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DATE: December 2, 2008

**TO: Frederic Zalac
National Reporter
Canadian Broadcasting Corporation**

**FROM: Magne Nerheim
Vice President of Research and Development
TASER International, Inc.**

RE: National Technology Systems (NTS) testing

I have reviewed the National Technology Systems (NTS[®]) testing results document provided to TASER International, Inc. (TASER) by the Canadian Broadcasting Corporation (CBC) and I generally agree with other reviewers - that the data shows a high degree of coherence in TASER[®] X26[™] electronic control device (ECD) output. Such coherence is no coincidence: we individually test every TASER X26 on an oscilloscope prior to shipment to ensure the output meets our specifications.

I also concur that there are four data that appear to be outliers – instances where current increased as resistance increased which would not be expected based on the laws of physics. In the four anomalies, measured current increased even as resistance increased from the 30 ohm (Ω) level to the 250 Ω level. According to further information provided by CBC, each anomaly occurred on the “first or second shot”.

The reason for these outlier measurements may be related to the fact that the TASER devices were not properly maintained (see the attached notes from the TASER instructor course). The TASER X26 training is to spark test the unit prior to every shift, both to ensure the unit is working properly and to condition the internal components. We believe the units in question may not have been spark tested for an extended period of time prior to the measurement.

If the TASER unit is not spark tested for an extended period of time, there is an internal component that can enter an “inactive” state. When this happens, much like a car that has not been started in a long time, it can take the device a moment to start-up. To the user, this appears as a momentary delay between when the trigger is pulled and when the device starts to arc. Inside the device, it takes a higher initial voltage to “wake up” the component that has become inactive from not being regularly operated. For the first pulse in the series, it may take a higher than normal voltage to get the system operating. However, this only occurs for the first initiation pulse discharge (the first of the 19 pulses per second). Once the device’s internal component is reactivated, it will operate at the normal discharge voltages for the balance of the roughly 100 individual pulses delivered over a 5 second discharge.

It appears that the researchers here may have captured this first initiation pulse discharge, then used it to calculate a higher net current using this higher value. This is incorrect as the initialization pulse is not indicative of the magnitude of the subsequent pulses and miscalculates



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an exaggerated current not representative of actual output (a more accurate way to capture the actual net current is to use the averaging function on their oscilloscope to average the pulses over a full second).

From a medical safety perspective, this phenomenon is not relevant for the following reasons:

- a. The first initiation pulse does not go into the body - the initiation pulse completes a circuit within the cartridge that ignites the propulsion system to launch the darts. In fact, the second and third pulses usually occur while the darts are still in flight, and only the subsequent pulses penetrate the body of the target after the darts reach the subject.
- b. The readings for this test used a much lower resistance (250 ohms) than the human body (600 ohms – see below). The output of these same initiation pulses into a human body would be significantly less (note how the output currents decrease as resistance is increased).
- c. Even the higher output charge of these initiation pulses measured into low resistance are well below international safety standards due to the high safety margin designed into the device.

These same units performed normally on every other test – supporting the hypothesis that the devices had not been properly spark tested before the 250 (W) test series (see attached “Table of NTS Test Results”).

If you refer to the TASER X26 specification sheet posted on TASER.com¹, you will see the output current listed as 2.1 mA. When we developed these specifications, we were delivering the output directly into a live subject (either human or pig) – which is where the measurements were taken for our specification sheet. We have found the output resistance of human subjects to range from 400 to 800 ohms, with an average of 600 ohms. Our specifications rate the device for the intended target - hence a 600 ohm resistor is the best “proxy”.

In the NTS testing document, they tested below and above the 600 ohm value, using 250 and 1000 ohm tests. Since 600 ohms is basically half way between 250 ohms and 1000 ohms, we are not surprised to see that the current results are below 2.1 mA at 1000 ohms and above 2.1 mA at 250 ohms. If you average the values to interpolate the result for a midpoint of 625 ohms, you would get the following table:

Net Current (mA)

	250 (W)	1000 (W)	Avg (625 ohm equiv.)
Low	1.7	1.18	1.44
Mean	2.26	1.41	1.835
High	3.4	1.72	2.56

¹ <http://www.taser.com/products/law/Documents/RD-SPEC-X26E-001-H.pdf>



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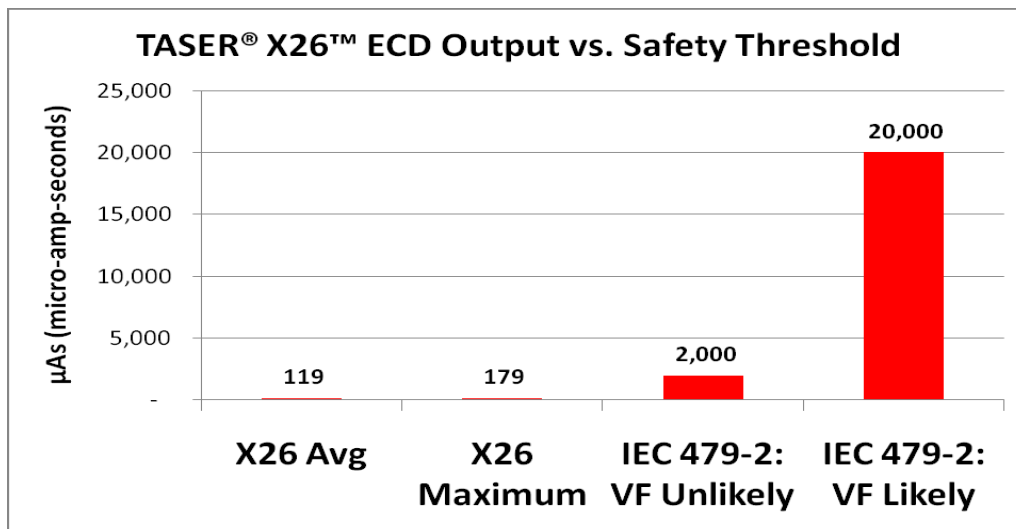
This table includes even the highest value, which appears to be a test anomaly as described above, yet still yields a highest 625 ohm equivalent of 2.56 mA, just about 20 percent above the specification (a reasonable tolerance). If you use the table for the 250 (D) tests, you get the following table (note that the highest output of 2.28 is within a nine percent tolerance range from 2.1 mA):

Net Current (mA)

	250 (D)	1000 (D)	Avg (625 ohm equiv.)
Low	2.03	1.18	1.605
Mean	2.49	1.41	1.95
High	2.84	1.72	2.28

These tests confirm our published specifications, with the expected finding that values will have a degree of variability as output loads change (see note 8 on the specifications sheet: "Output specifications may vary dependent upon temperature, battery charge and load characteristics."). All values fall within 3 standard deviations of the mean.

From a medical safety perspective, while the highest current discharge measured of 178 micro-ampere-seconds (μ As) (which is the same as microcoulombs [μ C]) could not occur in the human body due to higher resistance² and likely test errata mentioned above, this value is still less than 1% of the 20,000 μ As at which ventricular fibrillation (VF) in humans is likely according to the International Electrotechnical Commission (IEC) 479-2.



² Our measurements of human body resistance to the TASER X26 yields an average of 600 ohms vs. the 250 ohms used in the NTS tests. It is normal to expect higher currents at lower resistance levels.



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This data is consistent with the results of a recent U.S. Department of Justice study that evaluated over 950 real world TASER device applications and found an associated injury rate of only 0.3% - an injury rate far lower than any other option police have to respond to forcible resistance.³

Some further observations upon review of the data provided include:

1. The pulse rate is an average measure. We specify 19+0/-2 PPS. NTS testing found 19.5 PPS. This may be due to NTS doing a pulse-by-pulse calculation - not doing an average of 10 or more pulses. It was also noted that the PPS rate for different tests are exactly the same to 3 decimal places for numerous tests on the same units. Given how the TASER technology works, these results are nearly impossible to achieve.
2. The results from units A22, A23, J01 and K01 are interesting into 30 ohm: all D and W numbers are exactly the same, to 4 digits. This suggests a misprint of the data collected.

Our recommendation is that NTS repeat the test, first spark testing every unit as officers are trained to do, and discharge into a 600 ohm load. We would be happy to send NTS our manufacturing test protocol for them to use.

TASER International appreciates your continued interest in TASER technology, and sincerely hope that your report will focus on the proven injury reductions law enforcement experience with this technology rather than using engineering minutiae to confuse the viewer and create a false sense of controversy over a test that confirms the output of TASER X26's are consistent, and well below acceptable safety thresholds.

Sincerely,

Magne Nerheim
Vice President of Research and Development
TASER International, Inc.

³ Bozeman, III W, D G, B M, WE H, JJ H. Injury Profile of Electrical Conducted Energy Weapons
American College of Emergency Physicians Research Forum: Wake Forest University Louisiana State
University 2007.



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Excerpts from TASER Instructor Training Course:

Spark Test

- A daily spark test should be conducted once every 24 hours or prior to the start of your shift for individually issued X26.
- One spark (1/19th of a second) is adequate. However, this is not a practical duration. As long as the officer sees a visible spark between the electrodes, it is not necessary to extend the duration. In most cases, less than one second.
- The reason for the spark test is:
 - To verify the TASER device is working.
 - To verify that the batteries are performing and are adequately charged.
 - There are components in the high voltage section of the X26 that are more reliable when energized (“conditioned”) on a regular basis.

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Instructor Notes: Our primary concern is officer safety. While it is not possible to guaranty that any device will function properly each and every time, we continually strive for the highest level of quality and reliability. However, nothing can replace an operational check of the weapon to verify functionality and minimize the possibility of a weapon failure during field deployment. We are also sensitive to the cost associated with the use of the DPM (Digital Power Magazine) and have tried to minimize the test requirements without compromising officer safety.

The four primary functions checked during the daily spark test are:

- There are components in the high voltage section of the X26 that are more reliable when energized (“conditioned”) on a regular basis. This is due to the inherent design of the components and is not a function of the design of the device. The manufacturers of these components have provided us with information that supports the benefit of conducting a daily spark test.
- In addition to the conditioning of specific components, the only way to determine the proper functioning of all components is to conduct a daily spark test. There is no display



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or other method to verify proper device operation other than seeing the actual spark between the electrodes.

- The TASER X26 is a highly sophisticated electronic device. We build the weapons to be robust. However, there are many times that the weapons are subject to extreme conditions in the field including dropping, exposure to significant moisture, etc. Any of these factors could damage an internal component without any external indication. Conducting a daily spark test verifies the proper operation of all components.
- While the CID (Central Information Display) readout of DPM battery life is very accurate, there is a remote possibility that the battery could be discharged outside the device (e.g., if the DPM is improperly stored the metal contacts may be shorted out) and this would not affect the displayed percentage, even though the DPM is unintentionally depleted. The daily spark test confirms adequate DPM strength.

Our initial recommendation was to conduct the spark test prior to each shift. This was to alert officers who share a TASER device to conduct the check prior to their respective shift in case it might have been dropped or otherwise damaged on the previous shift. TASER International recommends a **minimum** of one spark test per work day and it is up to department policy to determine if additional checks are warranted when officers share a device.

The intent is to ensure that prior to beginning a shift, a spark test was conducted within the previous 24 hours. It is not necessary to spark test the device on days off, as long as a spark test is conducted prior to the start of the next shift

There are several possibilities that can result from the failure and/or malfunction of an internal component of the weapon:

Complete failure of the weapon including no spark and no laser or LED.

The laser and/or LED function properly, but the weapon fails to spark. This may be the result of the failure of one or more components of the high voltage section of the device.

When the trigger is pulled, the countdown on the CID is normal, but the weapon delays a second or more before beginning to spark. This is most often the result of a malfunction of a component in the high voltage section that requires conditioning on a daily basis. The daily spark test significantly minimizes the risk of this malfunction.

Partial power or low pulse rate. This is most likely caused by an extremely low DPM and should be observed during a spark test.

The life expectancy of the DPM is based primarily on the number of pulses. If the spark test is conducted for one second or less per day, the DPM would not have to be replaced for approximately 3 years.

If the device does not pass the spark test, contact TASER International for return authorization. The customer support number is 800.978.2737 extension 4. Also, we have a troubleshooting guide on our website at www.taser.com. Click on the technical support icon for a link to the troubleshooting guide. This may help correct some problems without the need to return the device to the factory.

Departments should review field deployments of the TASER devices to ensure that officers don't develop a habit of turning off their TASER device after one second during the spark test and transfer this practice to the field. Some departments have officers do their spark test while holding the TASER device in their non-dominant hand facing downward but still maintaining a visual on the spark. This method will not create bad muscle memory. Others require the supervisor to conduct all spark tests.



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Table of NTS Test Results:

In reviewing the test results, for the four units which you specified, we identified an anomaly for the 250 (W) test. Note in the chart below, that all four of these units tested within +/- 22% of the average values for the other tests, only the 250 (W) test produced outliers:

NET CURRENT (mA)									
Test	Avg	A03	A03 v Avg	A09	A09 v Avg	A18	A18 v Avg	B03	B03 v Avg
1000	1.41	1.72	21.99%	1.4	-0.71%	1.45	2.84%	1.3	-7.80%
100	2.39	2.73	14.23%	2.36	-1.26%	2.55	6.69%	2.09	-12.55%
250D	2.49	2.61	4.82%	2.35	-5.62%	2.68	7.63%	2.08	-16.47%
250W	2.26	3.4	50.44%	3.15	39.38%	3.36	48.67%	2.96	30.97%
30D	2.89	3.15	9.00%	2.67	-7.61%	2.94	1.73%	2.83	-2.08%
30W	2.58	2.78	7.75%	2.44	-5.43%	2.58	0.00%	2.74	6.20%
AMP SECONDS									
Test	Avg	A03	A03 v Avg	A09	A09 v Avg	A18	A18 v Avg	B03	B03 v Avg
1000	78.45	91.02	16.02%	75.15	-4.21%	73.33	-6.53%	78.19	-0.33%
100	132.58	144.8	9.22%	127	-4.21%	129	-2.70%	125.8	-5.11%
250D	137.89	138.3	0.30%	126.3	-8.41%	135.4	-1.81%	125.5	-8.99%
250W	124.46	171.8	38.04%	169.3	36.03%	169.8	36.43%	178.6	43.50%
30D	159.01	166.9	4.96%	143.5	-9.75%	149.9	-5.73%	144.6	-9.06%
30W	141.93	147.38	3.84%	131.1	-7.63%	131.8	-7.14%	139.7	-1.57%