Leonesio Consulting, LLC
412 South White Street • Suite 210
Athens • Tennessee 37303
Phone: (423) 933-1911 • Web: www.leonesio.com

Michael Leonesio's response to Mr. Brave's SFPD/SF Police Commission answers

1. If the SFPD decides to purchase CEWs [Conducted Electrical Weapons] from your company, what model number is available? Is it the X26P or a different model?

   BRAVE Question 1 Response: The 2 CEWs that are available are the Smart CEWs: the X2 CEW and the X26(P) CEW.

   Leonesio response: Mr. Brave is correct in his statement that the X2 and X26P weapons would be available for purchase by SFPD. But to expand on his answer, I think it is important to know the differences between the weapons.

   - The differences between the X2 and X26P are:
   - The X2 is a 2-shot weapon, while the X26P is a single shot weapon.
   - The X2 uses "smart cartridges" and has the ability to read cartridge data. The X26P uses the older style cartridges used with the earlier X26e, M26 weapons.
   - The X26P is smaller and lighter than the X2.

2. As to the models that are available for purchase, what is the electrical output? I understand that in your previous model, the M26 model output was 85-120 microcoulombs [μC]. It has been said that the model that is available for purchase today has a lower output. If so, why was the electrical output lowered for the newer model?

BRAVE Question 2 Response: The outputs of the X2 and X26(P) CEWs are the same:

X2 CEW Output Specifications (April 5, 2017)	**X26P CEW Output Specifications** (April 5, 2017)
1. Output Specifications (per cartridge bay)[4,5] Waveform: Precision Shaped Pulse technology. Into 600-ohm (Ω) load: • Pulse duration: 50–125 microseconds (µs). • Peak loaded voltage: 840–1440 volts. • Pulse rate: 19 ± 1 pulses per second (PPS). • Full pulse charge: 63 ± 9 microcoulombs (µC). • Current: 1.2 milliamperes (mA) typical.	1. Output specifications:[4,5] Waveform: Precision Shaped Pulse technology. Into 600-ohm (Ω) load: • Pulse duration: 50–125 microseconds (µs). • Peak loaded voltage: 840–1,440 volts (V). • Pulse rate: 19 ± 1 pulses per second (PPS). • Full pulse charge: 63 ± 9 microcoulombs (µC). • Current: 1.2 milliamperes (mA) typical.

We cannot make a direct comparison between the obsolete M26 CEW and the modern Smart CEWs. The M26 CEW delivered a short alternating pulse with basically 2 positive pulses and 2 negative pulses. Modern CEWs are all rated by the "net" charge meaning that the negative charge portion is subtracted from the positive portions. The M26 CEW net charge was 32 µC but the main phase charge was 85 µC. A direct comparison — between the 1999 M26 AC CEW and the modern DC weapons — is meaningless.

Even with the modern weapons, there is another subtlety. The X26E CEW delivered 20–95 µC for arcing distances of 1.0–1.5 inches.1 This is typical when the probes are in the clothing and the charge must spark through the clothing and outer skin. The X26E CEW will deliver ≈ 108 µC [Adler2] when the probes are embedded in the skin. Smart CEWs are designed to deliver ≈ 63 µC *whether arcing or not.* This discharge level is above the 3 cm (1.2 in) sparking discharge of the X26E CEW at 50 µC, and has similar effectiveness while maintaining significantly increased precision. See the graphic below. Because the delivered charge of the Smart CEWs is well below the maximum delivered charge of the X26E CEW, they further increase cardiac safety margins. The X2 CEW pulse duration is also shorter so it uses the charge more efficiently.

The X26E CEW output is dependent on the connection to the subject. When a low resistance connection is established to a subject (both probes into low resistance tissue), the X26E CEW

delivers ≈ 108 μC (max specification 135). When a poor connection is made to the subject (arcing probes, and/or connecting through highly resistive tissue) the X26E CEW delivers as low as 20 μC. The next generation Smart CEWs (X2, and X26P CEWs) have charge metering and pulse calibration to regulate the delivered charge to 63 ± 9 μC. This allows enhanced cardiac safety margins while performing comparably to the 2003 X26E CEW technology.

Leonesio response: I would concur with Mr. Brave's citation to the published specifications. I would only add, that the published current figure of 1.2mA is an average current number, not peak current. Peak current on the X2/X26P weapons is approximately 2.4 Amps. I would be happy to discuss the significance of this if you like.

To Mr. Brave's second point that "We cannot make a direct comparison between the obsolete M26 CEW and the modern Smart CEWs." I would respond that we most certainly can.

To better understand how problematic and low the output of the X2 and X26P are, it is useful to compare the X2 and X26P to the failed Air TASER 34000 model. Company founder and CEO Rick Smith, in a 2008 expert report in a 6th Circuit case[1] and later in a 2012 white paper, co-authored by Mr. Brave, attributed the 34000 model's failure to deficient electrical output, writing, "Since the pulse intensity from the AIR TASER 34000 was found to be insufficient to cause motor neuron mediated stimulation of muscle, a new pulse waveform was developed for the TASER M26 ECD."[2] The 34000's charge output, referenced in this passage, was 70 microcoulombs (uC), seven microcoulombs higher than the output of the X2/X26P model weapons.[3]

Mr. Brave goes on to claim that the X2 and X26P weapons, with their charge metering and pulse calibration, "regulate the delivered charge" and perform "comparably to the 2003 X26E CEW technology." However, Mr. Brave provides no studies or other objective evidence to support his assertion that the X2 and X26P, with their greatly reduced output, performs comparably to the X26e or M26 weapons. In fact, the only reports I have seen from

[1] *Lee v. Metropolitan Government of Nashville and Davidson County,* 596 F.Supp.2d 1101 (6th Cir. 2009).
[2] Brief Introduction to TASER Electronic Control Devices, History, Electricity, Electrical Stimulation, Electrical Measurements, and the Human Body, 2012.
[3] See Appendix A for weapon specifications.

independent sources have either questioned the efficacy of the new weapons (SACMILL), or reported increased incapacitation failures following their adoption (LAPD).

To Mr. Brave's claim of enhanced cardiac safety margins, this may be true. After all, the new generation weapons are putting out half the charge of the previous models. But we heard similar cardiac safety claims with the older generation weapons, only to find out later that they indeed could (and did) affect the heart. And as before, Mr. Brave provides no independent studies or other objective evidence to support his assertion that the lower output of the X2 and X26P "increases cardiac safety margins." Notably, since the introduction of the new generation weapons, TASER has not changed their warnings with regard to cardiac safety.

Speaking to the subject of cardiac safety, SACMILL opined "While the hazard [of cardiac pacing] *may* be less with the TASER X2 CED, SACMILL is of the opinion that a risk still remains." [4]

3. It has been said that the model that is available for purchase today has a lower output.

BRAVE Response: That which has "been said," is only from those who do not understand charge metering and pulse calibration and have not followed TASER Training Programs and presentations since at least August 2009. Please see response above.

Leonesio response: Since Mr. Brave failed to answer the question, I will. Yes, the new generation weapons' electrical output is less than *all* previous TASER manufactured weapons. In fact, as previously cited in this response, the new generation X2/X26P weapons' electrical output is below that of the failed Air TASER 34000 model.

To Mr. Brave's response that those who disagree "do not understand charge metering and pulse calibration and have not followed TASER Training Programs and presentations since at least August 2009" I would offer, that regardless of how precise or controlled the weapon's output may be – IE. charge metering and pulse calibration – if the charge is "insufficient to

[4] U.K. Scientific Advisory Committee on the Medical Implications of Less-Lethal Weapons – Statement on the Medical Implications of Use of the TASER X2 Conducted Energy Device System, 8/30/16, p. 9;25. (emphasis added)

cause motor neuron mediated stimulation of muscle" the weapon will be largely ineffective. Attending a TASER Training Program or watching a TASER marketing presentation does not change that fact.

4. If so, why was the electrical output lowered for the new model?

BRAVE Response: Please see responses above. The output is more precisely controlled with charge metering and pulse calibration that was not available in the M26 (1999) and X26(E) (2003) CEWs. Think of this as a governor on a truck. To make sure that the truck had enough horsepower to get up long hills, they had enough horsepower so that they could go 100 mph down hills. Now, we have modern trucks with governors that go 63 mph up and down hills.

Leonesio response: Again, Mr. Brave does not answer the question; and this question is an important one. Without a specific explanation, and supporting research, there will be (and is) much speculation. Especially given the fact that the manufacturer has repeatedly, over the years, dispensed safety information that has turned out to be untrue.

Further, TASER (Axon) has failed to release any substantive data, beyond marketing claims, to validate and/or substantiate their efficacy or increased safety claims.

Appendix A

Weapon Electrical Output Specifications

Table 1 X26P Customer Specifications

Electrical Output Specifications with a 600 Ω Load	TASER X26P Specifications
Pulse rate	19 ± 1 pulses per second (pps)
Full pulse charge	63 ± 9 microcoulombs
Peak loaded voltage	840 to 1440 volts
Pulse duration: full waveform	50 to 125 microseconds

Table 2 X2 Customer Specifications

Electrical Output Specifications with a 600 Ω Load	TASER X2 Specifications
Pulse rate	19 ± 1 pps
Full pulse charge	63 ± 9 microcoulombs
Peak loaded main phase voltage	840 to 1440 volts
Pulse duration: full waveform	50 to 125 microseconds

Table 3 X26e Customer Specifications

Electrical Output Specifications with a 600 Ω Load	TASER X26 Specifications
Pulse rate	16.5 to 20 pps
Main phase charge	80 to 125 microcoulombs
Peak loaded main phase voltage	1400 to 2520 volts
Pulse duration: full waveform	105 to 155 microseconds

Table 4 Advanced TASER M26 Specifications

Electrical Output Specifications with a 500 Ω Load	TASER M26 Specifications
Pulse rate	15-20 +30/-25% pps
Main phase charge	70-120 microcoulombs
Peak loaded main phase voltage	6900 to 9400 volts
Pulse duration: full waveform	32 to 60 microseconds

Table 5 Air TASER 34000 Specifications[ff]

Electrical Output Specifications with a 1000 Ω Load	AirTASER 34000 Specifications
Pulse rate	10-15 pps
Main phase charge	70 microcoulombs*
Peak loaded main phase voltage	9000 volts
Pulse duration: full waveform	6.5 to 13 microseconds

[ff] As reported in *An Evaluation of the Electrical Properties and Bio-Behavioral Effects of Four Commercially Available TASERs and the Jaycor Sticky Shocker*, United States Air Force Research Laboratory, 2003.

*As reported by TASER International's Rick Smith in his 2008 expert report in the case of *Lee v. Metropolitan Government of Nashville and Davidson County*.

All other specifications published by TASER® International, Inc., 2009-2015.