge icon with a line through it and flashes, when the battery drops to a certain level then the icon will turn red and blink to indicate it needs to be re-charged as soon as possible, the critical fault indicator is a large black “X” displayed on a red background that dominates the whole screen and means the weapon should not be used, whereas a blinking battery indicator where the outline of the battery is red and there is a red “X” across the black interior of the battery only indicates the weapon did not recognise the battery correctly and the battery needs removing and reinserting or servicing. A magazine error is also displayed through a red icon.

When the weapon is loaded with inert cartridges, the display operates in the same way but the icons are blue. Blue icons also indicate when a function test is initiated (by pointing the device in a safe direction and shifting the multi-function selector switch to momentarily down twice until the lights go blue then switching it to the up “On” position) and has been completed and when the battery pack needs docking.

In general, the icons are clear and the different displays can be taught to new TASER 10™ users during training. The College of Policing should consider whether more time is needed during formative training to support users’ understanding of the CID due to the increased complexity, and whether understanding of the icons on the CID should be assessed in the summative written knowledge check. Investigation is also needed to better understand if there are conditions under which the animated icons could be distracting (e.g. low light conditions) and any impact of the new colour display on the understanding of the information on the CID for the user with CVD.

8.2.3.3 Effect

Despite the arcing ability of previous devices there was obviously an impact of clothing upon subdual rates and therefore the trust of the user in the ability of the CED to subdue subjects (although this is also dependent on achieving probe spread which will be considered in section 8.3.9). Understanding the possible impact of the clothing the subject is wearing on successful use of TASER 10™ is therefore an important human factor for use of the system and something the user will have to consider for each deployment of a probe. The independent technical testing that was carried out looked at the success of a probe hitting the “skin” against different clothing combinations (t-shirt, hoody, denim, hoody + t-shirt) at different ranges (2, 8 and 15 m). There were 10-15 shots taken using the TASER 10™ in the lab. Evaluation of these shots demonstrated close to 100% success rate for clothing penetration (99.4%, with the sole failure at 8 m for hoody + t-shirt) in producing electrical connection during laboratory based testing against a skin pack [10]. This appears to illustrate the success of the probes at penetrating these types of clothing and embedding in the skin, however, potentially more challenging clothing, such as [redacted] [7]. The recommendation from this work was to consider the potential impact of thick and loose clothing and to train users to aim at an alternative area to support subdual.[45]

In a dynamic situation where the subject is moving and there are many other factors to consider, the ability to target an area where clothing appears to be more easily penetrable will be more challenging (this will also be considered in terms of the cognitive demands in section 8.3.5). A full understanding of the limitations with respect to probes successfully penetrating the skin against a wide variety of challenging clothing in a dynamic situation has not been tested. It is recommended that during training the potential limitations against more challenging clothing are made clear, as well as the differences between the TASER 10™ and previous models in terms of the loss of the arcing feature.

If the TASER 10™ is introduced into service, the ability to make contact with a target in a dynamic environment should be specifically analysed. This is one area that cannot be fully assessed outside the operational environment, but could result in a rapid loss of confidence in the system

8.2.4 Training

8.2.4.1 General

To date the authors have had sight of the following training: *Draft Training Material from College of Policing: National Taser 10 Qualification Draft 0.2* [37], *TASER 10: J2 TASER use and safe handling* [11], *J4 Operational and tactical skills* [8], *Teaching Taser 10: Session One and Two* [8]. From a human factors point of view, the TASER 10™ training is obviously of fundamental importance to the successful use of the system for both existing CED users and those new to CEDs. The training will impact upon the users' development of the necessary **knowledge** (explicit and implicit), **skills** (physical such as continuous and discrete psychomotor skills for target tracking and weapon handling) and **attitudes** (behaviours relating to the task e.g. safety and integrity) around use of the CED. In a dynamic operational environment this will affect the situation awareness and cognitive load of the TASER 10™ officer impacting on their decision-making and judgement.

The specific training for CED users sits within the wider context of police training with several other arms of training which will influence the use of TASER 10™, including training in the National Decision Model (NDM), College of Policing conflict management guidelines, Public and Personal Safety training and training for use of force situations. They will need to be able to draw on this wider training to demonstrate competence in role-play scenarios, justify use of force and demonstrate understanding of how to deal with vulnerable people. There are a number of formative learning elements that include classroom-based learning (to develop knowledge, skills and support appropriate attitudes), practical exercises and procedural drills and live fire. The scenario-based training is also formative. The three summative assessments include an assessment of competence, written knowledge check and qualification shoot. The qualification shoot has been adapted to reflect the new features of the TASER 10™; the qualification shoot

[45] At the time of writing the Home Office is in discussions in relation to further testing using more challenging clothing.

includes multiple probe placement (x4 probes) at 10 m as well as carrying out a "warning display" attempting de-escalation and extending the cycle via the multi-function selector switch.

8.2.4.2 Training content – upskill training

The specific TASER 10™ upskill training [11] appears to cover all the key features of the TASER 10™ and the differences between previous models, e.g. in terms of requiring successive probe placements, the need to continually assess the subject for a change in behaviour as well as considering each probe deployment for appropriate use of force. It describes the component parts of the TASER 10™ e.g. selector switch, CID, side lights, warning alert etc. and is supplemented with three videos. These videos cover a voluntary exposure to TASER 10™: one video covering the firing, the second covering the perspective of the subject on the use of the device and the third showing probe removal. SACMILL saw these videos at the meeting on 23rd December 2024.

There is supplementary information on probe removal in the presentation. This is provided in Figure 53, this process is repeated in the video of probe removal.

s31(1)(a) [redacted]

Figure 53. Guidance on probe removal in the TASER 10™ training curriculum.

8.2.4.3 The need to fire multiple probes

It is worth noting that the video of the subject undergoing a voluntary exposure to TASER 10™ required three probes to be fired to get a connection, because the first probe to hit the subject's back failed to be retained despite them wearing what appears to be just a polo shirt. This failure to subdue under benign conditions, should reinforce to students that it is commonplace for more than two shots to be required.

The need for multiple probes (see section 6) is stated in the training presentation (see Figure 54) and two of the scenarios in the qualification test requires three probes to be fired because the initial attempts are ineffective. It is also understood that the inert cartridge may be used in training. This randomises the number of cartridges fired to make an electrical contact (between 2 and 5), so the need for multiple probes should be reinforced in training.

Discussion with College of Policing also highlighted two new elements they had trialled in the training scenarios. Firstly, a live fire formative session to encourage accuracy and move away from generic probe placement, where officers aim and fire at small numbered patches distributed over the target as the instructor call outs the numbers.[46] Secondly, placing a t-shirt over the HALT suit to prevent probe adherence to highlight the challenge of clothing which may stop a probe penetrating the skin.[47] The addition of these scenarios and the inert cartridge will help trainees to understand some of the challenges associated with probe placement for the TASER 10™. This will allow them to practice different courses of action that could address these challenges in a live situation. However, it is currently unclear whether the scenarios that have been trialled will be new mandatory elements of the training.

s31(1)(a) [redacted]

Figure 54. Slide on probe placement from the TASER 10™ upskilling presentation [11].

8.2.4.4 Training content – Operational Tactical Skills (module J4)

The J4 module covers operational and tactical skills for use of CEDs in general and has been updated with specific information on TASER 10™. Where use of the TASER 10™ is different to previous CEDs, e.g. lack of requirement to cant the weapon if the subject is not vertical, or to use a braced hip position to maintain distance for divergence, this is noted in the training material. The requirement for probes to hit the skin is also highlighted as well as the fact one probe is deployed per trigger pull and the **s31(1)(a)** [redacted]. Accuracy data from the technical testing will also be included in the final version. In terms of probe placement, advice is given on creating probe spread, avoiding sensitive areas and thick or loose clothing. For TASER 10™ a zoned approach to the surrounding area to consider where

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[46] Communication with College of Policing 14/01/25.
[47] Communication with College of Policing 08/01/25.

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missed shots may land goes beyond previous CEDs; first 45 ft (maximum range and greatest risk), second 45 ft (probe only risk) and final 20 ft (probe only risk lower to the ground). Additional information is provided on the ability for TASER 10™ to output energy to up to three subjects, however, this has challenges due to the following reasons: inability to determine who receives NMI, extended discharge to the first subject only and failure to equally distribute energy across subjects. It is clear in the training that use of TASER 10™ on multiple subjects is not trained (neither prohibited nor endorsed).

8.2.4.5 Training content – Teaching Taser 10: Sessions One & Two

This training is specifically for instructors who will be delivering training for TASER 10™. The first session includes the following key topics: testing and results, identified faults and prevention, training considerations and training infrastructure. It outlines the findings from the user handling trial: comparative accuracy between devices at different distances, laser vs mechanical sights and advantages for unconventional postures. It flags identified faults, how to recognise and prevent them, clean and maintain the devices. Under training considerations, it flags the key points around the single probes, the need to embed in skin, use and identification of magazines, multi-function selector switch, increased range and accuracy (e.g. 10 m is less forgiving than 3-4 m in terms of errors in accuracy so there needs to be greater emphasis on theory of shooting) and potential for introduction of virtual reality training. This makes it clear that VR cannot be used for summative assessment and needs instructor supervision to ensure correct use. There are also recommendations to support trainers in helping trainees fully understand these key points and including them in the drill, live fire and scenario training scenarios. The slide on training infrastructure emphasises need for a 10 m range.

The second session outlines the content of the TASER 10™ courses (i.e. 18 hours for initial training, 12 hours for upskill training and six hours for refresher training). It also highlights the four stages of competence from unconscious incompetence to unconscious competence. Factors to consider in drill sessions include making the training device-specific, number of trigger pulls, probes in the skin, how to use increased distance and minimising risk to subject.

8.2.4.6 Virtual reality training

Having viewed the TASER Virtual Reality (VR) system there may be opportunities to support training in a number of ways that could be of benefit, e.g. developing an understanding of the potential impact of different types of clothing on likelihood of hitting the skin when firing, understanding the range of the device and the impact of firing the device at range at a moving subject in terms of the missed shots, decision-making in more complex situations etc. If VR is explored as an option to support TASER 10™ training, it would be important to explore its suitability and effectiveness before including it within the training programme. For example, research has also looked at using VR to try and reduce the degradation of range estimation skills through training. However, findings suggest that there are significant differences in estimations between the two environments (live and virtual) which would make it difficult to use VR as an alternative method for practising this skill [45]. Communications with the College of Policing have made it clear that use of the TASER VR system e.g. to support difficult probe placement would not be mandated.[48]

8.2.4.7 Points related to training from IOPC papers

It is worth noting some points from recent IOPC papers which have directly related to CED training and consider whether these can be drawn upon for TASER 10™ training. For example, the IOPC review of cases of use of CED [32] makes a number of points which relate to improving training for officers:

- *Review, in partnership with relevant stakeholders, how effective current training is on ensuring that officers understand the importance of assessing the surrounding environment and considering any risk of injury to the individual when making decisions about whether to use Taser - particularly in relation to vulnerable individuals.*

The report highlights 14 cases where CED was used in potentially unsafe locations / circumstances. This point is still highly relevant given two recent cases of CED use on a subject at height where the subject subsequently died (pages 28 and 29, IOPC, 2024 [33]). Understanding the situation and the risks are extremely important when taking decisions around the use of CED. This point highlights the need for good situation awareness and continuous dynamic risk assessment before deploying CED in discharge mode. This needs to be directly supported in training through the consideration of dynamic operational environments where the CED officer may be deployed, it is in these complex dynamic environments where the officers will face the greatest challenges to their decision-making whilst under high cognitive load. The risks may be greater for TASER 10™ given the potential numbers of probes that can be fired and its increased range.

Although the current training provides formative training scenarios to practise decision-making in different situations, they are limited by resources available (usually a maximum of two HALT suited targets), the environment and the ability to recreate scenarios with realism. These scenarios will be of benefit, but there are opportunities to expand beyond this and to look to present more complex scenarios through other methods e.g. video simulation or VR. Expanding the scenario-based training to include specific examples e.g. mirroring examples from the IOPC reporting, exploring the most complex situations trained officers have experienced and discussing different decisions/outcomes would help support CED users in the field. If using a VR system was explored as an option it would be important to explore its suitability and effectiveness before including it within the training programme.[49] For example, by comparing between the different options to understand the fidelity and validity of different methods and how they could be used to support training judgemental skills (see Harris et al. [41] for an example of how this research has been conducted to compare outcomes from the different approaches in military decision training).

[48] Communication with College of Policing 14/01/25.
[49] VR will be included in the instructor migration training, however it cannot be mandated, due to the cost. Additional training is included in live formative training to encourage accurate probe placement [1].

The IOPC report [32] also highlights that in a third of cases opportunities to de-escalate were missed. This suggests that there may be opportunities in training to reinforce this that could be exploited within the TASER 10™ training. One of the recommendations from the report was to:

- *Evaluate the effect of the new conflict management guidelines upon policing practice and whether it places sufficient emphasis on communication and de-escalation techniques, particularly when dealing with people from vulnerable groups including children.*

It is important to consider this in light of the increased range of the device and potential difficulty communicating at range in a way that would support de-escalation. The training needs to acknowledge how de-escalation opportunities could be missed and ways of mitigating this when engaging with subjects. Could the potential for de-escalation be covered to a greater extent within the training for TASER 10™? Is it currently covered e.g. in formative training scenarios? De-escalation training is reportedly given greater emphasis in the public and personal safety training given to all officers [4] and now mentioned in greater detail in the CED Operational and Tactical Skills module [8]. **However, given the observations by the IOPC on missed de-escalation opportunities [32], it would be worthwhile gathering usable data to audit whether the effectiveness of de-escalation training is effective and, where applicable, improve training content.**

It is also important to note the evidence that Black people were subjected to more prolonged discharges of CED compared to other groups and this can be exacerbated where race and mental health challenges intersect. The report recommends:

- *Ensure that Taser training provides officers with an understanding of race disproportionality in Taser use, and the impact this has on public confidence and community relations with the police. The training should also provide officers with an informed understanding of the way in which disproportionality in Taser use relates to the wider and historical context regarding the policing of and the police's relationship with Black, Asian and minority ethnic communities.*

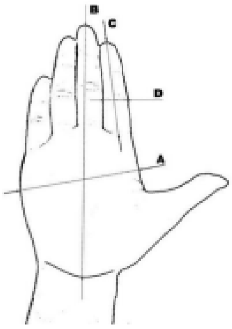
It has not been possible to view the extent of the training to understand if this is addressed explicitly within the current and planned TASER 10™ training. However, there is likely to be a review of training following the TASERD report [45] which focused specifically on disproportionate use.[50]

8.3 Human characteristics and equipment:

8.3.1 Anthropometry: Hand size

The user handling trials included participants with a wide variety of hand sizes. The mean measurements for male and female participants are given below for the dimensions pictured in Figure 55.

[50] Communication with College of Policing 14/01/25.



Officers	A (mm)	B (mm)	C (mm)	D (mm)
Female mean (range)	74 (64-84)	175 (164-186)	66 (62-72)	15 (8-18)
Male mean (range)	85 (74-98)	196 (181-231)	76 (68-86)	18 (11-22)

Figure 55: Hand size measurements and mean (range) measurements for participants.

[redacted] and [redacted] [20] conclude that these are “broadly similar” to the UK populous, however, the author could not find clear data on hand size for the UK population. Data is available from a NASA study in the US[51] where average hand length (measurement B) was reported to be 19 cm for men and 17 cm for women, and width (measurement A) is reported to be 9 cm for men and 8 cm for women, which broadly concur with the measurements in the above table.

In the feedback from the trial, a couple of challenges relating to hand size are flagged. Some of these have been mentioned already with respect to the operation of the multi-function selector switch. Specifically, comments were made by users about the ability to use the switch, female users made the following comments:

- *Safety switch button rather small and fiddly* (X2 user)
- *..due to having a smaller hand I sometimes struggled to maintain pressure up on the safety switch to preform [sic] the warning display/re-energise*. (X2 user)
- *I struggled to move the selector switch upwards to extend/re-energise the cycle. The shape of the switch presented me with resistance so I had to alter my grip on the device to achieve the outcome.* (X2 user)

Male users made the following comments:

- *This component is slightly too small - a larger switch (3-4mm) would make a better positive warning display easier to operate. At present the small switch (and quite stiff action) made performing the display difficult.* (X2 user)
- *As a user with larger hands, I found that my little finger slipped under the handle and I didn't have a positive grip when performing warning display.* (X2 user)
- *Cons - The selector switch was difficult to use in relation to warning display due to small thumbs. Switch could be bigger.* (X2 user)

[51] See https://www.healthline.com/health/average-hand-size#adults accessed 10/12/24.

- *I had no issues in operating the selector lever however those with smaller hand/thumb sizes may have difficulty in engaging the warning display function for a prolonged period of time.* (T7 user)
- *I do like the trigger switch but the extend and Reenergise could do with some work. I found it difficult with my thumb to push it up.* (T7 user)
- *I found the safety mechanism/lever difficult to operate with my dominant hand thumb and had to compensate with my off hand.* (new user)

Additionally, comments were made with respect to the size of the pistol grip:

- *Pistol grip small for people with large hands* (T7 user male)
- *Pistol grip is too small making retention in the event of a struggle nigh on impossible. In addition, trigger position is too far back requiring hand adjustment after arming in order to have comfortable and confident trigger pull.* (T7 user male)
- *Taser was easy to handle but handle/grip was quite wide for someone with small hands.* (new user female)
- *The pistol grip on the T7 is quite small in relation to my hand size. This is a concern when in a struggle with an offender.* (T7 user male)

The comments above make it clear that there were some issues encountered with the TASER 10™ by the participants in relation to their hand size in terms of the functioning of the safety switch and the size of the hand grip for users with (self-reported) small or big hands. N.B. comments were not matched to actual hand size. The current device is only available in one size so it is not possible to adjust the device itself to accommodate this, however, the suggestion is made that having different sizes available to tailor to the individual could be of advantage. In the meantime, it will be necessary to support users in modifying their use of the device, where possible, to support effective use of the device and this is noted in the following instructor comment in the report:

- *…t10 does require the instructors to look at the officer as an individual and tailor their grip / safety manipulation to their body mechanics.*

The training material for instructors needs to support them in doing this and provide clear methods of adjustment that can be used to help users who are finding the use of the device difficult due to hand size. Currently, this is reliant on instructors working with users on a one-to-one basis and allowing for reasonable adjustments, but this is not specifically addressed in the training material [4].

8.3.2 Colour vision

The use of a multi-colour display for the TASER 10™ may pose a particular challenge for the user with CVD due, in part, to the use of a significant number of critical red warning displays displayed on a black background e.g. cartridge errors, magazine errors, battery issues, function test failures. Additionally, information is displayed during training modes and function tests in blue. The side lights are also yellow, blue or red to denote duty, training or error.

Previously, work was conducted to understand how the training of CED users could be adapted to support officers with CVD (dichromacy or severe trichromacy) to become TASER users (see Sheridan [46]). The training was developed to allow for the use of the mechanical/fixed sight in the summative live firing assessment if the laser sight was not visible to the user. It is the authors' understanding that this option is likely to be available to the potential TASER 10™ user to allow those with CVD to continue to be able to be trained in TASER if they are unable to see the green laser. However, the increased complexity of the TASER 10™ CID and the use of multiple colours in the display (red, yellow and blue) poses a new challenge. Dichromats may have deficiencies in either red, green or blue, which could result in them not being able to see the red or blue icons on the CID, these coloured icons could also cause challenges for the trichromats as well.

It is recommended that further work is undertaken to understand any issues that users with CVD may have with TASER 10™, as there are risks in terms of the user understanding the warning displays on the device which could pose human factors challenges in terms of operating the device safely if they are not seen. One approach that could be considered for personnel with CVD, if training on the CID is included to a greater extent in the TASER 10™ training and included in the summative knowledge assessment, is to use the evidence from this assessment from users with CVD to determine whether they can qualify in TASER 10™.[52]

8.3.3 Hearing: Audible alerts

There are a number of different audible alerts from the TASER 10™. These vary in their volume, duration and pitch. Table 5 below summarises the noises.

Notifications	Warnings	Alerts
Low level beep • Low battery • Mode changes	Medium level beep • Automatic shut-down warning	Loud sound • Armed Alert • Warning Alert
		High-pitched sound • Connection alert

Table 5: Audible alerts produced by TASER 10™.

The technical testing assessed the sound level 50 cm from the firer to assess the level of sound for the user in terms of the device being fired, the warning alert and the connection alert. The findings showed the mean sound level for the connection alert (78.51 dBA) and warning alert (89.30 dBA) [10]. The sounds for the warnings and notifications were not assessed, it is unclear if these may be difficult to detect by some officers with hearing impairments or officers with normal hearing in a noisy environment. It seems unlikely that subjects would not be able to hear the warning alert and see the

[52] The College of Policing have reported that they will be asking about issues of the TASER 10™ CID with officers with CVD [1].

strobe lighting. The firing of the device was not significantly louder than previous devices (it was tested against the X2) and was not expected to exceed safety limits, but this would need verifying in individual environments, especially in training where both staff and students will be exposed to repetitive noise.

The CoP draft upskill training [11] covers the different sounds, their meaning and when they would be triggered. In terms of the user trials, a number of challenges with the warning alert and connection alert were highlighted in the first two trials, including a Cat B fault with warning tones (unclear if connection or warning alert) extending beyond the time frame. This was apparently addressed in a firmware update but was still experienced during the third user trial during 2% of exercises. Additionally, there were erratic/intermittent connection alerts that were noted, however, these were believed to be due to the inconsistent conductivity of targets. It is unclear if the extended warning tones have been addressed in more recent updates or if it has been determined for certain that erratic alerts were due to the target. It will be important to monitor these challenges during training and capture any errors in the sound during operational circumstances to establish if these issues persist. If they do there could be potential implications for the officer in understanding if there is a successful connection or not, and this could impact upon their decision making.

The only comments on the sounds made by users related to the warning alert sound. This has been covered already in section 8.2.3.1 of this report.

8.3.4 Form factor and compatibility with other equipment

In terms of the form factor of the TASER 10™, this is largely consistent with previous versions of CED in terms of size (reported as 20 cm long, 4.4 cm wide, 11 cm high) and weight (device 290 g, ten cartridges @ 11 g per cartridge 110 g, magazine 77 g, 79 g battery, total 556 g). In the user trial, 96% of officers agreed or strongly agreed that the size and weight was suitable for carriage and use with other equipment. This was higher than the assessment of previous devices made by users of the other devices (90% agreed or strongly agreed this applied to the use of the X2, 78% agreed or strongly agreed this applied to the T7).[53]

The form factor for the VR device appears to match the real device (476 g for the device with cartridges and magazine, 79 g for the battery, total 557 g[54]), this would support the transfer of training experience on the VR to use of the real device in terms of the weight and feel.

Given the consistency in form factor with previous devices, no new challenges are foreseen in terms of the human factors with respect to use to the equipment and compatibility with other equipment the users may be carrying. The only point to note that may differ between the TASER 10™ and extant devices, is the use of gloves and the operation of the new multi-function selector switch. Given the challenges flagged in

[53] It should be noted that the ability to carry the device operationally with minimum interference with other equipment is a Systems Requirement (see section 3) for the TASER 10™.

[54] To note these measurements were not conducted with certified and calibrated equipment so there may be some minor discrepancies, however, these measurements appear to be consistent Axon's specifications which provides a level of assurance.

the user trial with manipulating the switch, it will be important for users to trial any gloves they might choose to use (e.g. in cold conditions) before using them in earnest in operations. This would allow them to check under benign conditions that there are no issues and that the gloves do not impact on the ability to effectively use the multi-function switch (or any other hand-operated feature of the new device). Not being able to use the switch in a timely and effective manner in a live challenging situation could have serious consequences.

8.3.5 Cognitive load and situation awareness[55]

What is cognitive load and situation awareness (SA) and why are they important for the TASER 10™ user? For the purposes of this report the following definition of cognitive load is applied:

> *“the dynamic relationship between the demands of an officer’s tasks, and available perceptual, attentional, and cognitive resources”* (Hollands et al. [42])[56]

As illustrated in the definition, the cognitive load on the officer is important because perceptual, attentional and cognitive resources are limited, therefore, it is important to understand any additional cognitive demands from the use of TASER 10™. If the cognitive demand of using the technology has increased, then this will impact upon the cognitive resources available to the user for other aspects of their tasks, e.g. ability to deploy de-escalation techniques, monitor the behaviour of the subject or other people in the vicinity. Research also shows that if the usability of technology changes this can impact both error rates and skills retention (see Sanders [47]), so there are important aspects in relation to training to consider.

Situation awareness (SA) is defined as:

> *"The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future"* (Endsley [40] p.36).[57]

Having good situation awareness will mean the user understands the different elements in the environment and, using their experience, can project how events might evolve in the future. This is fundamental to applying the NDM, taking decisions based upon information about the current situation and justifying use of force. Understanding if there are any aspects of TASER 10™ use which might impact upon the SA of the user is therefore important.

There is also an interaction between cognitive load and SA. At low levels of cognitive load, then, the cognitive resources of the officer to support SA will not be impacted. If

[55] Within the literature the terms “situation awareness” and “situational awareness” are used interchangeably, for the purposes of this report the author has gone with “situation awareness”.
[56] For the purposes of this report “soldier” has been replaced by “officer” in the quoted definition of cognitive load.
[57] There are a number of alternative definitions of SA however, this is arguably the most commonly used. Other definitions include the consideration / reflection on the past, as well as the present and future (see Bedny & Meister [34]), or reference to SA being wholly externally directed (see Smith and Hancock [48]).

cognitive load is high, however, then these resources may be directed towards other tasks which would mean less attention may be paid to the evolving situation. This can lead to a degradation in the officer's understanding of the current situation, which could then impact on effective decision-making.

There are both positive and negative aspects of the TASER 10™, in comparison to previous devices, which will impact upon the cognitive load of the task and aspects of SA (some of these have been discussed in section 6). These will be considered in the sub-sections that follow:

8.3.6 Positives: reduced complexity of cartridge options

One of the benefits of TASER 10™ on the cognitive load on the user is that it removes the complexity of having two different cartridges available, as was the case for TASER 7™ which had both close quarter and stand-off cartridges (noting that the TASER X2™ and all previous versions had a single cartridge option). Therefore, the user does not have to consider whether the pre-loaded cartridges will be appropriate to the range of the subject. This is likely to reduce the cognitive load of the officer as they simply do not have to take into account this consideration when poised to fire the device.

8.3.7 Positives: firing cartridges singularly

Additionally, as cartridges are fired singularly, as opposed to in a diverging pair for all earlier models, users only have to focus upon sighting one probe at a time when firing the device. This is done using the single green laser or, if used in stealth mode, a location where the laser is not working or poorly visible or by an officer with CVD, the mechanical sighting system. Previous analysis has demonstrated that sighting the bottom probe can prove particularly challenging and the user is most likely to miss the subject with the bottom probe (e.g. analysis of TASER X2™ data demonstrated that this was 4.6 times more likely than a top probe miss [7]). Again, this is likely to reduce the cognitive load of the user as they can focus upon targeting a single point of aim on the subject and do not have to consider the location of the lower red laser (which was less visible to the eye for those with normal colour vision and colour deficiency) which indicated the aim for the lower probe. Officers also do not need to be trained in the variability in the divergence of probes between different versions of CED or differences in dispersion of probes that was seen in trials of TASER 7™ in comparison with the TASER X2™.

8.3.8 Positives: easier to target different orientations/challenging locations

Another benefit is the ease of targeting subjects at challenging orientations when not in a vertical orientation, for example when supine, or when part of a subject is obscured e.g. by a wall. Previously, the requirement to tilt the device to try and achieve placement of the diverging probes on a supine subject was cognitively challenging. Additionally, any obscuration of the subject made it difficult to place cartridges just on the upper or lower parts of the torso without risking targeting a sensitive area. The ability to fire probes independently lowers the cognitive challenge of targeting a diverging pair or probes and provides more options to the officer in terms of being able to successfully place two probes far enough apart solely on either the upper or lower part of the torso.

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8.3.9 Challenges: sighting and delivering a second probe with appropriate probe spread

Although there are significant benefits from no longer having to fire two diverging probes simultaneously, one of the challenges with the TASER 10™ is the need to successfully sight and deliver a second probe that has the required probe spread to achieve NMI. Previous studies suggest that a minimum spread of 23 cm is needed to achieve NMI that will prevent most subjects from proceeding with a task [24]. Therefore, an additional cognitive load on the user is to successfully deliver the second probe an appropriate distance away from the first. This will require rapidly re-aiming the device whilst trying to dynamically assess the appropriate location to target, avoiding sensitive areas in a potentially moving subject at a varying range (previous analysis of TASER X2™ data showed that officers report subjects were moving in 85% of incidents when probes were fired [7]). Whilst managing the cognitive load of the second shot users will also need to maintain situation awareness and consider the wider environment surrounding the subject, the evolving situation and the potential risk of the probe unintentionally hitting other individuals. The user trial suggests that this can be done both quickly and accurately in a training situation [20], however, arguably the implications of this change has not been fully assessed in a more dynamic uncertain situation. It is also unclear if having the responsibility for the successful placement of the second shot places an additional burden of responsibility on an officer that was not felt before. It will be important to collect data from training and operational scenarios to better understand the implications of this change, and the impact on cognitive load and SA, as well as any knock-on effects on decision-making in more realistic dynamic situations.

8.3.10 Challenges: probes hitting the skin of subject successfully with appropriate probe spread after two probes have been fired

s31(1)(a) [redacted]. The requirement to fire a minimum of two probes successively with appropriate probe spread, whilst trying to penetrate different types of clothing to ensure hitting the skin successfully, could be cognitively challenging in a dynamic situation. Once the first two probes have been deployed and hit the target, if there is still no change in behaviour then the user will need to fire at least one more probe to try and achieve NMI. The additional difficulty with the TASER 10™ will be that if both probes appear to have hit the target, but have not induced behaviour change, they will have to try to fire a third probe sufficiently distant from the first two probes to achieve NMI. If the firing of the third probe then fails to induce a behavioural consistent with NMI, then the officer will not know which (if any) of the probes have embedded in the skin. This will escalate in complexity as more probes are fired.

As the incident continues to unfold, the officer will still need to maintain good SA of the area around the subject to reduce the risk to bystanders. This will be challenging as the cognitive demands increase in terms of trying to successfully place further probes at a sufficient distance from any probes that have hit the subject but have not induced NMI.

8.3.11 Challenges: novel procedure for enabling the warning alert

A complexity of the TASER 10™ are the changes to the procedure for the officer seeking to warn the subject of potential escalation. This is significantly different from previous devices (TASER 7™ and TASER X2™) in terms of the sequence of actions that must be taken to enact a warning using the device. Using the “arcing” display is the third action to be taken in non-discharge mode (after draw and aim) to warn a subject. This was done previously by holding down the ambidextrous arc switch, which was used to provide this warning (and consciously take the decision to prolong the length of electrical discharge after firing the probes). The TASER 10™ differs significantly in that the warning mode now needs to be delivered by using the multi-function selector switch which serves the additional functions of enacting stealth mode and arming the device. This increases the cognitive complexity of use and as a result will impact upon the cognitive load of the officer trying to make sure they select the correct position of the switch. Comments flagged in the user trial [16] suggested that this could be particularly difficult in a challenging evolving situation:

- *The safety (?) (/) motor skills under pressure can be hard to manipulate. (X2 user)*

Additionally, the user handling trials suggested that this complexity was resulting in erroneously triggering the warning or failing to deliver the warning. This needs to be addressed directly in the practical exercises and procedural drills during training, to ensure that all users can successfully consistently deliver a warning.

Similarly to the introduction of the TASER X2™ and TASER 7™, the NPCC’s recommendation remains that, once trained in the new device, users should not revert to use of older devices. This would risk the introduction of additional cognitive complexity e.g. reverting to procedures for previous devices when using the TASER 10™. The NPCC implementation plan (in its current draft) states that officers will only be authorised to use one model of CED operationally, this also applies to trainers who may maintain competence on more than one model of CED. Dstl have sought some clarification on this matter and understands that the next draft of the implementation will carry different instructions (see section 7).

8.4 Situation factors

The use of CED by the police involves taking decisions in a dynamic operational context where there may be high levels of uncertainty. The quality of decision-making around the use of TASER is of fundamental importance to its success as a means to protect the public and police. As such “the safety, security and wellbeing of communities is a primary consideration in risk decision-making.” [50]. This point is important as it highlights the need to consider not just the physical and ergonomic implications of deployment of a new technology, but also the potential for psychological harms and societal impact.

The TASER 10™ will be used in a variety of social environments and there are risks around its use in terms of unintentional consequences, such as disproportionate use against different groups of people and use against vulnerable people (children and adults). These have been highlighted in previous reports [29] on CED use and have understandably raised concerns amongst communities and organisations. In the

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implementation plan for TASER 10™ it is clear that the approval process for its use must consider both ethical and societal issues [27].

How the public may view the technology needs to be considered through lay representation[58] and public engagement. The draft implementation programme has key messages around the TASER 10™ having increased accuracy, range and number of cartridges, to support safety and provide more opportunity to de-escalate. It is important that these messages land with communities as they could impact upon a subject's behaviour and response when threatened with use of a TASER 10™. For example, knowledge of the increased accuracy, range, number of cartridges and understanding of the new warning alert could result in subjects modifying and de-escalating their behaviour more quickly if they appreciate the capabilities of the system. However, it is also important to acknowledge that there may be unintentional consequences of the increased, accuracy, range, number of cartridges and change to the warning alert. These changes could lead to missed opportunities to de-escalate, difficulties communicating with subjects at range and increased number of discharges. This was highlighted by the comments from the user trial [16]:

- *Knowing that there are potentially 10 shots to fire may encourage more shots than normal as you know you there are more left*. X2 user.

If this did turn out to be the case, this could result in an increase in disproportionate use of TASER 10™ against certain groups and increased risk to bystanders of being accidentally hit by a probe due to the requirement to fire a minimum of two cartridges. As highlighted earlier, collecting objective evidence to assess the implications of the changes when TASER 10™ is used operationally is of utmost importance to monitor this and mitigate any potential harms and societal impact.

8.5 Summary of human factor findings

1. There were a high number of faults identified in the final user trial. If only the Category A and B faults are counted, the TASER 10™ meets its threshold for reliability of 95%, with faults being reported in 4.7% of cases. However, if the lower categories of faults are included, this threshold is not met with 7.1% of uses resulting in the reporting of a fault. There is a distinct lack of clarity around the threshold for the system requirement as this is not defined. The high level of faults raises human factors concerns regarding the reliability of the device and the resulting level of trust users might place in the system. It is understood that this will be reviewed as part of the system acceptance process and before the device is deemed acceptable by the NPCC (see section 3).

2. Testing demonstrated high accuracy of the device during user trials (with laser and mechanical sights) and technical testing which appears to demonstrate greater accuracy in comparison to previous devices and be maintained at greater range, although accuracy does decrease with the mechanical sight and at greater range. The high accuracy and increased range are likely to increase the trust in device and may inspire increased confidence in the use of the device particularly at

[58] This is important for review and assessment of proposals for use through Committee membership as well at the stage of wider public engagement.

greater range. It will be important for users to develop an understanding of the limits of the device and the decreases in accuracy at range. This is also dependent on accurate range estimation, a skill that humans are not good at when estimating egocentric ranges. The assumption cannot be made that officers will accurately judge when targets reach the limits of the devices range, this needs to be made clear in training.[59]

3. There is additional complexity in the use of the new multi-function selector switch which serves a number of different functions in comparison with previous devices and includes operation of the warning alert. Users reported finding this took some time to get used to during training to lay down the procedural memory needed for the psychomotor skill, and a number of errors were reported, e.g. failing to activate, or accidentally activating, the warning alert.

4. The warning alert is perceived by users of extant devices to be dissatisfactory in comparison with the arcing (and crackling) of the previous devices and there are clear concerns that it will be less effective which could result in a lack of trust in the ability for this to operate as a successful deterrent. There is no evidence that supports (or negates) this perception or previous data which reveals how effective the arcing has been as a deterrent in the past. The lack of confidence in the warning display could reduce the likelihood of use and result in an escalation of force.

5. The Central Information Display is different from previous devices, displays more information and uses colour (blue, yellow, red) and animation. Whether the animation could be distracting in a live situation needs investigating. More time may need to be dedicated to understanding the CID in training.

6. The user will need to make sure the probe embeds in the skin of the subject in order to induce NMI and the loss of the arcing effect in the TASER 10™ means that the discharge will not now arc across a small air gap if the probe lands in clothing. Technical testing suggests good penetration of clothing, however, the most difficult combinations of clothing were not tested ([redacted]).

7. The TASER 10™ Virtual Reality system could provide additional opportunities to practise the skills needed to successfully use TASER 10™ in a cost effective way. It may also support training of specific skills that are very difficult to enact within the training environment due to resource limitations. For example, formative training scenarios that include the most challenging situations an officer may face to support developing their decision-making skills in uncertain situations.

8. Recent cases have made it clear that assessing the surrounding environment and considering risk of injury to the subject is of paramount importance and can have huge impacts upon the safety of the subject. This needs to be explicitly covered in TASER 10™ training as the risks may be greater given the potential numbers of probes that can be fired and the increased range.

[59] Please note the observations obtained from [redacted] in section 9.

9. There are a number of recommendations from the IOPC report into CED use that make reference to training e.g. around de-escalation and race disproportionality in CED use. Greater reference has been made to this in the draft training material, however, whether this is sufficient in the context of the TASERD report remains to be seen [45].

10. The user trial demonstrated that officers with larger or smaller hands may find the operation of the multi-function selector switch challenging and the grip itself either small or large in relation to their hand size. Consideration of this should be made by trainers to support officer's operation of the device. Additionally, any hand protection that might be worn by officers needs to be trialled in the training environment to ensure the multi-function selector switch can still be used effectively. It may be advantageous in the future for the manufacturer to offer different sizes of device to accommodate different users.

11. The new CID includes colour combinations and warning signals that may be poorly visible to the officer with certain types and severities of CVD. This needs to be explored further to appreciate how their understanding of the information on the CID may be impacted and if it could pose a safety risk. Training could proceed with officers with CVD using the previous approach to training using the mechanical sight if needed and including a summative assessment of their ability to interpret the information displayed on the CID.

12. There were a number of issues with the audible alerts during the user trials and it is unclear if these have been resolved or if errors with extended warnings and erratic connection alerts may persist. It is also unclear if some of the alerts may be problematic for users that have hearing deficiencies.

13. The requirement to sight and deliver successive probes at a suitable distance from any previous probes for NMI adds cognitive load to the user. As an incident extends and more probes are fired, monitoring the subject for behaviour change, whilst trying to maintain good situation awareness, will be challenging. The implications of this change for live dynamic situations have arguably not been assessed.

8.6 Human factors recommendations

1. TASER 10™ faults (live and HALT system) are closely monitored to understand possible impacts of current and emerging faults on the user and mitigations which may need to be put in place through training and manufacturer updates.

2. Updates to the device and firmware are not implemented until the NPCC has had the chance to assess the knock-on implications any changes to the system may have on its use, and understand any trends for new faults that are identified.

3. Training should make it clear that the TASER 10™ decreases in accuracy at range and the user will be less accurate when using the mechanical sight (the latter is covered in training [8] and the training now regards the 'optimum effective range' as **s31(1)(a)**, which is a range where the probe drop is likely to be unimportant). Officers must be made aware of the limits of the device and the drop-off in the

point of impact from the point of aim. The difficulty of achieving accurate range estimation must also be highlighted and the lack of awareness of poor range estimation that could impact decision-making.

4. During training officers must be allowed the time to practise the use of the multi-function selector switch (particularly the warning display) to the point where its use is performed intuitively without error. The training interval needed for skills retention in the TASER 10™ user should be investigated to better understand the refresher training that might be needed to maintain the successful use of this switch under high cognitive load in a live situation.

5. It is unknown whether the change in warning display could reduce the deterrence effect in comparison to previous devices. Data should be collected on the use of the warning alone and when this changes the behaviour of the subject to understand its effectiveness. Additionally, it is important to educate the public so they have a grasp of what the warning alert from the TASER 10™ looks and sounds like, so they understand that it is different from previous devices and they should change their behaviour if it is used.

6. There may need to be more time dedicated to teaching users about CID, the icons, display and animation on the display during training compared to previous devices to ensure there is no confusion. This should also be included in the summative knowledge check to verify understanding.

7. Testing the penetration against the most challenging clothing combinations ([redacted]) should be considered to better understand when penetration is least likely. The requirement to hit the skin and likely limitations of penetration of the most difficult clothing should be clear during training as well as the loss of the arcing feature.

8. The VR system should be investigated for opportunities to support existing training and reinforce skills and decision-making that is currently difficult to practise within the training environment.

9. Include situation assessment and assessment of the likelihood of injury to the subject explicitly in training making reference to recent cases e.g. use in potentially unsafe locations and deaths from falls from height, as well as the challenges of making these decisions when under pressure.

10. Assessing the surrounding environment and considering risk of injury to the subject need to be covered to a greater extent in TASER 10™ training and the potential amplification of these risks given the potential numbers of probes that can be fired, their increased energy and their increased range.

11. There are a number of recommendations from the IOPC report into CED use that make reference to CED training e.g. around de-escalation and race disproportionality in CED use. These should be explicitly considered for TASER 10™ training and potential unintended consequences of the increased number of probes and range of the device.

12. Trainers need to support users with varying hand size to help them to tailor their grip and use of the multi-function selector switch if they find this challenging during training. Officers should also trial the use of any hand protection under training / benign conditions to ensure that operation of the switch is not impacted.

13. The impact of the new CID on interpretation of the information by those with CVD should be investigated before training officers with CVD on the device. A trial could be conducted where officers with CVD are trained in TASER 10™ using the mechanical sight, if needed, and a summative assessment including interpretation of safety critical displays on the CID is conducted to understand the potential impact.

14. Warning alerts need to be monitored to determine if the errors seen in the user trials persist. The detection of the audible alerts by officers with hearing deficiencies should be assessed during training to determine if there are any challenges and they cannot hear the audible alerts.

15. The College of Policing need to be alert to any unforeseen circumstances arising from the cognitive challenge of sighting and delivering successive probes with appropriate probe spread in dynamic situations where situation awareness must be maintained. The ability to do this and any negative outcomes must be closely monitored during training and operations if the TASER 10™ is procured.

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9 Operational reporting

At the outset of the project, it was anticipated that the international operational experience from 'early adopters' of the system could help to guide the assessments (technical, user and medical).

9.1 [redacted]

[redacted]

[redacted]
This is only taken from a low number of deployments, so it should be considered in the context of these low numbers. The total distribution of the number of firings per incident is given in Figure 56.

[redacted]

Figure 56: [redacted] data [52]: number of firings per incident.

[redacted]

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s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

9.2 **s41** [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

Table 6: **s41** [redacted]

s41 [redacted]

s41 [redacted]

s41 [redacted]

[redacted] **s41** [redacted]

9.3 Other anecdotal evidence

The 'r/AskLE' forum on Reddit has some discussion on the TASER 10™ seemingly by US police officers.[60]

One potentially interesting aspect emerged in a thread discussing how use of force applies to the TASER 10™ versus older devices:

> "In LE it's taught that each pull of the trigger with a taser is an individual use of force (x2 shoots 2 probes) so each pull needs to be justified. Does this change with the taser 10 because you need two probes with good spread to reach neuromuscular incapacitation and taser 10 only shoots one probe at a time? Thoughts?"

To which one of the thread contributors responded:

> "Yes, the "each trigger pull needs to be justified" guidance still applies. Here's my example of this in practice: since my agency switched to the TASER 10, we've had two occasions in which the first trigger pull was justified, but the subject gave up when they were hit with the first probe. The officer recognized that the resistance was gone and did not fire a second probe. These were both fleeing subjects, not fighting subjects, so it was easy to see that they stopped running and put their hands up.
>
> "Now, I think it will be understood that when a TASER is used, it is a very fast paced, rapidly evolving situation, and the officer is making split second decisions. In the example I gave above, I don't see the officer getting in trouble if they deploy another probe before recognizing that the resistance level has changed."

While the argument put forward by the (alleged) police officer seems highly plausible, its appearance in an online forum does not, of course, make it fact. Nevertheless, it seems possible that a subject may become compliant following the impact of the first clothing-penetrating probe, thereby obviating the need to seek NMI (and, with it, potential penetrative and fall injuries) with the firing of follow-up probes.

It is recommended that this aspect is raised with the College of Policing for them to consider whether they would want to cover this in their TASER 10™ training.

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[60] https://www.reddit.com/r/AskLE/comments/1hiq1st/taser_10/

10 Additional testing

10.1 The need for further testing

The need for additional testing was identified after review of the technical testing [10]. This came from several observations, namely:

- The mean point of impact from the (single) handle used in the technical testing was lower than the mean point of impact observed in the user handling trial [20]. This was noticeable at the (reported) zeroing range of ~10 m. The reason for this could be simply that the weapon is zeroed taking into account the effect of recoil as the weapon is hand-fired, or it could be more sinister, such as the handle used in the technical testing was not zeroed, either because the laser sight had been knocked out of position or because the weapon had not been correctly zeroed prior to release by the manufacturer, thereby raising wider quality control issues.

- When the technical testing was observed by police officers local to the test house, they commented that the clothing selection was not particularly challenging and individuals are known to wear thicker sets of clothing or combinations of clothing. This may be with the intention of reducing the effectiveness of CEDs, or may be for other reasons, such as to conceal offensive weapons. There was, therefore, concern that the results from this testing may mislead the acceptance and put officers at risk: even if it didn’t put officers at risk, it may reduce trust in the system.

- Axon reports that the TASER 10™ can only energise four skin-embedded probes at one time, but this has not been independently demonstrated. SACMILL raised concern that a wide distribution of probes and multiple excitations may increase the risk to subjects. They therefore wished to see confirmation that only four probes could be excited.

11 Medical implications of the TASER 10™ system

11.1 System effectiveness

When used to fire probes, the ability of a CED system to induce NMI has medical implications because the failure to subdue a subject may result in other, potentially more injurious, forms of force being used. Poor effectiveness will also erode both user and public trust in the system.

The TASER 10™ deviates from previous devices in that the probes need to be in contact with the skin to induce NMI. This means that the darts of the probes need to perforate any clothing and at least two darts need to embed in the skin. Analysis of UK data for the skin penetration rates for extant CEDs, together with limited operational data for the TASER 10™ from two groups of international law enforcement partners, indicate that two probe firings will not necessarily be sufficient for the TASER 10™. In fact, these partners report that anything from one to ten probe firings of the TASER 10™ needed to be deployed in the incidents they cite.

The College of Policing train the need to focus on a behavioural change in the subject. This training is supplemented with a video of a volunteer on whom three TASER 10™ probe firings were required to induce NMI. Additionally, the training magazines reinforce that two probe firings are not necessarily sufficient.

The UK analysis of skin penetration rates for extant CEDs in summer and winter months indirectly supports the notion that a seasonal variation exists in the number of probes required to cause NMI. This is presumed to be due a seasonal variation in the clothing worn by subjects. Testing of the TASER 10™ against simple clothing layers did not demonstrate issues with penetration of an underlying skin simulant layer, but whether more challenging clothing can similarly be overcome by the dart of the TASER 10™ probe is yet to be confirmed.

As noted in section 6.2.1, a human volunteer study provides evidence to suggest that the ability of the TASER 10™ discharge to prevent the study participants from achieving an objective in a goal-directed task is similar to that seen with the TASER 7™ [23]. The present authors then conjecture that the subdual effectiveness of the TASER 10™ might be expected to be around 90% with an adequate probe spread. The latter is based on the officer-reported effectiveness of TASER X2™ and TASER 7™ discharge when the darts of their probes have embedded in skin [21][25].

While the focus may be on the induction of NMI, it is worth noting that the proposed UK training for the TASER 10™ does not at present take into account the possibility that a subject may become compliant after the firing of a single probe, thus obviating the need to fire further probes and, therefore, avoiding any additional medical risks associated with their firing. This then raises the issue of whether force escalation should include a single probe as a tactical option and a use of force.

11.2 Probe ballistics

The higher kinetic energy and momentum of the TASER 10™ probe presents a number of issues. On one hand, the greater energy should mean a greater probability of skin

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penetration but, on the other, it may be assumed that it will increase the risk of direct injury (from impact and penetration). Secondary injury from free-flying or ricocheting probes is also a consideration. In particular:

- There is evidence in the technical testing that the greater energy of the TASER 10™ probe could result in deeper penetration into a skin simulant pack than the lower energy TASER X2™ probe, although there was no statistically significant difference. Whether this becomes operationally significant has yet to be determined.
- The dart length of the TASER 10™ probe assembly is about 11 mm and is ostensibly the same as that used for previous models of CED used by UK police forces. However, there is an impact absorber at the base of the dart (in front of the main body of the probe) that is intended to cushion impact. When this impact absorber compresses during impact, the dart length is effectively increased and has the potential to penetrate further into the subject than the darts used by previous CEDs. Moreover, when the impact absorber is fully compressed, which may occur when the dart fully inserts into bone, the dart length could effectively increase to about 15 mm. Whether this becomes clinically significant has yet to be determined.
- The greater impact energy also increases the risk for bone penetration for superficial bones (for example, head, ribs and pelvis). The testing produced isolated cases of bone penetration in simulated bone, including fracture and deformation of the dart potentially adding a complication to the removal procedure (and increasing the risk of bone infection). In addition, examples were noted in testing where the dart deformed in a manner that could result in a risk of increased soft tissue injury when it is extracted from the skin.
- The probes detach at the limit of the tethering wire, which can result in free-flying probes that can continue in a ballistically unstable state for an extended distance. This phenomenon is noted in the College of Policing training for the TASER 7™ the probes of which similarly detach. The free-flying range has been extended for the TASER 10™ to reflect its greater kinetic energy. Officers are expected to consider the backdrop to accommodate such risks when preparing to fire probes. The occurrence of free-flying probes and the consequent risk presented to people down-range of the subject should be monitored as part of routine usage reporting.

Each of these have medical implications. Whilst a first statement should comment on these to the best of SACMILL’s ability, these should also be monitored in UK use as well as observing the medical literature and the experience of international partners who have adopted the TASER 10™.

An Axon-sponsored study, in which TASER 10™ probes were fired at a distance of 24 inches at the bare abdomen, thigh, buttock and back of twenty human volunteers, reported no evidence of tissue overpenetration “defined a priori as a wound that would be deeper than it is wide upon visual inspection” [58]. Notwithstanding the limited sample size, the authors confined the targeted regions to Axon’s so-called preferred

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target areas. Therefore, injuries to other areas, such as head and neck, were not explored.

11.3 Electrical output of the TASER™ 10

When measured across a 600 Ω load in accordance with the method prescribed by Axon (section 4.10), the pulse charge, peak loaded voltage and pulse repetition frequency were found to be similar to the equivalent parameters for other Axon CEDs.[61]

The method used measures the waveform parameters across only one of the forty-five potential output paths[62] of the TASER 10™, however, there is no reason to suspect that the parameters would be any different for the other forty-four paths as they are all governed by the same firmware.

Although not measured in the technical testing, the pulse repetition frequency of the TASER 10™ for two output paths (equivalent to there being four skin-embedded darts in a single individual) is said by Axon to be 43-45 Hz (twice that of a single path). As Axon assert (subject to independent confirmation) that a maximum of only four skin-embedded darts may be energised at any one time, 43-45 Hz is the maximum pulse rate to which an individual would be exposed.

The maximum pulse rate generated by the TASER 10™ is identical to the output of the TASER 7™ when both cartridges have been deployed and all four probes are in electrical contact with the subject [7]. Apart from the expected injuries arising from exposure to CED discharge (such as head injury), the authors are not aware of any adverse medical consequences that have been directly attributed to the pulse frequency of the TASER 7™ and would not expect any novel adverse medical consequences to emerge with the TASER 10™. This opinion is based on the proviso that the electrical output of the TASER 10™ is limited to a maximum of four skin-embedded darts (with a corresponding maximum pulse discharge frequency of 43-45 Hz).

The physiological effects of TASER 10™ discharge, administered for eight seconds, in human volunteers have been assessed in a study sponsored by Axon [54]. Discharge was applied via multiple skin-embedded darts positioned at various body locations. A number of physiological and biochemical parameters were monitored before and during exposure, one-hour post-exposure and on the following day. The authors noted that the findings were similar to those seen with exposure to discharge from previous Axon CEDs. However, of note is that five of the twenty-two subjects exposed to TASER 10™ discharge via at least two probes located on the back, became apnoeic throughout the duration of the eight second exposure. Although apnoea induced by TASER X26™ discharge to the back has been reported in another human study in 2013 [55], this is the first time that apnoea has been cited in an Axon-sponsored study. In addition to apnoea, the TASER 10™ study reported syncope in two participants which occurred at the end of exposure. Syncope was previously reported in one participant in an Axon-sponsored

[61] The waveform of all previous Axon CEDs carries an initial brief very high voltage (ca. 50 kV) component to enable arcing across a small air gap. The waveform parameters cited in the respective Axon specifications documents for the earlier devices relate to the 'main phase' of the waveform, which excludes the initial '50 kV' component.
[62] An output path is equivalent to a probe pair.

study of the effects of the TASER 7™ [56]. This latter event, which also occurred at the end of the discharge period, prompted SACMILL to cite it in the Committee's medical statement on the TASER 7™, where it was described as a novel injury mechanism which could increase the risk of injury from falls [4].

As part of their general approach to the development of their CEDs, Axon examine the cardiac effects of the electrical discharge in an anesthetised pig model. This was done for the TASER 10™ (in comparison with TASER X26™ and TASER 7™) by applying 5-second discharges through electrodes inserted at various locations on the chest of the animal [59]. Drops in mean arterial pressure were used as the surrogate end-point for the induction of cardiac capture or ventricular fibrillation. There were no instances of ventricular fibrillation in this study and the authors reported that there was no statistically significant difference between the blood pressure drops produced by the three devices.

11.4 System management

The draft NPCC TASER 10™ implementation plan notes that strict management of the system will be required in forces managing mixed types of CED. This strict management needs to ensure that officers can only be issued with the model of CED for which they are authorised. This management also requires ensuring that the devices have the correct configuration (centrally managed through Axon) and have undergone the correct maintenance. Failure to do so, could result in devices that have reduced reliability.

The management also requires strict examination, quarantining and maintenance of devices that may have become damaged for whatever reason (for example, being dropped). Failure to do so could result in the issuing and use of devices that may not operate correctly (for example, the magazine cannot seat correctly or the laser sight does not align with the intended point of probe impact (i.e. the device is not correctly zeroed).

11.5 System complexity

The TASER 10™ is different to its forerunners in use in UK policing. Officers used to one device will need to undergo training to ensure they are correctly converted to the TASER 10™. The new device has altered functionality with some of the user interfaces when compared to the legacy devices, for example, the CID is a colour display with a greater number of icons that could lead to ambiguity in reading and the multi-function selector switch (simply an on-off switch with some earlier variants) is now the main control for the operation of the device. This multi-function selector switch now initiates the device (switches it on), selects covert mode, initiates a warning alert and extends the duration of the discharge. Many of these functions were achieved with distinct user interfaces in previous devices. This may result in confusion in a dynamic complex environment, which could result in additional discharges from the device (for example, if the user was used to pulling the trigger to extend the discharge) or even switching the device off. The rate at which this could happen would be probably low, given the College of Policing training, but any unintentional uses of the multi-function selector switch or misreading the CID could result in negative medical consequences. It is, therefore, essential that any complexity-related issues arising in use of the TASER 10™ are captured, that stakeholders are informed and that remedial actions are taken.

11.6 Training considerations

The accuracy and consistency of the operational and training probes were comparable, in that they both followed similar trajectories and dispersions around the mean point of impact. This means that the ‘Hook and Loop’ training cartridges suitably simulate operational cartridges and there should be little difference in point of aim and point of impact expectations for officers when involved in operational incidents. There are, therefore, no medical implications arising from the use of one design of probe in training versus another design in operations.

When probes are fired, the training advises that “*Users should continually assess for a change in behaviour*” and “*Users should ensure there is justification for each probe deployment*” [11]. This should reduce the number of probe deployments to a minimum, but quite how this will be monitored needs to be assessed. Each individual incident will have a series of logs that could be examined, but the ability to undertake this is limited, the burden to undertake such work would be unwieldy and the benefit is debatable, especially as a change in the subject’s behaviour cannot be assessed through the data logged on the device. This would therefore be reliant on other sources of information. This also raises the issue of single shots causing a subject to comply (section 11.1). The anecdotal operational reporting (see section 9) reports four cases in 65 incidents where only one probe hit the subject and this appeared to be sufficient to resolve the situation. This means that in six percent of cases the single probe was sufficient to cause a change in behaviour. How this will be monitored in UK service has yet to be defined.

Although the maximum range of the TASER 10™ probe is nominally 13.6 m (45 ft), the technical testing demonstrated that probes could achieve distances beyond that, with probes detaching at around 15 m when they reach the limit of their tethering wire. While the College advises in training that the “maximum effective range” is [redacted], Dstl understands that the College is [redacted] as the upper practical limit.[63] While the latter advice would keep probe accuracy from excessively degrading and means that probes would be well-removed from the range at which they would detach from their wires (assuming no probes miss the subject), how realistic is it to expect officers to gauge an upper practical limit of [redacted], particularly in light of the phenomenon of range underestimation (sections 4.3.1 and 8.2.2)?

The present authors suggest that it might be useful for the College to train distance estimation with reference to the dimensions of a familiar object (such as a car) as a guide. Such a method is already used in TASER 7™ training, where it is proposed that the width and length of an average car could be used to estimate the appropriate engagement distances for the close-range (CQ) and longer-range (SO) cartridges.

It is understood that the typical length of a large SUV is around 4.7-4.8 m.[64] Perhaps picturing two of these nose-to-tail (9.4-9.6 m) could provide a suitable estimate of subject distance while allowing some room for error at the upper end of the range. There is no minimum range for the TASER 10™ probe.

[63] Email [redacted]-[redacted] 10:29 14/01/2025.
[64] Automobile dimensions.com (https://www.automobiledimension.com/large-suv-4x4-cars.php).

As with other CEDs, the assessment process that prospective TASER 10™ officers undergo at the end of the training period is in three parts: a written knowledge check, a scenario-based assessment and a qualification shoot. The present authors have reviewed the draft qualification shoot and the draft knowledge check and are satisfied that they assess against the main aspects of the TASER 10™ system, including the need for multiple probe placements at various ranges, the need for the probe's darts to embed in the skin and the ability to correctly operate the multi-function selector switch.

The TASER 10™ VR system was experienced by one of the present authors (SJS) and one of the members of SACMILL. The system is seen as being a useful augmentation to conventional training, particularly where it might permit scenarios that would otherwise not be practical to emulate. It is understood that the TASER 10™ Axon VR system has exercises that consider the following scenarios [57]:

- Subjects at varying distance up to 13.7 m (45ft).
- Subjects in unconventional postures.
- Clothing and probe placement.
- Drills such as drawing.
- Moving subjects in various directions and speeds.

It is understood that VR will not be used in any aspect of the assessment process (section 8.2.4.5).

11.7 Operational considerations

The user handling trials conducted by the College of Policing concluded that officers could be trained in the device and that it had suitable accuracy in the hands of the user. Additional review of the system by the NPCC, taking into account the results from all of the testing, also concluded that the device was suitable for service. The NPCC also considered the reliability concerns noted during the user handling trials (and from anecdotal reporting by international partners); this matter was discussed and the residual risk accepted through a formal acceptance panel.

Nevertheless, there are some aspects that will require consideration in each environment the TASER 10™ is trained, such as the availability of suitable facilities (given the extended range of the device). There will also need to be an assessment of the sound produced by the device and any health and safety considerations arising from repeated exposure to impulsive noise: this will be establishment/environment specific. This is unlikely to be an issue for subjects, however, officers who are subjected to repeated daily exposures may require hearing protection.

The probe dispersion of the TASER 10™ in the user handling trials was reassuringly low at shorter ranges (up to 5 m), began to fall off at 10 m and, by 13.7 m, had markedly degraded, with a distinct drop-off in the trajectory of the probes (section 5.2.2, Figure 32 and Figure 33). TASER 10™ officers aware of the propensity of the probe to drop-off at longer distances may conceivably be tempted to aim higher to compensate. However,

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[redacted] **s31(1)(a)** [redacted]

How might the trajectory drop-off at range interact with the human propensity to underestimate distance (section 4.3.1.4)? There are at least two considerations:

- If a TASER 10™ officer perceives a subject to be 10 m away, but the subject is in reality 13.7 m away, then the officer might anticipate little drop-off of the probe point of impact. The probe, however, will impact some 15 cm below the point of aim, presenting a reduced medical risk to superior structures (head/face/neck) but may increase the risk to the groin region (depending on the point of aim). If the aim point is mid-thigh (for example), then the probe may fly towards a region presenting a smaller target area and thereby increase the risk of a probe miss.

- The probe will have travelled 3.7 m further to reach the subject at 13.7 m. This means that the energy of the probe will be less than it would otherwise have been had the subject been located at 10 m (see Figure 50). This would likely mean a reduced ability of the dart of the probe to perforate clothing and embed in the skin. Therefore, one potential knock-on effect of distance underestimation might conceivably be a reduced ability to induce NMI.

In the context of distance underestimation, while there may be few primary medical implications associated with probe drop-off, there may be secondary implications from a reduced subdual effectiveness. If the latter occurs in practice, this may tip the balance to the use of more injurious force options. Overall, then, the above arguments tend to reinforce the notion that ‘closer is better’ and adoption of the distance estimation strategy outlined in section 11.6.

The injury-causing potential of the TASER 10™ probe in operational practice is yet to be established, with the energy of the probe exceeding that of probes fired from previous devices (section 6.5.1 and Figure 50). The outcome from the independent technical testing is discussed in section 11.2.

The NPCC hopes that the TASER 10™ will provide greater opportunities to de-escalate incidents. The degree to which this aspiration will be achieved should be examined during post-use review.

Notwithstanding potential complications when a dart of the TASER 10™ probe enters bony tissue (see section 4.6), extraction of the probe appears relative straightforward and follows the practice used for probe removal on devices that preceded the TASER 7™ (see Figure 53 in section 8.2.4.2). The College’s advice on TASER 10™ probe removal is in a single slide in ref. [11] (reproduced in Figure 53). It differs from the advice given in the TASER 10™ user manual in that the College’s advice does not caution against twisting the probe as it is pulled out whereas Axon’s advice does (“as

65 Email [redacted] **s40(2)** - [redacted] **s40(2)** ‘RE: A few more T10 questions’ 16:23 14/01/2025.

the barbed tip may cause additional injury”). It is recommended that this extra guidance is introduced into the proposed TASER 10™ training.[66]

According to the product’s hazard labelling, the sighting laser of the TASER 10™ belongs in the Class 3R category (section 2.10) and this was confirmed in the technical testing (section 4.9). The laser is the same as that used for aiming the upper probe of the TASER 7™, and it is considered that few (if any) medical implications likely to be associated with its normal use either operationally or in training (see section 2.10).

Although the output waveform of the TASER 10™ lacks the brief initial very high voltage (ca. 50 kV) component that allowed the output of previous CEDs to arc across a small air gap, the waveform voltage is still high, reaching nearly 1,000 V (section 4.10). While this lower voltage will not arc across the sort of distances (1-2 cm) that the very high voltage CEDs would, there is still the possibility of sparking, albeit on a much smaller scale should two or more probes/darts be in close proximity to each other. A communication from the College of Policing provides some further information:

> “The potential reduced flammability risk the T10 presents has featured in some of Axon’s marketing material and gets a brief mention in their training material. When I asked for more information to quantify risk, the reply I had was a bit anecdotal. They mentioned they hadn’t been able to get T10 to ignite gasoline. The speculation being that being the lack of spark removes the potential ignition source. The did also allude to a spark being theoretically possible if the two probes were exactly 1.6mm apart.”[67]

It appears, therefore, that a risk of ignition of explosive vapour or flammable liquid still remains with the TASER 10™, albeit possibly to a smaller extent than with previous devices. In the absence of independent testing, however, it is suggested that the assumption should be that the TASER 10™ poses the same ignition risk as earlier high voltage devices.

A component of the TASER 10™ warning alert consists of the device’s torch alternating between 1000 lm and 210 lm at a frequency 20 Hz (section 2.9.1). It is understood that “[p]eople with photosensitive epilepsy are affected by lights that have different flash or flicker rates from as low as 3 to as high as 60 per second. Lights that flash or flicker between 16 and 25 times a second are the most likely to trigger seizures.”[68] However, the incidence of this form of epilepsy is said to be extremely low (less than 1 in 3000 people[69]). Therefore, the TASER 10™ officer is unlikely to encounter a person with this condition although it is not entirely impossible.

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66 Although advice not to twist or rotate the probe does not appear in the Powerpoint presentation made available to Dstl [11], it does appear in the current training for all earlier CEDs (J5 Post Deployment V6.2 06.03.2023.pptx).

67 Email [redacted] - [redacted] ‘T10 ignition hazard’ 11:14 04/02/2025.

68 https://www.epilepsy.org.uk/info/seizure-triggers/photosensitive-epilepsy#:~:text=People%20with%20photosensitive%20epilepsy%20are,most%20likely%20to%20trigger%20seizures

69 https://epilepsysociety.org.uk/about-epilepsy/epileptic-seizures/seizure-triggers/photosensitive-epilepsy#:~:text=Around%201%20in%20100%20people,contrasting%20light%20and%20dark%20patterns

Although device reliability improved over the course of the three user handling trials, whether this positive direction of travel is maintained remains to be seen.

11.8 Data to understand training and doctrinal improvements and the understanding of medical implications

Many of the preceding observations will have a direct impact on trust in the system; for example, if the device is seen as unreliable, inaccurate under certain circumstances, injurious, ineffective or fragile, then user trust will be diminished. It is important that such influences are monitored through the analysis of operational use data. In particular, aspects of the operational use that should be gathered relevant to the TASER 10™ include:

- Any issues with the use of the multi-function selector switch, including use issues or selecting an incorrect option due to confusion, a lack of motor skills under the pressure of an operational incident, due to the use of personal protective equipment (such as gloves) or due to personal factors, such as hand size and strength.

- Any issues (or perceived issues) with the effectiveness or audibility of the simulated warning alert.

- Any evidence for the de-escalatory effect of the TASER 10™.

- Any accuracy issues or loss in situational awareness with the use of fixed sights.

- Any issues with the visibility of the green laser, for example under bright light conditions, complex operational deployments (with multiple tactical options) or clothing.

- Any issues with connection due to accuracy, loose or thick clothing (including any perception of tactics used by subjects to reduce the effectiveness of the TASER 10™).

- The alternative tactical options that were considered or needed before or after probe firing of the TASER 10™.

- The number of probe firings required to obtain an NMI effect and the perceived reasons why a number (greater than two) firings were required. Similarly, whether the device was effective in obtaining compliance after only one firing.

- The range at which probes were fired and the pros and cons of range (for example, stand-off to provide additional time or negotiation options or difficulties targeting the subject).

- Whether officers were authorised and had experience of use of other CEDs.

- Issues with range estimation.

- Visibility of the subject at extended range, particularly where lighting and meteorological conditions are less than optimal.

- How reliant the officer was on the connection alert to assess effectiveness and was the connection alert audible in the operational environment. Is it a useful feature?

- Whether an extended exposure to discharge was required.

- Whether the complete system (sighting, CID, warnings and use of the multi-function selector switch) was too complex or confusing in a dynamic operational environment. This would include any observations on the readability of the CID in an operational environment.

- Any overall trust considerations in the system, from personal experience, reported concerns or anecdotal reporting.

This reporting should include the more typical operational use reporting data used with other CEDs, such as the operational information, medical outcomes, additional tactical options, etc. This reporting should be used to enhance training, advise the doctrine as well as assist SACMILL in the understanding of medical implications of the system (both reported and to assist in the pre-emptive assessment/prediction of medical implications).

- Officer-reporting of probe spread and disposition (either in skin or clothing) was first undertaken on the operational usage form for the TASER X2™ and continues with the reporting for TASER 7™. Probe disposition is worth continuing for the TASER 10™ though there is the potential confounding if many probes are deployed; whether the returned data prove valuable remains to be seen.

- Also, probe spread data is open to confounding, especially where a plurality of probes has been deployed. Again, whether the data prove valuable and interpretable remains to be seen.

12 Conclusions and recommendations

This report has considered the primary aspects of the TASER 10™ system and offers the authors' opinion on the medical implications of the system for SACMILL consideration. The purpose of the report is to set the groundwork, from Dstl's non-medical perspective, for the Committee's medical statement on the new CED system.

The first draft of this report was provided to SACMILL on 15/11/2024 in advance of the Committee's meeting on 22/11/2024. The second draft was provided to SACMILL on 11/12/2024 in advance of its meeting on 16/12/2024. Since then, the report has further evolved as more results have come in from the technical testing and more information has become available from other sources (such as the NPCC Implementation Programme and international law enforcement bodies).

At the time of writing, SACMILL is considering the third draft of its medical statement on the TASER 10™ system, having initiated the first draft after its meeting on 16/12/2024. This had progressed to the second draft prior to SACMILL's third meeting on 23/01/2025. The Committee will hold its fourth meeting on the TASER 10™ statement on 25/02/2025 where it is anticipated that agreement will be reached on the final form of the medical statement.

The following are the recommendations that emerge from Dstl's assessment of the TASER 10™ system.

Recommendation 1

Although there was a progressive reduction in the TASER 10™ reliability issues detected in the three user handling trials, that there were any significant issues in a device that had been on the market for more than six months may be a cause for concern. Therefore, should the TASER 10™ system be authorised for UK use, it is recommended that the NPCC LL administration closely monitors performance in the field and in training so that the TASER 10™ community is advised in a timely manner of any emerging faults and actions taken to address those faults.

Recommendation 2

Anecdotal evidence suggests that subjects could become compliant after being struck by a single TASER 10™ probe, thereby avoiding the need to attempt induction of NMI and removing any medical risks (e.g. head injury from falls). While recognising that 'single probe compliance' in a fast-moving incident may not be straightforward, it is recommended that TASER 10™ training teaches officers to at least be alert to this possibility and to de-escalate accordingly.

Recommendation 3

Given the human propensity towards range underestimation and the extended engagement range that the TASER 10™ offers, it is recommended that the College of Policing considers providing advice in training on range estimation techniques. It is proposed that visualising the length of two nose-to-tail SUVs (about 9.5 m) may provide suitable mental imagery. This may be important in circumstances where probes are fired at subjects at a range where accuracy is reduced or who may be beyond the range at which probes detach from their wires to become a free-flying hazard. Another advantage of keeping a ceiling on subject distance when probes are fired is that the probes will not lose excessive energy thereby increasing the chance of perforating through clothing and embedding in the skin.

Recommendation 4

Given the multi-coloured central information display, it si recommended that he College of Policing seeks advice from a colour vision expert on any difficulties officers with various types and severities of colour vision deficiency might encounter.

Recommendation 5

Given the NPCC’s aspiration that the greater range of the TASER 10™ might offer increased de-escalation opportunities, it is recommended that this is something that is monitored in operational use. Greater de-escalation might be reflected in a decreased proportion of discharge uses relative to all types of use of the device.

Recommendation 6

The multi-function selector switch is something that presents the user with a greater device complexity than similar (but less functional) switches on earlier devices, raising the possibility of user error in a dynamic and stressful environment. It is recommended that this is something that should be monitored should the TASER 10™ be authorised for operational service.

Recommendation 7

Consideration should be given by forces adopting the TASER 10™ to virtual reality training systems to complement conventional training methods.

Recommendation 8

Although The TASER 10™ output waveform lacks the brief very high voltage (50 kV) initial component that allows the waveform of previous devices to arc across a small distance in air, the peak voltage of the TASER 10™, at around 0.9 kV, is still high and arcing in air is still expected, albeit over a much smaller distance, and there remains a risk of ignition of explosive vapours and flammable liquids. Therefore, it is recommended that caution around the use of probe discharge should remain in place for the TASER 10™ until such time as the risk of ignition is informed by independent testing.

Recommendation 9

During probe discharge, the sound pressure level generated by the TASER 10™ was found to within the health and safety legislation for impulsive auditory exposures. However, compliance with legislation should be confirmed in individual training establishments to ensure that staff and trainees are not exposed to excessive cumulative noise from repeated exposures.

Recommendation 10

Should the TASER 10™ system be authorised by the Home Office, it is suggested that SACMILL should request the system's operational performance is monitored to obtain reassurance that the system performs in the manner anticipated and that the Committee is notified of any adverse medical outcomes associated with its use. Based on experience with the TASER 7™, the authors suggest that an initial formal review of the performance of the TASER 10™ should be conducted after the device has been used operationally on 1500 occasions or once the number of incidents in which the device has been used to discharge probes has exceeded 150.

Recommendation 11

Should the TASER 10™ system be authorised for use, it is recommended that SACMILL reinforces the need for further medical review in the event that a substantive element of the system is changed from that initially considered by the Committee.

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APPENDIX A Home Office tasking request

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7a.	**Abstract: ***	A medical assessment of less-lethal weapons is required as part of the information relied upon by the Home Secretary to make a decision on whether or not to authorise a new weapon system for police use. This assessment is undertaken by SACMILL, which is an independent medical committee. SACMILL has been asked by the Home Office to assess the TASER 10™ system. The TASER 10™ is a novel concept Conducted Energy Device (CED) that follows-on from four previous generations of CED that have been authorised for use by the police in the UK. The purpose of this report is to provide SACMILL with a scientific and technical grounding in all aspects of the TASER 10™ system and to offer Dstl's opinion on its medical implications should SACMILL wish to use it, in whole or in part, to develop and inform its own independent opinion.
7b.	**Abstract UK protective marking: ***	UK OFFICIAL
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8.	**Keywords:**	TASER 10™; conducted energy device; medical implications; less-lethal weapons

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