A Comparison of the GED and other Devices that Deliver Electrical Current

The electrical properties of the Graduated Electronic Decelerator (GED3A) and GED-4 are frequently presented incompletely and incorrectly. Subsequently, the incomplete or incorrect information is used to make specious comparisons between the GED and other devices (whose properties are also misrepresented) or safety guidelines. Here, the properties of various devices are presented, compared, and summarized.

Purpose of Device

Devices that deliver electrical current, of course, are designed for a specific purpose. In order to understand why each devices has certain properties, one must understand the effect each device is designed to cause. The GED3A and GED-4 are designed to deliver a safe and localized stimulus that will serve as a decelerator for severe problem behaviors. The Taser®, contrary to popular belief, is not specifically designed to cause pain. Rather it is designed to cause neuromuscular incapacitation by stimulating motor nerves that prevent coordinated movement.[1] The purpose of electroconvulsive therapy (ECT) machines is to induce a seizure by passing current through the brain. Finally, the purpose of defibrillation is to restore an effective heart rhythm.[2]

Path of the Current

The GED3A and GED-4 current passes through the skin. It does not pass through the heart or the brain and cannot be placed on these locations. In contrast, Tasers, ECT, and defibrillations devices are designed specifically to pass current through the body to cause certain effects.

Alternating versus Direct Current (AC/DC)

The GED3A and GED-4 use direct current (DC) as opposed to alternating current (AC). AC and DC current have different effects at equivalent current levels. The table below[3] describes the differential effects of AC and DC current at equivalent amperages.

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[1] Taser®. (2016). End-User Certification Course M26 Conducted Electrical Weapon. Version 20. Retrieved from: https://www.dropbox.com/sh/al8io78ytiq9etx/AACCgumyhWb3YkljQPbDBAYXa?dl=0

[2] Akselrod, H., Kroll, M.W., & Orlov, M.V. (2009). History of defibrillation. In I.R. Efimov, M.W. Kroll, & P. Tchou (Eds.), *Cardiac Bioelectric Therapy (pp. 15-40).* New York: Springer

[3] Neitzel, Dennis K. CPE. (2006). The Hazards of Electricity – Do You Know What They Are? Presented at the 2006 IEEE IAS Electrical Safety Workshop, February 7-10, Philadelphia, Pennsylvania.

AC (60 Hz) (mA)	DC (mA)	Effects
0.5 – 1.5	0 – 4	Perception
1 – 3	4 – 15	Surprise (Reaction)
3 – 22	15 – 88	Reflex Action (Let Go)
21 – 40	80 – 160	Muscular Inhibition
40 – 100	160 – 300	Respiratory Block
>100	>300	Usually Fatal

Pulses Per Second

The GED3A and GED-4 do not continuously pass current through the skin during an application. Instead, 80 pulses of current are sent through the skin per second. However, the GED3A and GED-4 also have a duty cycle of 25%. The cycle consists of 3 ms of pulses at a rate of 80 per second followed by 9 ms of no pulses. Thus, during an application, the device is only delivering current 25% of the time (20 pulses per second).

Energy Delivered (measured in Joules)

Compared to other devices, the GED3A and GED-4 deliver far less energy to a much smaller area of the body. For example, compared to the Taser® M26, the GED3A delivers less than 1% of the total energy. Compared to ECT, the GED3A delivers less than .5% of the total energy. GED-4 does not significantly increase the amount of energy transferred relative to Taser® M26 and ECT. The properties of various devices that deliver electrical current are summarized in the table below:

Properties of Various Electrical Stimulation Devices

Device	Current Path	AC or DC	mA	Volts	Pulses per second	Duration (seconds)	Total Joules (energy) per Application
GED3A	Surface of the Skin	DC	15.25	60	20	2	<0.45
GED-4	Surface of the Skin	DC	41	66	20	2	<1.353
Cattle Prod[4]	Surface of the Skin	AC	18.5	2400	50-500	~1	<44.4
Taser® M26[5]	The body	AC	<4	50,000[a]	20	5	50[b]
ECT (Thymatron System IV)[6]	The skull and brain	AC	900	450	variable	8 (max)	100 (max)
Defibrillator[7]	Through the Chest	DC	19400[c]	2425	-	.006	269

[a]50,000 Volts is the peak arcing voltage. The peak voltage across the body is reported to be 5000. See Taser® User Certification Course Version 18 Released July 2011.

[b]0.5 J per pulse * 20 pulses/s * 5 second duration = 50 J

[c] Maximum initial current at 125Ω

[4] Geddes, L.A. & Roeder, R.A. (2005). Handbook of Electrical Hazards and Accidents. Tucson, AZ: Lawyers & Judges Publishing Company, Inc.
Foxx, R. M., McMorrow, M. J., Bittle, R. G., & Bechtel, D. R. (1986). The successful treatment of a dually-diagnosed deaf man's aggression with a program that included contingent electric shock. *Behavior Therapy, 17*, 170-186.

[5] Taser® User Certification Course Version 18 Released July 2011.
Taser®. (2016). End-User Certification Course M26 Conducted Electrical Weapon. Version 20. Retrieved from: https://www.dropbox.com/sh/al8io78ytiq9etx/AACCgumyhWb3YkljQPbDBAYXa?dl=0

[6] Somatics, LLC. (n.d.)The Streamlined Somatics Thymatron® System Saves Time and Effort. Retrieved from: http://www.thymatron.com/downloads/somatics_brochure.pdf

[7] ZOLL Medical Corporation. (2016). R Series® ALS Operator's Guide. Retrieved from: http://www.zoll.com/WorkArea/DownloadAsset.aspx?id=23899