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Standard Practice for Corrections Application for Non-Lethal Electric Security Fences[1]

This standard is issued under the fixed designation F3297; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The purpose of this practice is to provide advice for the selection and use of non-lethal electric security fences to deter, detect, and delay an unauthorized breach of the perimeter.

1.2 The intended applications of this practice are detention and correctional facilities.

1.3 *Units*—The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard. The tolerance on physical dimensions is ±10 % unless otherwise specified.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *BSI Standard:*[2]

BS EN 60335-2-76 Household and similar electrical appliances – Safety – Part 2-76: Particular requirements for electric fence energizers

2.2 *IEC Standards:*[3]

IEC 60335-1 Household and similar electrical appliances – Safety – Part 1: General requirements

IEC 60335-2-76 Household and similar electrical appliances – Safety – Part 2-76: Particular requirements for electric fence energizers

2.3 *NFPA Standard:*[4]

NFPA 70 National Electrical Code

2.4 *UL Standard:*[5]

UL 69 Standard for Electric-Fence Controllers

3. Terminology

3.1 *Definitions:*

3.1.1 *electric fence energizer, n*—electrical device that is used to convert continuous power to a short-duration pulse using a fast-discharge electrical storage unit; it is also known as a controller.

3.1.2 *electric security fence zone, n*—predetermined section of the fence line that is monitored separately from other section of the fence line.

3.1.3 *gripple, n*—wire torque-tensioning device that incorporates a ceramic roller as the main tension ratchet part.

3.1.4 *pulse, n*—burst of electricity for a short period of time on a regular interval as opposed to continuous power.

3.1.5 *pulse rate, n*—number of pulses per second.

3.1.6 *security alarm panel, n*—device that detects a drop in the power of the pulse and, based on a specific algorithm, initiates an alarm.

4. Significance and Use

4.1 Electric security fences, in view of their high-deterrent impact, are a safe method to reduce security costs or enhance existing security. They have broad applications for situations in which both minimum or maximum security are needed. They are deployed in a wide variety of environments and geographies. In particular, electric security fences are used to decrease the need for security guards and other security systems.

4.2 This practice provides information to users and manufacturers of electric security fences, filling a void.

4.3 International standards exist at IEC and BSI (see Section 2) that cover some aspects of these systems.

[1] This practice is under the jurisdiction of ASTM Committee F33 on Detention and Correctional Facilities and is the direct responsibility of Subcommittee F33.06 on Control Systems.

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[2] Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsigroup.com.

[3] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st Floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.

[4] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

[5] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.

4.4 A standard issued by Underwriters Laboratories (UL) (UL 69) covers electric fence controllers to be used on lighting or line circuits in accordance with NFPA 70. However, UL 69 covers, specifically, electric fence controllers used only for the control of animals. Its requirements cover portable and permanently mounted electric fence controllers with peak-discharge or sinusoidal-discharge output for indoor or outdoor use, including battery operated controllers intended to operate from battery circuits of 42.4 V or less, line-operated controllers intended to operate from circuits of 125 V or less, combination controllers intended to operate from either a battery or a line circuit, and photovoltaic module battery operated controllers. The scope states that the requirements of UL 69 do not cover electric fence controllers for the continuous (uninterrupted) current type or intermediate equipment, such as a converter, a rectifier, or the like, that is sometimes used between the primary source of supply and an electric fence controller and is investigated only as part of a complete controller. UL 69 also states that the requirements do not cover electric fence controllers for use with electrified security fences.

4.5 In contrast to UL 69, this practice specifically addresses the use of electric security fences in detention and correctional facilities.

NOTE 1—Extensive research on the safety of pulsed electrical devices, which are used in electric fence controllers, is found in work by Amit Nimunkar and John Webster.[6] This research provides background on the safety of electric security fences and is of value to those wishing to understand the basic science behind these systems.

4.6 *Limitations of Electric Security Fences*—It is likely that electric security fences are not appropriate for use in environments associated with juvenile, mental health, or other special populations.

5. Design Characteristics for the Safe Operation of Security Fences

5.1 Electric security fences have the following key components: (*1*) a wire fence array (Section 6), (*2*) a controller (or electric fence energizer) that continuously monitors an electric fence and generates an alarm when pre-programmed conditions are met (Section 7), (*3*) one or more electric fence access gates (to provide access to the facility), and (*4*) electric fence insulators (to maximize return voltage). The electric security fence system shall be designed such that when tested by operating the energizer at the rated voltage with a 500 Ω load connected across the terminals the output characteristics are:[7]

5.1.1 The pulse repetition rate shall not exceed 1 Hz;

5.1.2 The impulse duration of the impulse shall not exceed 10 ms;

5.1.3 For energy limited energizers, the energy/impulse shall not exceed 5 J;

5.1.4 For current limited energizers, the output current shall not exceed:

5.1.4.1 The value specified in Eq 1, where impulse duration is measured in ms and output current is measured in mA:

$$\text{impulse duration} = 41.885 \times 10^3 \times (\text{output current})^{-1.34} \quad (1)$$

5.1.4.2 For an impulse duration of less than 0.1 ms, 15 700 mA.

NOTE 2—IEC 60335-2-76 provides background for safe use including range of maximum current and duration combinations, maximum frequency of pulse, and maximum energy per pulse.

5.2 All energized wires in a multi-energizer system shall be energized simultaneously. Pulse repetition rates less than 1 Hz shall be allowed.

5.3 The controller shall be able to function in an operating environment with temperature ranges of -20 to +60°C and relative humidity ranges of up to 95 %.

5.4 Each energizer shall have a backup power supply appropriate for the site-specific application under full load in the event of a power failure. Eight hours of backup shall be the minimum, but additional coverage is encouraged.

5.5 The energizers shall, depending on conditions, activate alarms when any of the following conditions occur: circuit opens, conductor-to-conductor shorts, conductor-to-ground shorts, and sufficient circuit-resistive loading.

5.6 *Key Additional Features*—The following additional features shall be allowed to aid redundancy, ease of use, and maintenance with the tradeoff being increasing complexity and cost.

5.6.1 Independent switchable energizers increase cost and complexity, but they enhance redundancy so that, when an energizer fails, at least a portion of the system will remain active.

5.6.2 Two or more auxiliary supervised alarm inputs allows for the setting of multiple trigger points for alarms. This is helpful in minimizing false alarms and giving early warning of potential maintenance needs.

5.6.3 Two or more programmable outputs allows for integration with other security systems such as gates or cameras.

5.6.4 Illuminated indicators on the energizer allow for ease of monitoring proper system functioning, monitoring, and indication of alarms. They are useful for showing the following: pulse rate, return pulse, high-voltage (HV) alarm, output on, data received, data transmitted, and tamper.

5.6.5 It is feasible to configure the system so that each zone can be independently deactivated without affecting the performance of the overall system, for maintenance purposes.

5.7 The system shall incorporate lightning suppression in accordance with the manufacturer's specifications. Lightning suppression is achieved in multiple ways providing varying degrees of protection.

6. Wire Fence Array

6.1 The configurations of the wire array shall be allowed to vary to suit different applications. To ensure an effective system and minimize maintenance cost, the following design limitations shall be met:

6.1.1 All metals in contact with the fence array shall be manufactured of materials that ensure that electrolysis is minimized.

6.1.2 If joint clamps are used, they shall be galvanized.

[6] Nimunkar, A. J. and Webster, J. G., "Safety of pulsed electric devices," *Physiol. Meas.*, Vol 30, 2009, pp. 101–114.

[7] Source IEC 60335-2-76.

6.1.3 Tensioning devices shall be easily managed (meaning that gripples shall not be accepted).

6.1.4 All steel anchor and support posts shall be hot dipped to a minimum thickness of 30 ± 5 µm.

6.1.5 Intermediate posts shall be galvanized and mounted no further apart than 3.6 ± 0.4 m on center.

6.1.6 When attaching to a chain link fence, 50 ± 5 mm spacing brackets shall be required.

6.1.7 Plastic components shall be specifically designed for security applications and meet the minimum requirements of the controller manufacturer.

6.1.8 Ultraviolet (UV)-stabilized material for long useful life in outdoor use shall be used.

6.1.9 A self-cleaning design shall be used.

6.2 The following additional features shall be allowed, as they aid redundancy, ease of use, and maintenance with the tradeoff being increasing complexity and cost.

6.2.1 There are two main configurations of electric security fence: freestanding or attached to an existing fence, wall, or supporting structure. While it is possible that there will be cost differences between the types, selection is usually based on site considerations. The most common configuration is for the electric security fence to be attached to a chain link or other type of perimeter fence. If the electric security fence is freestanding, it shall be separated from the public by means of a physical barrier not less than 1.5 m high or an equivalent natural barrier.

6.2.2 Electric security fence zones shall be configured based on site specifications and manufacturer's electrical resistance, ideally on the order of 100 m in length.

6.2.3 Wire shall comply with the manufacturer's specifications. A variety of wire types and gauges of wire shall be allowed. The choice is driven by the site's requirements and the entirety of the manufacturer's system.

6.2.4 The wire spacing and configuration shall be allowed to vary to suit different applications. Normally, the spacing shall be between a minimum of 50 mm and a maximum of 150 mm. The objective is to maximize the effectiveness of the security while minimizing initial and ongoing maintenance cost.

6.2.5 Wires shall be tensioned consistent with the manufacturer's specifications.

6.2.6 Fence infrastructure shall be to the electric security fence controller manufacturer's specifications.

7. Controls

7.1 There are many methods of control to suit different applications. To ensure an effective system, maximize up time, and minimize maintenance cost, the following design limitations shall be met:

7.1.1 Reliable communication backbone shall be configured in a self-healing loop, star configuration, or other systems suitable for high-security applications to minimize downtime and increase ease of use;

7.1.2 Programmable logic controller (PLC) or software design control system shall be specifically designed for operation with the energizers;

7.1.3 Each controller to be field programmable to change the existing operating parameters or enable newly developed features to be added to the system. System enhancements shall be allowed such as video control interface and allowing multiple operation permission levels controlled by the administrator; and

7.1.4 The control systems shall do the following: monitor system operation, perform diagnostics to aid maintenance, and notify of attempts to tamper with the system. In addition, the control system will record user inputs with the system, events, real-time reference ground voltage, current energizer operating mode, tamper alarms, and the event log.

7.2 The control system shall also be allowed to report real-time fence circuit voltages, primary power source failure notification, low battery, and battery failure depending on site needs.

8. Training

8.1 To maximize effectiveness and minimize maintenance cost, effective training shall be done appropriate to the employee's responsibilities. Training shall be consistent with the user's training policy and procedures.

9. Environment and Usage Shall Drive Additional Maintenance Needs

9.1 The following shall be minimum maintenance frequencies.

9.2 The following shall be done daily:

9.2.1 *Alarm Test in Each Zone*—This shall be done by shorting a wire to ground or touching wire to wire using an approved testing tool recommended by manufacturer.

9.2.2 *Fence Line Visual Inspection*—A daily inspection of the fence line shall be done to remove trash, repair any attempts to compromise the system, and note situations proactively that might compromise the system such as vegetation growth.

9.3 The following shall be done weekly in addition to the daily maintenance:

9.3.1 Visual inspection of controller cabinets looking for signs of tampering or component failure.

9.3.2 *Voltage Verification of Each Zone*—Ensure that each zone is operating within the manufacturer's specification for zone voltage.

9.3.3 If the system has a battery management system, check the voltage on the batteries and visually inspect their condition looking for signs of tampering or damage.

9.4 The following shall be done annually in addition to the daily and weekly maintenance schedules:

9.4.1 Inspect for signs of apparent wear, tampering, or damage, the lightning arrestors, tamper switches, lead-out cables, and batteries.

9.5 Batteries shall be replaced based on environment and usage every two years as a minimum.

10. Signage

10.1 Signs shall be placed at intervals not exceeding 10 ± 1.0 m and on every gate.

11. Keywords

11.1 electric security fence; energizer; non-lethal; return voltage