Department of Planning, Zoning & Building

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October 31, 2012

Mr. Clifford I. Hertz, P.A.
Broad and Cassel
One North Clematis Street, Suite 500
West Palm Beach, FL 33401

Re: Proposed ULDC Amendments for Electric Fences

Mr. Hertz:

This letter serves to outline the next steps necessary to facilitate your proposed Unified Land Development Code (ULDC) amendments related to the use of electric fences. Pursuant to Board of County Commission (BCC) direction on September 29, 2012, and your subsequent communications with County staff, we are confirming that Phase 1 of the two-Phase ULDC Amendment process has been completed.

Amendments to the ULDC require presentation to the Land Development Regulation Advisory Board (LDRAB) and two or more BCC public hearings. A LDRAB subcommittee is also required.

The following provides a tentative timeline, required fees, and other general details for this particular amendment request.

Tentative Timeline of Key Meeting/Hearing Dates:

Note that all meeting or hearing dates are tentative and subject to change. The following provides a timeline for required meetings or public hearings. Additional meetings will be required to ensure clear communication during this process.

Dates:	Meeting/Hearing:
Nov/Dec. 2012	LDRAB Subcommittee Meeting(s)
Jan. 23, 2013	LDRAB/LDRC*
Feb. 28, 2013	BCC – Request for Permission to Advertise ULDC Amendments
March 28, 2013	BCC – Adoption Hearing
Early April 2013	Effective Date of Amendments
* The LDRAB also sits as the Land Development Regulation Commission (LDRC)	

ULDC Amendment Phase 2 – Fees

The fees for Phase 2 are determined based on whether or not an LDRAB subcommittee will be required to review the amendments, as well as the cost of any required legal advertisements.

As discussed with your client or other representatives, use of electric fences as proposed, will require a review of a broad range of regulations or other considerations. These include, but are not limited to requirements for landscaping, height limitations, visibility, use of materials for fencing, and, consideration of other aesthetic or public safety concerns. As such, it has been decided that the proposed amendments will require an LDRAB subcommittee, resulting in a Phase 2 fee of $4,857 (Code 03154).

As the proposed amendments will only require two BCC public hearings (of which only one requires a legal ad), the advertising fees for the LDRAB meeting and BCC hearing will total $1,100.

Total fees due prior to convening the LDRAB subcommittee will be: $5,957.

Other Considerations:

The ULDC amendment process will not address any Building Code issues. Therefore, it is critical that any Building code issues be addressed concurrently, to ensure that permits can be issued upon adoption of these amendments.

Upon preliminary review of the proposed amendments and discussions related to the proposed variances AV 2012-2802 for the Marine Connection facility, staff has identified several areas of concern, mostly related to aesthetics, landscaping and public safety. Prior to providing detailed feedback on materials submitted thus far, we are requesting a meeting with you, your client or any pertinent consultants. This meeting will serve to ensure we're all on the same page and have a clear understanding of the issues.

If you should have any questions or require additional information, please feel free to contact me directly at (561) 233-5234, or William Cross, Principal Site Planner, at (561) 233-5088 or wcross@pbcgov.org.

Sincerely,

Jon MacGillis, ASLA
Zoning Director

JM/WJC

c. Verdenia Baker, Deputy County Administrator
Rebecca D. Caldwell, Executive Director, PZ&B
Richard Gathright, Building Director
Maryann Kwok, AICP, Chief Planner, Zoning
Leonard W. Berger, Asst. County Attorney
William J Cross, AICP, Principal Site Planner, Zoning
Wendy Hernandez, Zoning Manager
Monica Cantor, Senior Site Planner, Zoning
Autumn Sorrow, Senior Site Planner, Zoning
Jon E. Schmidt, Jon E. Schmidt and Associates
Chris Barry, AICP, Jon E. Schmidt and Associates
AV2012-28012

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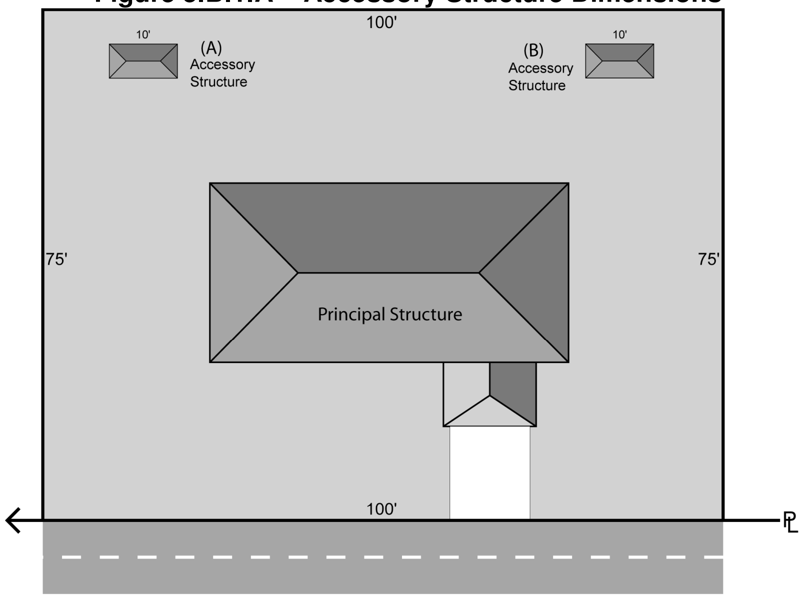
Accessory structures shall meet the setback requirements in Table 3.D.1.A, Property Development Regulations.

4) Dimensions

In the U/S Tier, all accessory structures located on a parcel in a residential district shall not occupy more than 25 percent of the distance between property lines. **[Ord. 2008-037]**

Figure 5.B.1.A – Accessory Structure Dimensions



In the U/S Tier, all accessory structures located on a parcel in a residential district shall not occupy more than 25 percent of the distance between property lines.

<u>This Example:</u>
Distance between property lines 100'
Total of A+B accessory structures 10'+10'=20'
100' X 25% = 25' maximum allowed by Code

2. Fences, Walls and Hedges

a. Height

The height of a fence or wall shall be measured in accordance with Article 7.F, PERIMETER BUFFER LANDSCAPE REQUIREMENTS. Hedges may be planted and maintained along or adjacent to a lot line to a height not exceeding eight feet in the required side (to the required front setback) and rear yards and not exceeding a height of four feet in the required front yards. The height shall be measured adjacent to the hedge from the lowest grade on either side of the hedge.

b. Appearance

The exterior surface of a wall shall be finished with paint, stucco, or other commonly accepted material, and continuously maintained in its original appearance.

c. Dangerous Materials

1) Fences or walls in any zoning district, shall not be electrified or contain any substance such as broken glass, spikes, nails, barbed wire, razors, or any other dangerous material designed to inflict discomfort, pain or injury to a person or animal, except as allowed below. **[Ord. 2010-005] [Ord. 2011-001]**

2) Barbed Wire Exceptions

The use of barbed wire is prohibited. However, the County recognizes that barbed wire may be necessary to secure certain uses such as public utilities, prisons, bona-fide agriculture, public-owned natural areas, commercial or industrial uses that have outdoor storage areas. Therefore, the County allows the installation of barbed wire as part of the top of the fence or wall for specific uses pursuant to Art. 4.B, SUPPLEMENTARY USE STANDARDS or for situations stated below. The barbed wire shall not exceed 20 percent of the overall permitted height of the fence or wall. Bonafide agricultural uses, prisons, and other uses as authorized by the Zoning Director pursuant to provisions, Art. 5.B.1.A.2.c.2).c) below, shall be permitted to exceed the 20 percent provision. The calculation of the overall height of a fence or wall is inclusive of any barbed wire: **[Ord. 2005-002] [Ord. 2010-005] [Ord. 2011-001]**

a) Properties with a Conservation FLU designation, for the purposes of protecting publicly owned natural areas; **[Ord. 2005-002] [Ord. 2010-005] [Ord. 2011-001]**

b) Properties where the owner can document a valid Development Permit; and **[Ord. 2010-005] [Ord. 2011-001]**

c) The Zoning Director shall have the authority to allow the installation of barbed wire for any uses pursuant to Art. 4.B, SUPPLEMENTARY USE STANDARDS, when the applicant demonstrates a need to comply with Federal, State or Local Government regulations. In support of the barbed wire installation, the Zoning Director may require the applicant to perform mitigation in order to address compatibility with adjacent properties or visibility from adjacent street right-of-way. **[Ord. 2010-005] [Ord. 2011-001]**

d. Sight Distance

Walls and fences shall comply with Article 11.E.9.E, Minimum Safe Sight Distance and Corner Clips at Intersection.

e. Residential Districts

The maximum height for a fence or wall on or adjacent to a lot line or in a landscape buffer shall be as follows:

1) Within required front setback:

a) four feet, or **[Ord. 2005-041]**

b) six feet for property owned by PBC for preservation or conservation purposes. **[Ord. 2005-041]**

2) Within required side, side street, and rear setback: six feet.

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Jon E. Schmidt and Associates
Land Planning and Landscape Architecture

September 26, 2012

Clifford I. Hertz, P.A.
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RE: Proposed Code Language for Electrified Fencing in the Palm Beach County (PBC) Unified Land Development Code (ULDC)

Dear Mr. Hertz,

Below is the proposed code language to incorporate electrified fencing into the PBC ULDC for your review and comment. Note that there were uses that had provisions related to fencing that were left out of these revisions due to the nature of the use. Those uses were as follows:

- Aviculture, Hobby Breeder
- Day Care
- Kennel, Type I (Private)
- Kennel, Type II (Commercial)
- Type IV Kennel (Animal Shelter)
- Veterinary Clinic

Article 1.I.2.F (related to Definitions and Acronyms)

12. Fence - an artificially constructed barrier of any material or combination of materials erected to enclose or screen areas of land.
13. Fence, Electrified — Any fence, barrier or enclosure partially or totally enclosing a building, field or yard, carrying any electrical pulse or charge through any part, section or element thereof.
~~13.~~14. Fenestration – windows, doors and openings in a building façade or wall allowing light and views between interior and exterior. [Ord. 2010-022]

Article 3.B.14.G (related to Supplementary Standards in the Westgate Community Redevelopment Area Overlay [WCRAO])

Table 3.B.14.G - WCRAO Supplementary Standards by Sub-Area

Sub-areas	NR	NRM	NG	NC	UG	UH	UI
Minimum Enclosed Living Area							
Single Family Dwelling Unit	1,000 s.f.	1,000 s.f.	-	-	-	-	-
Accessory Dwelling	300 s.f	300 s.f	300 s.f	-	-	-	-
Fences and Walls:							
Prohibited Materials (7)	Chain link, wire mesh, barbed wire, wood basket weave, or corrugated metal panels						
Architectural Features:							
Arcades and Galleries (1)	-	-	-	Required - Westgate Avenue	-	-	-
Minimum Building Depth	-	20'	20'	20'	30'	-	30'
Minimum 1st Floor Height		-	-	12'	-	-	-
Minimum Number of Floors				2 (2)	-	-	-
Windows and Doors:							
Minimum Glazing of Frontage (3)	-	(3)	(3)	(3)	-	-	-
Porches, Balconies and Entryways							
Front Setback Maximum Encroachment (8)	8'	6'	6'	-	-	-	-
Min/Max Porch Depth (4)	6'/10'				-	-	-
Min/Max Porch Length (4)	8'/50% of building facade				-	-	-
Min/Max Balcony Depth	3'/3'						
Min/Max Balcony Length	6'/50% total of building façade						
Parking:							
Location of Surface Parking	-	Rear	Rear	Rear	-	-	-
Driveways (5)	-	Rear	Rear	Rear	-	-	-
Location of Accessory Dwellings and Garages:							
Detached – **Location**	Back of rear façade of primary structures.			-	-	-	-
Detached – **Setbacks**	5' side or rear (6)			-	-	-	-
Attached – **Location**	Setback a min. of 20' from front façade			-	-	-	-
Landscaping:							
See Article 7, Landscaping for provisions allowing for reduction in Perimeter and foundation planting requirements.							
Min. Pervious Surface Area	-	20%	20%	20%	-	-	-
Key							
-	Subject to the supplementary standards of the lot's zoning district						
[Ord. 2006-004] [Ord. 2009-040]							

Notes:

1. See Art**.** 3.B.14.G.3.d, Arcades and Galleries, Figure 3.B.14.G, WCRAO Arcade and Gallery Standards**. [Ord. 2006-004]**
2. Required second floor shall meet minimum frontage and depth requirements. **[Ord. 2006-004]**
3. See Art. 3.B.14.G.3.c, Fenestration Details - Windows and Doors. **[Ord. 2006-004]**
4. Excludes stoops. **[Ord. 2006-004]**
5. Access from the front or side may be permitted for lots with no rear street frontage. **[Ord. 2006-004]**
6. Minimum 20 foot setback shall be required for garages fronting on a street or alley. **[Ord. 2006-004]**
7. Chain link fences may be installed for the following: **[Ord. 2009-040]**
   Single-family residential use provided a continuous native hedge is planted along the exterior side of the fence and adequate room for maintenance is provided along the property lines adjacent to public R-O-W. The hedge shall be maintained at the same height as the chain link fence. Black or green vinyl coated chain link fence may be installed along remaining perimeter property lines not adjacent to a public R-O-W. **[Ord. 2009-040]**
   Nonresidential uses within the UI sub-area if the chain link fence is black or green vinyl coated. Furthermore, a fence, electrified may be used in combination with a vinyl-coated chain link fence in the UI sub-area in accordance with Art. 5.B.1.A.3. **[Ord. 2009-040]**
8. The maximum encroachment for porches, balconies, and entryways located in NC sub-area shall only apply to permitted residential or hotel uses. These ground floor improvements shall not conflict with the placement of street trees. **[Ord. 2011-001]**

Article 4.B.1.A.7.b.1).b) (related to the screening of the Agricultural, Storage use)

…

7. Agriculture, Storage

The storage of equipment or products accessory or incidental to a principal agricultural use.

a. General

Storage of hazardous waste or regulated substances shall comply with local, state and federal regulations.

b. Outdoor Storage

Outdoor agricultural storage shall comply with the following standards: 1) Urban Service Area

a) Setbacks

Outdoor agricultural storage shall meet the principal use setbacks of the district in which it is located.

b) Screening

Outdoor agricultural storage shall be screened from view by a solid fence, wall or building. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3.

Article 4.B.1.A.35.c (related to the screening of the Contractor Storage Yard use)

35. Contractor Storage Yard

A lot used for the storage of construction material, equipment, or three or more commercial vehicles used by building trades and services, other than construction sites. **[Ord. 2005-002]**

a. Construction Equipment

Mechanical equipment principally used in construction activity. Such equipment shall include but is not limited to bobcats, front-end loaders, over-head cranes, graders, dump trucks, compactors, forklift, steam rollers, earth movers, bulldozer, backhoe, concrete mixer, trenchers, cable/pipe layers or any such equipment that is not a street worthy vehicle.

b. Office Permitted

An accessory office shall be permitted subject to Article 5.B, ACCESSORY AND TEMPORARY USES.

c. Screening

Outdoor storage shall be screened from view in accordance with Article 5.B, ACCESSORY AND TEMPORARY USES. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. For a storage yard contiguous to property in a residential district, an opaque fence/wall a minimum of eight feet in height shall be installed along the inside edge of the required landscape buffer.

d. Flex Space

This use shall be allowed as a flex space component pursuant to the applicable approval process indicated in Table 3.E.1.B – PDD Use Matrix, Table 4.A.3.A – Use Matrix, and pursuant to Article 5.B.1.C, Flex Space. **[Ord. 2010-005]**

e. Barbed Wire

Barbed wire may be installed pursuant to Art. 5.B.1.A.2.c, Dangerous Materials, except when located adjacent to a parcel having a residential FLU designation or use. Barbed wire shall not be visible from any public street. **[Ord. 2011-001]**

Article 4.B.1.A.105.a.3) (related to the screening of the Recycling Plant use)

105. Recycling Plant

A permanent facility designed and used for receiving, separating, storing, converting, baling or processing of non-hazardous recyclable materials that are not intended for disposal. The use may include construction debris recycling or other intensive recycling processes such as chipping and mulching.

a. Compatibility, Screening, Buffering

To ensure compatibility with surrounding uses, adequate setbacks, screening and buffering around the perimeter of the proposed recycling plant shall be required at the time the facility is constructed. The standards shall be waived if any of the required landscape buffer is not visible from adjacent lots or streets.

1) Lot Size

The minimum lot size for recycling plants in all industrial districts shall be five acres. However, the minimum lot size or greater for the underlying district shall apply for recycling plants that operate completely in enclosed buildings.

2) Setbacks

Except for a freestanding office, no part of a recycling plant and its accessory ramps, on site circulation system, or storage areas shall be located within 50 feet of any property line.

a) IL District

If the facility is in an industrial district and is contiguous to land in an industrial district or IND FLU designation the setback shall be 25 feet from that contiguous property line.

b) Civic and Residential Uses

No part of a recycling plant, its accessory ramps, on site circulation system or storage areas shall be sited within 150 feet of a school, park, church, library or residential lot. In no case shall the setback be less than the requirement of the district.

c) CC, CG, IG, IL Districts

No additional setback beyond district setbacks shall apply to recycling plants that operate completely in enclosed buildings and are located in the CC, CG, IG, and IL districts.

3) Screening and Fencing

All storage areas shall be screened from view by on-site walls, fences, or buildings. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. Such screening shall be designed and installed to ensure that no part of a storage area can be seen from street or adjacent lots. In no case shall the height of recyclable or recovered materials, or non-recyclable residue stored in outdoor areas, exceed

20 feet or the height of the principal building on the lot, whichever is greater. For an outdoor recycling plant contiguous to property in a residential district, an opaque fence/wall a minimum of eight feet in height shall be placed along the inside border of the required landscape buffer.

Article 4.B.1.A.123.c (related to the screening of the Solid Waste Transfer Station use)

123. Solid Waste Transfer Station

A facility where solid waste from smaller vehicles is transferred into larger vehicles before being shipped or transported to a solid waste processing or disposal facility. Solid waste may be sorted but not processed at a transfer station.

a. Frontage

The facility shall front on and access from an arterial or collector street.

b. Setbacks

All portions of a transfer station, including structures, ramps, parking and on site circulation areas, shall be setback a minimum of 25 feet from all property lines, lakes, canals, water management tracts, retention/detention areas, drainage swales, and other water bodies.

c. Screening

All storage areas shall be screened from view by walls, fences or buildings. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. Such screening shall be designed and installed to ensure that no part of a storage area can be seen from streets or adjacent lots. In no event shall the height of solid waste stored outdoors exceed 25 feet.

Article 4.B.1.A.131.d (related to the screening of the Truck Stop use)

131. Truck Stop

A facility which provides fueling, parking, washing, repair and maintenance services, food service, overnight accommodations, and incidental retail sales for transient commercial vehicles.

a. Frontage

A minimum of 200 feet on an arterial street only.

b. Lot Size

1) Ten Acres or Less Shall be permitted as a Class A conditional use in the IL and IG districts. 2) Greater than Ten Acres Shall require approval as a MUPD or PIPD. The proposed site shall have an IND FLU designation.

c. Setbacks

Parking shall be setback a minimum of 200 feet from any existing residential use, district or FLU designation.

d. Buffer

Perimeter landscape buffers adjacent to an existing residential district, use or FLU designation shall include a six foot high berm topped by a six foot high opaque wall or fence. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3.

Article 4.B.1.A.134.b & d.2).a) (related to the screening of the Utility, Minor use)

134. Utility, Minor

Mechanical equipment associated with utility distribution, collection, or transmission networks, required by their nature to be relatively dispersed throughout their service area other than electric generation and transmission facilities. Typical uses include gas and water regulators, electrical distribution substations, chlorine injection and potable water booster pump stations; water reclamation treatment, storage and distribution facilities, membrane bioreactor plants, sewage lift stations, telephone exchange buildings, and communication substations. **[Ord. 2006-004] [Ord. 2007-013]**

a. Floor Area

1) Residential Districts [Ord. 2004-040]

A maximum of 3,000 square feet of gross enclosed floor area of buildings. Square footage calculations shall not include tanks and unoccupied accessory facilities. **[Ord. 2007-013]**

2) Non-residential Districts

A maximum of 10,000 square feet of gross enclosed floor area of buildings. Square footage calculations shall not include tanks and unoccupied accessory facilities. **[Ord. 2004-040] [Ord. 2007-013]**

3) A minor utility exceeding either standard above may be approved as a Class A Conditional Use or a Requested Use. **[Ord. 2004-040]**

b. Buffer

A minor utility shall be located and buffered to ensure compatibility with surrounding land uses. Increased setbacks, screening, and buffering around the utility may be required to ensure compatibility. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. **[Ord. 2004-040]**

c. Lift Station

1) New Subdivisions

Facilities located in new subdivisions shall be subject to DRO approval concurrent with the subdivision approval.

2) Streets

Facilities located within streets or utility easements shall not be subject to DRO approval.

d. Electric Distribution Substations

For the purposes of this section, shall be defined in accordance with F.S. 163.3208, as an electric substation which takes electricity from the transmission grid and converts it to a lower voltage so it can be distributed to customers in the local area on the local distribution grid through one of more distribution lines less than 69 kilowatts in size. An electrical distribution substation shall comply with the following: **[Ord. 2007-013]**

1) Exemptions

Electrical substations are exempt from the floor area limitations. **[Ord. 2007-013]**

2) Landscape Buffering in Residential Areas

Where located in and adjacent to parcels with residential uses or a FLU designation landscape buffering shall be upgraded as follows: **[Ord. 2007-013]**

a) An eight-foot wall or fence shall be installed around the substation where equipment or structures are setback less than 50 feet. Landscaping materials shall be native. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. **[Ord. 2007-013]**

b) An open green space shall be maintained between required perimeter buffers and security fencing, equipment or structures, by installing native landscaping, including trees and shrub material, around the substation where equipment or structures are setback between 50 and 100 feet. Required green spaces shall be planted with double the amount of interior trees and shrubs required by Table 7.C.3, Minimum Tier Requirements, in addition to normal interior landscaping requirements. **[Ord. 2007-013]**

Article 4.B.1.A.135.c.3) (related to the screening of the Vehicle Sales and Rental use in the Light Industrial [IL] Zoning District)

135. Vehicle Sales and Rental

An establishment engaged in the sale, rental, or lease of new or used motorized vehicles, equipment, or mobile homes as defined by the Department of Motor Vehicles. Typical uses include auto and truck rental, lease and sales; boat rental and sales; mobile home and recreational vehicle sales; construction equipment rental yards; moving trailer rental, and large implement sales or rental.

…

c. District and Overlay Limitations

1) CC, CG IL, and MUPD Districts

a) Truck and Trailer Rental

Truck and trailer rental, limited to a maximum of five vehicles per lot, shall be permitted as an accessory use to an auto service station or convenience store with gas sales subject to DRO approval. Truck and trailer rental exceeding five vehicles shall be permitted subject to requested or Class B conditional use approval. Designated storage spaces for each truck or trailer shall be depicted on the approved site plan. All storage spaces shall be setback a minimum of 100 feet from the front and side street property lines, or in a location which is fully screened from view from any public street by a combination of walls, fences or landscaping. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. No truck or trailer shall be stored or temporarily parked in a required parking space, handicapped parking space, driveway, queuing area, fire lane, or other vehicular circulation area.

2) CG and MUPD Districts

A vehicle sales and rental facility consisting of an indoor vehicle showroom only shall be allowed subject to DRO approval and the following criteria.

a) Floor Area

A maximum of 30,000 square feet and 15 display vehicles.

b) New Vehicles

Display shall be limited to new vehicles only.

c) Test Drives

Test drives shall not be permitted from the indoor vehicle showroom or on-site.

d) Parking

Vehicles for sale or lease shall not be parked or displayed outside of the showroom. Trucks used to transport vehicles to and from the showroom shall not be parked in required loading spaces and shall not be stored on-site.

e) Vehicle Operations

Display vehicles shall not operate engines during store hours. Engines shall only be permitted to operate during the transport of vehicle into or out of the showroom.

f) Maintenance and Repair

Maintenance, repair, painting or detailing shall not occur on-site.

3) IL District

In the district vehicle sales and rental uses shall be limited to the following:

a) Accessory Use

In the IL districts limited vehicle sales may be permitted as an accessory use to general repair and maintenance facilities, subject to DRO approval. The vehicle sales use shall be limited to a maximum of five vehicles per lot. Designated storage spaces for each vehicle shall be depicted on the approved site plan. All storage spaces shall be setback a minimum of 100 feet from the front and side street property lines, or in a location which is screened from view from any public street by a combination of walls, fences or landscaping. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. No vehicle shall be stored or temporarily parked in a required parking space, handicapped parking space, driveway, queuing area, fire lane, or other vehicular circulation area.

(1) Display

Vehicles on display shall be located within 100 feet of a repair bay.

Article 4.B.1.a.139 (related to the screening of the Water or Treatment Plant use)

139.Water or Treatment Plant

A facility designed for treatment and disposal of more than 5,000 gallons per day of water or wastewater.

…

1) **Buffer**
Perimeter landscape buffers shall have a minimum width of 25 feet or be equal to the setback requirements if less than 25 feet. **[Ord. 2007-013].**

2) **Trees**
A single row of trees shall be planted all landscape buffers at a ratio of one 14 foot tall tree for each 25 linear feet. **[Ord. 2007-013]**

3) **Screening**
Screening consisting of a hedge, berm, or fence which will present a visual screen at least six feet in height within one year of installation shall be provided around the perimeter of the site. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. **[Ord. 2007-013]**

Article 4.C.4.E.1 (related to the screening of the Communication Tower use)

…

E. Perimeter Buffering

1. Fence/Wall

A fence or wall, a minimum of eight feet in height measured from finished grade, shall be constructed around the base of each communication tower and accessory equipment structure, and around each guy anchor. Access to the communication tower shall be through a locked gate. Barbed wire along the top of the fence or wall may be used in any zoning district to preclude unauthorized tower access~~.~~ and fencing may include a fence, electric in accordance with Art. 5.B.1.A.3.

Article 4.C.8.E (related to the fencing of the Communication Cell Sites on Wheels [COWs] use)

Section 8 Communication Cell Sites on Wheels (COWs)

COWs shall comply with the following supplementary use standards. COWs means a temporary facility utilized to ensure adequate telecommunications capacity during periods of high usage or during periods when traditional modes of communication are unavailable. COWs consist of a folding or telescoping monopole or guyed structure, with attached antenna, mounted on a trailer or truck.

A. States of Emergency
The requirements of this Section may be waived in the case of a declared state of emergency, as provided by law.

B. Special Permit
A Special Permit must be obtained from the Zoning Division prior to the placement of the facility.

C. Use limitations
COWs shall be permitted only in association with recognized large-scale special events with a minimum projected daily attendance of 30,000 or greater. The Zoning Director may consider allowing COWs for events with projected

attendance of less than 30,000 people. The applicant shall provide documentation that the existing communication facilities cannot accommodate the increase in usage. [Ord. 2011-016]

D. Time Limitations

The Special Permit shall be valid for seven days, including installation and removal.

1. Time Extensions

The Special Permit may be extended up to an additional ten days by the Zoning Director based upon individual circumstances and demonstration of need by the applicant.

E. Fencing

The COW shall be enclosed by a temporary fence a minimum of six feet in height, or other barrier approved by the Zoning Division. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3.

Article 5.B.1.A.2 (related to the Fences, Walls and Hedges)

2. Fences, Walls and Hedges

a. Height

The height of a fence or wall shall be measured in accordance with Article 7.F, PERIMETER BUFFER LANDSCAPE REQUIREMENTS. Hedges may be planted and maintained along or adjacent to a lot line to a height not exceeding eight feet in the required side (to the required front setback) and rear yards and not exceeding a height of four feet in the required front yards. The height shall be measured adjacent to the hedge from the lowest grade on either side of the hedge.

b. Appearance

The exterior surface of a wall shall be finished with paint, stucco, or other commonly accepted material, and continuously maintained in its original appearance.

c. Dangerous Materials

1) Fences or walls in any zoning district, shall not be electrified or contain any substance such as broken glass, spikes, nails, barbed wire, razors, or any other dangerous material designed to inflict discomfort, pain or injury to a person or animal, except as allowed below. **[Ord. 2010-005] [Ord. 2011-001]**

2) Barbed Wire Exceptions

The use of barbed wire is prohibited. However, the County recognizes that barbed wire may be necessary to secure certain uses such as public utilities, prisons, bona-fide agriculture, public-owned natural areas, commercial or industrial uses that have outdoor storage areas. Therefore, the County allows the installation of barbed wire as part of the top of the fence or wall for specific uses pursuant to Art. 4.B, SUPPLEMENTARY USE STANDARDS or for situations stated below. The barbed wire shall not exceed 20 percent of the overall permitted height of the fence or wall. Bonafide agricultural uses, prisons, and other uses as authorized by the Zoning Director pursuant to provisions, Art. 5.B.1.A.2.c.2).c) below, shall be permitted to exceed the 20 percent provision. The calculation of the overall height of a fence or wall is inclusive of any barbed wire: **[Ord. 2005-002] [Ord. 2010-005] [Ord. 2011-001]**

a) Properties with a Conservation FLU designation, for the purposes of protecting publicly owned natural areas; **[Ord. 2005-002] [Ord. 2010-005] [Ord. 2011-001]**

b) Properties where the owner can document a valid Development Permit; and **[Ord. 2010-005] [Ord. 2011-001]**

c) The Zoning Director shall have the authority to allow the installation of barbed wire for any uses pursuant to Art. 4.B, SUPPLEMENTARY USE STANDARDS, when the applicant demonstrates a need to comply with Federal, State or Local Government regulations. In support of the barbed wire installation, the Zoning Director may require the applicant to perform mitigation in order to address compatibility with adjacent properties or visibility from adjacent street right-of-way. **[Ord. 2010-005] [Ord. 2011-001]**

3) Fence, Electric Exceptions and Regulations[1]

The use of electrified fencing is prohibited except in instances as detailed below. The County recognizes that electrified fencing may be necessary to secure certain uses such as, but not limited to, commercial or industrial uses that have outdoor storage areas. Therefore, the County allows the installation of electrified fencing behind a fence or wall for specific uses pursuant to Art. 4.B, SUPPLEMENTARY USE STANDARDS or for situations stated below. The fence, electric shall not exceed a height of two (2) feet above the overall height of an existing fence or wall or the permitted height of a fence or wall. Bonafide agricultural uses, prisons, and other uses as authorized by the Zoning Director pursuant to provisions, Art. 5.B.1.A.2.c.3).a) through c) below shall be permitted to exceed the two (2) feet allowance described above.

a) Properties with a Conservation FLU designation, for the purposes of protecting publicly owned natural areas;

b) Properties where the owner can document a valid Development Permit for the fence, electric; and

c) The Zoning Director shall have the authority to allow the installation of electrified fencing for any uses pursuant to Art. 4.B, SUPPLEMENTARY USE STANDARDS, when the applicant demonstrates a need to comply with Federal, State or Local Government regulations. In support of the electrified fencing installation, the Zoning Director may require the applicant to perform mitigation in order to address compatibility with adjacent properties or visibility from adjacent street right-of-way.

d) Regulations

No electric fence shall be installed, operated or maintained except as provided in this subsection.

(1) Electric fences shall be constructed, maintained and operated in conformance with the specifications set forth in International Electrotechnical Commission Standard 60335-2-76.

(2) The electric charge produced by the fence upon contact shall not exceed energizer characteristics set forth in paragraph 22.108 and depicted in Figure 102 of International Electrotechnical Commission Standard No. 60335-2-76.

(3) Electric fences shall be completely surrounded on the side facing the property exterior by a non-electrified fence or wall that is not less than six feet in height and at least four inches from the electric fence. When adjacent to a residential district or use the non-electrified fence shall include a solid material that would prevent a person from being able to penetrate the non-electrified fence.

(4) Electric fences shall be clearly identified with warning signs that read "Warning - Electric Fence" or similar terms and which are posted at intervals of not less than 50 feet with at least one sign on each exterior perimeter side of the fence.

(5) No electric fence shall be installed until after receiving a permit from the PBC Building Division confirming that the plans for the fence meet the requirements of this subsection.

(6) This subsection does not apply to professionally designed electrified devices installed near or under ground level for the purposes of keeping household pets on property.

d. Sight Distance

Walls and fences shall comply with Article 11.E.9.E, Minimum Safe Sight Distance and Corner Clips at Intersection.

e. Residential Districts

The maximum height for a fence or wall on or adjacent to a lot line or in a landscape buffer shall be as follows:

1) Within required front setback:
   a) four feet, or **[Ord. 2005-041]**
   b) six feet for property owned by PBC for preservation or conservation purposes. **[Ord. 2005-041]**
2) Within required side, side street, and rear setback: six feet.

f. Nonresidential Districts

The maximum height for a fence or wall on or adjacent to a lot line or in a landscape buffer shall be as follows:

1) Within the required front setback: six feet.
2) Within the required side, side street, and rear setback: eight feet.

g. Attachments

Gates, gateposts, decorative features, and lights attached to a fence or wall in the front setback shall not exceed three feet in any horizontal distance or two feet in height above the fence or wall. Decorative features and lights shall be spaced a minimum of eight feet apart.

h. Exceptions

1) Fences and walls up to eight feet in height shall be permitted within a street buffer adjacent to a golf course.
2) Fences around tennis courts may exceed six feet in height, subject to the setback requirements in Table 5.B.1.A, Tennis Court Setbacks.
3) The ZC and BCC may require increased heights in order to ensure adequate screening and buffering between incompatible uses.

4) DRO may approve increased fence heights and modify allowable locations for fences with and without barbed wire for minor utilities, water and wastewater treatment plants. **[Ord. 2007-013]**

[1]*See City of Richmond, Virginia Code of Ordinances Section 14-12.*

Article 5.B.1.A.3 (related to the Outdoor Storage regulations)

3. Outdoor Storage

Outdoor storage of merchandise, inventory, equipment, refuse, or similar material in all nonresidential districts shall be subject to the following standards.

a. General

Outdoor storage may only be allowed when incidental to the use located on the premises.

b. Location

Outdoor storage areas shall not be located in any of the required setbacks.

c. Nonresidential Districts, Except Industrial

Outdoor storage areas shall be completely screened from view by landscaping, fences, walls, or buildings. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3.

d. Industrial Districts

Outdoor storage areas shall be completely screened from view from all streets and adjacent residential districts by landscaping, fences, walls, or buildings up to a height of 12 feet. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3.

e. Exceptions

The following uses or material are exempt from this Section:

1) Storage and sales of landscape plant material.
2) Storage of material used for road construction on a lot directly adjacent to the roadway under construction.
3) Uses which allow outdoor storage by definition or in another Section.

Article 5.B.1.A.18.b.1).b) (related to the screening of generators)

18. Permanent Generators

a. Applicability

1) Permitted Use

Use of permanent generators shall be permitted during periods of electrical power outages in utility systems maintained by the utility service provider or when the BCC declares a state of emergency. **[Ord. 2006-004] [Ord. 2007-013]**

2) Type II and III CLF, Club Houses and Nursing or Convalescent Facility

A permanent emergency generator shall be required for all Type II and III CLFs, Nursing or Convalescent Facilities, and PDD or TDD clubhouses 20,000 square feet, or greater. **[Ord. 2006-004] [Ord. 2007-013]**

a) Exemptions

(1) Developments that have a BCC or DRO approved plan that graphically indicates a clubhouse(s) shall be exempt from the generator requirement except for projects that exceed 75 percent or more of the assessed value as stated below. **[Ord. 2007-013]**

(2) Renovations or additions that do not exceed 75 percent or more of the Improvement Value may be exempt from these requirements. **[Ord. 2007-013] [Ord. 2011-016]**

(3) A PDD or TDD clubhouse located in the Coastal High Hazard Area as defined by the Plan, shall be exempt from this requirement. **[Ord. 2007-013]**

(4) A PDD or TDD that has one or more clubhouses with a generator meeting the requirements of this Section, shall be exempt for any other remaining clubhouses within the development. **[Ord. 2007-013]**

b. Standards

1) General

The following standards shall apply to all permanently installed generators. **[Ord. 2006-004]**

a) Maximum Permissible Sound Level

Refer to Art. 5.E.4.B.2, and Table 5.E.4.B Maximum Sound Levels. **[Ord. 2006-004]**

b) Screening

Generators that are not located within, or completely screened by a building, shall be screened from view when adjacent to or visible from a public R-O-W or parcels with a conservation or residential FLU or use. Screening may include the use of fences, walls or hedges, or a combination thereof. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3. **[Ord. 2006-004]**

c) Maintenance Cycle

Generators may be operated for exercising purposes one time per week, excluding Sundays, for a period not exceeding 30 minutes between the hours of 10:00 a.m. to 5:00 p.m. **[Ord. 2006-004]**

d) Location and Setbacks

Generators shall meet the district setback requirements for principal structures, but shall not be located between the front or side street façade of a building and a R-O-W or in an easement, unless: **[Ord. 2006-004] [Ord. 2007-001]**

(1) Encroachment is limited to ten percent of setback; **[Ord. 2007-001]**

(2) Where applicable, the applicant indicates that a HOA has been notified of the application for building permit; **[Ord. 2007-001]**

(3) The generator shall be screened from view from any public rights-of-way or adjacent property lines by an opaque fence/wall. Fencing may include a fence, electric in accordance with Art. 5.B.1.A.3.; and **[Ord. 2007-001]**

(4) If this criteria cannot be met, the applicant may apply for a Type IB variance, pursuant to Article 2.D.3.G.2. **[Ord. 2007-001]**

Article 7.F.3 (related to walls and fences in perimeter buffers)

Section 3 Walls and Fences

If a wall or fence is used, the following shall apply: **[Ord. 2007-001] [Ord. 2007-013]**

A. Location of Wall or Fence

It is recommended that walls and fences collocated in a buffer with a berm be located at the top of berm. Walls and fences with a continuous footer shall be setback a minimum of ten feet from the edge of the property line. Fences may be permitted adjacent to a property line only when used in compatibility buffers. **[Ord. 2007-001] [Ord. 2007-013]**

B. Location of Planting

A minimum of 75 percent of required trees shall be located between the exterior of the wall or fence along a R-O-W, or facing adjacent property, except when a fence is used in a compatibility buffer and located along the property line. Shrubs or hedges shall be installed on both sides of the wall or fence along a RO-W, or facing adjacent property, except when a fence is used in a compatibility buffer and located along the property line. **[Ord. 2007-013]**

C. Conflict with Easements

If the placement of the wall or fence conflicts with an easement, the wall or fence shall not encroach upon the easement unless consistent with Article 3.D, PROPERTY DEVELOPMENT REGULATIONS (PDRs). [Ord. 2007-013]

D. Architectural Treatment

If a wall is used in a compatibility or incompatibility buffer, both sides of a wall shall be given a finished architectural treatment that is compatible and harmonious with adjacent development. **[Ord. 2007-013]**

E. Chain Link Fences

Vinyl coated chain link fences are permitted only if used in the R-O-W buffer, installed behind an opaque six foot high hedge or approved by the BCC, or ZC. **[Ord. 2007-001] [Ord. 2007-013]**

1. Exception
   A fence, electric in accordance with Art. 5.B.1.A.3 shall not be required to be vinyl coated.

Please let me know if you have any questions or comments.

Sincerely,

Christopher P. Barry

Christopher P. Barry, AICP, Planner

cc: Cindy Gsell, Director, Business Development, Sentry Security d/b/a Electric Guard Dog, via email

Richmond, Virginia, Code of Ordinances >> PART II - CITY CODE >> Chapter 14 - BUILDINGS AND BUILDING REGULATIONS* >> ARTICLE I. - IN GENERAL >>

ARTICLE I. - IN GENERAL

Sec. 14-1. - Adoption of Uniform Statewide Building Code.

The Virginia Uniform Statewide Building Code, 2009 Edition, as promulgated by the state board of housing and community development, along with its associated referenced standards and all future editions and amendments are hereby adopted and incorporated into this Code by reference and made applicable within the city. Annual testing of all backflow prevention devices in accordance with Part III, Article 2, section 131, item 12, subsection 505.5.2 of the Uniform Statewide Building Code, amending the International Property Maintenance Code (IPMC) will be as required in the IPMC and in accordance with the written policy of the commissioner of buildings.

(Code 1993, § 5-1; Ord. No. 2011-45-56, § 1, 3-28-2011)

State Law References: Statewide building code, Code of Virginia, § 36-98.

Sec. 14-2. - Applicability.

The construction, reconstruction, alteration, conversion, repair, maintenance or use of structures and buildings within the city, and installation of equipment therein, shall be governed by the uniform statewide building code as promulgated by the state board of housing and community development, together with the local fee schedule.

(Code 1993, § 5-2)

Sec. 14-3. - Code violations prohibited; penalty.

It shall be unlawful for any person, partnership, firm or corporation to occupy, construct, alter, extend, repair, remove, demolish, maintain or use any building or equipment regulated by the uniform statewide building code, or cause the same to be done, in conflict with or in violation of any of the provisions of the uniform statewide building code. Violations of the uniform statewide building code shall be punishable as outlined in Code of Virginia, § 36-106.

(Code 1993, § 5-3)

State Law References: Penalty, Code of Virginia, § 36-106.

Sec. 14-4. - Commissioner of buildings.

Responsibility for enforcement of the technical standards adopted as part of the uniform statewide building code is assigned to the department of planning and development review, bureau of permits and inspections. The commissioner of buildings shall be the "building official" and the "building maintenance official" as defined in the uniform statewide building code and shall administer and enforce the provisions of the uniform statewide building code within the city. The bureau of permits and inspections shall be deemed to be the "building department" within the purview of Code of Virginia, § 36-105. References in this chapter to the building official and the building maintenance official shall be deemed to include the commissioner of building's duly authorized representatives.

(Code 1993, § 5-4; Ord. No. 2009-220-2010-8, § 2, 1-25-2010)

Cross References: Officers and employees, § 2-71 et seq.

State Law References: Enforcement of building code, Code of Virginia, § 36-105.

Sec. 14-5. - Fee schedules.

For the purposes of this chapter, fees for plan examination, permits and inspections shall be as established by the council. Fee schedules shall be published and available to the public through the office of the commissioner of buildings as set forth in appendix A to this Code.

(Code 1993, § 5-5)

Cross References: Fee schedule, app. A.

State Law References: Authority to levy fees, Code of Virginia, § 36-105.

Sec. 14-6. - Fee adjustments.

Every person to whom a building permit is issued, before final inspection of the work, shall submit a cost affidavit to the commissioner of buildings. The value of the work shall be considered the higher of the contractor's stated final value or R S Means' estimated value. The value of work shall include all material, labor, subcontracts, owner furnished material, overhead and profit. Upon receipt of the cost affidavit from the permit holder, the commissioner of buildings shall adjust such fee and shall refund any excess fee to the permit holder or collect any additional fee as is necessary. If the stated final value exceeds that of R S Means, the stated final value shall be used. If the stated final value is less than R S Means, the R S Means value shall be used. The commissioner of buildings, or the designee thereof, may, at the commissioner of buildings' discretion, perform an audit on any project to which a building permit fee shall apply.

(Code 1993, § 5-6; Ord. No. 2006-173-172, § 1, 6-26-2006; Ord. No. 2011-45-56, § 1, 3-28-2011)

Sec. 14-7. - Fee refunds in certain cases.

If a building permit is revoked or a building project is abandoned or discontinued, the commissioner of buildings shall provide fee refunds for the portion of the work which was not completed less plan review and administrative fees.

(Code 1993, § 5-7)

Sec. 14-8. - Permit validity.

A building permit shall be valid when duly issued by the bureau of permits and inspections for an installation at the site named thereon for the work described on the application.

(Code 1993, § 5-8)

Sec. 14-9. - Commencing work without approved permit.

Any person who shall commence any work subject to this chapter without first obtaining a proper permit when required shall, when subsequently obtaining such permit, pay the fee for the entire amount of work covered by the permit. Payment of such fee shall not preclude prosecution for a violation of the uniform statewide building code for commencing work without a permit. Any person issued a stop work order shall pay an administrative fee set by the city council to cover the costs of issuing the stop work order and any legal actions occurring from the stop work order.

(Code 1993, § 5-9)

Sec. 14-10. - Periodic inspection of existing structures.

The commissioner of buildings shall have the authority to periodically inspect all buildings and structures, whether permanent or temporary, as permitted by state law and the uniform statewide building code.

(Code 1993, § 5-10)

Sec. 14-11. - Disregard of notice of unsafe or hazardous buildings; abatement of conditions.

If the owner, agent of the owner or person in control of a building which is found by the commissioner of buildings to be unsafe or a hazard under the uniform statewide building code fails or refuses to comply in a timely manner with any notice mailed or posted as provided by law or if the commissioner of buildings deems it necessary, without providing notice, to take such emergency measures as are set forth in the uniform statewide building code, including the demolition of a building, the commissioner of buildings shall cause such hazardous or unsafe condition to be abated. Costs incurred in abatement of such condition shall be paid from the city treasury on certification of the commissioner of buildings, and a lien in the amount of such costs, including a charge for administrative costs as set forth in appendix A to this Code, shall be placed against the property and shall remain in force until paid. All unpaid liens shall accrue interest at the rate specified for other nuisance abatement liens.

(Code 1993, § 5-11)

Sec. 14-12. - Barbed, razor and electric wire fences.

(a) *Barbed and razor wire fences.* No barbed or razor wire shall be used for the purpose of wholly or partially enclosing any lot or premises within the city. However, barbed ends of fences, barbed wire and razor wire may be used on top of any wall or fence wholly or partially enclosing any lot or premises zoned for commercial or industrial use, and barbed wire may be used on top of any wall or fence wholly or partially enclosing any public school, park, recreational or playground site in any residential, commercial or manufacturing district, provided that:

(1) Such wall or fence is at least six feet in height.

(2) The barbed wire or razor wire is installed on arms or brackets extending from the top of such wall or fence inwardly over the private property to be wholly or partially enclosed.

(3) Not more than three strands of barbed wire shall be so installed, and the first strand shall be at least six inches from the face of the wall or fence.

(b)

Electric fences. No electric fence shall be installed, operated or maintained in the city except as provided in this subsection.

(1) Electric fences shall be constructed, maintained and operated in conformance with the specifications set forth in International Electrotechnical Commission Standard 60335-2-76.

(2) The electric charge produced by the fence upon contact shall not exceed energizer characteristics set forth in paragraph 22.108 and depicted in Figure 102 of International Electrotechnical Commission Standard No. 60335-2-76.

(3) Electric fences shall be completely surrounded on the side facing the property exterior by a non-electrified fence or wall that is not less than six feet in height and at least six inches from the electric fence.

(4) Electric fences may be installed, operated or maintained only in B-3 general business, M-1 light industrial and M-2 heavy industrial zoning districts.

(5) Electric fences shall be clearly identified with warning signs that read "Warning - Electric Fence" or similar terms and which are posted at intervals of not less than 50 feet with at least one sign on each exterior perimeter side of the fence.

(6) No electric fence shall be installed until after certification from the Department of Economic and Community Development that the plans for the fence meet the requirements of this subsection.

(7) This subsection does not apply to professionally designed electrified devices installed near or under ground level for the purposes of keeping household pets on property.

(c) Violation of this section shall be punishable by a fine of up to $2,500.00.

(Code 1993, § 5-12; Ord. No. 2009-143-161, § 1, 9-14-2009; Ord. No. 2009-222-2010-10, 1-25-2010)

Sec. 14-13. - Relation to city's master plan.

(a) The planning commission shall cause a copy of the master plan for the city and all amendments thereto to be filed in the office of the commissioner of buildings. Before the commissioner of buildings shall consider the application for a permit to construct, alter, repair or move any building, structure or sign, the estimated cost of which shall exceed $10,000.00, the commissioner of buildings shall ascertain from the director of planning and development review whether the property involved in the permit application is set apart in the master plan or in any other plan implementing or executing the master plan for acquisition by the city.

(b) If it shall appear that the property has been so set apart, the director of planning and development review shall, within 30 days, notify the commissioner of buildings in writing and shall report the fact to the planning commission. Upon receipt of such notice, the commissioner of buildings shall not issue the permit.

(c) Within 30 days of receipt of the report from the director of planning and development review, the city planning commission may recommend to the city council that the property be then acquired. Should the city planning commission fail to recommend acquisition of the property within 30 days, or should the city council fail to authorize acquisition of the property within 45 days after receiving the recommendation of the city planning commission, the commissioner of buildings shall proceed to consider the application for permit as provided by the uniform statewide building code.

(Code 1993, § 5-14; Ord. No. 2009-220-2010-8, § 2, 1-25-2010)

Sec. 14-14. - Building permits within Chesapeake Bay Preservation Areas.

The commissioner of building shall not issue a building permit until the Chesapeake Bay Administrator has certified that the proposed construction and use of the premises conform with the applicable provisions of chapter 50 of this Code.

(Ord. No. 2004-329-319, § 1, 12-13-2004)

Sec. 14-15. - Vacant building registration; penalty.

It shall be unlawful for any owner or owners of buildings or structures which have been vacant for a continuous period of twelve months or more to fail to register on an annual basis the vacant buildings or structures with the department of planning and development review. Such registration shall be on a form prescribed by the department of planning and development review. The annual fee for such registration shall be twenty-five dollars ($25.00). Failure to register shall result in a fifty dollar ($50.00) civil penalty or in a two hundred fifty dollar ($250.00) civil penalty if the property is located in a conservation or redevelopment area or in a designated blighted area. Upon re-occupancy, the owner shall notify the department of planning and development review in writing.

(Ord. No. 2006-253-259, § 1, 10-23-2006; Ord. No. 2009-220-2010-8, § 2, 1-25-2010)

Secs. 14-16—14-45. - Reserved.

Print

The Philadelphia Code

CHAPTER 9-3800. ELECTRIC FENCES [952]

§ 9-3801. Scope.

This Chapter provides for the operation of electric security fences. It does not apply to electric fences primarily for the containment of livestock or zoo animals.

§ 9-3802. Regulations.

The construction and use of electric security fences shall be allowed in the City of Philadelphia only as provided in this Section, subject to the following standards:

(1) *Electrification.*

(a) The energizer for electric security fences shall be driven by a commercial storage battery not to exceed 12 volts DC. The storage battery shall be charged primarily by a solar panel, and may be augmented by a commercial trickle charger.

(b) The electric charge produced by the fence upon contact shall not exceed energizer characteristics set forth in paragraph 22.108 of International Electrotechnical Commission (IEC) Standard No. 60335-2-76 and depicted in Figure 102 thereof.

(2) *Perimeter fence or wall.* No electric security fence shall be installed or used unless it is completely surrounded by a non-electric fence or wall that is not less than six feet in height.

(3) *Location.* Electric fences shall not be permitted in any residentially-zoned district or in any property that includes a dwelling other than a caretakers' residence.

(4) *Height.* Electric security fences shall have a height of no more than 10 feet.

(5) *Warning signs.* Electric security fences shall be clearly identified with warning signs, at intervals of not less than thirty feet, which shall include the following words prominently displayed: "Warning - Electric Fence." At least one warning sign shall be placed on each side of the fence facing an area accessible to the public.

§ 9-3803. Penalties.

A violation of this Chapter shall be a Class II offense.

Notes

[952] Added, Bill No. 120328 (approved August 27, 2012).

NORME INTERNATIONALE

CEI IEC 60335-2-76

INTERNATIONAL STANDARD

Edition 2.1

2006-04

Edition 2:2002 consolidée par l'amendement 1:2006
Edition 2:2002 consolidated with amendment 1:2006

Appareils électrodomestiques et analogues – Sécurité –

Partie 2-76: Règles particulières pour les électrificateurs de clôtures

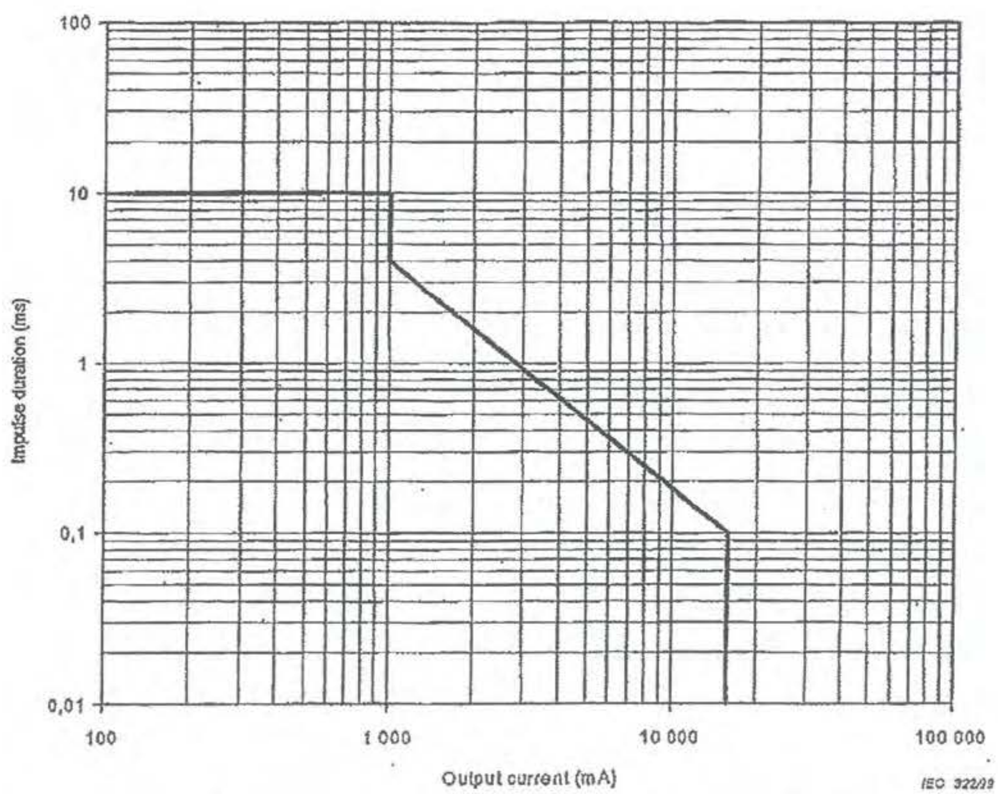
Household and similar electrical appliances – Safety –

Part 2-76: Particular requirements for electric fence energizers

Numéro de référence
Reference number
CEI/IEC 60335-2-76:2002+A1:2006

22.108 Energizer output characteristics shall be such that
– the impulse repetition rate shall not exceed 1 Hz;
– the **impulse duration** of the impulse in the 500 ^ component of the **standard load** shall not exceed 10 ms;
– for **energy limited energizers** the energy/impulse in the 500 ^ component of the **standard load** shall not exceed 5 J;
NOTE The energy/impulse is the energy measured in the impulse over the impulse duration.
– for **current limited energizers** the **output current** in the 500 ^ component of the **standard load** shall not exceed for
□ an **impulse duration** of greater than 0,1 ms, the value specified by the characteristic limit line detailed in Figure 102;
□ an **impulse duration** of not greater than 0,1 ms, 15 700 mA.
*Compliance is checked by measurement when the **energizer** is supplied with the voltage in 11.5, the **energizer** being operated under conditions of **normal operation** but with the **standard load** connected to its output terminals. When measuring the impulse repetition rate the **standard load** is not connected.*

The measurements are made using a measuring arrangement with an input impedance consisting of a non-inductive resistance of not less than 1 M^ in parallel with a capacitance of not more than 100 pF.



NOTE The equation of the line relating impulse duration (ms) to output current (mA) for 1 000 mA < output current < 15 700 mA, is given by impulse duration = 41,885 × 10^3 × (output current)$^{-1,34}$

Figure 102 – Current limited energizer characteristic limit line

Annex CC
(informative)

Installation of electric security fences

CC.1 General

An **electric security fence** should be installed so that, under normal conditions of operation, persons are protected against inadvertent contact with **pulsed conductors**.

NOTE 1 This requirement is primarily intended to establish that a desirable level of safety is present or is being maintained in the **physical barrier**.

NOTE 2 When selecting the type of **physical barrier**, the likely presence of young children should be a factor in considering the size of openings.

CC.2 Location of electric security fence

The **electric fence** should be separated from the **public access area** by means of a **physical barrier**.

Where an **electric fence** is installed in an elevated position, such as on the inner side of a window or skylight, the **physical barrier** may be less than 1,5 m high where it covers the whole of the **electric fence**. If the bottom of the window or skylight is within a distance of 1,5 m from the floor or access level then the **physical barrier** need only extend up to a height of 1,5 m above the floor or access level.

CC.3 Prohibited zone for pulsed conductors

Pulsed conductors shall not be installed within the shaded zone shown in Figure CC1.

NOTE 1 Where an **electric security fence** is planned to run close to a site boundary, the relevant government authority should be consulted before installation begins.

NOTE 2 Typical **electric security fence** installations are shown in Figure CC2 and Figure CC3.

CC.4 Separation between electric fence and physical barrier

Where a **physical barrier** is installed in compliance with CC.3 at least one dimension in any opening should be not greater than 130 mm and the separation between the **electric fence** and the **physical barrier** should be

- within the range of 100 mm to 200 mm or greater than 1 000 mm where at least one dimension in each opening in the **physical barrier** is not greater than 130 mm;
- greater than 1 000 mm where any opening in the **physical barrier** has all dimensions greater than 50 mm;
- less than 200 mm or greater than 1 000 mm where the **physical barrier** does not have any openings.

NOTE 1 These restrictions are intended to reduce the possibility of persons making inadvertent contact with the **pulsed conductors** and to prevent them from becoming wedged between the **electric fence** and the **physical barrier**, thereby being exposed to multiple shocks from the **energizer**.

NOTE 2 The separation is the perpendicular distance between the **electric fence** and the **physical barrier**.

CC.5 Prohibited mounting

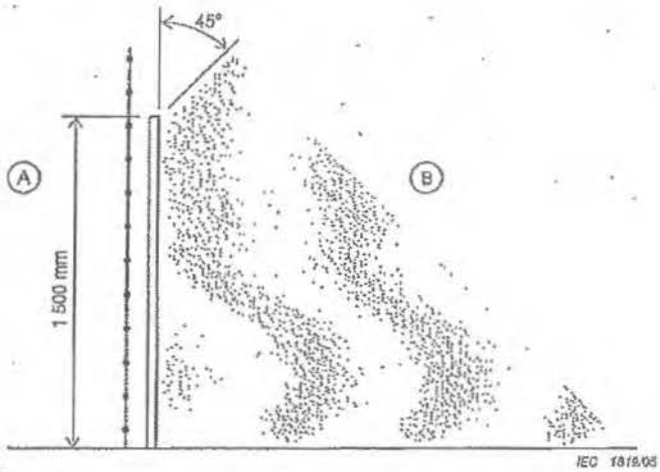
Electric fence conductors should not be mounted on a support used for any overhead power line.

CC.6 Operation of electric security fence

The conductors of an electric fence should not be energized unless all authorized persons, within or entering the secure area, have been informed of its location.

Where there is a risk of persons being injured by a secondary cause, appropriate additional safety precautions should be taken.

NOTE An example of a secondary cause is where a person may be expected to fall from a surface if contact is made with pulsed conductors.



Key

A = Secure area

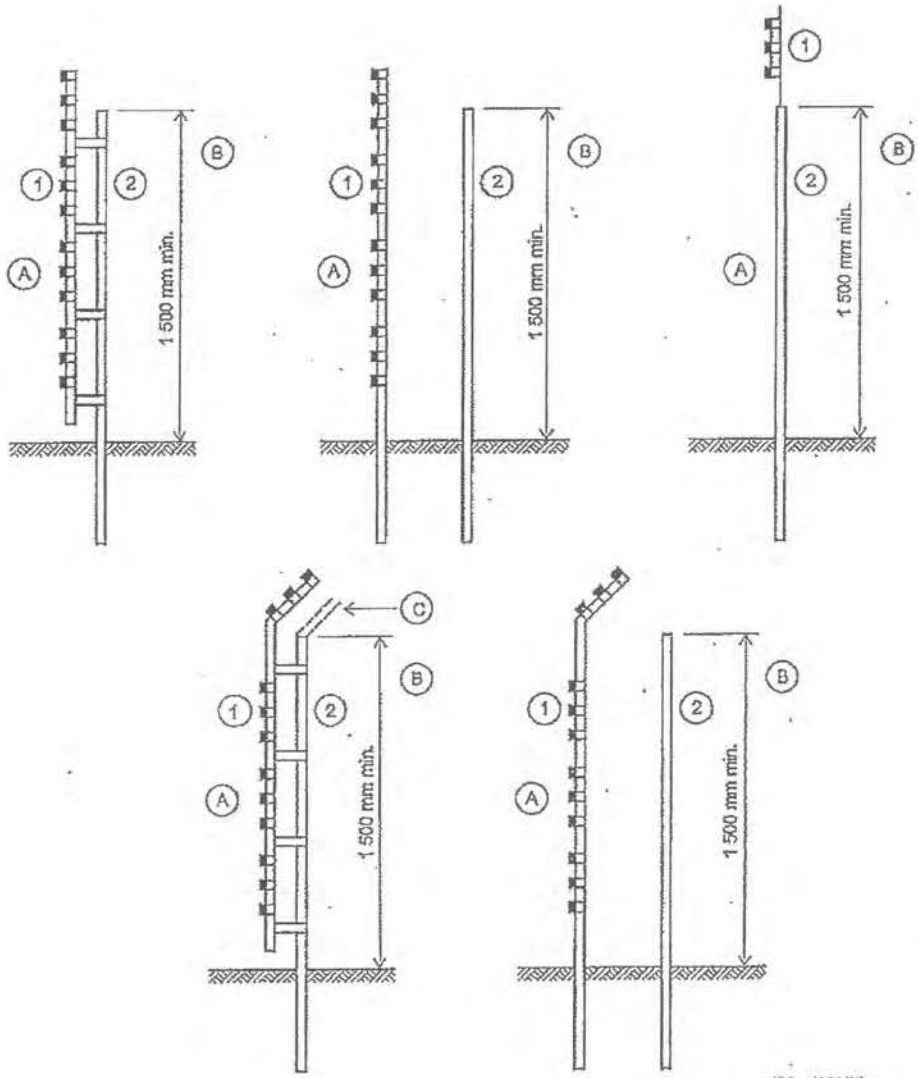
B = Public access area

Physical barrier

Prohibited area

Electric security fence

Figure CC.1 – Prohibited area for pulse conductors



Key

A = Secure area

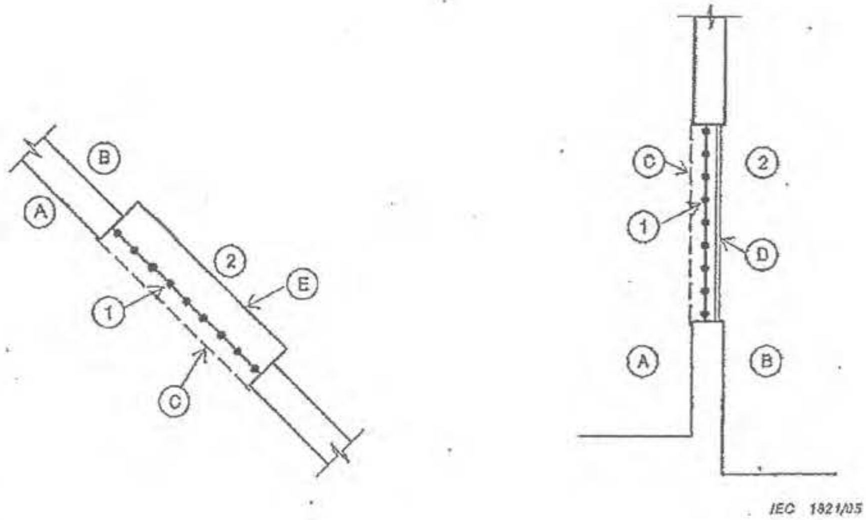
B = Public access area

C = Barrier where required

1 = Electric security fence

2 = Physical barrier

Figure CC.2 – Typical constructions where an electric security fence is exposed to the public



Key

A = Secure area

B = Public access area

C = Barrier where required

D = Glass window pane

E = Skylight in roof

1 = Electric security fence

2 = Physical barrier

Figure CC.3 – Typical fence constructions where the electric security fence is installed in windows and skylights

Bibliography

The bibliography of Part 1 is applicable except as follows.

Addition:

IEC 60335-2-86, *Household and similar electrical appliances – Safety – Part 2-86: Particular requirements for electric fishing machines*

IEC 60335-2-87, *Household and similar electrical appliances – Safety – Part 2-87: Particular requirements for electric animal stunning equipment*

THE UNIVERSITY of WISCONSIN MADISON

January 8, 2008

Edward T. Dickerson, PhD., P.E.

Dear Dr. Dickerson,

I have tested the Gallagher Group Ltd PowerPlus B600 and Gallagher Group Ltd PowerPlus B280 electric fence energizers. I tested them to the International Electrotechnical Commission Standard: IEC 2006 *Household and similar electrical appliances – Safety – Part 2-76: Particular requirements for electric fence energizers*, (IEC 60335-2-76, Edition 2.1). It is the most appropriate standard to use because it specifically describes "electric security fences" 40 times.

I describe the testing methods and the results in detail in the attached paper: Amit J. Nimunkar and John G. Webster, "Safety of electric fence energizers." Figure 3 in this paper shows the electric current versus time for these two electric fence energizers and compares them with three other electric fence energizers in use in the USA. Table 1 shows the electric fence energizer electric current I_{rms}, compares it with the IEC standard I_{rms}, and shows that all five electric fence energizers pass the IEC standard electric tests.

I conclude that the Gallagher Group Ltd PowerPlus B600 and Gallagher Group Ltd PowerPlus B280 electric fence energizers passed all IEC electric tests and thus are safe to use.

If I can provide you any further information, please let me know.

Sincerely,

John G. Webster, Professor Emeritus
Phone 608-263-1574
Webster@engr.wisc.edu

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Safety of electric fence energizers

Amit J. Nimunkar1 and John G. Webster1

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E-mail: Webster@engr.wisc.edu (John G. Webster) Tel 608-263-1574, Fax 608-265-9239

Abstract

The strength–duration curve for tissue excitation can be modeled by a parallel resistor–capacitor circuit that has a time constant. We tested five electric fence energizers to determine their current-versus-time waveforms. We estimated their safety characteristics using the existing IEC standard and propose a new standard. The investigator would discharge the device into a passive resistor–capacitor circuit and measure the resulting maximum voltage. If the maximum voltage does not exceed a limit, the device passes the test.

Key words: strength–duration curve, cardiac stimulation, ventricular fibrillation, electric safety, electric fence energizers, standards.

1. Introduction

The vast majority of work on electric safety has been done using power line frequencies such as 60 Hz. Thus most standards for electric safety apply to continuous 60 Hz current applied hand to hand. A separate class of electric devices applies electric current as single or a train of short pulses, such as are found in electric fence energizers (EFEs). A standard that specifically applies to EFEs is IEC (2006). To estimate the ventricular fibrillation (VF) risk of EFEs, we use the excitation behavior of excitable cells. Geddes and Baker (1989) presented the cell membrane excitation model (Analytical Strength–Duration Curve model) by a lumped parallel resistance–capacitance (*RC*) circuit. This model determines the cell excitation thresholds for varying rectangular pulse durations by assigning the strength–duration rheobase currents, chronaxie, and time constants (Geddes and Baker, 1989). Though this model was originally developed based on the experimental results of rectangular pulses, the effectiveness of applying this model for other waveforms has been discussed (IEC 1987, Jones and Geddes 1977). The charge–duration curve, derived from the strength–duration curve, has been shown in sound agreement with various experimental results for irregular waveforms. This permits calculating the VF excitation threshold of EFEs with various nonrectangular waveforms. We present measurements on electric fence energizers and discuss their possibility of inducing VF.

2. Mathematical background and calculation procedures

Based on the cell membrane excitation model (Weiss–Lapique model), Geddes and Baker (1989) developed a lumped *RC* model (analytical strength–duration curve) to describe the membrane excitation behavior. This model has been widely used in various fields in electrophysiology to calculate the excitation threshold. Figure 1 shows the normalized strength–duration curve for current (I), charge (Q) and energy (U). The expression of charge is also known as the charge–duration curve which is important for short duration stimulations.

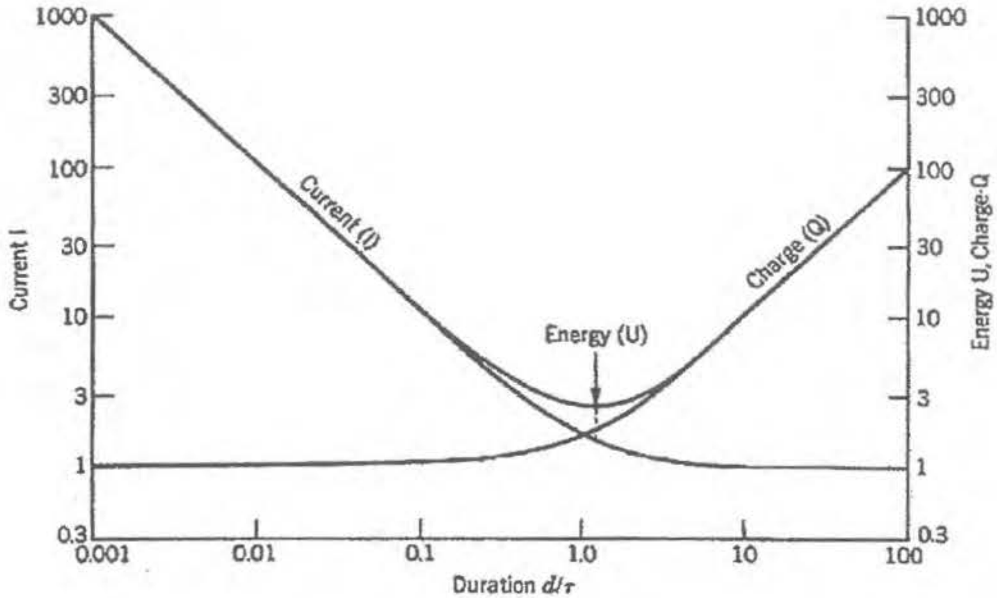


Figure 1. Normalized analytical strength–duration curve for current I, charge Q, and energy U. The x axis shows the normalized duration of d/τ. Note that for $d \ll \tau$, Q is constant and the most appropriate variable for estimating cell excitation. (from Geddes and Baker, 1989).

The equation for the strength–duration curve is (Geddes and Baker, 1989),

$$\Delta v = IR(1 - e^{-\frac{t}{\tau}}), \tag{1}$$

where I is a step current intensity, R is the shunt resistance, Δv is the depolarization potential threshold which is about 20 mV for myocardial cells, τ is the RC time constant, and t is the time I is applied.

If we let the stimulation duration go to infinity, the threshold current is defined as the rheobase current ($I = b$). If we substitute I in equation (1) by b and define the threshold current $I_d = \Delta v/R$ for the stimulation with duration d. Equation (1) becomes,

$$I_d = \frac{b}{1 - e^{-\frac{d}{\tau}}}. \tag{2}$$

We can calculate the threshold charge (Q_d) by integrating equation (2) and it becomes,

$$Q_d = I_d d = \frac{bd}{1 - e^{-\frac{d}{\tau}}}, \tag{3}$$

For short duration stimulation ($d << \tau$) with duration shorter than 0.1 times the *RC* time constant, equation (3) can be approximated by equation (4) and it yields equation (5),

$$1 - e^{-\frac{d}{\tau}} \approx \frac{d}{\tau}, \tag{4}$$

$$Q_d = b\tau \tag{5}$$

Equation (5) suggests that the charge excitation threshold for short duration stimulation is constant and equals the product of the *RC* time constant τ and the rheobase b. Geddes and Bourland (1985) showed that the charge–duration curve for single rectangular, trapezoidal, half sinusoid and critically damped waveforms had a good agreement for short duration stimulations. Therefore we used the same model to estimate thresholds for stimulation sources where I was not constant, under the same stimulation setting.

Cardiac cell excitation has been intensively studied at the 60 Hz power line frequency because most accidental electrocutions occur with 60 Hz current, which has a longer duration relative to the cardiac cell time constant of about 2 ms. However, EFEs operate with pulse durations much shorter than the time constant.

3. Methods

Figure 2 shows our experimental test set-up. The EFEs under test consist of Gallagher Group Ltd PowerPlus B600 (EFE1), Gallagher Group Ltd PowerPlus B280 (EFE2), Speedrite HPB (EFE3), Intellishock 20B (EFE4) and Blitzer 8902 (EFE5) EFEs. The short duration electrical pulses from these EFEs are passed though a series of eleven 47 Ω (ARCOL D4.29, HS50 47 R F) resistors which measure 518 Ω, which represents approximately the internal resistance of the human body. It is further connected to two 18 Ω (RH 10 207 DALE 10 W 3%) resistors connected in parallel which measure 9.08 Ω. This is used as the sensing resistor across which the oscilloscope measures the output voltage. For these very short pulses it is important to use noninductive resistors because the same current flowing through a resistor that has substantial inductance will measure a larger current than a resistor that is noninductive. To reduce electromagnetic interference, a faraday cage, covered with aluminum foil, was connected to ground. This diverted the electromagnetic interference to ground. The data were collected in EXCEL format from a disk in the Agilent 54621 oscilloscope. The calculations for different parameters presented in Table 1 and the Figures 3–5 were plotted using MATLAB.

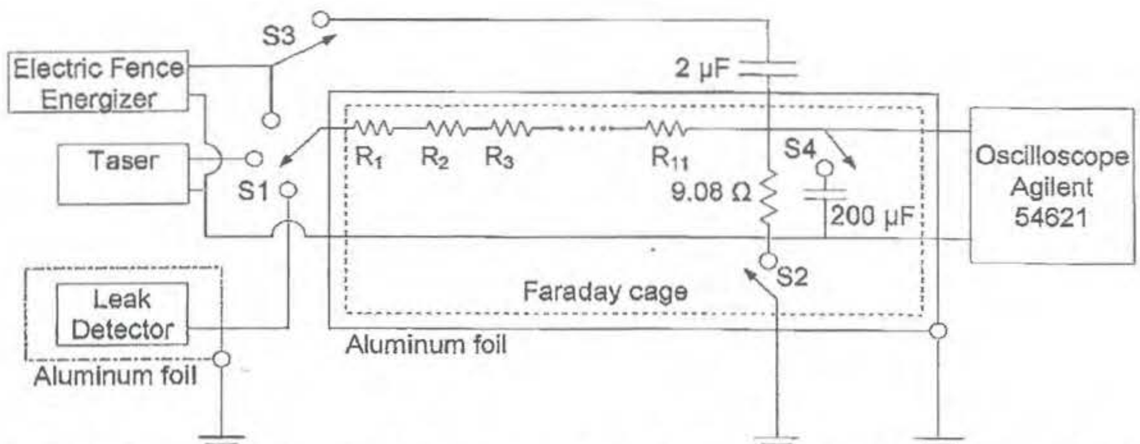


Figure 2. The EFE is selected by S1. The current flows through a string of 47 Ω resistors R_1–R_{11} (total 518 Ω) which approximates the internal body resistance of 500 Ω. The 9.08 Ω yields a low voltage that is measured by the oscilloscope.

3.1. Determination of current

EFEs are used in conjunction with fences wires to form animal control fences and security fences. We tested five EFEs (EFE1–EFE5) using the experimental set-up in Figure 2 and obtained the output currents shown in Figure 3.

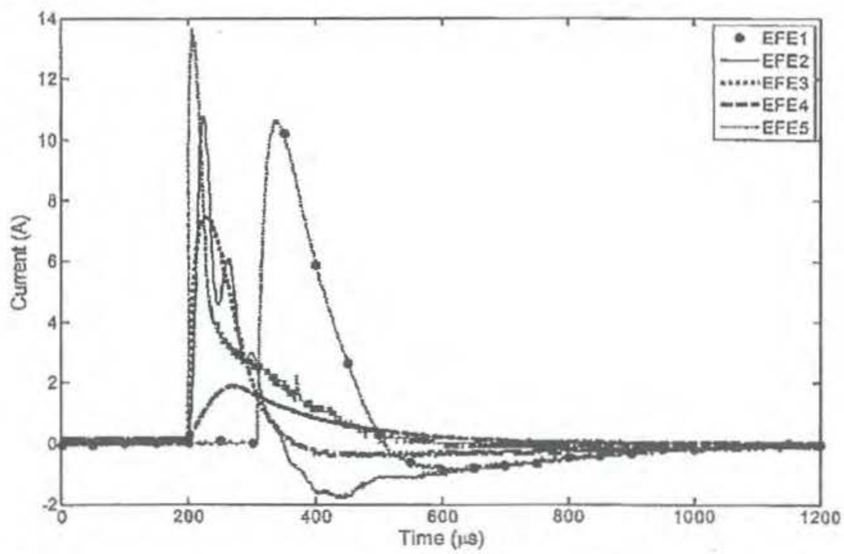


Figure 3. The output current waveform for five EFEs. EFE1 yields about 7.75 A for 151 µs = 1170 µC, EFE2 yields about 3.34 A for 345 µs = 1150 µC, EFE3 yields about 5.69 A for 91 µs =

518 μC, EFE4 yields about 1.25 A for 252 μs = 315 μC and EFE5 yields about 5.7 A for 137 μs = 781 μC.

4. Results

Table 1 shows the approximate results for the rms current, power, duration and charge for all the EFEs.

Table 1 Approximate results for all EFEs.

EFEs		EFE1	EFE2	EFE3	EFE4	ECF5
Parameters	Units					
A. (IEC)						
Total Energy	A^2ms	7.94	4.04	3.10	0.42	4.69
95% Energy Duration	μs	129	346	91	253	138
I_{rms}	A	7.65	3.33	5.69	1.25	5.69
IEC Standard I_{rms}	A	13.0	6.21	16.8	7.85	7.37
Pass IEC Standard	Yes/No	Yes	Yes	Yes	Yes	Yes
B. Proposed standard						
Voltage	V	3.88	2.91	NAv	NAv	NAv
Duration	μs	233	132			
Current	A	3.33	4.41			
Charge	μC	776	582			

NA- not applicable, NAv- not available

IEC (2006) defines in 3.116 "impulse duration: duration of that part of the impulse that contains 95% of the overall energy and is the shortest interval of integration of $I^2(t)$ that gives 95% of the integration of $I^2(t)$ over the total impulse. $I(t)$ is the impulse current as a function of time." In 3.117 it defines "output current: r.m.s. value of the output current per impulse calculated over the impulse duration." In 3.118 it defines "standard load: load consisting of a non-inductive resistor of 500 Ω ± 2.5 Ω and a variable resistor that is adjusted so as to maximize the energy per impulse or output current in the 500 Ω resistor, as applicable." In 22.108, "Energizer output characteristics shall be such that – the impulse repetition rate shall not exceed 1 Hz; – the impulse duration of the impulse in the 500 Ω component of the standard load shall not exceed 10 ms; – for energy limited energizers the energy/impulse in the 500 Ω component of the standard load shall not exceed 5 J; The energy/impulse is the energy measured in the impulse over the impulse duration. – for current limited energizers the output current in the 500 Ω component of the standard load shall not exceed for an impulse duration of greater than 0.1 ms, the value specified by the characteristic limit line detailed in Figure 102; an impulse duration of not greater than 0.1 ms, 15 700 mA. The equation of the line relating impulse duration (ms) to output current (mA) for 1 000 mA < output current < 15 700 mA, is given by impulse duration = $41.885 \times 10^3 \times (\text{output current})^{-1.34}$." We used these definitions and calculated the total energy, the shortest duration where 95% of the total energy occurs, the rms current for that duration from Figure 3 for the EFEs (EFE1–EFE5). Similarly we calculated the output current using the relationship impulse duration = $41.885 \times 10^3 \times (\text{output current})^{-1.34}$, provided by the IEC for all the EFEs (EFE1–EFE5). Table 1 lists these under the heading "A. (IEC)". Table 1 shows that all the EFEs pass the IEC standard.

5. Proposed new standard

IEC (2006) uses the rms current for the shortest duration where 95% of the total energy occurs as the standard to determine if the EFE is safe for use. Geddes and Baker (1989) have shown that for pulses shorter than the cardiac cell time constant of 2 ms, the electric charge is the quantity that excites the cells. We propose a simple experimental set-up shown in Figure 2 to determine the maximum amount of charge that would flow from the EFEs and cause cardiac cell excitation. The cardiac cell is modeled as an *RC* circuit in Fig. 2 with $R = 9.08\ \Omega$ and $C = 200\ \mu F$ (GECONOL 9757511FC 200 μF ±10% 250 VPK) with the *RC* time constant of 1.82 ms. For the EFEs (EFE1 and EFE2) the switches S1 and S4 are closed. This allows the 200 μF capacitor to charge rapidly (about 100 μs) and discharge fairly slowly ($\tau = RC = 1.82$ ms). Figures 4 and 5 show the voltage vs time waveforms for the different EFEs. The test was not performed for electric fence energizers EFE3–EFE5.

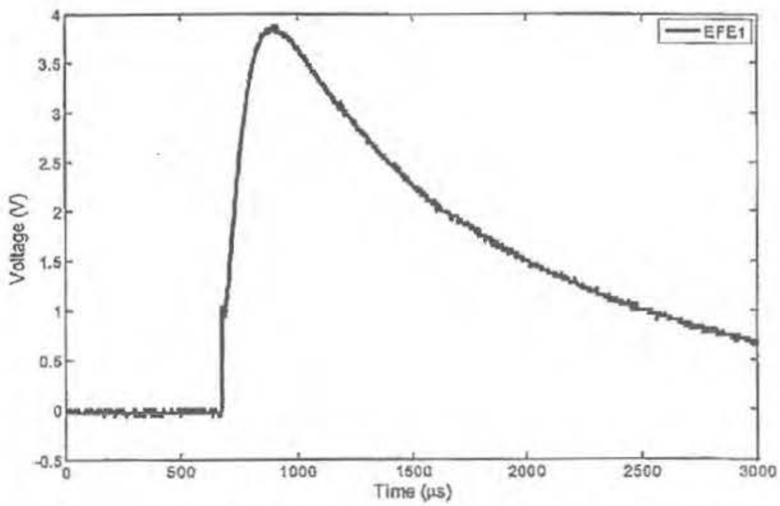


Figure 4. Output voltage waveform for EFE1. The maximal charge that flows through the cardiac cell model is given by $Q = CV = 200\ \mu F \times 3.88\ V = 775\ \mu C$, the current during which the capacitor charges to maximal value is given by $I = CV/T = (200\ \mu F \times\ 3.88\ V)/233\ \mu s = 3.33$ A.

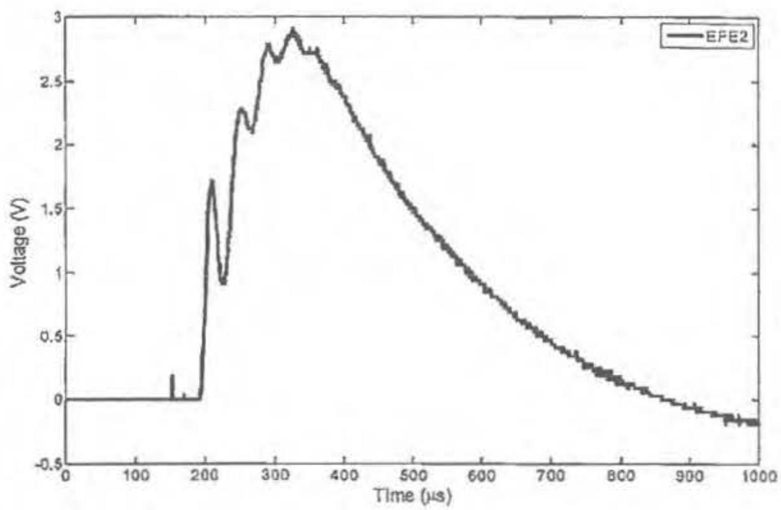


Figure 5. Output voltage waveform for the electric fence energizers EFE2. The maximal charge that flows through the cardiac cell model is given by $Q = CV = 200\ \mu\text{F} \times 2.91\ \text{V} = 582\ \mu\text{C}$, the current during which the capacitor charges to maximal value is given by $I = CV/T = (200\ \mu\text{F} \times 2.91\ \text{V})/132\ \mu\text{s} = 4.41\ \text{A}$.

6. Discussion

Geddes and Baker (1989) have shown that for pulses shorter than the cardiac cell time constant of 2 ms, the electric charge is the quantity that excites cardiac cells. Because the first half wave is the largest, the charge integrated in the first half wave determines cardiac cell excitation. The next half wave discharges the cardiac cell capacitance and does not contribute to cardiac cell excitation. Thus we list integral $I(t)$ = charge Q in Table 1.

IEC (2006) integrates $I^2(t)$, which is roughly equal to $I(t)$. Their Figure 102 roughly follows charge.

We propose revising EFE standards for measuring current to determine a safety standard to prevent VF. The new standard would measure cardiac cell excitation. It would not require the complex calculations required to determine "The current which flows during the time period in which 95 percent of the output energy (is delivered)." It would use a simple circuit similar to that in Figure 2 composed of resistors and a capacitor. The investigator would discharge the device into the circuit and measure the maximum voltage. If the maximum voltage does not exceed 5 V (as a conservative estimate), the EFE passes the test. The 500 Ω resistor closely approximates the resistance of the body and determines the current that flows through the body.

Acknowledgements

We thank L Burke O'Neal and Silas Bernardoni for their help and suggestions.

References

Geddes L A, and Baker L E 1989 *Principles of applied biomedical instrumentation* (New York: John Wiley & Sons) pp 458–61

Geddes L A and Bourland J D 1985 The strength-duration curve. *IEEE. Trans. Biomed. Eng.* **32(6)** 458–9

IEC 1987 *International Electrotechnical Commission IEC Report: Effects of current passing through the human body* (IEC 60479-2) pp 47

IEC 2006 *Household and similar electrical appliances – Safety – Part 2-76: Particular requirements for electric fence energizers*, (IEC 60335-2-76, Edition 2.1)

Jones M and Geddes L A 1977 Strength duration curves for cardiac pacemaking and ventricular fibrillation *Cardiovasc. Res. Center Bull.* **15** 101–12

THE UNIVERSITY of WISCONSIN MADISON

Safety of electric security fences

John G. Webster
Professor Emeritus of Biomedical Engineering
University of Wisconsin-Madison
Madison WI 53706

Electric current shocks us, not voltage

Most of us can remember receiving an electric shock; it can happen during a regular day. How can that happen and when? Walking across a carpet during dry weather, then touching a doorknob and feeling a spark that jumps to the doorknob is a very common way. Placing a finger inside of a lamp socket that inadvertently was turned on is yet another. Touching the spark plug in a car or lawn mower has happened to many people as well. But why are we all still alive after receiving these electric shocks during a regular day? *We are still alive because even though the voltage is high, not enough electric current flowed through our heart.*

Even when the voltage is high, when the current flows for only a very short duration we can not be electrocuted. Furthermore, it is even hard to get electrocuted in the home because the power line voltage of 120 volts can't drive enough continuous current through the high resistance of our dry skin. Kitchens and bathrooms fall in a different category; they are dangerous places because our skin may be wet. When our skin is wet, our skin resistance is low and permits a large electric current to flow through the body as shown in Figure 1. A large enough current can cause ventricular fibrillation. During ventricular fibrillation the pumping action of the heart ceases and death occurs within minutes unless treated. In the United States, approximately 1000 deaths per year occur in accidents that involve cord-connected appliances in kitchens, bathrooms, and other wet locations.

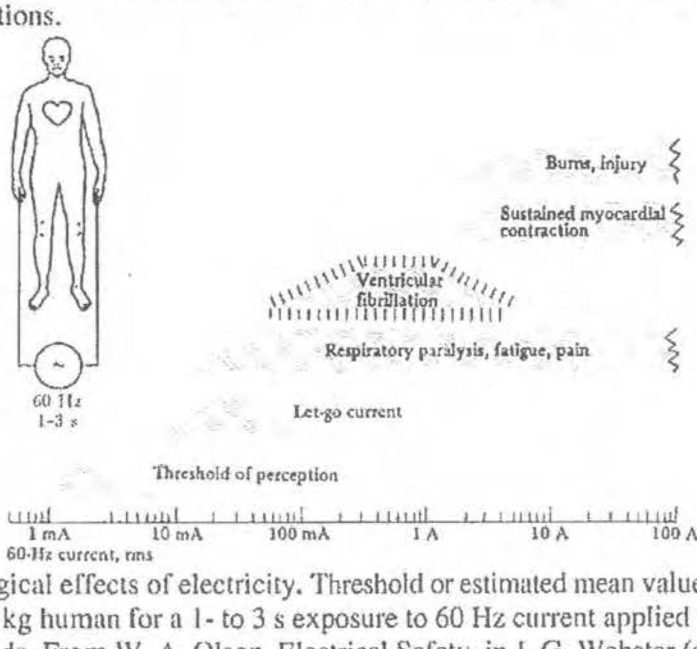


Figure 1 Physiological effects of electricity. Threshold or estimated mean values are given for each effect in a 70 kg human for a 1- to 3 s exposure to 60 Hz current applied via copper wires grasped by the hands. From W. A. Olson, Electrical Safety, in J. G. Webster (ed.), *Medical Instrumentation Application and Design*, 3rd. ed., New York: John Wiley & Sons, 1998.

Short duration pulses are safer than continuous electric current

Figure 2 shows that shock durations longer than 1 second are the most dangerous. Note that as the shock duration is shortened to 0.2 seconds, it requires much more electric current to cause ventricular fibrillation. Electric security fences have taken advantage of this fact by shortening their shock duration to an even shorter duration of about 0.0003 seconds. Therefore, electric security fences are safe and do not lead to ventricular fibrillation due to the short 0.00003 second shock duration. .

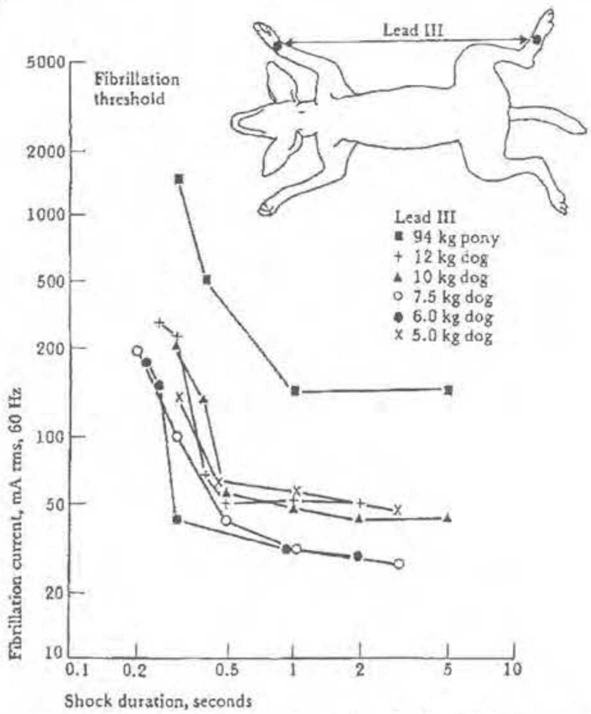


Figure 2 Thresholds for ventricular fibrillation in animals for 60-Hz ac current. Duration of current (0.2 to 5 s) and weight of animal body were varied. Fibrillation current versus shock duration for a 70 kg human is about 100 milliamperes for 5 second shock duration. It increases to about 800 milliamperes for 0.3 second shock duration. From L. A. Geddes, *IEEE Trans. Biomed. Eng.*, 1973, 20, 465–468.

Electricity near the heart is most dangerous

There are four situations where electricity may be applied close to the heart. (1) Figure 3(b) shows when a catheter tube is threaded through a vein into the heart, any accidental current is focused within the heart and a small current can cause ventricular fibrillation. (2) Cardiac pacemakers also pass electric current inside the heart, but the current is kept so small that ventricular fibrillation does not occur. (3) A Taser weapon may rarely shoot a dart between the ribs very close to the heart and apply a 0.0001 second pulse, but this has not been shown to cause ventricular fibrillation. Typically when a person takes an overdose of drugs, he creates a disturbance, police are called, the person refuses to obey, the police Taser him, afterwards he dies of a drug overdose, and the newspapers report, "Man dies after Taser shot." (4) A defibrillator applies a 0.005 second, 40 ampere electric current. This causes massive heart contraction that can change ventricular fibrillation to normal rhythm and save a life.

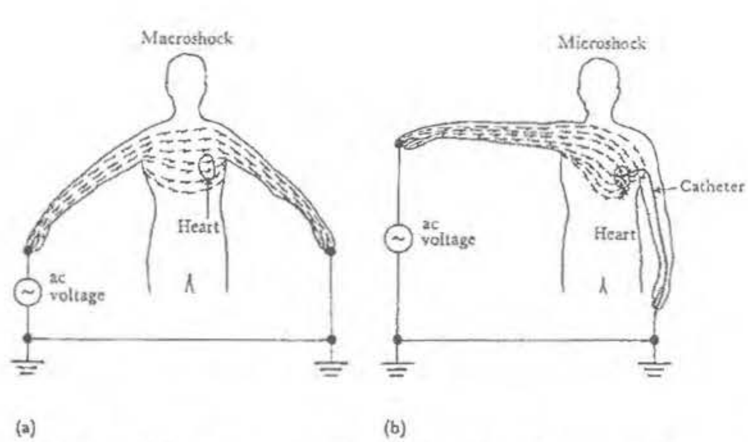


Figure 3 Effect of entry points on current distribution. (a) *Macroshock,* externally applied current spreads throughout the body, (b) *Microshock,* all the current applied through an intracardiac catheter flows through the heart. From F. J. Weibell, "Electrical Safety in the Hospital," *Annals of Biomedical Engineering,* 1974, 2, 126–148.

When comparing an electric security fence to the above examples, we know that an electric security fence is similar to Figure 3(a). Why do we know that? If a person contacts an electric fence, electric current is concentrated in the limbs and causes a deterrent shock; when it continues to pass through the torso, it spreads out and becomes more diffuse. Therefore as shown in Figure 3(a) and in Figure 2 electric security fences are safe because the deterrent shock spreads out and becomes more diffuse and is of a very short duration.

Only power lines cause ventricular fibrillation

Table 1 shows that short duration electric pulses, even though applied near the heart do not cause ventricular fibrillation. In contrast, the continuous current from power lines kills 1000 persons per year.

Table 1 Only power lines cause ventricular fibrillation

	Duration of pulse in seconds	Current in amperes	Likely to be applied near heart?	Caused ventricular fibrillation?
Power lines	Continuous	0.1	No	1000 per year
Electric security fence	0.0003 0.8 times/sec	10	No	No
Taser	0.0001 19 times/sec	2	May be	No
Cardiac pacemaker	0.001 1 time/sec	0.005	Yes	No
Defibrillator	0.005 1 time	40	Yes	Cures ventricular fibrillation
Spark plug	0.00002 1 time	0.2	No	No
Doorknob	0.00002 1 time	0.2	No	No

ELECTRIC GUARD DOG

Critical Components of Site Security

Palm Beach County, FL

History of Electric Security Fence

Our first guard dogs took a bite out of crime. Literally.

- Founded in 1973
- Built world's largest guard dog service; too many negative aspects and liability to the public when mean dogs 'escape' at the hands of intruders.
- Suffered break-in in 1991
- Designed and patented the Electric Guard Dog™ in 1991.
- Non-Residential Perimeter security system

#1 Theft Deterrent in the U.S.

Our Multi-Layered, Solar-Powered System cannot be:

- Distracted
- Disarmed
- Corrupted
- Silenced

Protecting tax base businesses, employees, property and profits with the same vigilance 365 days a year.

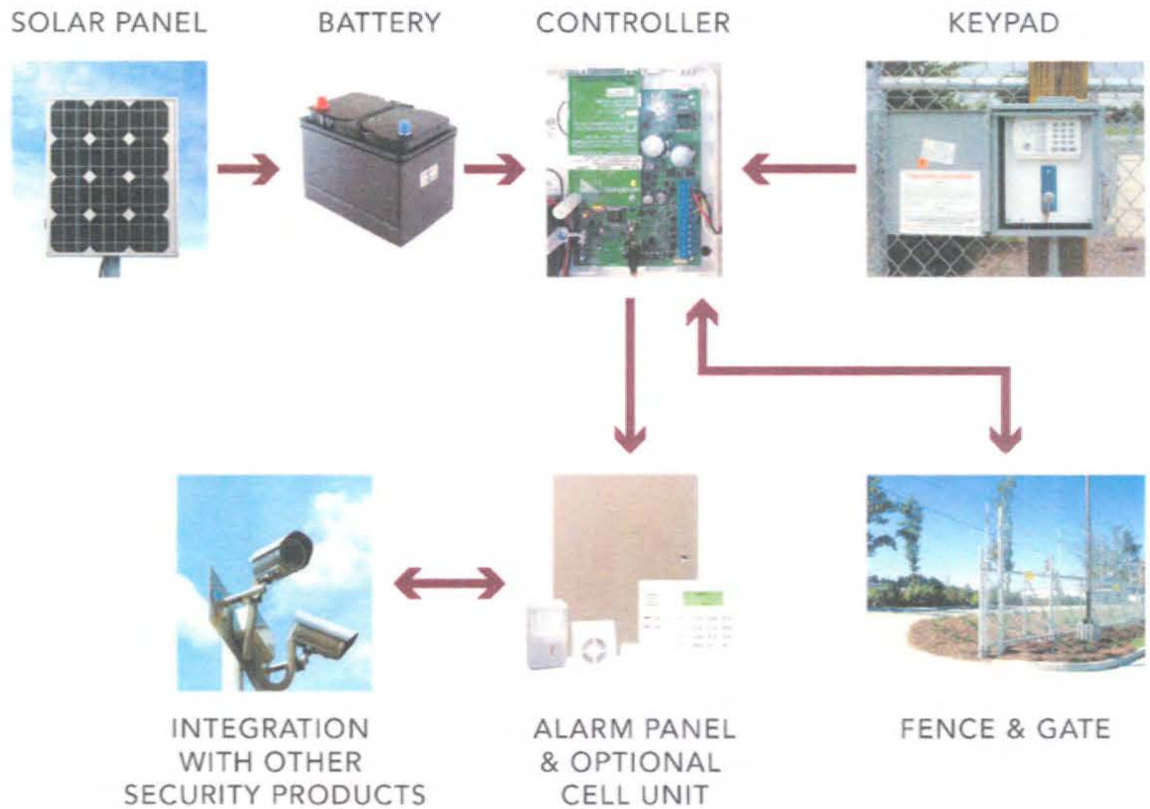
Aesthetics

Aesthetics

Aesthetics

How it works

Core Electrical Components Chart



How It Works

Usually our sign is deterrent enough.

How it works

Three Layers of Security:

Alarm Deterrent

- Silent & Audible
- 24-Hour Monitoring and dispatch similar to home security systems.
- Low False Alarm Rates

Shock Deterrent

- An Electrical Pulse Every 1.3 Seconds; Therefore poses NO medical risks - yet strong enough to zap intruders away from the fence.
- A "Safe but Memorable" Shock Upon Contact (.0001-.0004 seconds)
- Cannot be Scaled Or Cut

Physical Deterrent

- 10 Foot Electric Fence approximately 3" – 12" behind perimeter fence and **not directly exposed to the public**. – **NOTE: The perimeter fence is NEVER electrified – contact with the electric fence occurs only if someone is illegally trespassing!**
- 20 Strands of Wire
- Multi-Lingual Warning Signs visible from inside and outside the property.

How it works

Always On & Green

The Electric Guard Dog is solar-powered so security is:

- Cost-effective
- Always Vigilant
- Environmentally-friendly

No increase in power bills. No power failures. Great addition to city's green strategy.

Critical Concerns

Our cities know they benefit from:

- Decreased crime rates
- Less First Responder calls to location; frees city personnel to patrol and protect other areas.

Our customers know they're protected from:

- Dangers to Employees
- Property Losses
- Disruptions in Productivity
- Jeopardized Reputations
- Insurance Issues

Key Benefits

Safe and Effective Security

- Pulsed Electricity
- Independently Tested by Specialists
- Certified by IEC
- Member of the following Safety Councils & Security Associations:

Key Benefits

Pulsed Electricity is safe.

Table 1 Only power lines cause ventricular fibrillation

	Duration of pulse in seconds	Current in amperes	Likely to be applied near heart?	Caused ventricular fibrillation?
Power lines	Continuous	0.1	No	1000 per year
Electric security fence	0.0003 0.8 times/sec	10	No	No
Taser	0.0001 19 times/sec	2	May be	No
Cardiac pacemaker	0.001 1 time/sec	0.005	Yes	No
Defibrillator	0.005 1 time	40	Yes	Cures ventricular fibrillation
Spark plug	0.00002 1 time	0.2	No	No
Doorknob	0.00002 1 time	0.2	No	No

Source: *Safety Of Electric Security Fences*, Dr. John G. Webster, Professor Emeritus, Biomedical Engineering Department, University of Wisconsin

Key Benefits

Security Guards

- High Cost
  - 24/7 X 21 Eight Hour Shifts = 4.2 Employees
  - High turnover
- Liability
  - High Liability Issues
    - Human Error, Human Vices
- Effectiveness
  - Can be distracted, disarmed, corrupted or silenced

Video Cameras

- Low cost, but not effective; Record crime but don't prevent it.
- Immediate response only if using monitor system

Alarm Systems

- Low Cost, but not effective

Cities Installed

Florida Jurisdictions

The following jurisdictions in Florida have approved land development code to allow electric security fences:

Boyton Beach
Cocoa
Lauderdale Lakes
Miami-Dade County
Tampa
Riviera Beach
Orlando
Hollywood
Pompano Beach
Fort Myers
Village of Palm Springs
Hillsborough County
City of West Palm Beach
Jacksonville
Delray Beach
Opa Locka
Port St. Lucie
St. Lucie County
Davie
Lakeland
Fort Pierce
Seffner
Orange
Ocala FL (code update in progress);
St. Petersburg (code update in progress)

PALM BEACH COUNTY
SHERIFF'S OFFICE
RIC L. BRADSHAW, SHERIFF

September 17, 2012

Honorable Shelly Vana, Chair
Palm Beach County Commission
12th Floor Governmental Center
301 N. Olive Ave.
West Palm Beach, FL 33401

Re: Electric Security System

Dear Commissioner Vana:

It has come to my attention that the Palm Beach County Zoning Code prohibits electric security systems such as the ones designed by Electric Guard Dog. These types of systems are an effective deterrent to crime especially for outdoor storage facilities when placed behind a chain link fence or other fence or wall. Last night a burglary took place at The Boat Connection on South Military Trail at its outdoor storage facility. Had an electric security system been in place it may have deterred this type of criminal activity. In general, the more crime deterrent security systems that are in place, the less calls law enforcement needs to respond to.

I urge you and the Palm Beach County Commission to take all steps to allow for the use of electric security systems at the earliest possible time.

Sincerely,

Ric L. Bradshaw
Sheriff

cc: Honorable Karen T. Marcus
Honorable Paulette Burdick
Honorable Steven L. Abrams
Honorable Burt Aaronson
Honorable Jess R. Santamaria
Honorable Priscilla A. Taylor

3228 Gun Club Road ▪ West Palm Beach, Florida 33406-3001 ▪ (561) 688-3021 ▪ Email: BradshawR@pbso.org

Mr. Michael Pate
Electric Guard Dog
7608 Fairfield Rd.
Columbia, SC 29203

10/18/12

Reference:	Job Number SAFN6587
Initial Review Date:	12/1/11
Final Review Date:	12/1/11
Final Installation Facility Name:	To be determined by Manufacturer
Final Installation Facility Address:	To be determined by Manufacturer

Dear Mr. Pate,

We have completed our referenced field inspection in accordance with our Field Labeling program. The 47 units (Battery Powered Security Fence Systems) inspected on 12/1/11 were labeled during our visit.

The equipment was evaluated in accordance with the applicable sections of the National Electrical Code (NEC), the Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation 1st edition (ACES & A];CIL), and the IEC Standard(s) as noted below.

This test report contains only findings and results regarding the indicated equipment for installation at the particular final installation location. Any modifications other than normal maintenance items will require re-inspection before being placed back into service. This evaluation is not intended as an approval of equipment at any locations other than the site locations on file with MET Laboratories.

All Battery Powered Security Fence Systems are subjected to multiple random audits per year to conform that the labeled units are installed and constructed in compliance with IEC 60335-2-76.

This completes the work anticipated under our Field-Labeling program. If you should have any questions, please do not hesitate to contact us.

Sincerely,

Josh Hunt
Project Engineer
MET Southeast

Reviewed By,

Brad Collison
Managing Engineer
MET Southeast

THE NATIONAL ASSOCIATION OF RADIO AND TELECOMMUNICATIONS ENGINEERS, INC. BRADLEY D. COLLISON NARTE PS-000222-NCE

Product Information

	Unit 1	Unit 2	Unit 3
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	EF154	EF154	EF154
Serial #	482732624	482732625	482732626
Manufacturer	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog
Ratings	12VDC, 5J & 2J	12VDC, 5J & 2J	12VDC, 5J & 2J
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169710	169711	169712

	Unit 4	Unit 5	Unit 6
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	EF157	EF155	EF154
Serial #	482732627	482732965	482732964
Manufacturer	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog
Ratings	12VDC, (2) 2J	12VDC, (3) 5J	12VDC, 5J & 2J
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169713	169714	169715

	Unit 7	Unit 8	Unit 9
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	EF154	EF154	EF154
Serial #	482732963	482732966	482732967
Manufacturer	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog
Ratings	12VDC, 5J & 2J	12VDC, 5J & 2J	12VDC, 5J & 2J
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169716	169717	169718

	Unit 10	Unit 11	Unit 12
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	EF153	EF153	EF153
Serial #	482732968	482732969	482732970
Manufacturer	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog
Ratings	12VDC, (2) 5J	12VDC, (2) 5J	12VDC, (2) 5J
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169719	169720	169721

	Unit 13	Unit 14	Unit 15
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	EF154	EF154	EF153
Serial #	482732971	482732972	482732973
Manufacturer	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog	Advanced Perimeter Systems Electric Guard Dog
Ratings	12VDC, 5J & 2J	12VDC, 5J & 2J	12VDC, (2) 5J
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169722	169723	169724

	Unit 16	Unit 17	Unit 18
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	EF153	B80	B1600
Serial #	482732974	48273000	48273299
Manufacturer	Advanced Perimeter Systems Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, (2) 5J	12VDC, 560.2mJ, 70mA	12VDC, 4.9J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169725	169726	169727

	Unit 19	Unit 20	Unit 21
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B280	B280	B280
Serial #	482732998	482732997	482732996
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 2.1J, 220mA	12VDC, 2.1J, 220mA	12VDC, 2.1J, 220mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169728	169729	169730

	Unit 22	Unit 23	Unit 24
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B280	B80	B600
Serial #	482732995	482732994	482732983
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 2.1J, 220mA	12VDC, 560.2mJ, 70mA	12VDC, 4.5J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169731	169732	169733

	Unit 25	Unit 26	Unit 27
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B600	B600	B600
Serial #	482732984	482732985	482732986
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 4.5J, 500mA	12VDC, 4.5J, 500mA	12VDC, 4.5J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169734	169735	169736

	Unit 28	Unit 29	Unit 30
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B600	B600	B600
Serial #	482732987	482732988	482732989
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 4.5J, 500mA	12VDC, 4.5J, 500mA	12VDC, 4.5J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169737	169738	169739

	Unit 31	Unit 32	Unit 33
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B180	B1600	B600
Serial #	482732990	482732991	482732992
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 1.1J, 130mA	12VDC, 4.9J, 500mA	12VDC, 4.5J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169778	169779	169776

	Unit 34	Unit 35	Unit 36
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B600	B80	B1600
Serial #	482732975	482732976	482732977
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 4.5J, 500mA	12VDC, 560.2mJ, 70mA	12VDC, 4.9J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169777	169780	169781

	Unit 37	Unit 38	Unit 39
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B600	B1600	B600
Serial #	482732978	482732979	482732980
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 4.5J, 500mA	12VDC, 4.9J, 500mA	12VDC, 4.5J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169782	169783	169784

	Unit 40	Unit 41	Unit 42
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B600	B600	B600
Serial #	482732981	482732633	482732634
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 4.5J, 500mA	12VDC, 4.5J, 500mA	12VDC, 4.5J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169785	169786	169787

	Unit 43	Unit 44	Unit 45
Description	Battery Powered Security Fence System	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B1600	B1600	B1600
Serial #	482732635	482732636	482732637
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 4.9J, 500mA	12VDC, 4.9J, 500mA	12VDC, 4.9J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169788	169789	169790

	Unit 46	Unit 47
Description	Battery Powered Security Fence System	Battery Powered Security Fence System
Model	B1600	B600
Serial #	482732982	482732993
Manufacturer	Gallagher Group Electric Guard Dog	Gallagher Group Electric Guard Dog
Ratings	12VDC, 4.9J, 500mA	12VDC, 4.5J, 500mA
Standard(s)	IEC 60335-2-76	IEC 60335-2-76
Field Label #	169791	169792

Equipment Evaluation

ENCLOSURE

- The enclosure for the Energizers is constructed of galvanized steel (18”x24”x8”)
- The enclosure for the Advance Per miter Systems Controller is contained in a minimum 3R rated polymeric enclosure.
- Two knockouts are provided for the enclosure (High Voltage Fence Wiring & Control Wiring) these wires are not to be contained in the same raceway.
- Both enclosures are provided with a lock to protect unintentional contact with electrically live parts.
- Both enclosures are intended to be mounted vertically with their provided mounting holes.
- A disconnect switch is not provided within the control enclosure, since connection means for the power source (12VDC battery) is contained within a separate enclosure.

CONDUCTORS

- All internal control wiring is NRTL Listed cable rated at 18AWG with 2, 8 or 10 conductors.
- The insulation rating of these conductors is 300V.
- All internal control wiring is separated from the high voltage fence wiring and is contained in a separate raceway.
- The high voltage fence wiring is rated at #14 19/27 tinned copper, dielectric strength of 15kV, insulation resistance of 2.5kV, and spark voltage of 15kV.

CONNECTORS

- All internal connections are made via NRTL Listed wire terminals secured to a NRTL certified terminal block.
- A installation drawing with a terminal block diagram of connection means is provided with the enclosure.

POWER SOURCE

- Both units are intended for connection only to a 12VDC supply source.
- These units are not rated for connection to mains or line voltage.
- The 12VDC source is in the form of a lead acid battery. Normally a photovoltaic cell is provided to charge the battery.

MARKINGS

- The fence charger enclosure was supplied with the following permanent markings.

  1. Manufacturers Identification, Model Number, Serial Number and Ratings located inside the enclosure.
  2. WARNING – DO NOT CONNECT TO MAINS located on the front door/cover.
  3. DO NOT RUN FENCE AND CONTROL WIRING IN SAME RACEWAY located inside the enclosure.
  4. 12VDC POWER SOURCE ONLY located inside the enclosure.

FENCE INSTALLATION REQUIREMENTS

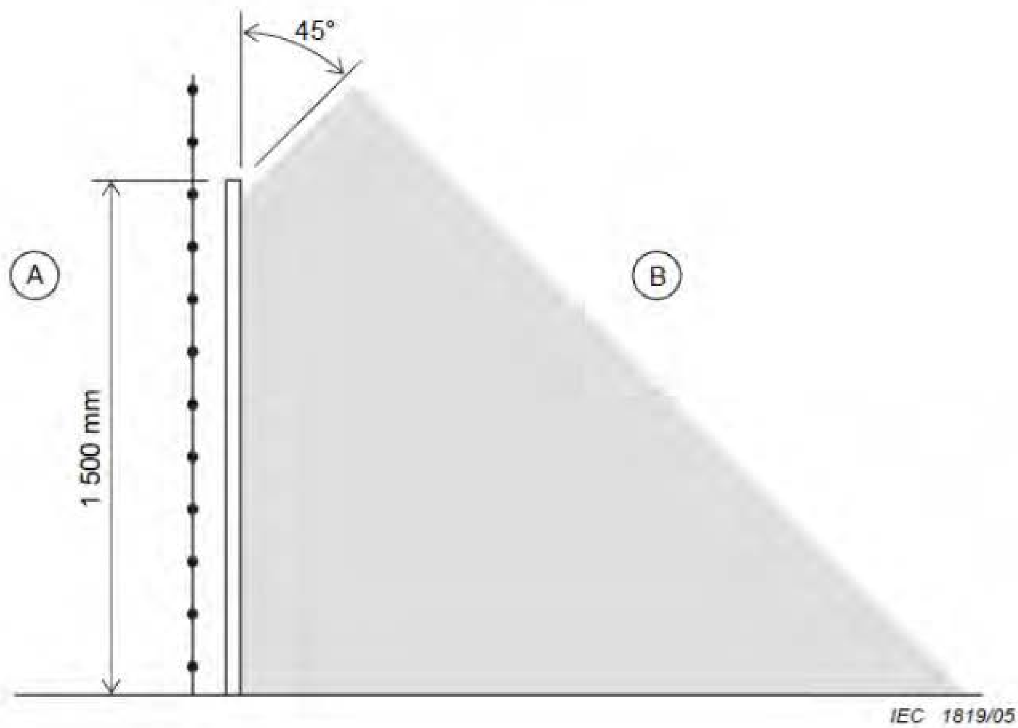
- All electric fence must have a physical barrier installed to prevent public access. The electric fence shall be installed in accordance with the following below from Annex CC from IEC 60335-2-76.

CC.3 Prohibited zone for pulsed conductors

Pulsed conductors shall not be installed within the shaded zone shown in Figure CC1.

NOTE 1 Where an **electric security fence** is planned to run close to a site boundary, the relevant government authority should be consulted before installation begins.

NOTE 2 Typical **electric security fence** installations are shown in Figure CC2 and Figure CC3.



Key

A = **Secure area**

B = **Public access area**

Physical barrier

Prohibited area

Electric security fence

Figure CC.1 – Prohibited area for pulse conductors

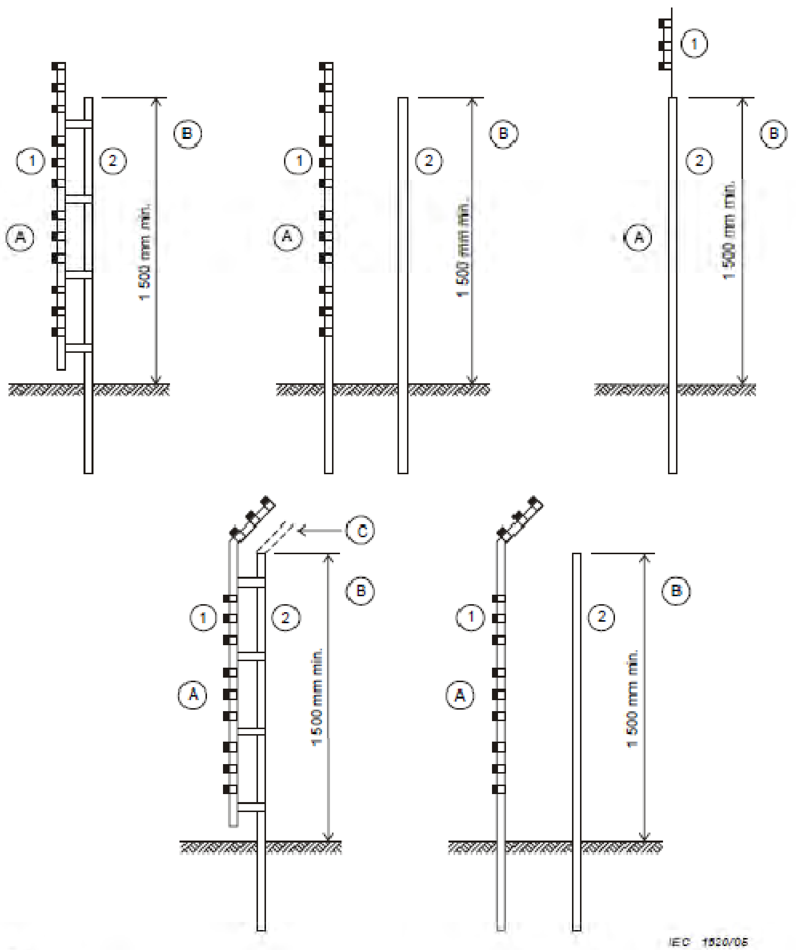
CC.4 Separation between electric fence and physical barrier

Where a **physical barrier** is installed in compliance with CC.3 at least one dimension in any opening should be not greater than 130 mm and the separation between the **electric fence** and the **physical barrier** should be

– within the range of 100 mm to 200 mm or greater than 1 000 mm where at least one dimension in each opening in the **physical barrier** is not greater than 130 mm;
– greater than 1 000 mm where any opening in the **physical barrier** has all dimensions greater than 50 mm;
– less than 200 mm or greater than 1 000 mm where the **physical barrier** does not have any openings.

NOTE 1 These restrictions are intended to reduce the possibility of persons making inadvertent contact with the **pulsed conductors** and to prevent them from becoming wedged between the **electric fence** and the **physical barrier**, thereby being exposed to multiple shocks from the **energizer**.

NOTE 2 The separation is the perpendicular distance between the **electric fence** and the **physical barrier**.



Key
A = Secure area
B = Public access area
C = Barrier where required
1 = Electric security fence
2 = Physical barrier

Figure CC.2 – Typical constructions where an electric security fence is exposed to the public

FIELD CONNECTION REQUIREMENTS

- All Field Installed components shall comply with the applicable sections of the NEC. The Electric Security Fence System has the option to be energized from a isolated Solar Panel or supplied by a 120Vac circuit for a battery charger for the 12VDC batteries. In the event that the system is connected to a 120Vac circuit, the system shall be installed in accordance to the NEC and shall utilize a UL listed trickle battery charger.
- Installations with a solar panel shall include a UL Listed unit which installed in full accordance with the UL guide card and manufacturers installation instructions.
- All electrical components (batteries, chargers, energizers, etc..) must be installed in their supplied enclosures or with a minimum 3R rated enclosure.
- All fence connections shall be in accordance with the supplied installation instructions. The wiring shall be of UL listed wire which matches or exceeds the ratings for Item 10 below.
- Any modifications to the installation instructions or requirements set forth in this report is subject to violating compliance to this certification.
-

Electrical Components

Item	Component	Mfg	Part No.	Ratings	Cert.
1	Power Fence Energizer	Electric Guard Dog/Gallagher Group	B80	12VDC, 70mA, 1.3s, energy = 500 ohms, 560.2mJ	CE
2	Power Fence Energizer	Electric Guard Dog/Gallagher Group	B180	12VDC, 130mA, 1.3s, energy = 500 ohms, 1.1J	CE
3	Power Fence Energizer	Electric Guard Dog/Gallagher Group	B280	12VDC, 220mA, 1.28s, energy = 500 ohms, 2.1J	CE
4	Power Fence Energizer	Electric Guard Dog/Gallagher Group	B600	12VDC, 500mA, 1.3s, energy = 500 ohms, 4.5J	CE
5	Power Fence Energizer	Electric Guard Dog/Gallagher Group	B1600	12VDC, 500mA, 1.3s, energy = 500 ohms, 4.9J	CE
6	Electro Fence Controller	Advanced Perimeter Systems	EF154, 153, 155, 157	12VDC, 1.3s, 2J or 5J	CE
7	Voltage Alarm	Electric Guard Dog/Gallagher Group	IPX4, CAN 005 550 845	Battery type = 12V, 10-100mA, IPX4	CE
8	Relay	Adv. Signal	ASRB-1	12-24VDC	UL
9	Solar Controller	Sunguard	Solar Controller	12V, 4.5A	CE
10	External Power Wiring from Charger to Fence	Multiple	Multiple	0.030 in. thick PVC Jacketed, 14 AWG, 19 x 37 Tinned Copper. Dielectric Strength: 15 kV, Insulation Resistance: 2.5 kV, Spark Voltage: 15 kV.	UL
11	Photovoltaic Cell	Kyocera	KC60	16.9VDC, 3.55A	UL
12	Batteries	Random	Random	12VDC, Deep Cycle AGM	CE
13	Charge Controller	Sun Selector	M-4	25VDC, 6A	CE

Photo Documentation

Figure 1: EF153

Figure 2: B1600 & Voltage Alarm

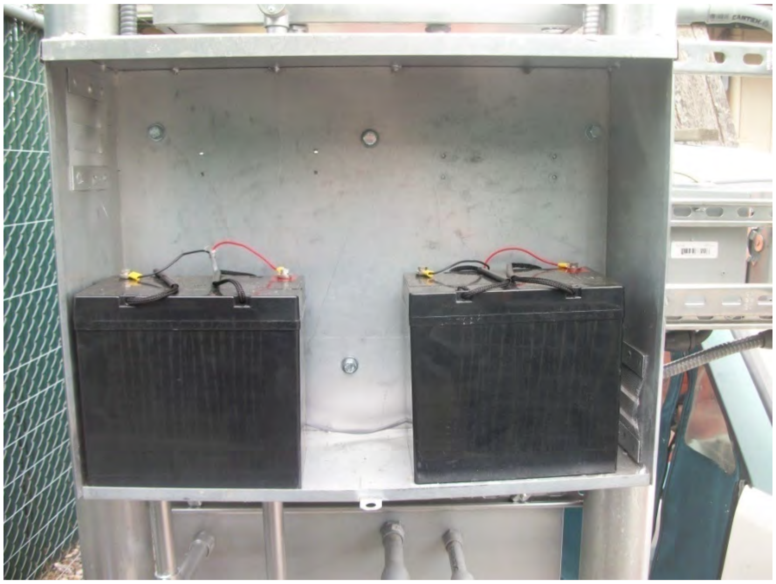


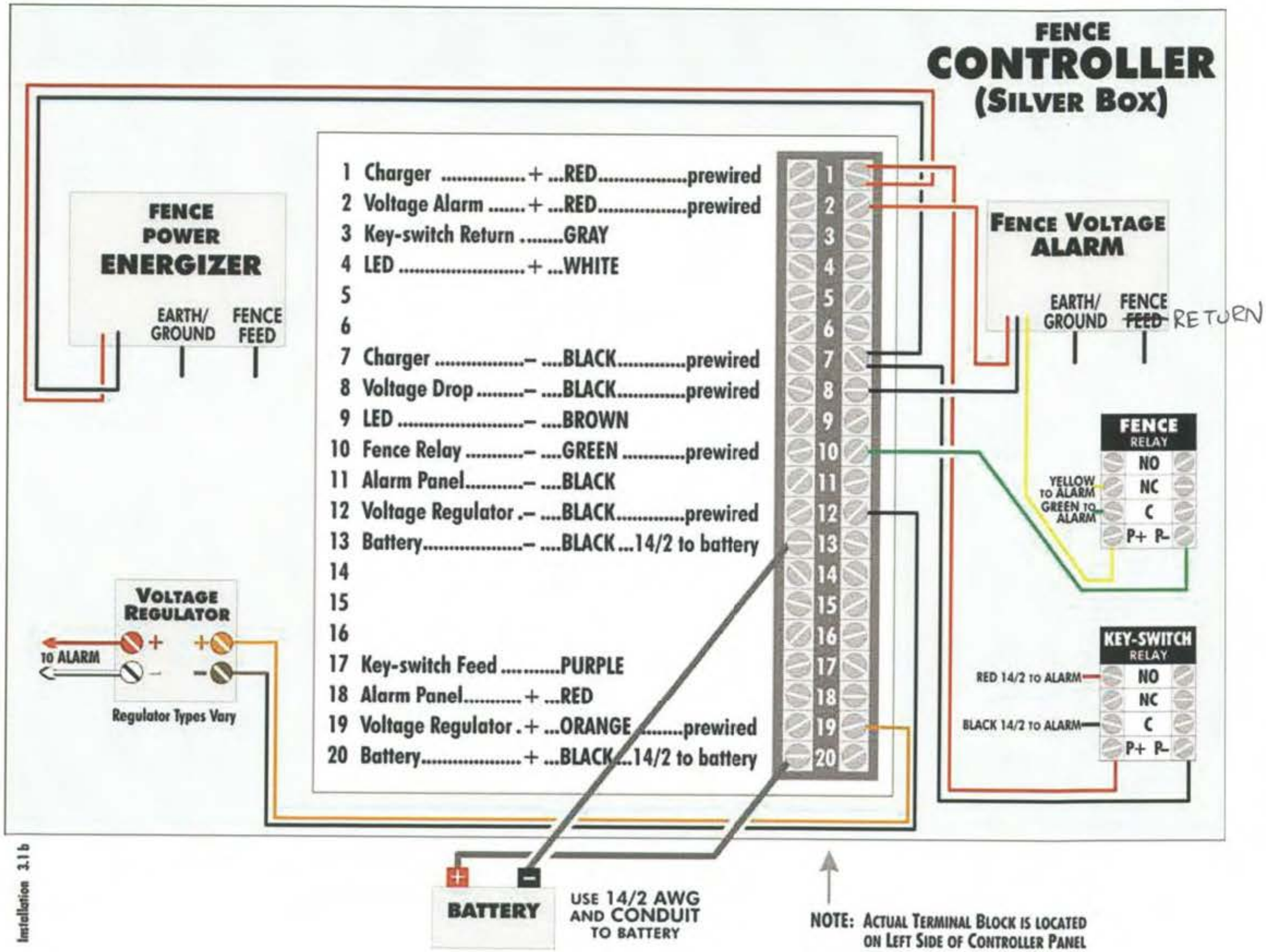
Figure 3: Battery Compartment

Figure 4: Solar Panel System

Figure 5: Fence Connections

Figure 6: Fence Warning and Physical Barrier

Electrical Diagram for BXXXX units



Fence Installation Diagram

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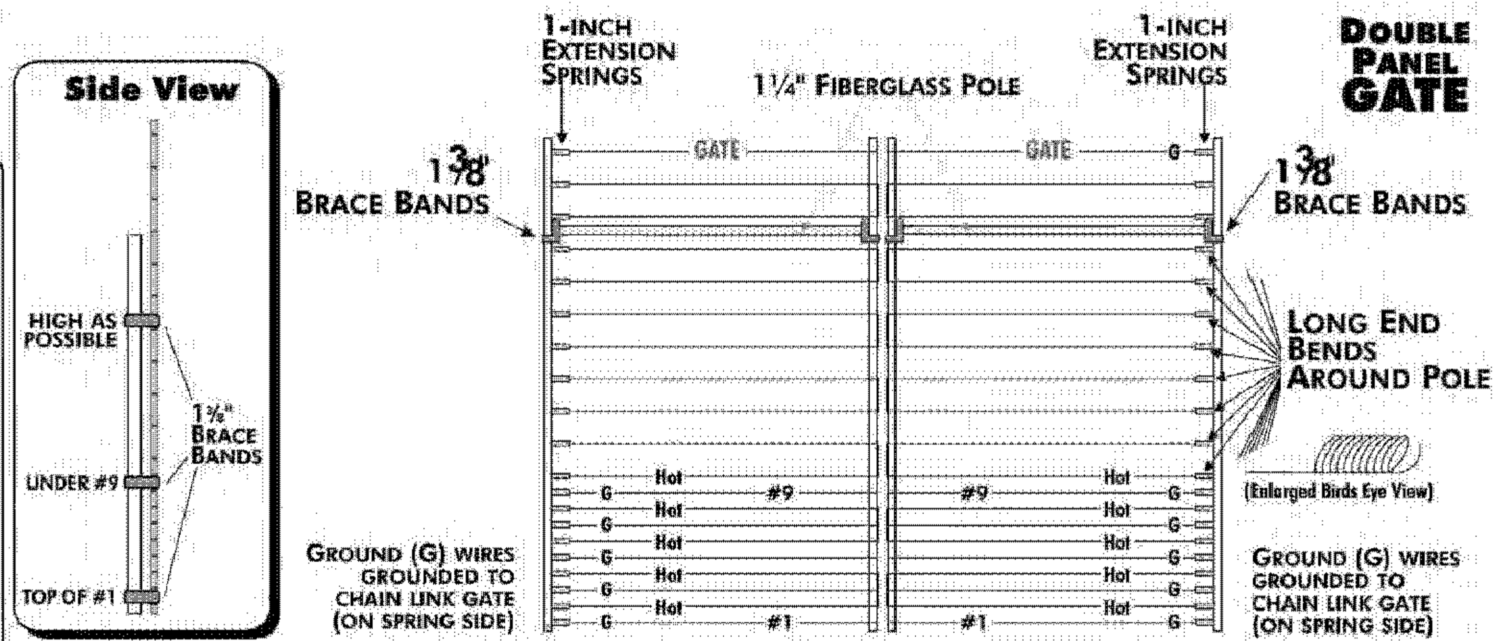

1. Brace Bands are located on top of #1, under #9, and asd high on the chain linke as possible.
2. Springs are located on opposite side of lock.
3. All contacts must include spring.
4. All contacts must have bolt through fiberglass (no set screws).
5. All Brace Bands hooked to chain link must have set screw.
6. Every gate panel must have a sign.
7. All gate contacts must be secured in a manner that ensures contact when closed by a blind person.

INSTALLATION 2.13

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2.A Gates
Use splices on jumpers on gates, all other jumpers use joint clamps not splices.

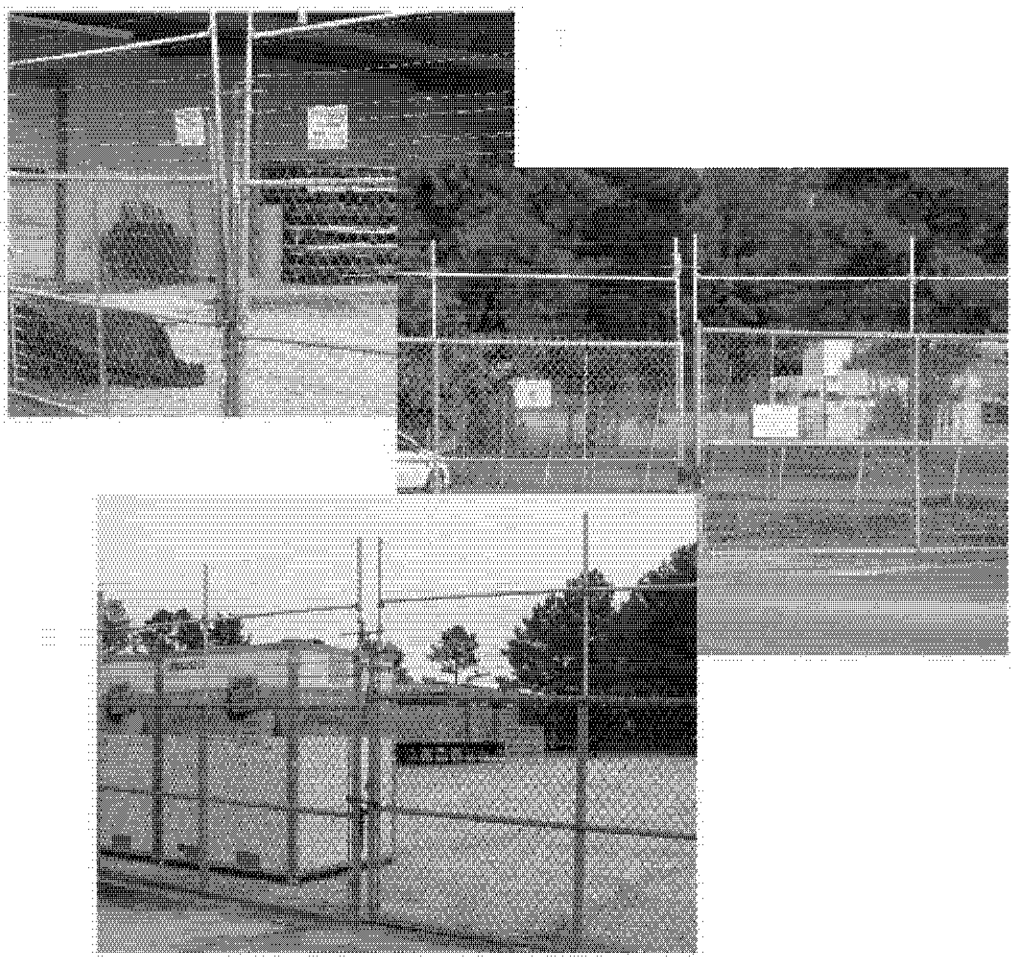
2.B Gates
Back side of roll gate must use steel pole not fiberglass pole. Gate must slide between electric and perimeter fence.

2.C Gates
Gates should close tightly without play. If customer closes his gate with a chain, ask to cut off any excess length, so chain only meets using last two links. This will avoid chain tail shorting out gate and close tight enough to avoid wind pushing it open and losing contact.

POOR GATE CONNECTIONS ARE A COMMON CAUSE OF FENCE ALARMS.

2.D Gates
Current travels only one way through the gate. If it returns, then trench under gate wire #19 to 19 with weather heads on each side.

2.2 Double Panel



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Fiberglass Poles Rapid Tighteners & Warning Signs

RAPID TIGHTENERS

Rapid Tighteners are installed in every section – between 6 inches and 3 feet from a fiberglass pole – toward the center of the pull.

The tighteners are alternated on opposite sides of the pole to prevent grounds from hitting hots.

Wire should be wrapped two or three times around each tightener.

WARNING SIGNS

Warning Signs must be installed every 60 feet, which is the MAXIMUM distance between Warning Signs.

The Externally Visible Language should be alternated, so that every sign showing the English side is followed by one showing the Spanish side to people situated outside the fence.

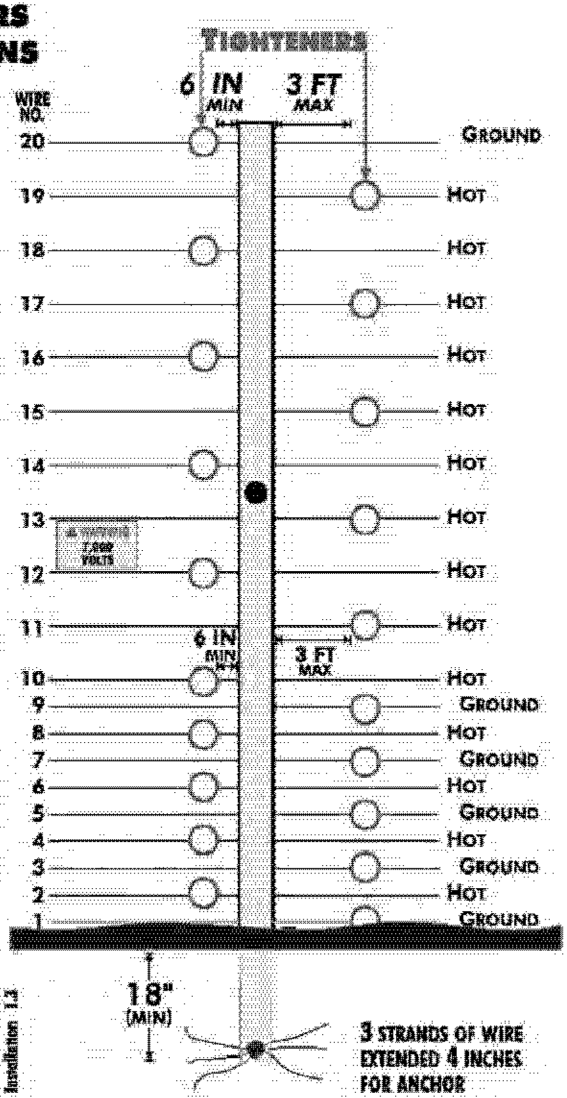
All Warning Signs should be mounted between Wires 12 & 13.

FIBERGLASS POLES

Fiberglass Poles are set at a MAXIMUM of 30-foot intervals.

They are always placed directly in front of a perimeter post so they can be braced to the perimeter post, if necessary.

The BOTTOM WIRE should be flat on the ground.



Installation 1.3

1.3A Fiberglass line post
Fiberglass straight line. Install metal poles, pull bottom wire, then install fiber right behind line so fiber are in a straight line.

1.3B Fiberglass line post
Install rapid tightners in a safe, flat easily accessable area.

1.3C Fiberglass line post
Pins installed in the fiberglass poles need to have the end facing into the yard, level with the ground.

University of Wisconsin Report on Gallagher Energizers

THE UNIVERSITY of WISCONSIN MADISON

January 8, 2008

Edward T. Dickerson, PhD., P.E.

Dear Dr. Dickerson,

I have tested the Gallagher Group Ltd PowerPlus B600 and Gallagher Group Ltd PowerPlus B280 electric fence energizers. I tested them to the International Electrotechnical Commission Standard: IEC 2006 *Household and similar electrical appliances – Safety – Part 2-76: Particular requirements for electric fence energizers*, (IEC 60335-2-76, Edition 2.1). It is the most appropriate standard to use because it specifically describes "electric security fences" 40 times.

I describe the testing methods and the results in detail in the attached paper: Amit J. Nimunkar and John G. Webster, "Safety of electric fence energizers." Figure 3 in this paper shows the electric current versus time for these two electric fence energizers and compares them with three other electric fence energizers in use in the USA. Table 1 shows the electric fence energizer electric current I_{rms}, compares it with the IEC standard I_{rms}, and shows that all five electric fence energizers pass the IEC standard electric tests.

I conclude that the Gallagher Group Ltd PowerPlus B600 and Gallagher Group Ltd PowerPlus B280 electric fence energizers passed all IEC electric tests and thus are safe to use.

If I can provide you any further information, please let me know.

Sincerely,

John G. Webster, Professor Emeritus
Phone 608-263-1574
Webster@engr.wisc.edu

Department of Biomedical Engineering
2130 Engineering Centers Building University of Wisconsin–Madison 1550 Engineering Drive Madison, Wisconsin 53706–1609
608/263–4660 Fax: 608/265–9239 Email: bme@engr.wisc.edu http://www.bme.wisc.edu/

Safety of electric fence energizers

Amit J. Nimunkar1 and John G. Webster1

1Department of Biomedical Engineering, University of Wisconsin, 1550 Engineering Drive, Madison, WI 53706 USA.
E-mail: Webster@engr.wisc.edu (John G. Webster) Tel 608-263-1574, Fax 608-265-9239

Abstract

The strength–duration curve for tissue excitation can be modeled by a parallel resistor–capacitor circuit that has a time constant. We tested five electric fence energizers to determine their current-versus-time waveforms. We estimated their safety characteristics using the existing IEC standard and propose a new standard. The investigator would discharge the device into a passive resistor–capacitor circuit and measure the resulting maximum voltage. If the maximum voltage does not exceed a limit, the device passes the test.

Key words: strength–duration curve, cardiac stimulation, ventricular fibrillation, electric safety, electric fence energizers, standards.

1. Introduction

The vast majority of work on electric safety has been done using power line frequencies such as 60 Hz. Thus most standards for electric safety apply to continuous 60 Hz current applied hand to hand. A separate class of electric devices applies electric current as single or a train of short pulses, such as are found in electric fence energizers (EFEs). A standard that specifically applies to EFEs is IEC (2006). To estimate the ventricular fibrillation (VF) risk of EFEs, we use the excitation behavior of excitable cells. Geddes and Baker (1989) presented the cell membrane excitation model (Analytical Strength–Duration Curve model) by a lumped parallel resistance–capacitance (*RC*) circuit. This model determines the cell excitation thresholds for varying rectangular pulse durations by assigning the strength–duration rheobase currents, chronaxie, and time constants (Geddes and Baker, 1989). Though this model was originally developed based on the experimental results of rectangular pulses, the effectiveness of applying this model for other waveforms has been discussed (IEC 1987, Jones and Geddes 1977). The charge–duration curve, derived from the strength–duration curve, has been shown in sound agreement with various experimental results for irregular waveforms. This permits calculating the VF excitation threshold of EFEs with various nonrectangular waveforms. We present measurements on electric fence energizers and discuss their possibility of inducing VF.

2. Mathematical background and calculation procedures

Based on the cell membrane excitation model (Weiss–Lapique model), Geddes and Baker (1989) developed a lumped *RC* model (analytical strength–duration curve) to describe the membrane excitation behavior. This model has been widely used in various fields in electrophysiology to calculate the excitation threshold. Figure 1 shows the normalized strength–duration curve for current (I), charge (Q) and energy (U). The expression of charge is also known as the charge–duration curve which is important for short duration stimulations.

2

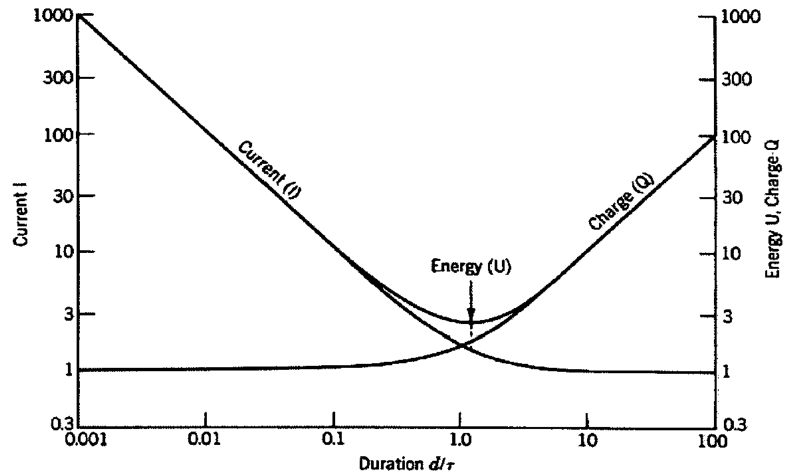


Figure 1. Normalized analytical strength–duration curve for current I, charge Q, and energy U. The x axis shows the normalized duration of d/τ. Note that for $d << \tau$, Q is constant and the most appropriate variable for estimating cell excitation. (from Geddes and Baker, 1989).

The equation for the strength–duration curve is (Geddes and Baker, 1989),

$$\Delta v = IR(1 - e^{-\frac{t}{\tau}}), \tag{1}$$

where I is a step current intensity, R is the shunt resistance, Δv is the depolarization potential threshold which is about 20 mV for myocardial cells, τ is the RC time constant, and t is the time I is applied.

If we let the stimulation duration go to infinity, the threshold current is defined as the rheobase current ($I = b$). If we substitute I in equation (1) by b and define the threshold current $I_d = \Delta v/R$ for the stimulation with duration d. Equation (1) becomes,

$$I_d = \frac{b}{1 - e^{-\frac{d}{\tau}}}. \tag{2}$$

We can calculate the threshold charge (Q_d) by integrating equation (2) and it becomes,

$$Q_{\mathrm{d}} = I_{\mathrm{d}} d = \frac{bd}{1 - e^{-\frac{d}{\tau}}}, \tag{3}$$

For short duration stimulation ($d << \tau$) with duration shorter than 0.1 times the *RC* time constant, equation (3) can be approximated by equation (4) and it yields equation (5),

$$1 - e^{-\frac{d}{\tau}} \approx \frac{d}{\tau}, \tag{4}$$

$$Q_{\mathrm{d}} = b\tau \tag{5}$$

Equation (5) suggests that the charge excitation threshold for short duration stimulation is constant and equals the product of the *RC* time constant τ and the rheobase b. Geddes and Bourland (1985) showed that the charge–duration curve for single rectangular, trapezoidal, half sinusoid and critically damped waveforms had a good agreement for short duration stimulations. Therefore we used the same model to estimate thresholds for stimulation sources where I was not constant, under the same stimulation setting.

Cardiac cell excitation has been intensively studied at the 60 Hz power line frequency because most accidental electrocutions occur with 60 Hz current, which has a longer duration relative to the cardiac cell time constant of about 2 ms. However, EFEs operate with pulse durations much shorter than the time constant.

3. Methods

Figure 2 shows our experimental test set-up. The EFEs under test consist of Gallagher Group Ltd PowerPlus B600 (EFE1), Gallagher Group Ltd PowerPlus B280 (EFE2), Speedrite HPB (EFE3), Intellishock 20B (EFE4) and Blitzer 8902 (EFE5) EFEs. The short duration electrical pulses from these EFEs are passed though a series of eleven 47 Ω (ARCOL D4.29, HS50 47 R F) resistors which measure 518 Ω, which represents approximately the internal resistance of the human body. It is further connected to two 18 Ω (RH 10 207 DALE 10 W 3%) resistors connected in parallel which measure 9.08 Ω. This is used as the sensing resistor across which the oscilloscope measures the output voltage. For these very short pulses it is important to use noninductive resistors because the same current flowing through a resistor that has substantial inductance will measure a larger current than a resistor that is noninductive. To reduce electromagnetic interference, a faraday cage, covered with aluminum foil, was connected to ground. This diverted the electromagnetic interference to ground. The data were collected in EXCEL format from a disk in the Agilent 54621 oscilloscope. The calculations for different parameters presented in Table 1 and the Figures 3–5 were plotted using MATLAB.

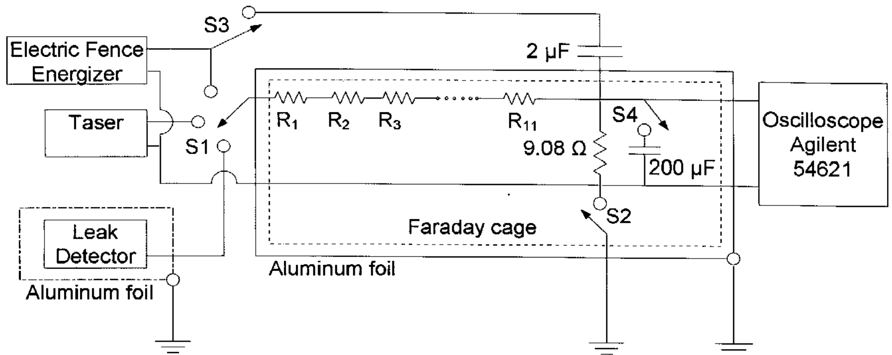


Figure 2. The EFE is selected by S1. The current flows through a string of 47 Ω resistors R_1–R_{11} (total 518 Ω) which approximates the internal body resistance of 500 Ω. The 9.08 Ω yields a low voltage that is measured by the oscilloscope.

3.1. Determination of current

EFEs are used in conjunction with fences wires to form animal control fences and security fences. We tested five EFEs (EFE1–EFE5) using the experimental set-up in Figure 2 and obtained the output currents shown in Figure 3.

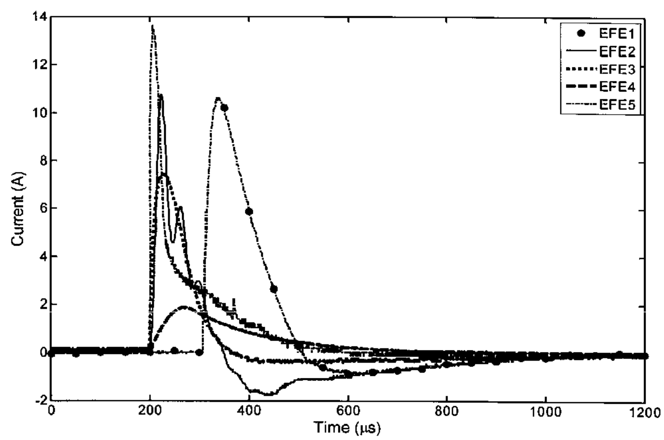


Figure 3. The output current waveform for five EFEs. EFE1 yields about 7.75 A for 151 μs = 1170 μC, EFE2 yields about 3.34 A for 345 μs = 1150 μC, EFE3 yields about 5.69 A for 91 μs =

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518 μC, EFE4 yields about 1.25 A for 252 μs = 315 μC and EFE5 yields about 5.7 A for 137 μs = 781 μC.

4. Results

Table 1 shows the approximate results for the rms current, power, duration and charge for all the EFEs.

Table 1 Approximate results for all EFEs.

EFEs Parameters	Units	**EFE1**	**EFE2**	**EFE3**	**EFE4**	**ECF5**
A. (IEC)						
Total Energy	A^2ms	7.94	4.04	3.10	0.42	4.69
95% Energy Duration	μs	129	346	91	253	138
I_{rms}	A	7.65	3.33	5.69	1.25	5.69
IEC Standard I_{rms}	A	13.0	6.21	16.8	7.85	7.37
Pass IEC Standard	Yes/No	Yes	Yes	Yes	Yes	Yes
B. Proposed standard						
Voltage	V	3.88	2.91	NAv	NAv	NAv
Duration	μs	233	132			
Current	A	3.33	4.41			
Charge	μC	776	582			

NA- not applicable, NAv- not available

IEC (2006) defines in 3.116 "impulse duration: duration of that part of the impulse that contains 95% of the overall energy and is the shortest interval of integration of $I^2(t)$ that gives 95% of the integration of $I^2(t)$ over the total impulse. $I(t)$ is the impulse current as a function of time." In 3.117 it defines "output current: r.m.s. value of the output current per impulse calculated over the impulse duration." In 3.118 it defines "standard load: load consisting of a non-inductive resistor of 500 Ω ± 2.5 Ω and a variable resistor that is adjusted so as to maximize the energy per impulse or output current in the 500 Ω resistor, as applicable." In 22.108, "Energizer output characteristics shall be such that – the impulse repetition rate shall not exceed 1 Hz; – the impulse duration of the impulse in the 500 Ω component of the standard load shall not exceed 10 ms; – for energy limited energizers the energy/impulse in the 500 Ω component of the standard load shall not exceed 5 J; The energy/impulse is the energy measured in the impulse over the impulse duration. – for current limited energizers the output current in the 500 Ω component of the standard load shall not exceed for an impulse duration of greater than 0.1 ms, the value specified by the characteristic limit line detailed in Figure 102; an impulse duration of not greater than 0.1 ms, 15 700 mA. The equation of the line relating impulse duration (ms) to output current (mA) for 1 000 mA < output current < 15 700 mA, is given by impulse duration = $41.885 \times 10^3 \times (\text{output current})^{-1.34}$." We used these definitions and calculated the total energy, the shortest duration where 95% of the total energy occurs, the rms current for that duration from Figure 3 for the EFEs (EFE1–EFE5). Similarly we calculated the output current using the relationship impulse duration = $41.885 \times 10^3 \times (\text{output current})^{-1.34}$, provided by the IEC for all the EFEs (EFE1–EFE5). Table 1 lists these under the heading "A. (IEC)". Table 1 shows that all the EFEs pass the IEC standard.

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5. Proposed new standard

IEC (2006) uses the rms current for the shortest duration where 95% of the total energy occurs as the standard to determine if the EFE is safe for use. Geddes and Baker (1989) have shown that for pulses shorter than the cardiac cell time constant of 2 ms, the electric charge is the quantity that excites the cells. We propose a simple experimental set-up shown in Figure 2 to determine the maximum amount of charge that would flow from the EFEs and cause cardiac cell excitation. The cardiac cell is modeled as an *RC* circuit in Fig. 2 with $R = 9.08\ \Omega$ and $C = 200\ \mu F$ (GECONOL 9757511FC 200 μF ±10% 250 VPK) with the *RC* time constant of 1.82 ms. For the EFEs (EFE1 and EFE2) the switches S1 and S4 are closed. This allows the 200 μF capacitor to charge rapidly (about 100 μs) and discharge fairly slowly ($\tau = RC = 1.82$ ms). Figures 4 and 5 show the voltage vs time waveforms for the different EFEs. The test was not performed for electric fence energizers EFE3–EFE5.

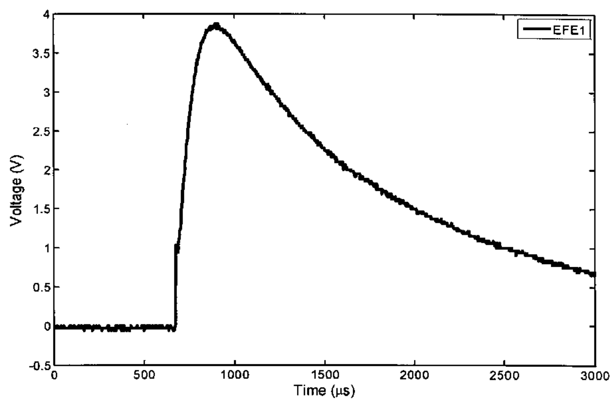

Figure 4. Output voltage waveform for EFE1. The maximal charge that flows through the cardiac cell model is given by $Q = CV = 200\ \mu F \times 3.88\ V = 775\ \mu C$, the current during which the capacitor charges to maximal value is given by $I = CV/T = (200\ \mu F \times 3.88\ V)/233\ \mu s = 3.33$ A.

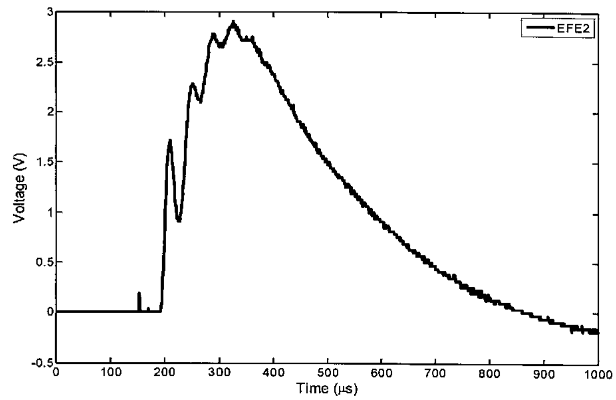

Figure 5. Output voltage waveform for the electric fence energizers EFE2. The maximal charge that flows through the cardiac cell model is given by $Q = CV = 200\ \mu F \times 2.91\ V = 582\ \mu C$, the current during which the capacitor charges to maximal value is given by $I = CV/T = (200\ \mu F \times 2.91\ V)/132\ \mu s = 4.41\ A$.

6. Discussion

Geddes and Baker (1989) have shown that for pulses shorter than the cardiac cell time constant of 2 ms, the electric charge is the quantity that excites cardiac cells. Because the first half wave is the largest, the charge integrated in the first half wave determines cardiac cell excitation. The next half wave discharges the cardiac cell capacitance and does not contribute to cardiac cell excitation. Thus we list integral $I(t)$ = charge Q in Table 1.

IEC (2006) integrates $I^2(t)$, which is roughly equal to $I(t)$. Their Figure 102 roughly follows charge.

We propose revising EFE standards for measuring current to determine a safety standard to prevent VF. The new standard would measure cardiac cell excitation. It would not require the complex calculations required to determine "The current which flows during the time period in which 95 percent of the output energy (is delivered)." It would use a simple circuit similar to that in Figure 2 composed of resistors and a capacitor. The investigator would discharge the device into the circuit and measure the maximum voltage. If the maximum voltage does not exceed 5 V (as a conservative estimate), the EFE passes the test. The 500 Ω resistor closely approximates the resistance of the body and determines the current that flows through the body.

Acknowledgements

We thank L Burke O'Neal and Silas Bernardoni for their help and suggestions.

References

Geddes L A, and Baker L E 1989 *Principles of applied biomedical instrumentation* (New York: John Wiley & Sons) pp 458–61

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Jones M and Geddes L A 1977 Strength duration curves for cardiac pacemaking and ventricular fibrillation *Cardiovasc. Res. Center Bull.* **15** 101–12

University of Wisconsin Report on Advanced Perimeter Energizers

Safety of Advanced Perimeter Systems EF152 and EF153 Electrofence controllers using IEC 60335-2-76 standard

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Abstract

We tested two Advanced Perimeter Systems EF152 and EF153 Electrofence controllers (EFCs) with two control units each (EFC1–EFC4) to determine their current-versus-time waveforms. We measured their safety characteristics using the existing IEC 60335-2-76 standard. We found that the electric fence controllers (EFC1–EFC4) passed the IEC 60335-2-76 standard.

1. Introduction

The vast majority of work on electric safety has been done using power line frequencies such as 60 Hz. Thus most standards for electric safety apply to continuous 60 Hz current applied hand to hand. A separate class of electric devices apply electric current as single or a train of short pulses, such as are found in electric fence controllers (EFCs). The standard that applies to EFCs is (IEC 60335-2-76, 2006). To estimate the ventricular fibrillation (VF) risk of EFCs, we use the excitation behavior of excitable cells. Geddes and Baker (1989) presented the cell membrane excitation model (Analytical Strength–Duration Curve model) by a lumped parallel resistance–capacitance (*RC*) circuit. This model determines the cell excitation thresholds for varying rectangular pulse durations by assigning the strength–duration rheobase currents, chronaxie, and time constants (Geddes and Baker, 1989). Though this model was originally developed based on the experimental results of rectangular pulses, the effectiveness of applying this model for other waveforms has been discussed (IEC 1987, Jones and Geddes 1977). The charge–duration curve, derived from the strength–duration curve, has been shown in sound agreement with various experimental results for irregular waveforms. This permits calculating the VF excitation threshold of EFCs with various nonrectangular waveforms.

2. Mathematical background and calculation procedures

Based on the cell membrane excitation model (Weiss–Lapique model), Geddes and Baker (1989) developed a lumped *RC* model (analytical strength–duration curve) to describe the membrane excitation behavior. This model has been widely used in various fields in electrophysiology to calculate the excitation threshold. Figure 1 shows the normalized strength–duration curve for current (I), charge (Q) and energy (U). The expression of charge is also known as the charge–duration curve which is important for short duration stimulations.

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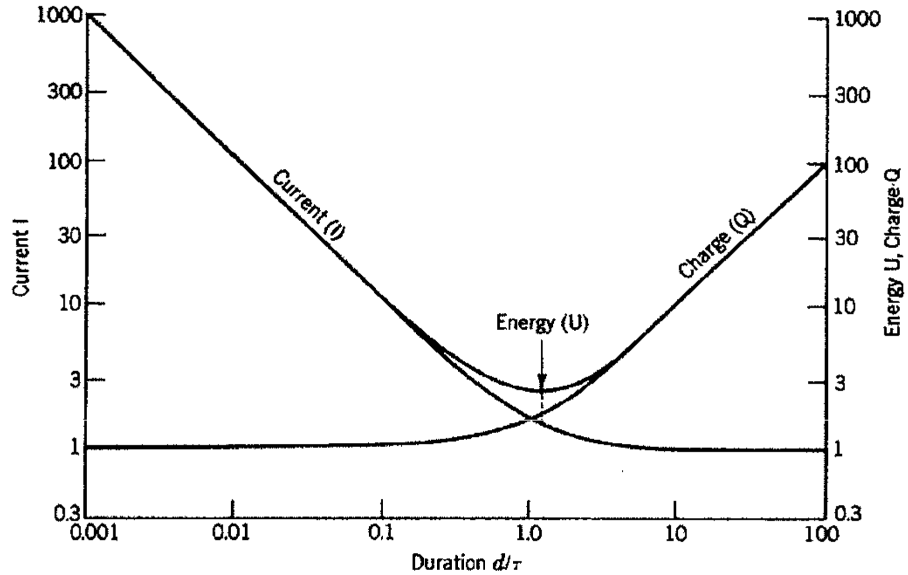

Figure 1. Normalized analytical strength–duration curve for current *I*, charge *Q*, and energy *U*. The *x* axis shows the normalized duration of d/τ. Note that for $d << \tau$, Q is constant and the most appropriate variable for estimating cell excitation. (from Geddes and Baker, 1989).

The equation for the strength–duration curve is (Geddes and Baker, 1989),

$$\Delta v = IR(1 - e^{-\frac{t}{\tau}}), \qquad (1)$$

where I is a step current intensity, R is the shunt resistance, Δv is the depolarization potential threshold which is about 20 mV for myocardial cells, τ is the RC time constant, and t is the time I is applied.

If we let the stimulation duration go to infinity, the threshold current is defined as the rheobase current ($I = b$). If we substitute I in equation (1) by b and define the threshold current $I_d = \Delta v/R$ for the stimulation with duration d. Equation (1) becomes,

$$I_d = \frac{b}{1 - e^{-\frac{d}{\tau}}}. \qquad (2)$$

We can calculate the threshold charge (Q_d) by integrating equation (2) and it becomes,

$$Q_d = I_d d = \frac{bd}{1 - e^{-\frac{d}{\tau}}}, \qquad (3)$$

For short duration stimulation ($d << \tau$) with duration shorter than 0.1 times the *RC* time constant, equation (3) can be approximated by equation (4) and it yields equation (5),

$$1 - e^{-\frac{d}{\tau}} \approx \frac{d}{\tau}, \qquad (4)$$

$$Q_d = b\tau \qquad (5)$$

Equation (5) suggests that the charge excitation threshold for short duration stimulation is constant and equals the product of the *RC* time constant τ and the rheobase *b*. Geddes and Bourland (1985) showed that the charge–duration curve for single rectangular, trapezoidal, half sinusoid and critically damped waveforms had a good agreement for short duration stimulations. Therefore we used the same model to estimate thresholds for stimulation sources where *I* was not constant, under the same stimulation setting.

Cardiac cell excitation has been intensively studied at the 60 Hz power line frequency because most accidental electrocutions occur with 60 Hz current, which has a longer duration relative to the cardiac cell time constant of about 2 ms. However, EFCs operate with pulse durations much shorter than the time constant.

3. Methods

Figure 1 shows our experimental test set-up. The EFCs under test consist of Advanced Perimeter System Electro-Fence Controller: Model No. EF152 Control Unit 1 (EFC1), Model No. EF152 Control Unit 2 (EFC2), Model No. EF153 Control Unit 1 (EFC3) and Model No. EF153 Control Unit 2 (EFC4) EFCs. The short duration electrical pulses from these ECFs passed through a series of five100 Ω (NH050100R0FE02 50 W 100 Ω 1% Vishay Wirewound resistors – Chassis Mount) noninductive resistors which measure 498 Ω, which represents approximately the internal resistance of the human body. Pulses passed through five 50 Ω (NH05050R00FE02 50 W 50 Ω 1% Vishay Wirewound resistors – Chassis Mount) noninductive resistors connected in parallel which measure 10.09 Ω. The oscilloscope measured the output voltage across these sensing resistors. For these very short pulses it is important to use high voltage noninductive resistors because the same current flowing through a resistor that has substantial inductance will measure a larger current than a resistor that is noninductive. The data were collected in EXCEL format from a disk in the Agilent 54621 oscilloscope. The calculations for different parameters presented in Table 1 and the Figures 2–5 were plotted using MATLAB.

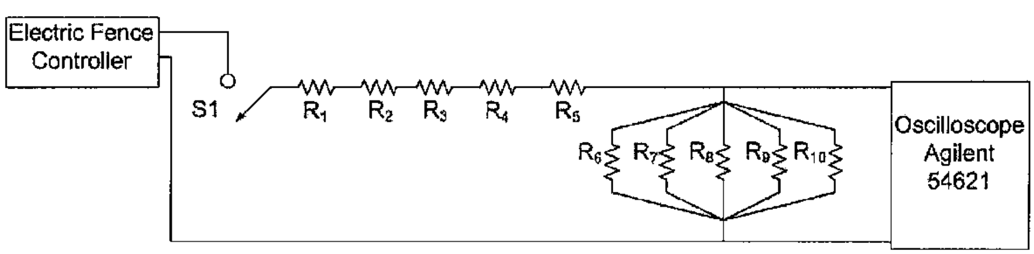

Figure 1. The switch S1 is closed to test the EFC according to IEC 60335-2-76 standard. The current flows through a string of 100 Ω resistors R_1–R_5 (total 498 Ω) which approximates the internal body resistance of 500 Ω. The resistors R_6–R_{10} in parallel (total 10.09 Ω) yields a low voltage that is measured by the oscilloscope.

EFCs are used for area security. We tested four EFCs (EFC1–EFC4) using the experimental set-up in Figure 1 and obtained the output currents shown in Figures 2–5. In Figure 1 the switch S1 is closed to test the EFC according to the IEC 60335-2-76 standard.

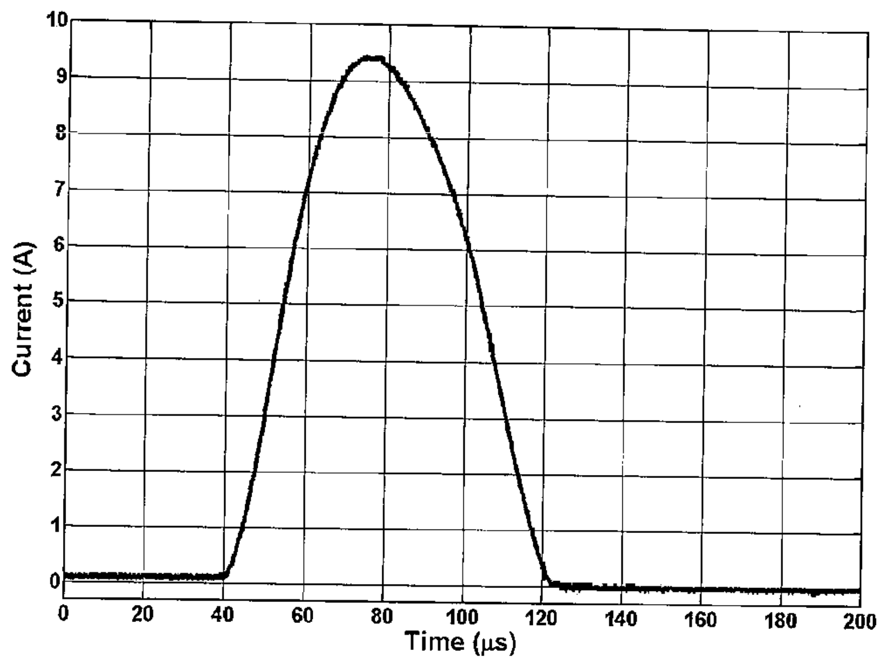

Figure 2. The output current waveform for electric fence controller EFC1. The I_{rms} according to IEC60335-2-76 standard for EFC1 is 7.89 A.

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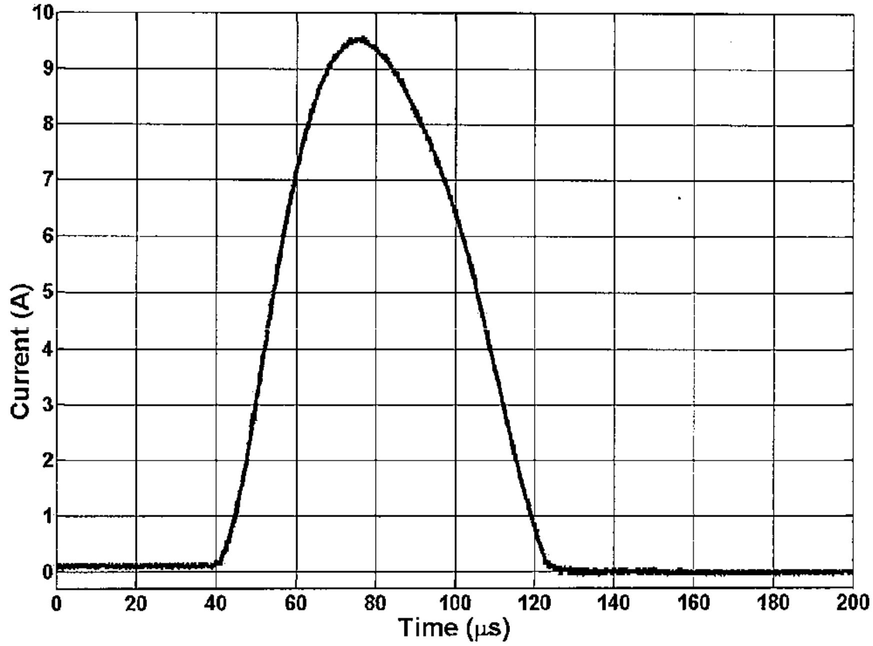

Figure 3. The output current waveform for electric fence controller EFC2. The I_{rms} according to IEC 60335-2-76 standard for EFC2 is 7.94 A.

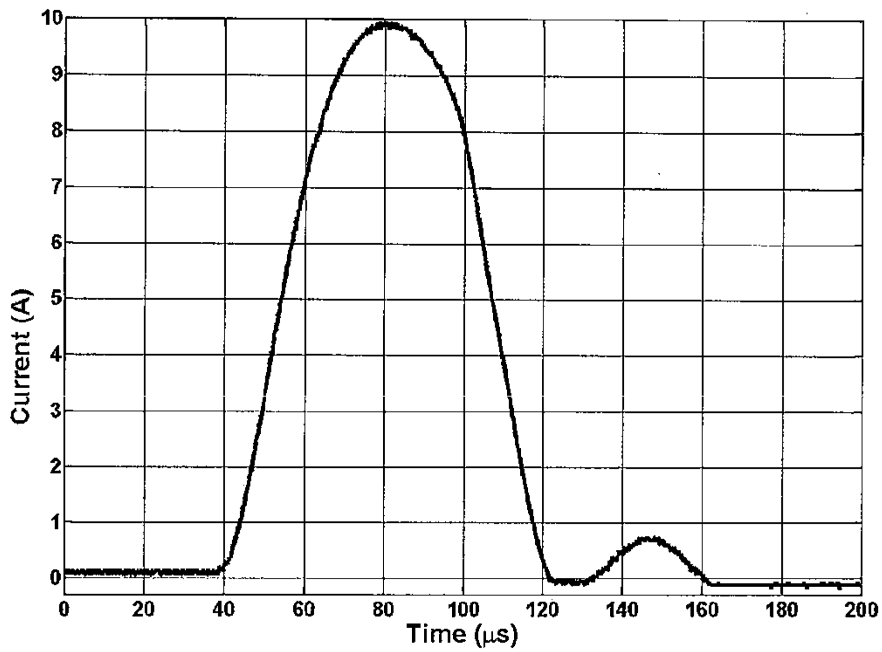

Figure 4. The output current waveform for electric fence controller EFC3. The I_{rms} according to IEC 60335-2-76 standard for EFC3 is 8.56 A.

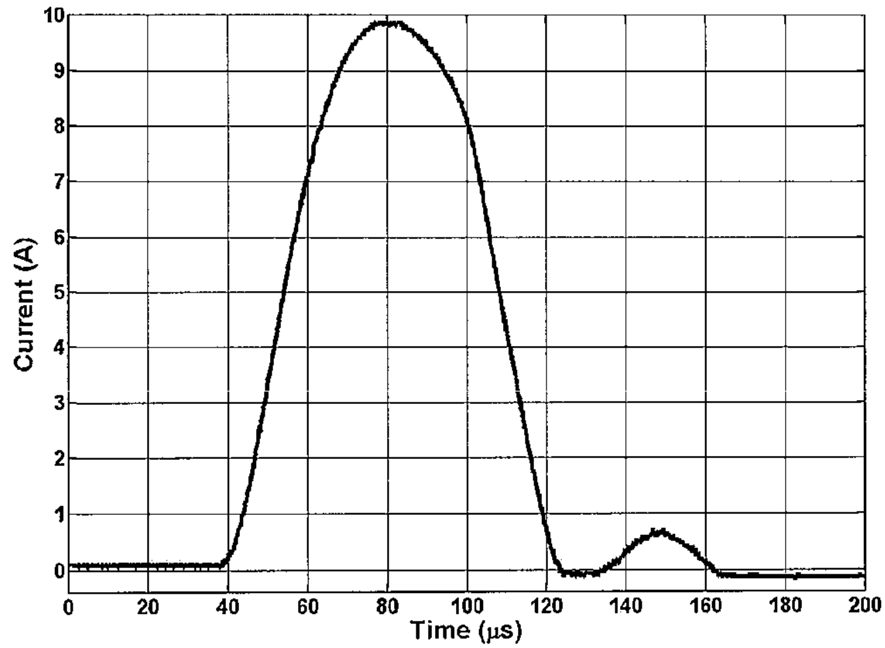

Figure 5. The output current waveform for electric fence controller EFC4. The I_{rms} according to IEC 60335-2-76 standard for EFC4 is 8.54 A.

4. Results

Table 1 shows the approximate results for the rms current, power, duration, impulse repetition rate and energy/impulse for all the EFCs.

Table 1 Approximate results for all EFCs.

EFCs		**EFC1**	**EFC2**	**EFC3**	**EFC4**
Parameters	Units				
Total Energy	$A^2 \cdot ms$	3.45	3.57	4.12	4.20
95% Energy Duration	μs	53	54	53	55
I_{rms}	A	7.89	7.94	8.56	8.54
IEC Standard I_{rms}	A	15.7	15.7	15.7	15.7
Impulse repetition rate (*IRR*)	Hz	0.82	0.82	0.81	0.81
IEC Standard *IRR*	Hz	1.00	1.00	1.00	1.00
Energy/Impulse	J	1.75	1.81	2.09	2.13
IEC Standard Energy/Impulse	J	5	5	5	5
Pass IEC Standard	Yes/No	Yes	Yes	Yes	Yes

IEC (2006) defines in 3.116 "impulse duration: duration of that part of the impulse that contains 95% of the overall energy and is the shortest interval of integration of $I^2(t)$ that gives

95% of the integration of $I^2(t)$ over the total impulse. $I(t)$ is the impulse current as a function of time." In 3.117 it defines "output current: r.m.s. value of the output current per impulse calculated over the impulse duration." In 3.118 it defines "standard load: load consisting of a non-inductive resistor of 500 Ω ± 2.5 Ω and a variable resistor that is adjusted so as to maximize the energy per impulse or output current in the 500 Ω resistor, as applicable." In 22.108, "Energizer output characteristics shall be such that – the impulse repetition rate shall not exceed 1 Hz; – the impulse duration of the impulse in the 500 Ω component of the standard load shall not exceed 10 ms; – for energy limited energizers the energy/impulse in the 500 Ω component of the standard load shall not exceed 5 J; The energy/impulse is the energy measured in the impulse over the impulse duration. – for current limited energizers the output current in the 500 Ω component of the standard load shall not exceed for an impulse duration of greater than 0.1 ms, the value specified by the characteristic limit line detailed in Figure 102; an impulse duration of not greater than 0.1 ms, 15 700 mA. The equation of the line relating impulse duration (ms) to output current (mA) for 1 000 mA < output current < 15 700 mA, is given by impulse duration = $41.885 \times 10^3 \times (\text{output current})^{-1.34}$." We used these definitions and calculated the total energy, the shortest duration where 95% of the total energy occurs, the rms current for that duration from Figures 2–5 for the EFCs (EFC1–EFC4). Table 1 lists the results. Table 1 shows that all the EFCs pass the IEC 60335-2-76 standard. For all EFCs, the impulse repetition rate is about 0.82 Hz and less than the recommended maximum 1 Hz repetition rate; the impulse duration of the impulse in the 500 Ω component of the standard load is about 0.055 ms and less than the recommended maximum 10 ms duration and the energy/impulse in the 500 Ω component of the standard load is about 2 J and less than the recommended maximum value of 5 J. Example calculation of energy/impulse for EFC4 is shown below:

Energy/impulse = $\int I^2(t)\, R\, dt = 4.20\ \text{A}^2\cdot\text{ms} \times 508\ \Omega = 2.13$ J.

5. Discussion

IEC (2006) integrates $I^2(t)$, which is roughly equal to $I(t)$. Their Figure 102 roughly follows charge. The 500 Ω resistor closely approximates the resistance of the body and determines the current that flows through the body. We found the Advanced Perimeter Systems EF152 and EF153 Electrofence controllers passed the IEC. 60335-2-76 standard.

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Geddes L A, and Baker L E 1989 *Principles of applied biomedical instrumentation* (New York: John Wiley & Sons) pp 458–61

Geddes L A and Bourland J D 1985 The strength-duration curve. *IEEE. Trans. Biomed. Eng.* **32(6)** 458–9

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Jones M and Geddes L A 1977 Strength duration curves for cardiac pacemaking and ventricular fibrillation *Cardiovasc. Res. Center Bull.* **15** 101–12

Conclusion

The products covered by this Report have been found to be operational and the construction complies with the applicable requirements outlined in referenced Standard(s). The equipment was field labeled.

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Electric fence energizer output for variable resistive loads

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Abstract
The goal of the experiment is to determine if the output from the electric fence energizer is depended on the attached loads. The electric fence energizer outputs a peak current of 14.6 A, 9.0 A and 5.4 A when connected to noninductive resistive loads of 235 Ω, 518 Ω and 986 Ω respectively. The relationship between the restive load and the current output from the electric fence energizer is linear and the output current drawn from the electric fence energizer increases as the load decreases. Because body resistance of a child is larger than body resistance of an adult, less current would flow through the child and the electric fence energizer would be safer for the child.

1. Methods

Figure 1 shows our experimental test set-up. The equipment under test is electric fence energizer, Gallagher Group Ltd PowerPlus B600. The short-duration electrical pulses from the electric fence energizer is passed through noninductive resistive load *R*, which is 235 Ω representing a possible lower internal body resistance, 518 Ω representing the internal resistance of an average human body and 986 Ω representing a possible higher internal resistance of a human body. It is further connected to noninductive resistor of 9.08 Ω. This is used as the sensing resistor across which the oscilloscope measures the output voltage.

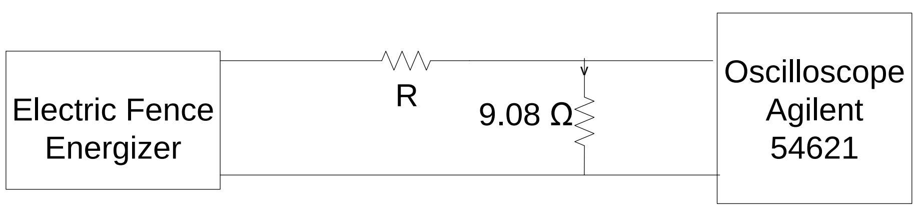

Figure 1. The experimental test set-up to determine the output from electric fence energizer for variable load *R*. The current flows through the variable noninductive load *R* (235 Ω, 518 Ω and 986 Ω) which approximates the possible internal body resistances. The 9.08 Ω yields a low voltage that is measured by the oscilloscope.

2. Results

Figure 2 shows the output waveform for noninductive resistive load of 518 Ω connected to the electric fence energizer. The noninductive resistive load of 518 Ω represents the approximate the internal body resistance of an average human. The waveform is similar to figure 4 presented by Nimunkar and Webster (2009), which indicated that our test set-up was operating reliably.

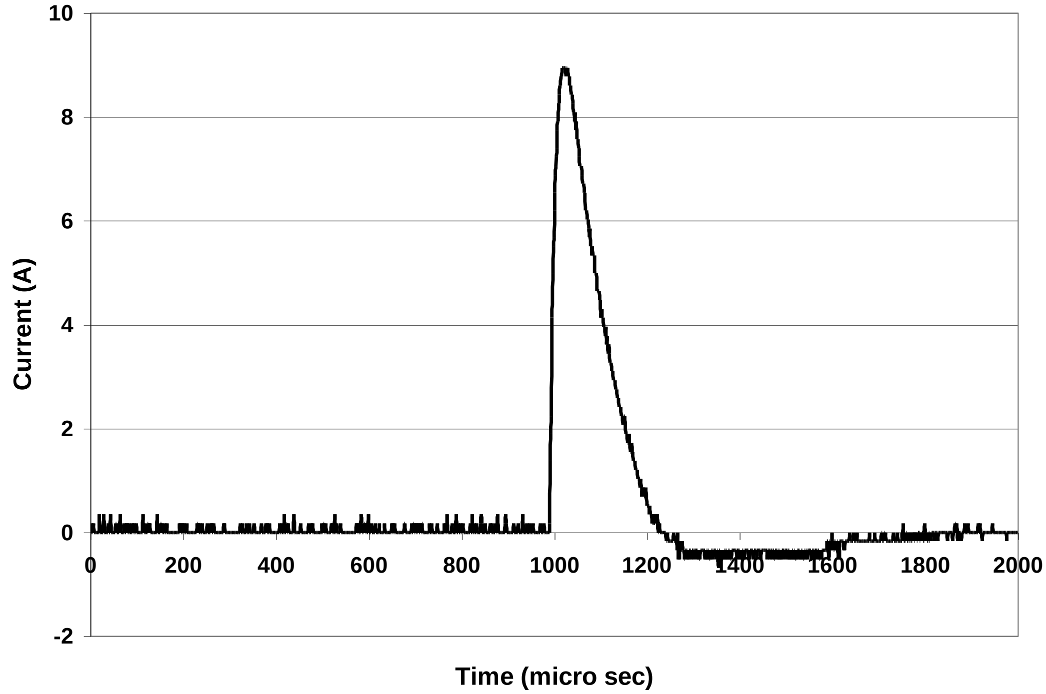

Figure 2. The output current waveform for electric fence energizer with load of 518 Ω. The output peak current is about 9.0 A.

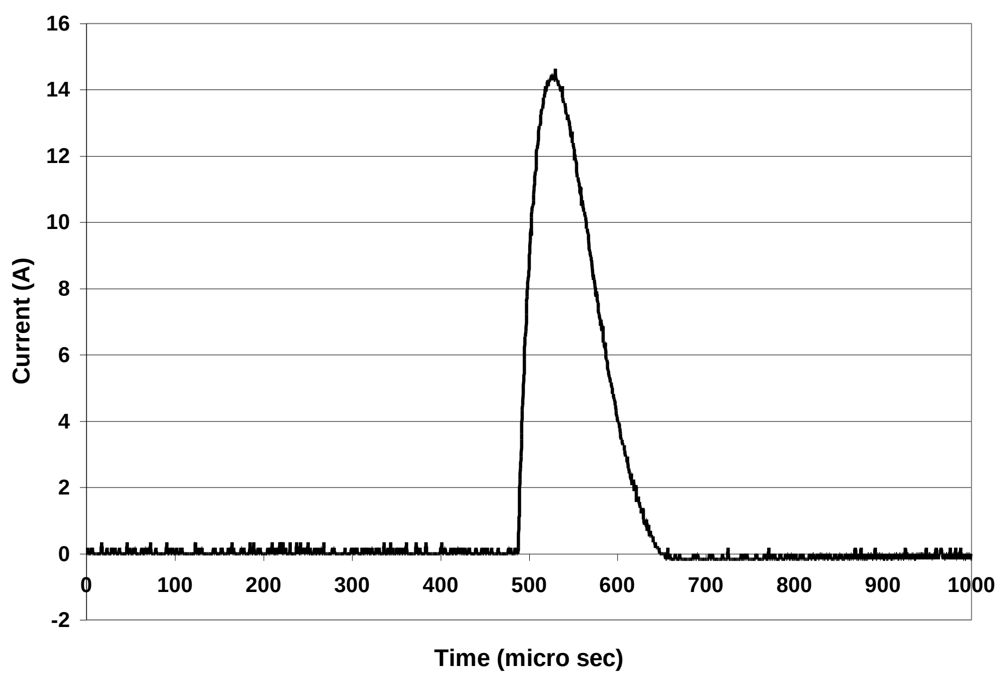

Figure 3. The output current waveform for electric fence energizer with load of 235 Ω. The output peak current is about 14.6 A.

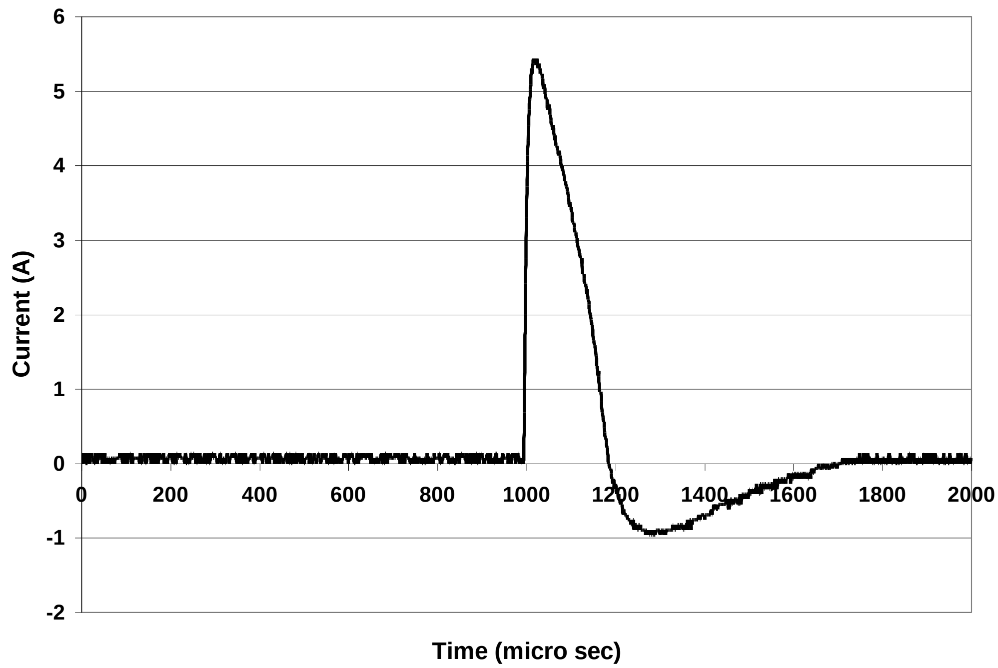

Figure 4. The output current waveform for electric fence energizer with load of 986 Ω. The output peak current is about 5.4 A.

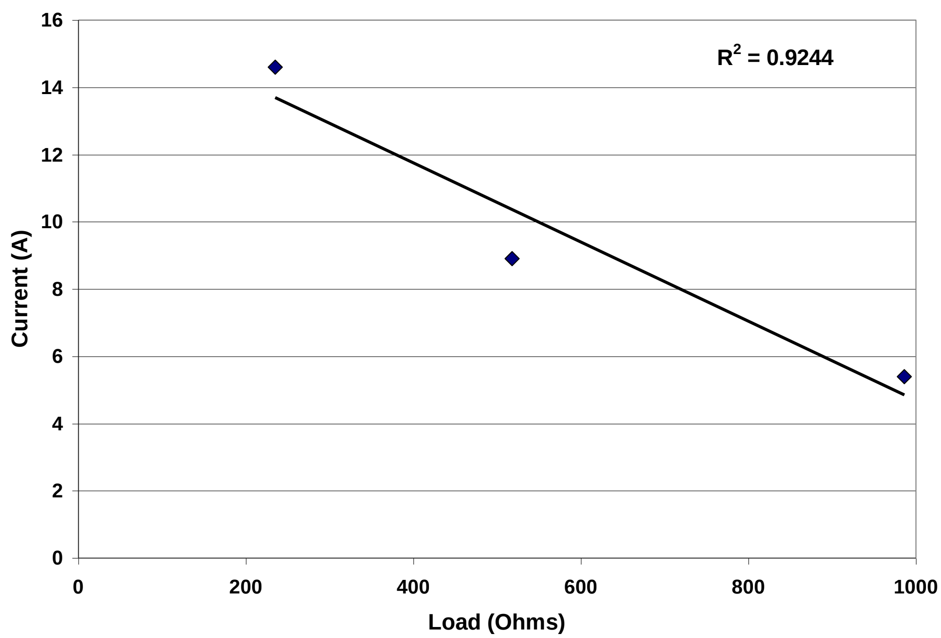

Figure 5. The relationship between the resistive load and the output current for electric fence energizers is linear. The output current drawn from the electric fence energizer increases as the load decreases.

Figure 3 and figure 4 shows the output waveform for noninductive resistive load of 235 Ω and 986 Ω respectively connected to the electric fence energizer. Figure 5 shows the linear relationship between the restive load and the current output from the electric fence energizer. It is seen that the output current drawn from the electric fence energizer increases as the load decreases.

3. Conclusion

The figure 2, 3 and 4 present the output current drawn from the electric fence energizer when attached to variable noninductive resistive loads. It is seen from figure 5 that as the load decreases the amount of current drawn from the electric fence energizer increases linearly.

The resistance of the human body is given by the formula: (resistance R) = (resistivity ρ)(length L)/(cross-sectional area A). Thus for the same shape and resistivity, R is proportional to L/A, which is proportional to L/L^2, which is proportional to $1/L$. If an adult is twice as tall as a child, the adult resistance would be ½ as large as that of the child. Thus less current would flow through the child, as shown by Figure 5 (higher child resistance yields lower child current. Thus it would be safer for a child than an adult.

Reference:

Nimunkar A J and Webster J G 2009 Safety of pulsed electric devices *Physiol Meas*. **30** (2009) 101-114.