TASER®[1] X26 ECD - DEMONSTRATIONS

By Michael Brave – December 27, 2011

Introduction:

There are numerous, mostly media created, misconceptions regarding the strength of the electrical charge delivered from a TASER X26 Electronic Control Device ("ECD"), *e.g.* "50,000 volts!!!!" Couple this with a lack of basic understanding and a deeply ingrained phobia of electricity – ***electricaphobia*** – and there exists a very negative underlying misunderstanding of basic TASER ECD electrical principles.

Thus, the challenge is to visually, tactilly, and verbally demonstrate basic TASER X26 ECD electrical principles in a short time frame and very easy to understand manner. That is the purpose of this memo, to present suggestions on how to accomplish this in a positive way.

The demonstrations or illustrations include:

1. Two (2) Duracell® CR123 3-volt (V) lithium cells
2. TASER ECD cartridge wire (36 gauge, 127 microns in diameter)
3. TASER ECD probes
4. 10,000 and 50,000 sheet stacks of (normal 20 pound) copy paper (to illustrate duration of "on" (or delivered electrical charge duration) ECD discharge time)
5. 19 and 95 sheets of bright green copy (type) paper
6. Why 19 pulses per second ("PPS") from TASER X26 ECD
7. Peak discharge comparison to "strong static shock"
   a. Including International Electrotechnical Commission ("IEC") Level IV standard
   b. Comparison to Van de Graff generator
8. TASER X26 ECD discharge will not activate a Ground Fault Interrupter
9. Ball analogy - all electricity is not the same (just as all "balls" are not the same)
10. Comparison with NSC Odds of Dying Charts

1. **Lithium Cells demo** - a TASER X26 ECD is powered by a battery of 2 3-V Duracell lithium cells. The 2 cells together comprise a "battery" of cells. Show the following:
   a. **Size of cells (very small, finite energy source):**
      i. Show the 2 lithium cells.
      ii. Explain that these are cells that are available at Best Buy, Staples, WalMart, etc. and are used in some digital camera type cells.
         (1) E.g. used in a Nikon F6 digital camera.

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iii. These cells do not have unlimited power, they are not connected to a strong or finite energy source, nor are they nuclear devices.

b. **Limited energy per discharge:**
   i. Explain that these two (2) cells can produce up to (quantity of) 195 five-second (5 second (s)) duration TASER X26 ECD discharges (from a single battery of cells).
   ii. Thus, the energy discharged by the TASER X26 ECD in a given discharge is very small.

c. **Number of Pulses per battery of (2) three-volt cells:**
   i. How many pulses per second (“s”) (“PPS”)? Answer - “19" PPS
   ii. How many seconds per trigger pull or cycle? Answer - “5" seconds
   iii. How many pulses per five second trigger pull? Answer - 19 PPS x 5 s = 95 pulses per 5 s cycle
   iv. How many (conservative) 5 second discharges per battery? Answer - 195
   v. 195 x 95 = (conservatively) 18,525 pulses per battery of cells
   vi. This can be rounded to 20,000 pulses per battery of cells
   vii. Since these are cells (as they are used in some digital cameras (such as the Nikon F6) – this 20,000 pulses number can be compared to:
      (1) Number of flashes from a digital camera with same battery of 2 cells
      (2) Number of digital photos that can be taken with same battery of 2 cells

2. **TASER Cartridge Wire** (36 gauge, 127 microns in diameter, smaller in diameter than some human hair, tensile strength is about 2 pounds) - some people have the misconception that a TASER ECD is a lightning bolt in the hand, or a horsepower (“hp”) in the hand (745 watts (W)). Also, many people understand the visual concept that it would take a very large cable to transmit the electrical energy from a lightning bolt.
   a. Show the TASER cartridge wire.
   b. Explain and show that the wire is easily broken (has a tensile strength of about 2 pounds).
   c. Take wire in your hands and pull it apart – break it.
   d. State that the cartridge wires are not car “jumper cables,” home extension cords, computer cords, nor even game player cords, etc.

3. **TASER Probes** - the purpose is to show that the point of contact for the TASER probes is very small, especially when compared to a medical external defibrillator pad.
   a. The TASER probe has a very small point of contact. And, TASER probes do not need to penetrate the skin to be effective, this is the reason for the 50,000 volts (V) open circuit peak voltage. Due to the sharp points up to 4 centimeters (cm) (or. 1.6 inch) cumulative air gap of thick clothing can be traversed (arced through) with this 50,000 V.

i. It takes approximately 1,000 volts to arc a 1 millimeter (mm) air gap. [Note 25.4 mm in 1 inch.]
   (1) This is why the 110 volt (V) electrical outlets in the house do not jump out of the wall.

b. **Comparison to medical external defibrillator:**
   i. Medical external defibrillators, that everyone has seen (probably on television), have pads or paddles approximately the size of medium size pancakes.
   ii. The defibrillator pads are large to drive electrical energy deep into a person's body.
   iii. Compared with a TASER probe – the probe is very small.

c. **Joule (J) output comparison - TASER X26 ECD and external defibrillator:**
   i. An automatic external defibrillator ("AED") commonly delivers an electrical charge 360 joules (J) of energy.
   ii. Thus, the AED delivers 3,600 times more energy in joules than the X26 ECD.
   iii. While a TASER X26 ECD only discharges 0.1 J per pulse into a person.
      (1) Note, the TASER X26 ECD does have 0.36 J per pulse at the main capacitor, however, this is INSIDE the X26 ECD and not delivered into the load (the person).

4. **Paper Stack** - the stack of copy paper is to visually show the duration that a TASER X26 ECD is "on" (and discharging) during one second, and five seconds, and this is compared to a normal wall electrical outlet.
   a. **One Second Demonstration** - The stack of copy paper (for a 100 µs ("microseconds") (or millionths of a second) needed for this demonstration is 10,000 sheets (about a four foot (4') high stack). With 19 (to demonstrate pulses per second) sheets of green copy paper.
      i. It has worked well to take the paper out of the boxes, keep them in their packaged reams, and open only one ream (500 pages).
      ii. Stack the paper.
      iii. Explain that the stack of 10,000 sheets of paper equals one second of time.
      iv. For the normal wall electrical outlet, the electricity is being transferred, "on" 100% of the time, or the full one second, or the full 10,000 sheets of paper.
      v. A TASER X26 ECD discharges at a rate of 19 pulses per second (pps) and each pulse is only 100 µs in duration.
         (1) Also the pulses are 52 milliseconds (ms) (or thousands of a second) apart.
      vi. Thus, "one" piece of paper from the stack of 10,000 sheets is the duration of "on" time for one TASER X26 ECD pulse (of 100 µs).

vii. Thus, “nineteen” (19) pieces of paper from the stack of 10,000 sheets of the TOTAL duration of “on” time (or delivered charge to the person) for a TASER X26 ECD for all 19 pulses within that second.
(1) Note, the best way to show this is to have 19 sheets of dark green copy paper. And, the individual sheets of dark green paper are equally interspersed within the 10,000 sheets.
viii. The rest of the stack of paper – 9,981 sheets – is the total time that the TASER X26 ECD is NOT on, (is “off”) or discharging.
ix. The equation (stack) is different for the Advanced TASER M26 ECD because the TASER M26 ECD has a shorter pulse duration (40 µs for full pulse width, with a shorter primary pulse duration of 10 µs).

b. **Five Second X26 ECD Stack of Paper Demonstration** - 50,000 sheets of paper (about 20 feet tall).
i. Same demonstration except for the 50,000 sheets the total “on” time is 95 sheets of (green) paper within the 50,000 sheets.

5. **Path of Least Resistance Demonstrations:**
a. **Pop/soda can** – (does not matter whether empty or full) use an X26 ECD in drive stun mode (no cartridge attached, or previously expended cartridge attached) and hold the pop can in one hand and the X26 ECD in the other. Arc the ECD on the can to show:
i. The electrical charge stays between the X26 ECD electrodes and does not flow to the other parts of the can - or, your hand.
ii. Also, move the X26 ECD away from and closer to the can to show the sound differences of the closed and open arcing.
(1) Arcing through the air (ECD away from can) causes a significantly louder noise (approximately 80 decibels).
(2) With no arcing - electrodes directly against the can - there is significantly less arcing noise (approximately 50 decibels).

b. **(Metal) Watch band** - I do the same demonstration on my “metal” watch band. The X26 ECD arcs on the metal band and only between the electrodes (4 cm or 1.6 inches apart). No electricity is felt or delivered to the person.

6. **Why 19 pps** – it may be helpful to explain an example of why TASER chose 19 pps for the TASER X26 ECD – use the Colorado Springs, CO incident as an example:
a. TASER chose 19 pps in order to maximize probability of inducing neuro-muscular incapacitation (“NMI”) control of a person without over stimulation (or unnecessary pulses to accomplish the objective).
b. When the TASER X26 ECD was first introduced in 2003, a five-second (5 s) discharge was – the first two (2) seconds were at 19 pps, and then the next three (3) seconds were at 15 pps. This was done to minimize the energy output and to attempt to save battery life.
c. Shortly after the X26 ECD was set to the 19/15 pulse discharge configuration, the pulse rate was changed (by software upgrade) to deliver 19 pps. One example of why is the Colorado Springs, CO handgun suicide that occurred.

i. In Colorado Springs (CO), a man was threatening to kill himself with a handgun. When an officer hit the man with a TASER X26 ECD, for the first two (2) seconds (19 pps) the man was literally frozen in place (NMI) and could not move. As soon as the ECD discharge rate (for the next three (3) seconds) dropped to 15 pps, the officers present watched the man force – as though in slow motion – the gun towards himself and pull the trigger.

d. Thus, the pulse rate for a TASER X26 ECD is now set to 19 pps.

7. **Strong Static Shock** – TASER X26 ECD pulses have a lower peak electrical current than a "strong static shock" [IEC 61000-4-2] [International Electrotechnical Commission, www.iec.ch]
   a. Because electrical devices need to be reasonably immune to strong static shocks, there are international standards that defines what a "strong static shock" is.
   b. Peak electrical current:
      i. IEC 61000-4-2 defines a strong (level 4) static shock as having a potential peak electrical current of 30 amperes (A).
      ii. A TASER X26 ECD has a peak electrical current of about 3 A, with an average (aggregate or actual) current of 1.9 milliamperes (mA) (or 0.0019 A) to 2.1 mA (or 0.0021 A), depending upon how it is measured.
   c. Voltage:
      i. A strong (level 4) static shock can have a peak voltage of 8,000 volts ("V").
      ii. A TASER X26 ECD delivers approximately 1,200 volts into the load (the person), or 600 volts average over the duration of the pulse, but only has an average voltage of 0.76 V (one second baseline)

8. **Van de Graff Generator** - A Van de Graff generator generates up to 25,000,000 volts. Yet, these are found in science museums, and grade school and high school science classes. When a person (including young children) touch the generator the person's hair stands on end from the static shock, but there is no injury.

9. **Ground Fault Interrupter (GFI)** - TASER X26 ECD discharge will not set off a GFI - the average current is too low to activate a GFI.

10. **Ball Analogy** - some people state that all electricity is the same. A simple analogy is stating that all electricity is not the same, just like all balls are not the same. There are significant differences between a nerf ball, a ping pong ball, wiffle ball, tennis ball, soccer ball, soft ball, base ball, football, basketball, rugby ball, bowling ball, medicine ball, and wrecking ball. The wrecking ball would represent lightning, the bowling ball would represent 110 V AC house current, and the tennis ball would represent the TASER X26 ECD.

11. **NSC (National Safety Council) Odds of Dying Comparison Chart** – First – see current selected science outline for some of the latest numbesr (there are updates to this - the latest is from 2009) compare the "odds of dying" between a TASER

ECD and the NSC Odds of Dying Comparison (Odds of Death Due to Injury, United States, 2003):

a. NSC Odds of Dying - http://www.nsc.org/lrs/statinfo/odds_back.htm
b. NSC Odds of Dying Graphic - http://www.nsc.org/lrs/statinfo/odds_dying.jpg
c. Examples of Odds of Dying:
    i. Total odds of dying any cause 1 in 1
    ii. Heart attack - 1 in 5
    iii. Cancer - 1 in 7
    iv. Stroke - 1 in 24
    v. Motor vehicle accident - 1 in 84
    vi. Suicide - 1 in 119
    vii. Falling - 1 in 218
    viii. Firearm assault - 1 in 314
    ix. Drowning - 1 in 1008
    x. Air/Space accident 1 in 5,051
    xi. Hot weather 1 in 13,729
    xii. Hornet, wasp, or bee sting - 1 in 56,789
    xiii. Legal execution - 1 in 62,468
    xiv. Lightning - 1 in 79,746
    xv. Earthquake - 1 in 117,127
    xvi. Flood - 1 in 144,156
    xvii. Fireworks discharge - 1 in 340,733