STRATBUCKER
& Associates

10744 West Center Road * Omaha, Nebraska 68124 * (402) 399-9500 * fax (402) 571-4017

INTRODUCTION

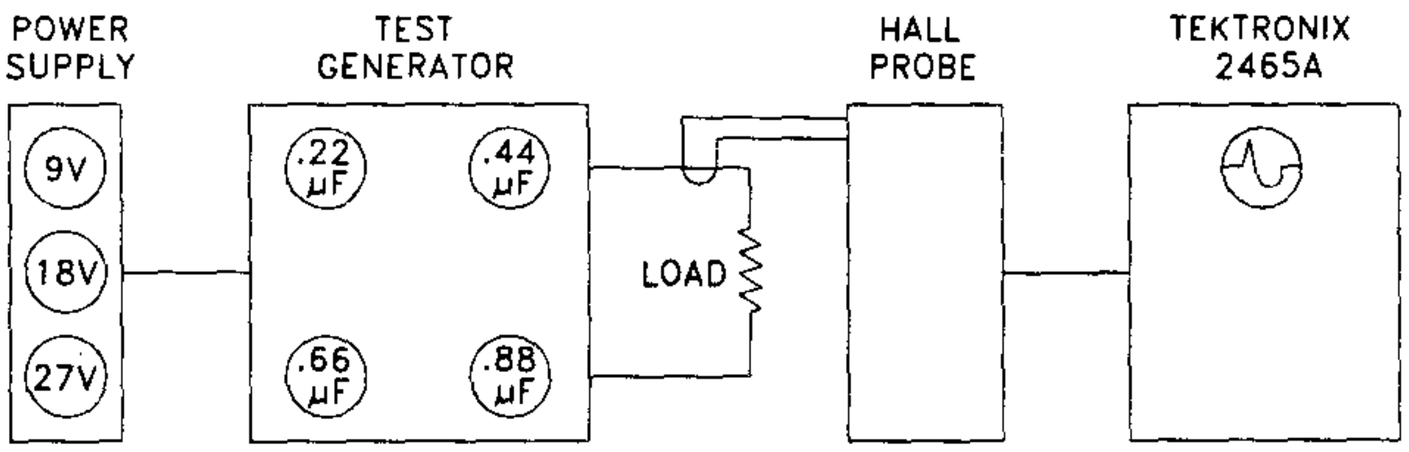
In late 1995, I was contacted by representatives of AIR TASER, Incorporated seeking to perform safety studies of the impulse generator module of the AIR TASER® product. The goal of the study was to perform an analysis to establish a margin of safety for the AIR TASER Model #34000 by testing significant increases in relevant electrical characteristics and evaluating the physiological response.

PROCEDURE

Over the past decade, I have tested a number of similar devices both physically and physiologically in my laboratory and have become quite familiar with the necessary procedures to accurately accommodate such testing. Accordingly, I agreed to commence such testing upon the completion of a test power supply with the four capacitor settings as follows:

	Capacitor value
• Standard AIR TASER Model #34000 generator	0.22 microfarads
• 2x standard model	0.44 microfarads
• 3x standard model	0.66 microfarads
• 4x standard model	0.88 microfarads

The tests also included each of the above noted capacitor sizes with one, two, or three 9 volt batteries as a power source. (The standard unit Model #34000 generator uses one such battery.)



In addition to the familiar physical measurements of the pulse wave form using a 100 megahertz Tektronix 2465A Oscilloscope, a new high bandwidth Hall effect probe was used to accomplish indirect current measurements in the test circuits.

The following table lists measured values of peak current, pulse repetition rate, and damped cycle width with the non-arcing output of the pulse generator loaded into 1000 Ohms.

Electrical Output Measurements

Capacitance (Microfarads)	Battery Input (Volts)	Peak Current (Amperes)	Interval (Milliseconds)	Pulse Width (Microseconds)	Load (Ohms)
0.22	9	10	230	6.5	1000
0.44	9	13	600	9.4	1000
0.66	9	16	750	11	1000
0.88	9	18	1000	11	1000
0.22	18	9.2	80	6.9	1000
0.44	18	14	250	9.5	1000
0.66	18	16	350	11.4	1000
0.88	18	18	500	12	1000
0.22	27	8	44	7	1000
0.44	27	12	88	10	1000
0.66	27	15	160	11	1000
0.88	27	17	400	13	1000

Most importantly, the above described protocol was to be evaluated in anaesthetized animals of representative size and cardiac status to adult humans. Accordingly, such physiologic testing was performed using market sized farm swine conveniently available to the laboratory.

On January 11, 1996 an animal test was performed using the identical protocol outlined in the physical study. An 18.2 kg Hampshire shoat, the standard subject used in many cardiac safety studies, was pre-medicated with atropine sulfate (0.02 mg/kg) intramuscularly. Shortly thereafter, Ketamine (10mg/kg) mixed with Xylazine (2.01mg/kg) were given intramuscularly in serial doses spaced by 15-20 minutes to affect stage I to stage II anesthesia for the one hour duration of the procedure. The airway was carefully managed, but intubation was not required nor was assisted ventilation. At the conclusion of the procedure, the animal was allowed to recover and was returned to its pen in excellent condition.

In each of the twelve steps in the 4 x 3 protocol described above, the animal was stimulated with the device via output electrodes placed on the left hindquarter to determine skeletal muscle response, vertically oriented on the anterior abdomen at the umbilicus to asses mid-abdominal response and finally with both vertical and transverse orientation at the level of the cardiac apex to assess any possible affect on cardiac rhythm. In this latter regard, it should be noted that a three channel battery powered cardiograph unit was continuously employed to accomplish orthogonal lead axes. Such technique overcomes the serious deficiencies of several prior reports in which the pulse generator axis coincides with a non-dominant electrocardiographic axis of the heart, nearly obliterating the animal's electrocardiogram and erroneously raising doubt as to the expected immunity of the cardiac rhythm to the effects of body surface electric discharges.[1]

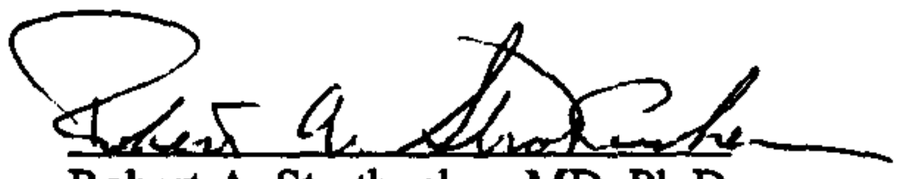
RESULTS

Of the more than 48 discharges of five seconds duration, there was no case in which the animal revealed any cardiac ectopy or myocardial injury. ***The cardiac tissue proved resistant to stimulation despite progressively increased skeletal muscle effects noted as the storage capacitors and the battery output were increased by several hundred percent.*** Respiration was briefly arrested during the application of some of the chest discharges, but returned spontaneously upon cessation of stimulation.[2] Several other mild autonomic effects such as increased heart rate and respiration rate were observed with the higher potency discharges. Both respiration and heart rate returned to normal in a matter of a few minutes. On the day following this rigorous protocol, the animal appeared to be completely normal with the exception of a few lingering electrical "signature" marks on its chest and abdomen.

DISCUSSION

These experiments corroborate our earlier findings[3] in consulting reports and peer review journals that the electrical emissions from stun type pulse generators, delivered to the body surface in the recommended manner do not cause serious cardiac rhythm abnormalities in the otherwise healthy adult heart. As this study investigated electrical outputs equivalent to 400% the capacitance and 300% the battery voltage of the standard AIR TASER Model #34000, an adequate margin of safety[4] appears to exist.

Respectfully Submitted,



Robert A. Stratbucker, MD, Ph.D.

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[1] O.Z. Roy and A.S. Podgorski, Tests on a Shocking Device – the Stun Gun. Med. & Biol. Eng. & Comput., 1989, 27, 445-448.

[2] Note: The AIR TASER was designed with a pre-programmed timing cycle in light of the potential for respiratory interruption. The unit automatically provides four 1 second pauses during each 30 second discharge to allow the subject to breathe. During this study, the animal promptly resumed normal breathing upon cessation of electrical stimulus. Hence, the four 1 second breaks allow the target to take four full breaths every 30 seconds, minimizing the risk of anoxia. (However, interruption of respiration for a full 30 seconds poses little health risk.)

[3] Robert A. Stratbucker and Matthew G. Marsh. IEEE The Relative Immunity of the Skin and Cardiovascular System to the Direct Effects of High Voltage - High Frequency Component Electrical Pulses. Proc. IEEE Engineering in Medicine & Biology Conference, October 1993, San Diego, CA.

[4] Pearce, J.A. et al: Myocardial Stimulation with Ultrashort Duration Current Pulses. PACE, Vol. 5, January-February 1982.