

INTERNATIONAL STANDARD



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

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	4
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references.....	8
3 Terms and definitions.....	9
4 General requirement.....	13
5 General conditions for the tests.....	14
6 Classification.....	14
7 Marking and instructions.....	15
8 Protection against access to live parts.....	18
9 Starting of motor-operated appliances.....	18
10 Power input and current.....	18
11 Heating.....	19
12 Void.....	21
13 Leakage current and electric strength at operating temperature.....	21
14 Transient overvoltages.....	21
15 Moisture resistance.....	23
16 Leakage current and electric strength.....	23
17 Overload protection of transformers and associated circuits.....	24
18 Endurance.....	24
19 Abnormal operation.....	25
20 Stability and mechanical hazards.....	28
21 Mechanical strength.....	28
22 Construction.....	28
23 Internal wiring.....	33
24 Components.....	33
25 Supply connection and external flexible cords.....	33
26 Terminals for external conductors.....	34
27 Provision for earthing.....	35
28 Screws and connections.....	35
29 Clearances, creepage distances and solid insulation.....	35
30 Resistance to heat and fire.....	36
31 Resistance to rusting.....	36
32 Radiation, toxicity and similar hazards.....	36
Annexes.....	43
Annex A (informative) Routine tests.....	43
Annex B (normative) Appliances powered by rechargeable batteries that are recharged in the appliance.....	44
Annex S (normative) Battery-operated appliances powered by batteries that are non-rechargeable or not recharged in the appliance.....	46
Annex AA (informative) Circuit for the independent control of the switching speed of the major impulse-switching device.....	50

Annex BB (normative) Instructions for installation and connection of electric fences	51
BB.1 Requirements Instructions for electric animal fences	51
BB.2 Requirements Instructions for electric security fences not supplied from a security energizer group	53
BB.3 Instructions for electric security fences supplied from a security energizer group	56
Annex CC (informative) Installation of electric security fences	60
CC.1 General	60
CC.2 Location of electric security fence	60
CC.3 Prohibited zone for pulsed conductors	60
CC.4 Separation between electric fence and physical barrier	60
CC.5 Prohibited mounting	61
CC.6 Operation of electric security fence	61
Bibliography	64
Figure 101 – Schematic examples of the different types of battery-operated energizers suitable for connection to the mains type A energizers, type B energizers and type C energizers	38
Figure 102 – Schematic examples of the different types of type D energizers	39
Figure 102 103 – Current limited energizer characteristic limit line	40
Figure 104 – Type R security energizer group test configurations	41
Figure 105 – Type S security energizer group test configurations	42
Figure AA.1 – Circuit for the independent control of the switching speed of the major impulse-switching device	50
Figure BB.1 – Symbol for warning sign	59
Figure CC.1 – Prohibited area for pulse conductors	61
Figure CC.2 – Typical constructions where an electric security fence is exposed to the public	62
Figure CC.3 – Typical fence constructions where the electric security fence is installed in windows and skylights	63
Table 101 – Battery source impedance	20
Table 102 – Rated supply voltage maximum and minimum value multiplier factors	20
Table 103 – Supply voltage value test settings	21
Table 104 – Test supply sequence for different supply type	21
Table 102 105 – Additional test voltages	24
Table BB.1 – Minimum clearances from power lines for electric animal fences	52
Table BB.2 – Minimum clearances from power lines for electric security fences not supplied from a security energizer group	54
Table BB.3 – Minimum clearances from power lines for electric security fences supplied from a security energizer group	57

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-76: Particular requirements for electric fence energizers

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

This part of International Standard IEC 60335 has been prepared by subcommittee 61H: Safety of electrically-operated farm appliances, of IEC technical committee 61: Safety of household and similar electrical appliances.

This third edition cancels and replaces the second edition published in 2002, Amendment 1:2006 and Amendment 2:2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- the text has been aligned with Edition 5.2 of Part 1;
- additional requirements for security fence energizers have been introduced (Clauses 3, 7, 19, 22, Figures and Annex BB);
- specific requirements for battery operated energizers have been moved to Annex S.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
61H/366/FDIS	61H/367/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60335 series, published under the general title *Household and similar electrical appliances – Safety*, can be found on the IEC website.

This Part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments. It was established on the basis of the fifth edition (2010) of that standard.

NOTE 1 When “Part 1” is mentioned in this standard, it refers to IEC 60335-1.

This Part 2 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert that publication into the IEC standard: Safety requirements for electric fence energizers.

When a particular subclause of Part 1 is not mentioned in this Part 2, that subclause applies as far as is reasonable. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 is to be adapted accordingly.

NOTE 2 The following numbering system is used:

- subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;
- unless notes are in a new subclause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
- additional Annexes are lettered AA, BB, etc.

NOTE 3 The following print types are used:

- requirements: in roman type
- *test specifications: in italic type*
- notes: in small roman type.

Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and associated noun are also in bold.

NOTE 4 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in

which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months or later than 36 months from the date of publication.

The following differences exist in the countries indicated below:

6.101: Only energy limited energizers are allowed (All EU and EFTA counties).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of November 2018 have been included in this copy.

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INTRODUCTION

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

This standard takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, national wiring rules may differ.

If an appliance within the scope of this standard also incorporates functions that are covered by another part 2 of IEC 60335, the relevant part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

NOTE 1 Throughout this publication, when "Part 1" is mentioned, it refers to IEC 60335-1.

When a part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 2 This means that the technical committees responsible for the part 2 standards have determined that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE 3 Horizontal and generic standards covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards. For example, in the case of temperature requirements for surfaces on many appliances, generic standards, such as ISO 13732-1 for hot surfaces, are not applicable in addition to Part 1 or part 2 standards.

~~An appliance that complies with the text of this standard will not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features that impair the level of safety covered by these requirements.~~

~~An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the standard.~~

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-76: Particular requirements for electric fence energizers

1 Scope

This clause of Part 1 is replaced by the following.

This part of IEC 60335 deals with the safety of **electric fence energizers**, the **rated voltage** of which is not more than 250 V and by means of which **fence** wires in agricultural, **domestic** or feral animal control **fences** and **security fences** may be electrified or monitored.

NOTE 101 Examples of **electric fence energizers** coming within the scope of this standard are:

- **mains-operated energizers**;
- **battery-operated electric fence energizers suitable for connection to the mains**, as shown in Figure 101 and Figure 102;
- **electric fence energizers** operated by non-rechargeable batteries either incorporated or separate.

This standard does not in general take into account

- the use of appliances by young children or infirm persons without supervision;
- the playing with appliances by young children.

NOTE 102 Attention is drawn to the fact that

- for appliances intended to be used on board ships or aircraft, additional requirements ~~may~~ can be necessary;
- in many countries, additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, the national water supply authorities and similar authorities.

NOTE 103 This standard does not apply to

- **electromagnetically coupled animal trainer collars**;
- appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas);
- separate battery chargers (IEC 60335-2-29);
- electric fishing machines (IEC 60335-2-86);
- electric animal-stunning equipment (IEC 60335-2-87);
- appliances for medical purposes (IEC 60601).

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60068-2-52:2017, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60320-3, *Appliance couplers for household and similar general purposes – Part 3: Standard sheets and gauges*

ISO 3864-1, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

3.1 Definitions relating to physical characteristics

3.1.1 Addition:

Note 1 to entry: For **type D energizers**, the **rated voltage** of the **energizer** is the **rated voltage** for battery supply.

~~3.1.6 Addition:~~

~~For **battery-operated electric fence energizers** not for connection to the mains, it is the average input current assigned to the **energizer** by the manufacturer.~~

Replacement:

3.1.9

normal operation

operation of the appliance under the following conditions: the **electric fence energizer** is operated as in normal use when connected to the supply, with no load connected to the output terminals

~~3.109~~

~~**battery charger**~~

~~appliance to be connected to the mains and intended for charging one or more batteries~~

~~3.113~~ 3.1.101

prospective peak voltage

peak output voltage of the impulse generator specified in Clause 14 that would be obtained with the **energizer** not connected to the test circuit

~~3.114~~ 3.1.102

rated voltage for battery supply

voltage for battery supply, for **type A energizers**, **type B energizers**, **type C energizers** and **type D energizers** assigned to the **energizer** by the manufacturer

~~3.115~~ 3.1.103

rated voltage range for battery supply

voltage range for battery supply, for **type A energizers**, **type B energizers**, **type C energizers** and **type D energizers** assigned to the **energizer** by the manufacturer, expressed by its lower and upper limits

~~3.116~~ 3.1.104

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

Note 1 to entry: $I(t)$ is the impulse current as a function of time.

~~3.117~~ 3.1.105

output current

RMS value of the **output current** per impulse calculated over the impulse duration

3.5 Definitions relating to types of appliances

3.5.101

electric fence energizer

appliance that is intended to deliver periodically voltage impulses to a **fence** connected to it

Note 1 to entry: **Electric fence energizers** are hereinafter also referred to as **energizers**.

3.5.102

mains-operated energizer

energizer designed for direct connection to the mains

3.5.103

battery-operated energizer suitable for connection to the mains energizer

- operated by batteries and having, or being designed for connection to, facilities for charging these batteries from the mains, or
- designed for operation from the mains and from batteries

3.5.104

type A energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit, a battery charging circuit and a battery, the impulse generating circuit being connected to the mains or the battery when the energizer is in operation

Note 1 to entry: **Type A energizers** are shown schematically in Figure 101.

3.5.105

type B energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit, a battery charging circuit and a battery, the impulse generating circuit being connected to the battery and disconnected from the battery charging circuit and the mains when the **energizer** is in operation.

Note 1 to entry: For recharging the battery, the impulse generating circuit is disconnected and rendered inoperable.

Note 2 to entry: **Type B energizers** are shown schematically in Figure 101.

3.5.106

type C energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit and a battery, the impulse generating circuit being connected to the mains or the battery when the energizer is in operation, and where it is necessary to remove the battery to recharge it using a ~~separate~~ battery charger or, in the case of a non-rechargeable battery, to replace it with a new battery

Note 1 to entry: **Type C energizers** are shown schematically in Figure 101.

3.5.107

type D energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit intended to be powered by a battery, ~~the impulse generating circuit being connected to the battery when the energizer is in operation and the energizer or the battery being connected to a separate battery charger for recharging the battery,~~ or a **detachable supply unit**, when the **energizer** is in operation. The impulse generating circuit or the battery may be connected to a **detachable supply unit** with or without incorporated battery charging circuitry for recharging the battery when the **energizer** is in operation.

Note 1 to entry: Examples of **Type D energizers** are shown schematically in Figure ~~101~~ 102.

3.5.108

battery-operated energizer

energizer deriving its energy solely from batteries or other sources of energy and not designed for connection to the mains

3.5.109

security electric fence energizer

energizer containing **fence circuits** that are intended to periodically deliver voltage impulses into **electric security fences**

Note 1 to entry: A **security electric fence energizer** is hereinafter also referred to as a **security energizer**.

3.5.110

independently timed security energizer

security energizer that includes an internal **impulse timing signal source** to set the timing of the periodic voltage impulses it delivers to an **electric security fence**

Note 1 to entry: An **independently timed security energizer** is hereinafter also referred to as an **independent security energizer**.

3.5.111

dependently timed security energizer

security energizer that is dependent on an external **impulse timing signal** to set the timing of the periodic voltage impulses it delivers to an **electric security fence**

Note 1 to entry: A **dependently timed security energizer** is hereinafter also referred to as **dependent security energizer**.

Note 2 to entry: Some types of **security energizer** may be configured either as an **independent security energizer** or a **dependent security energizer** at the time of installation.

3.5.112

security energizer group

one or two **security energizers** with a group total of two **fence circuits** used to supply adjacent **electric security fences** in a **security energizer fence system** that allows the two **fence circuits** to be contacted at the same time

Note 1 to entry: The **fence circuits** in a **security energizer group** may be galvanically connected.

3.5.113

type R security energizer

security energizer with one or two **fence circuits** that is suitable for use in a **type R security energizer group**

3.5.114

type R security energizer group

security energizer group containing only **type R security energizers**

3.5.115

type S security energizer

security energizer with one or two **fence circuits** that is suitable for use in a **type S security energizer group**

3.5.116

type S security energizer group

security energizer group containing at least one **type S security energizer**

Note 1 to entry: A **type S security energizer group** may contain a **type R security energizer**.

3.6 Definitions relating to parts of an appliance

3.6.3 Addition:

Note 101 to entry: It also includes terminals for the connection of the battery and other metal parts in a battery compartment that become accessible when replacing batteries even with the aid of a **tool**.

Replacement:

3.6.4

live part

conductive part that may cause an electric shock

~~3.111~~ 3.6.101

fence circuit

all conductive parts or components within an **energizer**, that are connected or intended to be connected galvanically to the output terminals

3.6.102

security energizer impulse timing signal

signal that is used to determine the timing of the periodic voltage impulses delivered by a **security energizer** to an **electric security fence**

Note 1 to entry: A **security energizer impulse timing signal** is hereinafter also referred to as an **impulse timing signal**.

Note 2 to entry: Examples of a **security energizer impulse timing signal** include wired (RS-485), wired with latency (internet clock, secure TCP/IP), wireless with latency (LAN, PAN), optical, GPS.

3.6.103

impulse timing signal source

signal source that generates the **impulse timing signal** required by a **dependent security energizer** to set the timing of the periodic voltage impulses it delivers to an **electric security fence**

Note 1 to entry: An **impulse timing signal source** may be used by one or more **dependent security energisers**.

Note 2 to entry: An example of an **impulse timing signal source** is an impulse signal from an adjacent **electric security fence** that is powered by an **independent security energizer** that belongs to the same **security energizer fence system**.

Note 3 to entry: An impulse signal from an adjacent **electric security fence** powered by an **independent security energizer** not belonging to the same **security energizer fence system** is not an example of a possible **impulse timing signal source**.

3.8 Definitions relating to miscellaneous matters

~~3.118~~ 3.8.101

standard load

load consisting of a non-inductive resistor of $500\ \Omega \pm 2,5\ \Omega$ and a variable resistor that is adjusted so as to maximize for

- **energy limited energizers**, the energy per impulse in the $500\ \Omega$ resistor;
- **current limited energizers**, the **output current** in the $500\ \Omega$ resistor.

Note 1 to entry: The variable resistor is connected in series or parallel with the $500\ \Omega$ resistor, whichever gives the more unfavourable result.

~~3.112~~ 3.8.102

earth electrode

metal structure that is driven into the ground near an **energizer** and connected electrically to the output earth terminal of the **energizer**, and that is independent of other earthing arrangements

~~3.125~~ **3.8.103****pulsed conductors**

conductors that are subjected to high voltage pulses by the **energizer**

~~3.120~~ **3.8.104****connecting lead**

electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**

~~3.110~~ **3.8.105****fence**

barrier for animals or for security purposes, comprising one or more conductors, such as metal wires, rods or rails

~~3.119~~ **3.8.106****electric fence**

barrier that includes one or more electric conductors, insulated from earth, to which electric pulses are applied by an **energizer**

~~3.121~~ **3.8.107****electric animal fence**

electric fence used to contain animals within or exclude animals from a particular area

~~3.122~~ **3.8.108****electric security fence**

fence used for security purposes that comprises an **electric fence** and a physical barrier electrically isolated from the **electric fence**

~~3.123~~ **3.8.109****physical barrier**

barrier not less than 1,5 m high intended to prevent inadvertent contact with the **pulsed conductors** of the **electric fence**

Note 1 to entry: **Physical barriers** are typically constructed from vertical sheeting, rigid vertical bars, rigid mesh, rods or chain-wire mesh.

~~3.124~~ **3.8.110****public access area**

any area where persons are protected from inadvertent contact with **pulsed conductors** by a **physical barrier**

~~3.126~~ **3.8.111****secure area**

area where a person is not separated from **pulsed conductors** below 1,5 m by a **physical barrier**

3.8.112**security energizer fence system**

electric security fence installation where the **fences** are energized by one or more **security energizers** containing one or more **security energizer groups** that can be **type R security energizer groups** or **type S security energizers groups**

Note 1 to entry: An **independent impulse timing signal source** used in a **security energizer fence system** may be used to set the timing of **dependent security energizers** in multiple **security energizer groups**.

4 General requirement

This clause of Part 1 is applicable.

5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

5.2 Modification:

Replace the test specification by the following:

The tests are made on two energizers as delivered, one being subjected to all the tests with the exception of that of Clause 18, and the other to the tests of ~~clause 5~~ 22.108 and Clause 18. However, the tests of Clauses 22 to 28 may be made on separate samples.

*For **type A energizers** and **type C energizers**, an additional sample is required for the test of Clause 18.*

Addition:

NOTE 101 Where **electronic circuits**, **electronic components** or other devices are normally encapsulated, specially prepared samples ~~may~~ can be ~~needed~~ used for the tests of 19.11 and 19.101.

5.3 Addition:

The measurements of 22.108 shall be carried out before the tests of Clause 14. ~~The tests specified in 14.101 shall be carried out on all appliances.~~

If any electronic component has been damaged during the tests of Clause 14, the tests of Clause 19 are made twice, once before and once after the damaged electronic components have been replaced by new electronic components.

5.5 Addition:

The energizer is mounted in a normal position such that the deviation from the position for which it is designed does not exceed 15°. However, if the energizer is provided with means for adjustment to the normal position, such as a spirit level, the energizer shall be adjusted to within ±2° of the normal position.

The earthing terminal of the fence circuit is connected to earth. However, if there is no indication as to which of the output terminals is to be connected to earth, the terminal that gives the most unfavourable result is earthed.

5.8.1 Addition:

*For **type A energizers**, **type B energizers**, **type C energizers** and **type D energizers** where the terminals for the connection of the battery have no indication of polarity, the more unfavourable polarity of the voltage source replacing the battery shall be applied.*

~~*For **battery-operated energizers** where the supply terminals for the connection of the battery have no indication of polarity, the more unfavourable polarity shall be applied.*~~

For mains-operated energizers and battery-operated energizers suitable for connection to the mains, the reference source impedance of the mains supply shall be 0,4 Ω + j0,25 Ω.

5.101 *All energizers are tested as motor-operated appliances.*

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 Replacement:

Mains-operated energizers and **battery-operated energizers suitable for connection to the mains** shall be **class II** with respect to protection against electric shock.

Compliance is checked by inspection and by the relevant tests.

6.2 Addition:

Energizers shall be of at least IPX4.

6.101 Energizers are classified as being either **energy limited energizers** or **current limited energizers**.

Compliance is checked by the appropriate tests.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 Addition:

Type A energizers, **type B energizers** and **type C energizers** shall be marked with the **rated voltage for battery supply** or **rated voltage range for battery supply**, in volts.

~~**Battery-operated energizers** shall be marked with the substance of the following:~~

~~— **WARNING: Do not connect to mains-operated equipment.**~~

Energy limited energizers that are marked with a maximum energy/impulse exceeding 5 J shall also be marked with the corresponding load resistance at which maximum energy/impulse is obtained.

Energizers shall be marked with symbol ~~1641~~ of ISO 7000-0790 (2004-01).

Type R security energizers shall be marked with symbol IEC 60417-6406 (2018-02).

Type S security energizers shall be marked with symbol IEC 60417-6407 (2018-02).

7.6 Addition:

[symbol IEC 60417-5036
(2002-10)]

dangerous voltage



[symbol IEC 60417-5017
(2006-08)]

earth; ground



[symbol IEC 60417-6406
(2018-02)]

time synchronized type R security energizer



[symbol IEC 60417-6407
(2018-02)]

time synchronized type S security energizer

The symbols for output (**fence**) and output (earth) shall be in accordance with symbols IEC 60417-5036 (2002-10) and IEC 60417-5017 (2006-08) respectively.

7.12 Addition:

Instructions for ~~types A, B and D~~ battery-operated energizers suitable for connection to the mains shall

- include a warning against using non-rechargeable batteries while the **energizer** is powered by mains;
- state that, during charging, ~~lead-acid batteries~~ vented rechargeable batteries ~~must~~ shall be placed in a well-ventilated area.

~~The instructions for battery-operated energizers shall in particular emphasize the warning marked on the energizer that states the substance of the following:~~

~~WARNING: Do not connect to mains-operated equipment.~~

Instructions for **type D energizers** shall list accessories made available by the manufacturer.

7.14 Addition:

The outer diameter of the circle of symbol IEC 60417-6406 (2018-02) and symbol IEC 60417-6407 (2018-02) shall be at least 15 mm.

7.101 Unless the correct mode of connection is obvious or irrelevant, the output terminals of the **energizer**, other than dedicated output earth terminals, shall be clearly and indelibly identified ~~by marking with the words EARTH and FENCE, or with symbols 5017 and 5036 of IEC 60417 respectively~~ using symbol IEC 60417-5036 (2002-10). Dedicated output earth terminals shall be clearly and indelibly identified using symbol IEC 60417-5017 (2006-08).

Where alternative output terminals are provided, they shall be similarly marked, or marked with the words FULL POWER, REDUCED POWER or REDUCED VOLTAGE, as appropriate.

If a switch to control the output energy is provided, the various positions of the switch shall be marked with the appropriate symbols, or with the words FULL POWER, REDUCED POWER or REDUCED VOLTAGE, as appropriate.

~~The lettering of the marking shall have a height of at least 3 mm and the symbols a height of at least 6 mm.~~

The height of characters in the marking shall not be less than that given by an 18 point font and the symbols shall have a height of at least 6 mm.

Compliance is checked by inspection and measurement.

7.102 For ~~types A, B, C and D energizers and~~ battery-operated energizers suitable for connection to the mains, the supply terminals for connection of the battery shall be clearly indicated by symbol ~~“+” or the colour red, if of~~ IEC 60417-5005 (2002-10) for positive polarity,

and by symbol “ ” ~~or the colour black, if of~~ IEC 60417-5006 (2002-10) for negative polarity, unless the polarity is irrelevant.

Compliance is checked by inspection.

7.103 Energizers shall be supplied with instructions that contain the information given in Annex BB regarding

- the installation of **electric fences**;
- the means of connecting the **energizer** to the **electric fence**.

Such information shall contain the substance of the wording given in Clause BB.1 (**electric animal fences**), Clause BB.2 (**electric security fences** not supplied from a security energizer group) or Clause BB.3 (**electric security fences** supplied from a security energizer group), as appropriate.

~~NOTE It is recommended that~~ **Energizers** intended for use with **electric security fences** may also be supplied with the information given in Annex CC.

Compliance is checked by inspection.

7.104 The instructions for a **security energizer** that is suitable for use in a **security energizer group** shall contain the substance of the following:

- only type R security energizers or type S security energizers can be used in security energizer groups;
- a type S security energizer shall not be used in a type R security energizer group;
- a type R security energizer may be used in a type S security energizer group;
- identification of the model or type reference of security energizers that are permitted to be used in the security energizer group;
- security energizer groups shall only include security energizers that are identified in the instructions;
- the permitted configurations and connections of security energizers that may be used in the security energizer groups;
- identification of the model or type reference of the device producing the impulse timing signal source that is suitable for use in the security energizer group;
- a security energizer fence system must be configured and installed by, or under the responsibility of an authorized installer;
- a security energizer fence system shall be serviced and maintained by, or under the responsibility of an authorized installer;
- after installation, a label shall be attached to each energizer in a security energizer group that provides the authorized installer's name, contact details and the installation date;
- after servicing, a label shall be attached to each energizer in a security energizer group that provides the authorized installer's name, contact details and the service date;
- an authorised installer is a person suitably trained by the manufacturer to be able to safely configure, install and maintain a **security energizer fence system** on the basis of professional training, knowledge, experience and familiarity of the relevant equipment.

The instructions for a **security energizer** that is suitable for use in a **security energizer group** shall

- provide an explanation of the hazards of not using **security energizer groups** in locations where two electric security fences can be contacted at the same time;
- provide an explanation of the hazards of not correctly configuring a **security energizer** when used in a **security energizer group**. These hazards include:

- receiving a too large impulse;
 - receiving consecutive two impulses that are not spaced apart enough in time;
 - touching an electric security fence whose isolation from the supply mains has been compromised;
- explain the meaning of the time synchronized symbols IEC 60417-6406 (2018-02) and IEC 60417-6407 (2018-02), if they are used;
 - provide a general explanation of the safety objectives and technical requirements of a **security energizer group** that can be properly understood by an authorized installer;
 - provide a general explanation of the safety objectives and technical requirements of a **security energizer fence system** that can be correctly understood by an authorized installer.

The front section of the instructions shall include the substance of the following warnings:

IMPORTANT WARNINGS

WARNING: These instructions must be fully complied with in every respect

WARNING: A security energizer group must be used at any point where two electric security fences can be contacted by a person at the same time

WARNING: Give special attention to the correct type selection and connection of security energizers used in a security energizer group

WARNING: A security energizer fence system should be checked for safety by an authorized installer prior to operation

DANGER: Failure to comply fully with the instructions could lead to a fatal electric shock

Compliance is checked by inspection.

8 Protection against access to live parts

This clause of Part 1 is applicable except as follows.

8.1.4 Addition:

*The means for the connection of the **fence** is not considered to be a **live part**.*

9 Starting of motor-operated appliances

This clause of Part 1 is not applicable.

10 Power input and current

This clause of Part 1 is applicable except as follows.

10.101 For **energy limited energizers** that are marked with a maximum energy/impulse exceeding 5 J, the value so marked shall not deviate from that delivered by more than $\pm 10\%$ and the load resistance at which it is obtained shall not deviate from the value marked on the **energizer** by more than $\pm 5\%$.

Compliance is checked by the following test.

The **energizer** is supplied at **rated voltage** or **rated voltage for battery supply**, as appropriate, under conditions of **normal operation** but with a variable resistive load connected across its output terminals.

The energy per impulse dissipated in the resistive load connected across the **energizer** output terminals is measured using the measuring arrangement described in 22.108. The resistive load value is measured after it is adjusted to maximize the energy per impulse measured.

11 Heating

This clause of Part 1 is applicable except as follows.

11.2 Addition:

For **type A energizers** when connected for mains supply, **type D energizers** when connected for battery ~~charger~~ **charging** supply and type B energizers when connected for mains supply with battery charge operation, a battery of the largest ~~type~~ **capacity** for which the **energizer** is designed is connected to the terminals for the connection of the battery supply. Before starting the test, the battery is discharged to such an extent that the voltage delivered by the battery does not exceed 0,75 times its nominal value.

11.5 Replacement:

The **energizer** is operated under **normal operation**, supplied as follows.

A **mains-operated energizer** is supplied with the most unfavourable supply voltage between 0,85 and 1,1 times **rated voltage**.

Type A energizers and **type C energizers**, when they are connected for mains supply, are supplied with the most unfavourable supply voltage between 0,85 and 1,1 times **rated voltage**.

A **type B energizer**, when it is connected for mains supply with battery charge operation, is supplied with the most unfavourable supply voltage between 0,85 and 1,1 times **rated voltage**.

Type A energizers, **type B energizers**, **type C energizers** and **type D energizers**, when they are connected for battery supply, ~~and battery-operated energizers~~ are supplied at the terminals for the connection of the battery with the most unfavourable supply voltage between

- 0,55 and 1,1 times **rated voltage for battery supply**, if the **energizer** can be used with non-rechargeable batteries;
- 0,75 and 1,1 times **rated voltage for battery supply**, if the **energizer** is designed for use with rechargeable batteries only.

The values specified in Table 101 for the internal resistance per cell of the battery shall be taken into account.

Table 101 – Battery source impedance

Supply to the terminals for the connection of the battery	Internal resistance per cell Ω	
	Non-rechargeable batteries	Rechargeable batteries
1,1 times rated voltage for battery supply	0,08	0,001 2
1,0 times rated voltage for battery supply	0,10	0,001 5
0,75 times rated voltage for battery supply	0,75	0,006 0
0,55 times rated voltage for battery supply	2,00	–
NOTE When determining the internal resistance of a battery, two or more cells connected in parallel are considered to be one cell.		

Type D energizers, ~~when they are connected for battery charger supply,~~ are supplied from a source incorporating a series resistance of 1 Ω and having the form of

- a half-wave rectified sine-wave with an RMS value equal to the **rated voltage for battery supply**,
- a full-wave rectified sine-wave with an RMS value equal to the **rated voltage for battery supply**,

whichever is the more ~~onerous~~ unfavourable.

Security energizers used in a **security energizer group** shall be tested together in any permitted configuration and connection that may be allowed in the group.

The maximum and minimum supply voltage values are set in accordance with Table 102 using multiplier factors based on the **rated voltage** or **rated voltage range** of the appliance.

Table 102 – Rated supply voltage maximum and minimum value multiplier factors

Supply voltage value	Mains	Battery (rechargeable)	Battery (non-rechargeable)
Minimum	0,85	0,75	0,55
Maximum	1,1	1,1	1,1

The **security energizer** feeding the first **fence circuit** is operated, for a given supply voltage type, on three supply voltage value settings in turn, the minimum value, the maximum value and one freely selected value between the minimum and maximum values, while the **security energizer** feeding the second **fence circuit** is supplied, for a given supply voltage type, with any supply voltage varied between the maximum and minimum values that is selected to produce the most unfavourable result.

The above tests are repeated, but with the first and second **security energizer** settings reversed. Refer to Table 103.

Table 103 – Supply voltage value test settings

Test	First fence circuit supply	Second fence circuit supply
1	Maximum value	Selected for worst case
2	Minimum value	Selected for worst case
3	Freely selected value	Selected for worst case
4	Selected for worst case	Maximum value
5	Selected for worst case	Minimum value
6	Selected for worst case	Freely selected value

The above tests are repeated for both mains and battery supply voltage operation as applicable in accordance with Table 104.

Table 104 – Test supply sequence for different supply type

Test	First fence circuit supply	Second fence circuit supply
MM	Mains	Mains
MB	Mains	Battery
BM	Battery	Mains
BB	Battery	Battery

NOTE 101 For a typical **security energizer group**, based on two **security energizers** that both can run on mains or rechargeable battery, there would be a total of twenty four tests performed. However in some cases where only mains or battery operation is indicated, the number can be less or in the case where a non-rechargeable battery option is also included, the number of tests could be doubled.

11.7 Replacement:

The **energizer** is operated until steady conditions are established.

12 Void

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is applicable except as follows.

13.1 Modification:

Compliance is checked by the tests of 13.2 and 13.3 for **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains only**.

Addition:

The **energizer** is operated under **normal operation** when supplied as specified in 11.5 for mains operation.

14 Transient overvoltages

14.101 Energizers shall be resistant to atmospheric surges entering from the **fence**.

Compliance is checked by the tests of 14.102 to 14.104 for **mains-operated energizers and battery-operated energizers suitable for connection to the mains**.

~~— 14.102 to 14.104 for mains-operated energizers and types A, B and C energizers;~~

~~— 14.102 to 14.104 for type D energizers;~~

~~— 14.104 for battery-operated energizers with a rated voltage exceeding 42,4 V.~~

NOTE The value of U_0 is the peak value of the **energizer** output voltage obtained during the test of 22.111.

Unless otherwise specified, during the tests, no disruptive discharges shall occur but surge protection devices are allowed to operate.

Mains-operated energizers and ~~types A, B, C and D~~ **battery-operated energizers suitable for connection to the mains** are fixed to a metal plate having dimensions that are at least 150 mm in excess of those of the orthogonal projection of the **energizer** on the plate, and are then installed as in normal use.

~~Battery-operated energizers are installed as in normal use.~~

The tests are made by means of an impulse generator producing positive and negative full lightning impulses having a front time of 1,2 μ s and a time to half-value of 50 μ s, the tolerances being

- ± 5 % for the peak value;
- ± 30 % for the front time;
- ± 20 % for the time to half-value.

Small oscillations in the impulse are allowed, provided their amplitude near the peak of the impulse is less than 5 % of the peak value. For oscillations during the first half of the front time, amplitudes up to 10 % of the peak value are allowed.

The shape of the impulses is adjusted with the **energizer** connected to the impulse generator. The adjustment shall be made at approximately 50 % of the test voltage specified. If, for the test of 14.104, it is not possible to obtain the correct shape of the impulses, it is only necessary to ascertain that the front time has the required value at approximately 50 % of the **prospective peak voltage** specified.

The impulse generator to be used for the tests shall have an energy content of at least 125 J at the test voltage.

14.102 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between

- the output terminals and AC input terminals connected together and the metal plate, for **mains-operated energizers** and **type A energizers**, **type B energizers** and **type C energizers**,
- the output terminals and the metal plate, for **type D energizers**,

the interval between consecutive impulses being at least 10 s.

Type D energizers are further tested as follows.

Each specified **detachable supply unit** is connected to the impulse generating circuit of the **energizer** in turn. The impulse voltages are applied between the **energizer** output terminals and the AC input terminals of the specified **detachable supply unit** connected together and the metal plate.

14.103 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between the output terminals connected together and

- the AC input terminals connected together, for **mains-operated energizers** and **type A energizers**, **type B energizers** and **type C energizers**,
- the terminals for connection of the external battery charger, for **type D energizers**,

the interval between consecutive impulses being at least 10 s.

If, during this test, a surge protection device operates, the test is repeated with the surge protection device rendered inoperative. During the repeat test no disruptive discharges are allowed.

If the **energizer** has more than one **fence circuit**, each **fence circuit** is subjected to this test in turn, the other **fence circuits** being open-circuited.

Type D energizers are further tested as follows.

Each specified **detachable supply unit** is connected to the impulse generating circuit of the **energizer** in turn. The impulse voltages are applied between the **energizer** output terminals and the AC input terminals of the specified **detachable supply unit** connected together and the metal plate.

14.104 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between the output terminals, the interval between the impulses being at least 10 s. The input terminals are open-circuited. For **type D energizers**, the input terminals of the impulse generating circuit are open-circuited.

15 Moisture resistance

This clause of Part 1 is applicable.

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.1 Modification:

Compliance is checked by the tests of 16.2, 16.3 and 16.101 for **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**.

~~— 16.2, 16.3 and 16.102 for **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**;~~

~~— 16.101 and 16.102 for **battery-operated energizers**.~~

16.2 Modification:

The test voltage is the upper limit of the voltage in 11.5.

16.3 Addition:

Other values of the test voltages and the points of application are shown in Table ~~102~~ 105.

Table 102 105 – Additional test voltages

Points of application	Test voltage ^a
Between the <i>mains</i> supply circuit and accessible parts for metal-encased class II energizers	$2U_0$ but not less than 10 000 V
Between the fence circuit and accessible parts ^b	$2U_0$ but not less than 10 000 V
Between the <i>mains</i> supply circuit and the fence circuit	$2U_0$ but not less than 10 000 V
^a The value $2U_0$ is a peak value equal to twice the maximum peak value of the output voltage measured in 22.111. ^b A gap of 50 mm around the output terminal shall be provided in the metal foil in contact with accessible parts .	

~~16.101 For battery-operated energizers the supply terminals are connected for 10 min to a voltage between 1,1 and 1,5 times rated voltage for battery supply, that is so chosen that the output voltage, without a load connected, has the maximum value, protective spark gaps, if any, being disconnected.~~

~~The insulation between the poles of the supply circuit is then subjected for 1 min to a d.c. voltage of approximately 500 V. Before this test is made, capacitors, resistors, inductors, transformer windings and electronic components that are connected between the poles of the supply circuit are disconnected. When a capacitor forms part of an integrated circuit and cannot be disconnected separately, the circuit as a whole is disconnected.~~

~~No breakdown shall occur during the test.~~

~~16.102 16.101~~ Immediately after the tests of 16.3 ~~and 16.101~~, the output characteristics are measured as specified in 22.108.

~~The values measured shall be within the limits specified in 22.108 and shall not deviate in an unfavourable way by more than 10 % from the values measured during the tests of 22.108.~~

17 Overload protection of transformers and associated circuits

This clause of Part 1 is not applicable.

18 Endurance

This clause of Part 1 is replaced by the following.

Mains-operated energizers and **battery-operated energizers suitable for connection to the mains** shall be so constructed that they are able to endure extreme temperatures that may be encountered in normal use. Moreover, overload **protection devices** shall not operate under these conditions.

Compliance is checked by the following test.

Mains-operated energizers, type A energizers and type C energizers when they are connected for mains supply are operated under conditions of **normal operation**. The voltage applied is the **rated voltage**.

Type D energizers, ~~when connected for battery charger supply~~, are operated under conditions of **normal operation**. The voltage applied is as specified in 11.5.

~~Battery-operated energizers and Type B energizers~~ connected for battery operation are placed in their normal position and are fitted with a battery having a nominal voltage equal to the **rated voltage for battery supply** of the **energizer**. The battery shall be of the largest **type capacity** for which the **energizer** is designed. The battery shall be fully charged at the beginning of the test and shall be replaced by a fresh one as soon as, during the test, the voltage of the battery decreases to 0,75 times its nominal voltage for a rechargeable battery or to 0,55 times its nominal voltage for a non-rechargeable battery **or until the energizer ceases to function due to low battery voltage.**

For **type A and D** energizers, a battery of the largest **type capacity** for which the **energizer** is designed is connected and placed in the battery compartment. Before starting the test, the battery is discharged to such an extent that the voltage delivered does not exceed 0,75 times its nominal value.

The other sample, for **type A energizers** and **type C energizers**, is to be connected for battery supply and supplied from a battery of the largest **type capacity** for which the **energizer** is designed. The battery shall be fully charged at the beginning of the test, and shall be replaced by a fresh one as soon as, during the test, the voltage of the battery decreases to 0,75 times its nominal voltage for a rechargeable battery or to 0,55 times its nominal voltage for a non-rechargeable battery.

The **energizer** is operated continuously for 168 h (seven days) at an ambient temperature of $-15\text{ °C} \pm 2\text{ °C}$ and then for 168 h (seven days) at an ambient temperature of $50\text{ °C} \pm 2\text{ °C}$.

The output terminals are loaded with a non-inductive resistor of $500\ \Omega \pm 2,5\ \Omega$ during the first 84 h of each period of 168 h and the load is removed for the remainder of these periods.

At the end of each of the periods of 168 h, the output characteristics are measured, as specified in 22.108, at the ambient temperature prescribed for the relevant period.

~~The values measured shall be within the limits specified in 22.108 and shall not deviate in an unfavourable way by more than 10 % from the values measured during the test of 22.108.~~

During the test, the **energizer** shall show no change impairing its further use, the sealing compound, if any, shall not flow out to such an extent that **live parts** are exposed and the **energizer** shall still meet the requirements of Clause 8.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.1 ~~Modification:~~

~~Instead of the indication of the subclauses applicable to the various types of appliances, the following applies:~~

~~**Energizers** are subjected to the tests of 19.11, 19.12, 19.101, 19.102, 19.103 and 19.104.~~

Addition:

The **energizer** is mounted as in 11.2, except that the battery, where applicable, is fully charged.

During the tests, fuses that are accessible to the user are short-circuited.

Energizers are also subjected to the tests of 19.101, 19.102, 19.103, 19.104 and 19.105.

Security energizer groups are also subjected to the tests of 19.106 and 19.107 as if they were an **energizer** supplied in one or more parts.

~~19.11.1 Addition:~~

~~Components, except the major switching device, directly related to the pulse interval timing of the major switching device where this is an **electronic component**, are exempt from the tests of 19.11.2.~~

~~19.11.3 Not applicable.~~

19.12 Addition:

If, for any of the fault conditions, the impulse repetition rate is greater than 1 Hz and the safety of the energizer depends upon the operation of a non-self-resetting protective device incorporating an internal fuse, the test is carried out three times to ensure that this fuse operates reliably and that internal parts are not damaged at the increased impulse repetition rate.

19.13 Addition:

The temperature rises of the windings shall not exceed the values shown in Table 8.

For a **type R security energizer**, during the tests the output characteristics of each **fence circuit** shall be as specified in 22.108 except for the impulse repetition rate and 22.113. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into a load consisting of a non-inductive resistor of 500 Ω shall not exceed 1,25 J/s after 3 min.

For all other **energizers**, during the tests the output characteristics of each **fence circuit** shall be as specified in 22.108 except for the impulse repetition rate. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into a load consisting of a non-inductive resistor of 500 Ω shall not exceed 2,5 J/s ~~for a period exceeding~~ after 3 min ~~before the energizer is rendered inoperative by a non-self-resetting protective device.~~

For a **type R security energizer group**, during the tests the impulse synchronisation shall be as specified in 22.114. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into a replacement load consisting of a non-inductive resistor of 500 Ω shall not exceed 2,5 J/s after 3 min.

For a **type S security energizer group**, during the tests the combined **fence circuit** output characteristics measured in the 500 Ω resistor R_T shall be as specified in 22.115 for test configurations 5 and 6 except for the impulse repetition rate. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into the 500 Ω load R_T shall not exceed 2,5 J/s after 3 min.

19.101 Energizers are subjected to each of the following conditions in turn, while being supplied with the voltage specified in 11.5, including those associated with such other fault conditions that are an actual consequence of the condition chosen:

- the energizer is placed in its most unfavourable position even if it is not likely to be installed in this position in normal use;
- parts intended for adjusting the energizer, other than those that are adjustable from the outside of the energizer without the aid of a **tool**, are adjusted to their most unfavourable position, even if these parts are not intended to be adjusted by the user, unless they are effectively sealed against further adjustment;
- the earthing conductor is removed from the earthing terminal of the fence circuit and connected to any other output terminal;

- the output terminals are short-circuited;
- switches, relay-contacts and the like, that form part of the impulse-device generating circuit, are short-circuited or open-circuited, whichever is the more unfavourable;
- fuses that are accessible without the aid of tools, series spark gaps in the fence circuit, discharging valves and thermal relays are short-circuited;
- except for electronic circuits, any creepage distance or clearance between live parts of different potential that is less than 5 mm for the fence circuit, or 2 mm or less for other circuits, is short-circuited, and any unlocked connection is loosened;
- the switching speed of an electronic component used as the major impulse-switching device shall be varied in the range 0,1 Hz to twice the rated frequency, in approximately a 1:2:5 progression sequence over three decades, by referencing the gate signal of this device to the voltage across it using an external independent control.

NOTE Details of a simple comparator circuit that has been found suitable for controlling the switching speed of the major impulse-switching device are given in Annex AA.

19.102 Type A energizers, type C energizers and type D energizers are subjected to each of the following conditions in turn, while being supplied with the voltage specified in 11.5:

- with the energizer connected for battery supply, terminals for the connection of the battery having an indication of polarity are connected to the opposite polarity, unless such a connection is unlikely to occur in normal use;
- with the energizer connected for mains operation, terminals for the connection of the battery supply are connected to the most unfavourable resistive load, including a short circuit.

19.103 Type B energizers connected for mains supply with battery charge operation are subjected to each of the following conditions in turn, while being supplied with the voltage specified in 11.5:

- the terminals for the connection of the battery having an indication of polarity are connected to the opposite polarity, unless such a connection is unlikely to occur in normal use;
- the terminals for the connection of the battery supply are connected to the most unfavourable resistive load, including a short circuit.

19.104 Battery-operated energizers and Type B energizers connected for battery supply are supplied with the voltage specified in 11.5. The supply terminals having an indication of polarity are connected to the opposite polarity, unless such a connection is unlikely to occur in normal use.

19.105 Battery operated energizers suitable for connection to the mains having a rated voltage for battery supply of less than 12 V are operated under normal operation when supplied with an input voltage of 13,2 V DC.

During the test, the energizer shall be connected to the voltage source via a 1 Ω series resistor.

This test is only applicable if the supply may be connected without modification of the energizer.

19.106 Type S security energizer groups are tested for every permitted configuration and connection specified in the instructions. As such, during the tests only a single fault is applied at a time in any one of the parts.

19.107 Security energizer groups are subjected to fault testing of the impulse timing signal source. All possible impulse timing signal outputs are considered for faults occurring within the impulse timing signal source such as stopping, intermittent operation, low level,

*high level, variable rate, high rate. Whenever possible when an external **impulse timing signal source** is used, a fault shall be introduced such that the **impulse timing signal source** is no longer a viable method of synchronization. However if it can be shown that a particular fault condition is unlikely to occur then it should not be considered.*

20 Stability and mechanical hazards

This clause of Part 1 is not applicable.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.101 The **energizer** shall withstand the effect of being dropped.

Compliance is checked by the following test.

The energizer is bolted centrally to a board 1 000 mm $\pm$ 5 mm long by 225 mm $\pm$ 5 mm wide and approximately 25 mm thick. The board is supported at each end on a rigid table by baulks of timber of such a size that the energizer is held clear of the table surface. One end of the board is lifted through a distance of 200 mm $\pm$ 5 mm and allowed to fall freely. The test is repeated 20 times. This procedure is then repeated with the board placed on each of its other longitudinal edges in turn.

After the test, the energizer shall show no damage within the meaning of this standard.

22 Construction

This clause of Part 1 is applicable except as follows.

22.12 Addition:

The requirement is not applicable to the **energizer** output terminal assembly including the terminal knob and washers.

22.31 ~~Modification~~ Addition:

The requirement applies only to **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**.

22.32 ~~Modification~~ Addition:

The requirement applies only to **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**.

22.46 Addition:

If programmable **protective electronic circuits** alone are used to ensure compliance with the output characteristics specified in 19.13, the software shall contain measures to control the fault/error conditions specified in Table R.2.

22.56 Replacement:

For **type D energizers**, a **detachable supply unit** shall be a listed accessory made available by the manufacturer.

Compliance is checked by inspection.

22.101 For **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**, internal connections shall be so fixed or protected, and **energizers** shall be so designed that, even in the event of the loosening or breaking of wires, a conductive connection cannot be formed between the mains supply and the **fence circuit**, and no other hazardous condition shall arise.

The input winding and the output windings of transformers used to isolate the **fence circuit** from the supply circuit shall be separated by an insulating barrier, and the construction shall be such that there is no possibility of any connection between these windings, either directly or indirectly through other metal parts.

In particular, precautions shall be taken to prevent

- displacement of input or output windings, or the turns thereof;
- undue displacement of parts of windings, or of internal wiring, in the event of a rupture or loosening of connections.

~~Compliance is checked by inspection and by the tests of the other clauses of this standard.~~

NOTE Isolation between the mains and the **fence circuit** may be achieved by the incorporation of a double-wound transformer situated either in the input circuit or in the **fence circuit**. If such transformers are incorporated in both circuits, at least one of these transformers ~~should~~ shall provide the required degree of isolation.

Compliance is checked by inspection and by the tests of the other clauses of this standard.

NOTE 1 Circuits connected between the input terminals and the primary side of the transformer providing the required degree of isolation are considered to be connected to the mains, and circuits connected between the output terminals and the secondary side of this transformer are considered to belong to the **fence circuit**.

NOTE 2 Examples of constructions that comply with the requirements of this subclause for windings are

- windings on separate spools of adequate insulating material, rigidly fixed with respect to each other and to the core of the transformer;
- windings on a single spool with a partition wall, both of adequate insulating material, provided that the spool and partition wall are pressed or moulded in one piece, or that, in the case of a pushed-on partition wall, there is an intermediate sheath or covering over the joint between the spool and the partition wall;
- concentric windings on cheekless formers, provided that
 - each layer of the winding is interleaved with adequate insulating material projecting beyond the end turns of each layer,
 - one or more separate sheets of insulating material of adequate thickness are provided between the input winding and the output windings, and
 - the windings are impregnated with a hard-baked or other suitable material that fully penetrates the interstices and effectively seals off the end turns.

NOTE 3 It is not to be expected that two independent fixings will become loose at the same time.

22.102 For **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**, transformers in the **fence circuit** shall be placed in a separate compartment. This compartment shall not contain any part that is, or can come, in contact with the mains, with the exception of the input winding of the transformer. ~~The bushings referred to in 22.105 shall be in the wall of this compartment.~~

Compliance is checked by inspection and by the tests of the other clauses of this standard.

22.103 For metal-encased **class II energizers**, the output terminals shall be placed so that external conductors connected to these terminals are not likely to come into contact with the enclosure.

Compliance is checked by inspection.

22.104 **Energizers** shall be so designed that

- the conductors for the connection of the **fence** and the **earth electrode** can be easily connected;
- it is possible to actuate switches and other controls, if this is necessary in normal use, after the **energizer** has been mounted and connected to the supply, without opening or removing any enclosure that provides protection against harmful ingress of water or unintended electric shock.

Compliance is checked by inspection.

22.105 For **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**, any assembly gap in **supplementary insulation** shall not be co-incidental with any such gap in **basic insulation**, neither shall any such gap in **reinforced insulation** give straight access to **live parts**.

Compliance is checked by inspection.

22.106 In **type A energizers**, **type B energizers** and **type C energizers**, terminals for the connection of the battery and other metal parts in a battery compartment that become accessible when replacing batteries, even with the aid of a **tool**, shall be insulated from **live parts** by **double insulation** or **reinforced insulation**.

In ~~**type D energizers and battery-operated energizers**~~, parts in a battery compartment that become accessible when replacing batteries, even with the aid of a **tool**, shall not be **live parts**.

Compliance is checked by inspection, measurement and by the tests specified for double insulation or reinforced insulation.

22.107 ~~**Battery-operated energizers and Battery-operated energizers suitable for connection to the mains**~~ shall be provided with means to prevent the user from being subjected to an electric shock due to the **energizer** output voltage, when connecting a battery to the **energizer**.

Compliance is checked by inspection.

NOTE Examples of such means are:

- a switch that isolates the terminals for the connection of the battery;
- a control that enables the output voltage to be reduced to zero;
- insulated crocodile clips or similar devices.

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;

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 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 102 103;
 - an **impulse duration** of less than or equal to 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. For energizers with more than one set of output terminals, the standard load is connected to each set of output terminals in turn. 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 Ω in parallel with a capacitance of not more than 100 pF.

22.109 If the **energizer** is provided with more than one ~~fence circuit~~ set of output terminals, the output characteristics shall be within the limits specified in 22.108 for any possible ~~connection of the fence circuits~~ configuration of the output terminals connected to the **standard load**.

The impulses for the individual sets of output terminals shall be synchronized and

- the **impulse duration** shall not exceed the value specified in 22.108;
- the impulse repetition rate shall not exceed the value specified in 22.108

for any possible combination of individual impulses.

Compliance is checked by the measurements specified in 22.108.

22.110 For **type A energizers** and **type B energizers** that have terminals for the connection of the battery, the no-load DC output voltage shall not exceed 42,4 V.

Compliance is checked by measuring the no-load DC output voltage appearing at the terminals for the connection of the battery when the energizer is connected for mains supply and is supplied at rated voltage.

22.111 The peak value of the output voltage, U_0 , shall be measured and recorded to enable the tests and measurements of 14.102, 14.103, 14.104 and 16.3 to be carried out.

Compliance is checked by the following tests:

*When the energizer is a **security energizer** marked as being permitted for use in a **security energizer group**, the peak value of the output voltage, U_0 , should be the highest value of voltage measured when it is connected in a **security energizer group** and tested in any permitted configuration and connection of **security energizers** that may be used in the **security energizer group** given in the instructions. The **security energizer group** is supplied with the voltage in 11.5 under conditions of **normal operation**, but with a load connected to the output terminals of the **security energizer** or **security energizer group**, consisting of a capacitor having a capacitance that can be varied between 0 nF and 200 nF in steps of approximately 10 nF.*

*These **security energizer group** tests are not applicable to a **type R security energizer group** where all the **type R energizers** in the group are exactly the same model.*

For all other energizers, the peak value of the output voltage, U_0 , is measured, using an ~~measuring~~ arrangement described in 22.108 with the energizer supplied with the voltage in

11.5 under conditions of **normal operation**, but with a load connected to the output terminals consisting of a capacitor having a capacitance that can be varied between 0 nF and 200 nF in steps of approximately 10 nF.

22.112 The **clearance** between parts of opposite polarity for connecting the battery in **battery operated energizers suitable for connections to the mains** shall not be less than 2 mm, when the **energizer** is fitted with conductors as in normal use.

Compliance is checked by measurement.

22.113 For a **type R security energizer**, the energy per impulse delivered by each **fence circuit** into the **standard load** shall not exceed 2,5 J.

*Compliance is checked by measuring the energy/impulse over the **impulse duration** with 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 each **fence circuit**.*

*When measuring the energy per impulse into the **standard load**, the variable resistor shall be adjusted to maximize the energy into the **standard load** and not the energy in the 500 Ω component of the **standard load**.*

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

22.114 Type R security energizer group output characteristics measured in the 500 Ω component of the **standard load** shall be such that

- the impulse repetition rate shall not exceed 1 Hz;
- the **impulse duration** of the impulse shall not exceed 10 ms.

*Compliance is checked by measurement when the **type R security energizer group** is supplied with the voltage in 11.5, being operated under conditions of **normal operation** but with the **standard load** connected to the output terminals as shown in Figure 104, Test configuration A and the test repeated with the **standard load** connected to the output terminals as shown in Figure 104, Test configuration B.*

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

22.115 Type S security energizer group output characteristics measured in the 500 Ω resistor R_T shall be such that

- the impulse repetition rate shall not exceed 1 Hz;
- the **impulse duration** of the impulse shall not exceed 10 ms;
- for **energy limited energizers**, the energy/impulse 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** shall not exceed for
 - an **impulse duration** of greater than 0,1 ms, the value specified by the characteristic limit line detailed in Figure 103;
 - an **impulse duration** less than or equal to 0,1 ms, 15 700 mA.

*Compliance is checked with the **type S security energizer group** supplied with the voltage specified in 11.5, and operated with the six test configurations shown in Figure 105, in turn. For each configuration, the test loads are varied as follows.*

- a) With resistor R_T connected, for test configurations 1 to 6, vary resistor R_A and resistor R_B to maximise the group output characteristics measured in resistor R_T ;
- b) With resistor R_T disconnected, for test configuration 1, vary resistor R_B to maximize the output characteristics measured in resistor R_B then reconnect resistor R_T and measure the group output characteristics in resistor R_T ;
- c) With resistor R_T disconnected, for test configuration 2, vary resistor R_A to maximize the output characteristics measured in resistor R_A then reconnect resistor R_T and measure the group output characteristics in resistor R_T ;
- d) With resistor R_T disconnected, for test configuration 6, vary resistor R_A and resistor R_B to maximize the output characteristics measured in resistor R_A and resistor R_B then reconnect resistor R_T and measure the group output characteristics in resistor R_T ;
- e) With resistor R_T disconnected, for test configurations 3, 4 and 5, vary resistor R_A and resistor R_B to maximize the output characteristics measured in resistor R_A and resistor R_B then reconnect resistor R_T and measure the group output characteristics in resistor R_T .

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

For each test, the **type S security energizer group** output characteristics measured in the 500 Ω resistor R_T shall not be exceeded.

23 Internal wiring

This clause of Part 1 is applicable except as follows.

23.7 Replacement:

For **mains-operated energizers and battery-operated energizers suitable for connection to the mains**, conductors identified by the colour combination green/yellow shall not be used.

Compliance is checked by inspection.

24 Components

This clause of Part 1 is applicable.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.1 Addition:

For **Type D energizers** ~~shall be~~ that are provided with a non-detachable flexible cord ~~with~~, the connecting means ~~that are~~ shall not be suitable for connection to the mains, ~~or~~.

An appliance inlet, on a **type D energizer**, ~~having~~ shall have at least the same degree of protection against moisture as required for the **energizer**, ~~that is~~ and shall not be compatible with appliance couplers complying with the standard sheets of IEC 60320-3.

Compliance is checked by inspection.

~~25.5 Addition:~~

~~The flexible leads or flexible cord used to connect the battery in battery-operated energizers shall be assembled with the energizer by a type X attachment.~~

25.7 Replacement:

~~Supply cords, other than the flexible leads or flexible cord connecting an external battery or battery box with an energizer,~~ shall not be lighter than

- ordinary polyvinyl chloride sheathed cord (code designation 60227 IEC 53);
- ordinary polychloroprene sheathed cord (code designation 60245 IEC 57).

The ordinary polychloroprene sheathed cord shall be used where, for climatic reasons, the ordinary polyvinyl chloride sheathed cord is not suitable.

Compliance is checked by inspection.

25.8 Addition:

The conductors in flexible leads or flexible cords used to connect the battery in ~~battery-operated type D~~ **energizers** shall have a nominal cross-sectional area of not less than 0,75 mm².

25.13 Addition:

This requirement is not applicable to the flexible leads or flexible cord connecting external batteries or a **battery box** with an **energizer**.

25.23 Addition:

In ~~types A, B, C, D and~~ **battery-operated energizers suitable for connection to the mains**, if the battery is placed in a separate box, the flexible lead or flexible cord connecting the box with the **energizer** is considered to be an **interconnection cord**.

~~25.101 Battery-operated energizers shall have suitable means for connection of the battery. If the type of battery is marked on the energizer, the means of connection shall be suitable for this type of battery.~~

~~Compliance is checked by inspection.~~

26 Terminals for external conductors

This clause of Part 1 is applicable except as follows.

26.1 Addition:

The second sentence of the requirement does not apply to the **energizer** output terminals.

26.5 Addition:

Terminal devices in an **energizer** for the connection of the flexible leads or flexible cord with **type X attachment** connecting an external battery or **battery box** shall be so located or shielded that there is no risk of accidental connection between supply terminals.

26.9 Addition:

The requirement does not apply to the **energizer** output terminals.

26.101 Output terminals shall be so designed or located that it is not possible to connect the **fence** or the **earth electrode** to the **energizer** by means of a plug that is designed for connection to a socket-outlet for mains supply.

Compliance is checked by inspection and by manual test.

26.102 Output terminals shall be fixed so that they will not work loose when external conductors are connected or disconnected.

Compliance is checked by inspection and by manual test.

26.103 Devices for clamping the conductors connecting the **fence** or the **earth electrode** to the **energizer** shall not serve to fix any other component.

Compliance is checked by inspection.

27 Provision for earthing

This clause of Part 1 is applicable except as follows.

27.1 Addition:

NOTE 101 In **class II energizers**, provision ~~may~~ can be made for connecting at least one of the output terminals to the **earth electrode**.

28 Screws and connections

This clause of Part 1 is applicable.

29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable ~~except as follows~~.

~~Addition:~~

~~Compliance is also checked by the requirements and measurements of 29.101.~~

~~29.101 Clearances between~~

- ~~— live parts of the fence circuit and other metal parts, or~~
 - ~~— metal enclosures and other metal parts of the energizer, including foil wrapped around the supply cord inside inlet bushings, cord guards, cord anchorages and similar parts,~~
- ~~shall not be less than 25 mm.~~

~~The clearances between the poles of the supply circuit in battery-operated energizers shall be not less than 2 mm, when the energizer is fitted with conductors as in normal use.~~

~~Compliance is checked by measurement.~~

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.2.1 Modification:

The glow-wire test is made at a temperature of 650 °C.

30.2.2 Not applicable.

31 Resistance to rusting

This clause of Part 1 is replaced by the following.

The enclosure of metal-encased **class II energizers** shall be adequately protected against corrosion.

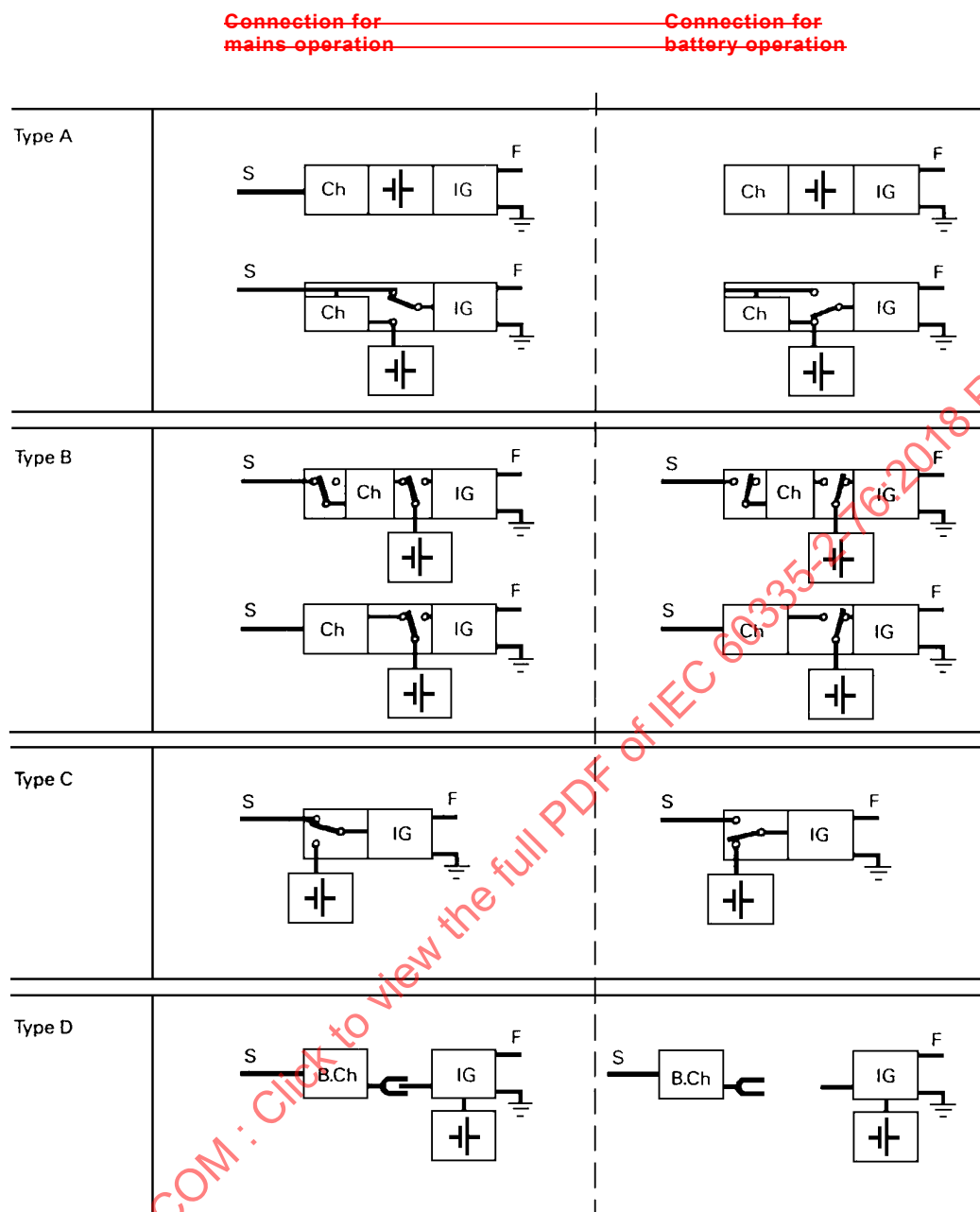
Compliance is checked by the salt mist test of IEC 60068-2-52. ~~Severity~~ Test method 2 is applicable.

Before the test, coatings are scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of 0,25 mm ± 0,02 mm. The pin is loaded so that the force exerted along its axis is 10 N ± 0,5 N. The scratches are made by drawing the pin along the surface of the coating at a speed of approximately 20 mm/s. Five scratches are made at least 5 mm apart and at least 5 mm from the edge.

After the test, the appliance shall not have deteriorated to such an extent that compliance with this standard is impaired. The coating shall not have broken and shall not have loosened from the metal surface.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is applicable.



IEC 425/97

Key

S — supply mains

Ch — battery charger circuit

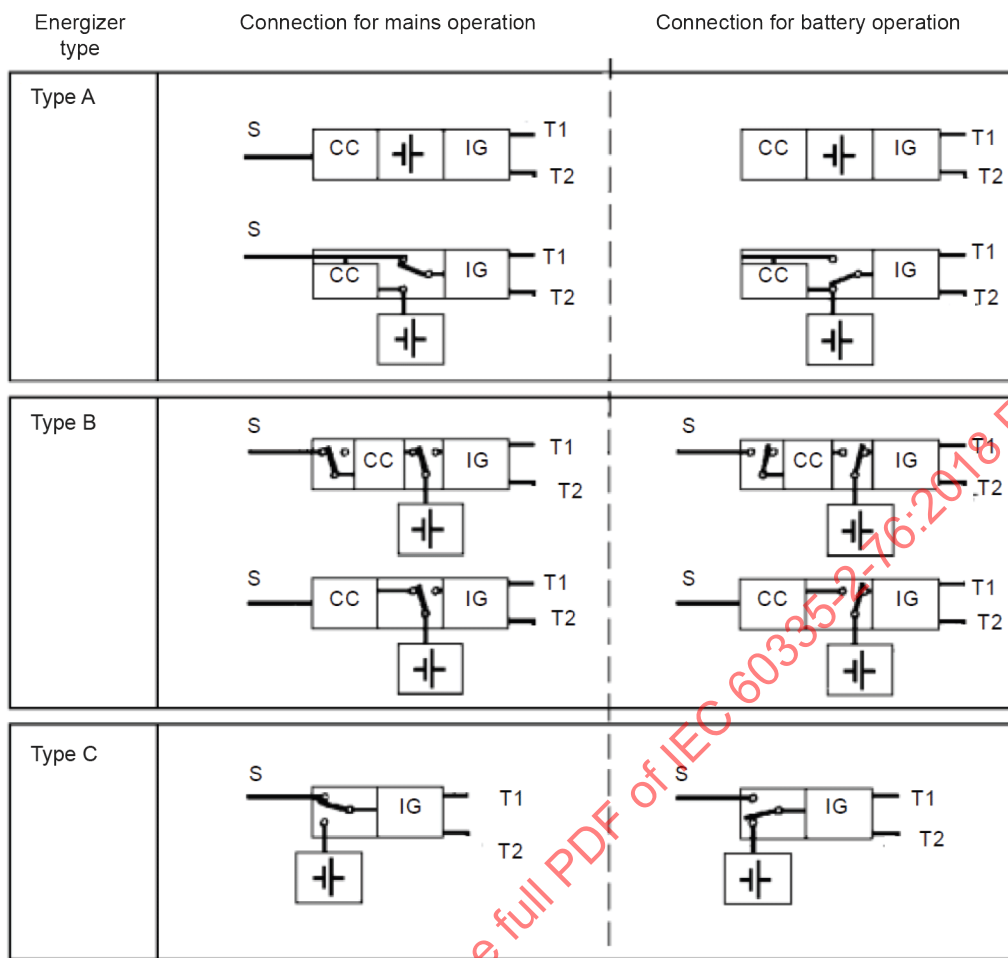
IG — impulse generating circuit

B.Ch — separate battery charger

— battery

F — fence connection

Figure 101 — Schematic examples of the different types of battery-operated energizers suitable for connection to the mains



IEC

Key

S supply mains

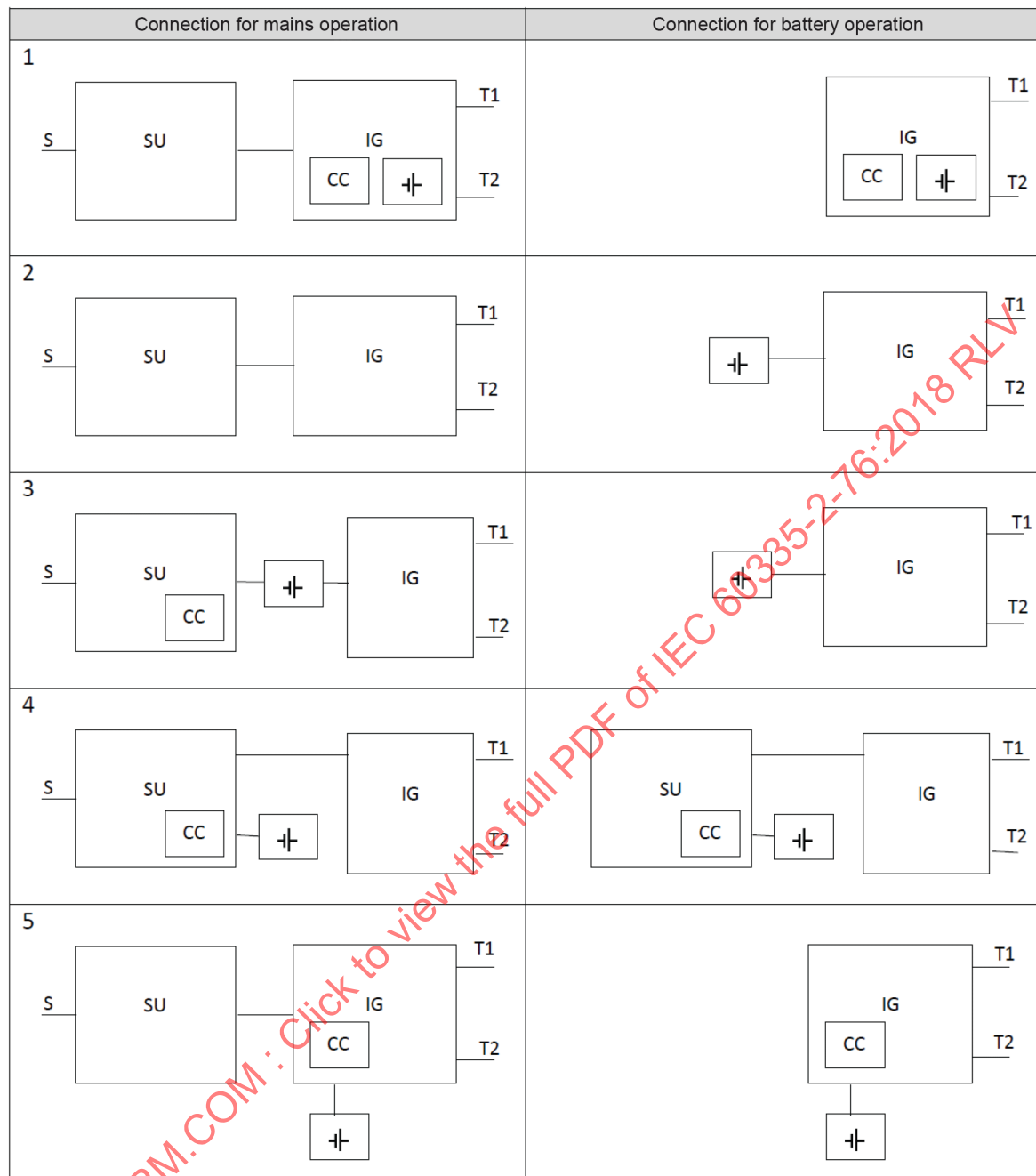
CC battery charging circuit

IG impulse generating circuit

battery

T1, T2 output terminals

Figure 101 – Schematic examples of type A energizers, type B energizers and type C energizers

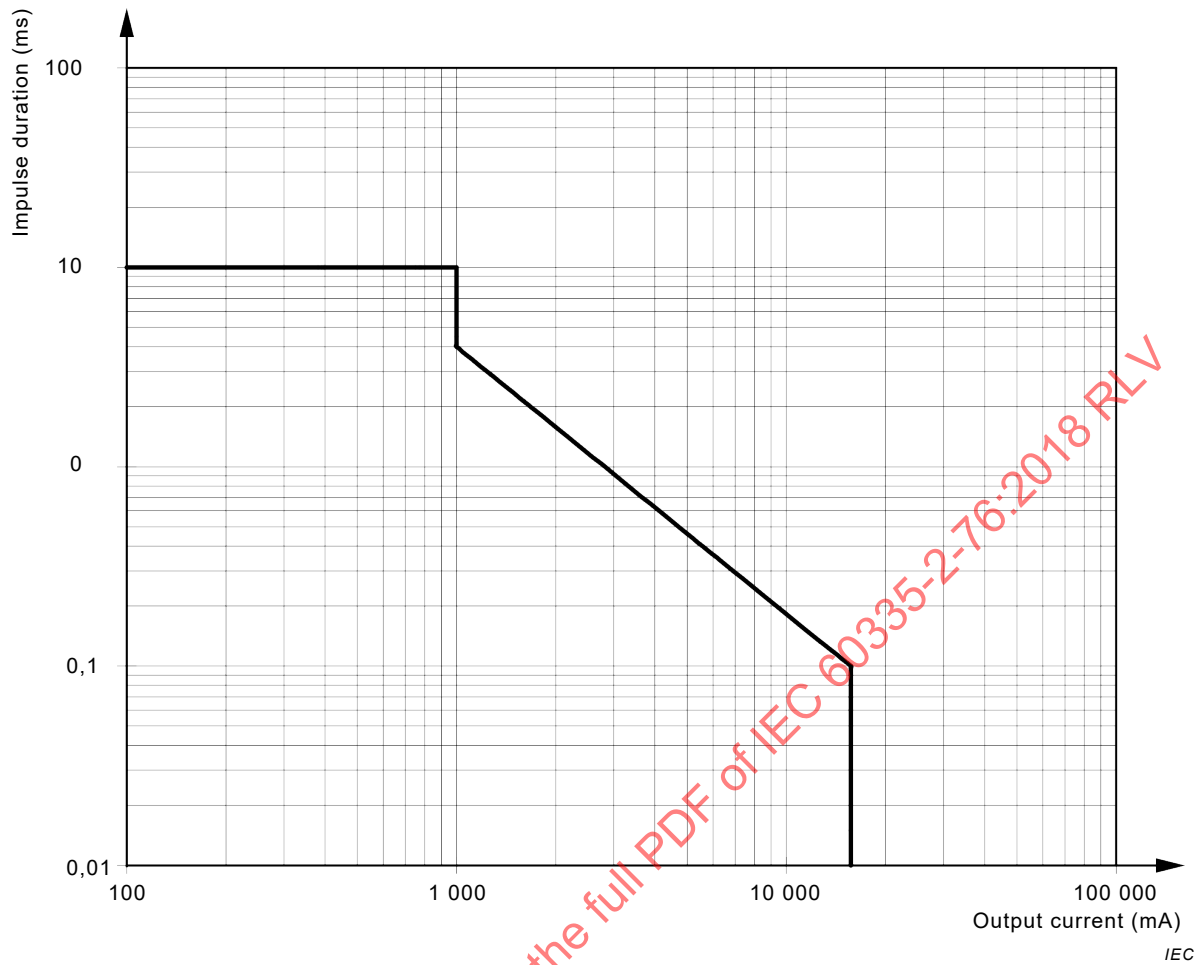


IEC

Key

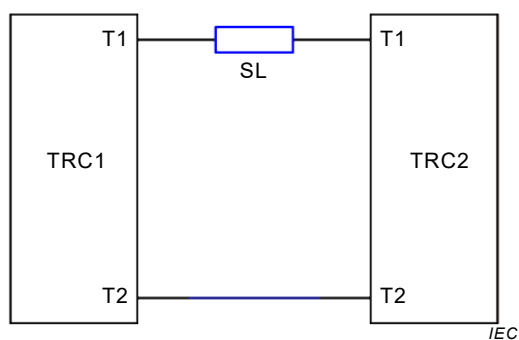
- S supply mains
 SU detachable supply unit
 CC battery charging circuit
 IG impulse generating circuit
 battery
 T1, T2 output terminals

Figure 102 – Schematic examples of the different types of type D energizers

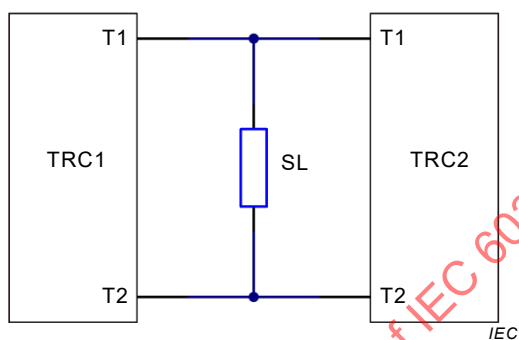


NOTE The equation of the line relating impulse duration (ms) to output current (mA) for 1 000 mA < output current < 15 700 mA, is given by $\text{impulse duration} = 41,885 \times 10^3 \times (\text{output current})^{-1,34}$.

Figure 103 – Current limited energizer characteristic limit line



Test configuration A



Test configuration B

Key

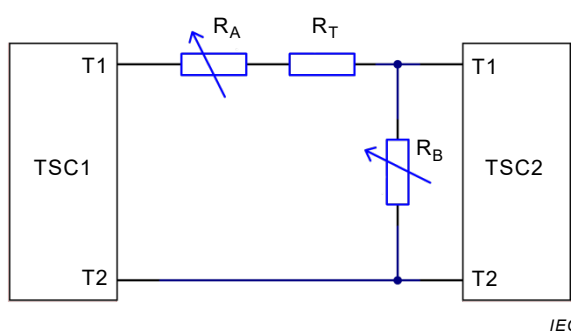
TRC1 type R fence circuit 1

TRC2 type R fence circuit 2

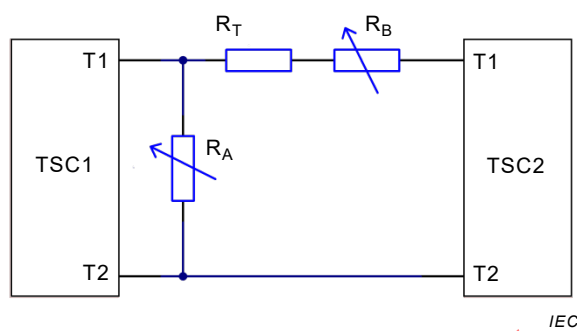
SL **standard load**

T1, T2 **type R security energizer group** output terminals

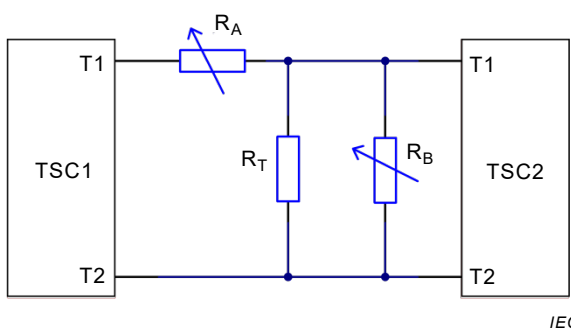
Figure 104 – Type R security energizer group test configurations



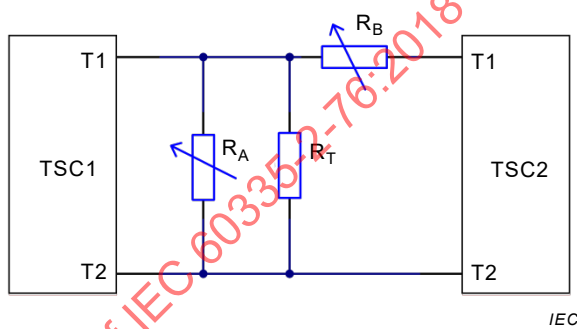
Test configuration 1



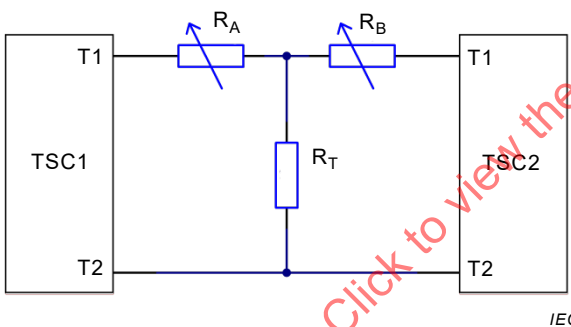
Test configuration 2



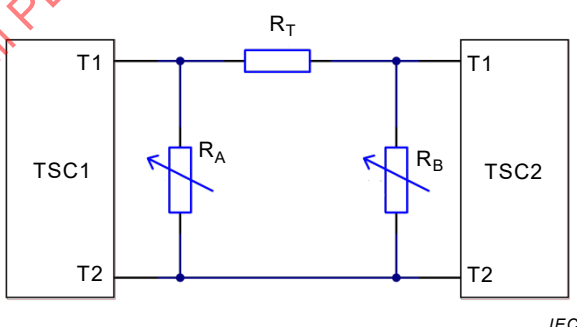
Test configuration 3



Test configuration 4



Test configuration 5



Test configuration 6

Key

TSC1 type S fence circuit 1

TSC2 type S fence circuit 2

R_A variable resistor

R_B variable resistor

R_T 500 Ω resistor

T1, T2 type S security energizer group output terminals

Figure 105 – Type S security energizer group test configurations

Annexes

The annexes of Part 1 are applicable except as follows.

Annex A (informative)

Routine tests

This annex of Part 1 is applicable except as follows.

A.2 Electric strength test

Addition:

For mains-operated energizers and battery-operated energizers suitable for connection to the mains, an electric strength test is carried out between the ~~mains~~ supply circuit and the fence circuit, the test voltage being 10 000 V AC, 50 Hz or 60 Hz, or 15 000 V DC for 1 s.

A.3 Functional test

Addition:

The energizer output characteristic shall be checked by operating the energizer at rated voltage with a 500 Ω load connected across the ~~fence~~ output terminals.

The energizer output characteristic shall be such that

- *the impulse repetition rate shall not exceed 1 Hz;*
- *the impulse duration of the impulse shall not exceed 10 ms;*
- *for energy limited energizers, the energy/impulse shall not exceed 5 J;*
- *for current limited energizers, the output current shall not exceed*
 - *the value specified by the characteristic limit line detailed in Figure ~~102~~ 103;*
 - *for an impulse duration of less than 0,1 ms, 15 700 mA.*

Annex B (normative)

Appliances powered by rechargeable batteries that are recharged in the appliance

This annex of Part 1 is applicable ~~except as follows~~ along with the following additions and modifications.

Addition:

~~The modifications to 3.19, 11.7, 19 and 30.2 are not applicable.~~

NOTE B.101 Rechargeable batteries that are recharged while connected to the appliance are considered to be recharged in the appliance.

7 Marking and instructions

7.1 Addition:

Energizers supplied by other sources of energy and not suitable for connection to the supply mains shall be marked with the symbol for “connection to mains operated equipment prohibited” or with the substance of the following warning.

WARNING: Do not connect to mains-operated equipment such as battery chargers.

The rules for a prohibition sign in ISO 3864-1, except for colours, apply to the symbol for connection to mains-operated equipment prohibited.

Modification:

The text referring to the **detachable supply unit** is not applicable.

7.6 Addition:



connection to mains-operated equipment prohibited

7.12 Addition:

If the symbol for “connection to mains-operated equipment prohibited” is used, its meaning shall be explained.

Modification:

The warning referring to the **detachable supply unit** is replaced by the substance of the following.

WARNING: Use only a detachable supply unit that is listed as an accessory made available by the manufacturer.

Add the following subclause:

7.14 *Addition:*

If the symbol for “connection to mains-operated equipment prohibited” is marked on the appliance, the outer diameter of the circle shall be at least 15 mm.

7.15 Not applicable.

30 Resistance to heat and fire

30.2 This subclause of Part 1 is not applicable.

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Annex S (normative)

Battery-operated appliances powered by batteries that are non-rechargeable or not recharged in the appliance

This annex of Part 1 is applicable along with the following additions and modifications.

7 Marking and instructions

7.1 Addition:

Battery-operated energizers shall be marked with the symbol for “connection to mains operated equipment prohibited” or with the substance of the following warning:

WARNING: Do not connect to mains-operated equipment such as battery chargers.

The rules for a prohibition sign in ISO 3864-1, except for colours, apply to the symbol for connection to mains-operated equipment prohibited.

7.6 Addition:



connection to mains-operated equipment prohibited

7.12 Addition:

If the symbol for “connection to mains-operated equipment prohibited” is used, its meaning shall be explained.

Add the following subclause

7.14 Addition:

If the symbol for “connection to mains-operated equipment prohibited” is marked on the appliance, the outer diameter of the circle shall be at least 15 mm.

Add the following clause.

14 Transient voltages

14.1 Addition:

Battery-operated energizers having a **rated voltage** exceeding 42,4 V are installed as in normal use and are then subjected to the test of 14.S.101.

14.S.101 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between the output terminals, the interval between the impulses being at least 10 s. The input terminals are open-circuited.

Add the following clause.

16 Leakage current and electric strength

16.1 Addition:

Battery-operated energizers are subjected to the tests of 16.S.101.

16.S.101 For **battery-operated energizers**, the supply terminals are connected for 10 min to a voltage between 1,1 and 1,5 times **rated voltage for battery supply**, that is so chosen that the output voltage, without a load connected, has the maximum value, protective spark gaps, if any, being disconnected.

No breakdown shall occur during the test.

Immediately after the tests, the output characteristics are measured as specified in 22.108.

The values measured shall be within the limits specified in 22.108.

Add the following clause.

18 Endurance

Addition:

Battery-operated energizers shall be so constructed that they are able to endure extreme temperatures that may be encountered in normal use. Moreover, overload **protection devices** shall not operate under these conditions.

Compliance is checked by the following test.

Battery-operated energizers are placed in their normal position and are fitted with a battery having a nominal voltage equal to the **rated voltage** of the energizer. The battery shall be of the largest capacity for which the energizer is designed. The battery shall be fully charged at the beginning of the test and shall be replaced by a fresh one as soon as, during the test, the voltage of the battery decreases to 0,75 times its nominal voltage for a rechargeable battery or to 0,55 times its nominal voltage for a non-rechargeable battery or until the **energizer** ceases to function due to low battery voltage.

The **energizer** is operated continuously for 168 h (seven days) at an ambient temperature of $-15\text{ °C} \pm 2\text{ °C}$ and then for 168 h (seven days) at an ambient temperature of $50\text{ °C} \pm 2\text{ °C}$.

The output terminals are loaded with a non-inductive resistor of $500\ \Omega \pm 2,5\ \Omega$ during the first 84 h of each period of 168 h and the load is removed for the remainder of these periods.

At the end of each of the periods of 168 h, the output characteristics are measured, as specified in 22.108, at the ambient temperature prescribed for the relevant period.

The values measured shall be within the limits specified in 22.108.

During the test, the **energizer** shall show no change impairing its further use, the sealing compound, if any, shall not flow out to such an extent that live parts are exposed and the **energizer** shall still meet the requirements of Clause 8.

19 Abnormal operation

19.S.103 Battery operated energizers having a rated voltage of less than 12 V are operated under **normal operation** when supplied with an input voltage of 13,2 V DC.

*During the test, the **energizer** shall be connected to the voltage source via a 1 Ω series resistor.*

*This test is only applicable if the supply may be connected without modification of the **energizer**.*

Add the following clause.

22 Construction

22.S.101 For **battery-operated energizers**, parts in a battery compartment that become accessible when replacing batteries, even with the aid of a **tool**, shall not be **live parts**.

*Compliance is checked by inspection, measurement and by the tests specified for **double insulation** or **reinforced insulation**.*

22.S.102 Battery-operated energizers shall be provided with means to prevent the user from being subjected to an electric shock due to the **energizer** output voltage, when connecting a battery to the **energizer**.

Compliance is checked by inspection.

NOTE Examples of such means are:

- a switch that isolates the terminals for the connection of the battery;
- a control that enables the output voltage to be reduced to zero;
- insulated crocodile clips or similar devices.

22.S.103 The **clearance** between parts of opposite polarity for connecting the battery in **battery operated energizers** shall not be less than 2 mm, when the **energizer** is fitted with conductors as in normal use.

Compliance is checked by measurement.

25 Supply connection and external flexible cords

Add the following new subclauses.

25.7 Addition:

This requirement is not applicable to the flexible leads or flexible cord connecting external batteries or a **battery box** to a **battery-operated energizer**.

25.23 Addition:

In **battery-operated energizers**, if the battery is placed in a box, the flexible lead or flexible cord connecting the box with the **energizer** is considered to be an **interconnection cord**.

25.S.101 *Addition:*

The conductors in flexible leads or flexible cords used to connect the battery in **battery-operated energizers** shall have a nominal cross-sectional area of not less than 0,75 mm².

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Annex AA (informative)

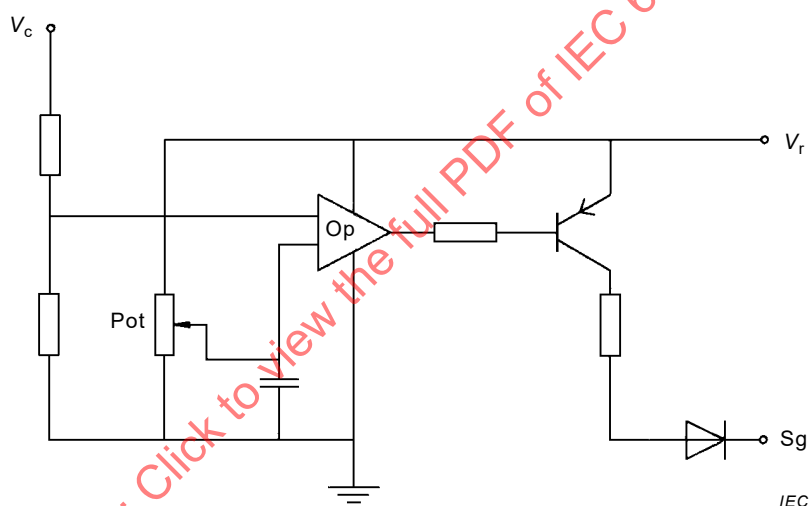
Circuit for the independent control of the switching speed of the major impulse-switching device

A suitable circuit for external independent control of the switching speed of semiconductor devices used as the major impulse-switching device in the energizer, in accordance with the eighth dashed item of 19.101, is shown in Figure AA.1.

The circuit is used to reference the gate signal of the major impulse-switching device to the voltage across this device so that it can be triggered at the same point in the charging cycle.

The reference voltage should be of such a value that the comparator is adjustable over the whole range of the energizer charging voltage, thereby allowing the switching speed to be set at any desired frequency.

The input impedance of the comparator circuit should be such that it does not influence the results of the test.



Key

- V_c charging voltage
- V_r reference voltage
- Sg gate signal
- Pot switching speed adjustor
- Op comparator

**Figure AA.1 – Circuit for the independent control of the switching speed
of the major impulse-switching device**

Annex BB (normative)

Instructions for installation and connection of electric fences

BB.1 ~~Requirements~~ Instructions for electric animal fences

For the purpose of these instructions, the term **connecting leads** means electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**.

Electric animal fences and their ancillary equipment shall be installed, operated and maintained in a manner that minimizes danger to persons, animals or their surroundings.

Electric animal fence constructions that are likely to lead to the entanglement of animals or persons shall be avoided.

WARNING: Avoid contacting electric fence wires especially with the head, neck or torso. Do not climb over, through or under a multi-wire electric fence. Use a gate or a specially designed crossing point.

An **electric animal fence** shall not be supplied from two separate **energizers** or from independent **fence circuits** of the same **energizer**.

For any two separate **electric animal fences**, each supplied from a separate **energizer** independently timed, the distance between the wires of the two **electric animal fences** shall be at least 2,5 m. If this gap is to be closed, this shall be effected by means of electrically non-conductive material or an isolated metal barrier.

Barbed wire or razor wire shall not be electrified by an **energizer**.

A non-electrified **fence** incorporating barbed wire or razor wire may be used to support one or more off-set electrified wires of an **electric animal fence**. The supporting devices for the electrified wires shall be constructed so as to ensure that these wires are positioned at a minimum distance of 150 mm from the vertical plane of the non-electrified wires. The barbed wire and razor wire shall be earthed at regular intervals.

Follow the energizer manufacturer's recommendations regarding earthing.

A distance of at least 10 m shall be maintained between the **energizer earth electrode** and any other earthing system connected parts such as the power supply system protective earth or the telecommunication system earth.

Connecting leads that are run inside buildings shall be effectively insulated from the earthed structural parts of the building. This may be achieved by using insulated high voltage cable.

Connecting leads that are run underground shall be run in conduit of insulating material or else insulated high voltage cable shall be used. Care ~~must~~ shall be taken to avoid damage to the **connecting leads** due to the effects of animal hooves or tractor wheels sinking into the ground.

Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables.

Connecting leads and **electric animal fence** wires shall not cross above overhead power or communication lines.

Crossings with overhead power lines shall be avoided wherever possible. If such a crossing cannot be avoided it shall be made underneath the power line and as nearly as possible at right angles to it.

If **connecting leads** and **electric animal fence** wires are installed near an overhead power line, the clearances shall not be less than those shown in Table BB.1.

Table BB.1 – Minimum clearances from power lines for electric animal fences

Power line voltage V	Clearance m
≤ 1 000	3
> 1 000 and ≤ 33 000	4
> 33 000	8

If **connecting leads** and **electric animal fence** wires are installed near an overhead power line, their height above the ground shall not exceed 3 m.

This height applies to either side of the orthogonal projection of the outermost conductors of the power line on the ground surface, for a distance of

- 2 m for power lines operating at a nominal voltage not exceeding 1 000 V;
- 15 m for power lines operating at a nominal voltage exceeding 1 000 V.

Electric animal fences intended for deterring birds, household pet containment or training animals such as cows need only be supplied from low output **energizers** to obtain satisfactory and safe performance.

In **electric animal fences** intended for deterring birds from roosting on buildings, no **electric fence** wire shall be connected to the **energizer earth electrode**. A warning sign shall be fitted to every point where persons may gain ready access to the conductors.

Where an **electric animal fence** crosses a public pathway, a non-electrified gate shall be incorporated in the **electric animal fence** at that point or a crossing by means of stiles shall be provided. At any such crossing, the adjacent electrified wires shall carry warning signs.

Any part of an **electric animal fence** that is installed along a public road or pathway shall be identified at frequent intervals by warning signs securely fastened to the **fence** posts or firmly clamped to the **fence** wires.

The size of the warning sign shall be at least 100 mm × 200 mm.

The background colour of both sides of the warning sign shall be yellow. The inscription on the sign shall be black and shall be either

- the symbol of Figure BB.1, or
- the substance of “CAUTION: **Electric animal fence**”.

The inscription shall be indelible, inscribed on both sides of the warning sign and have a height of at least 25 mm.

Ensure that all mains-operated, ancillary equipment connected to the **electric animal fence circuit** provides a degree of isolation between the **fence circuit** and the supply mains equivalent to that provided by the **energizer**.

NOTE Ancillary equipment that complies with the requirements relating to isolation between the **fence circuit** and the supply mains in Clauses 14, 16 and 29 of the standard for the **electric fence energizer** is considered to provide an adequate level of isolation.

Protection from the weather shall be provided for the ancillary equipment unless this equipment is certified by the manufacturer as being suitable for use outdoors, and is of a type with a minimum degree of protection IPX4.

BB.2 **Requirements** Instructions for electric security fences not supplied from a security energizer group

For the purpose of these instructions, the term:

- **connecting leads** means electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**;
- **physical barrier** means a barrier not less than 1,5 m high intended to prevent inadvertent contact with the **pulsed conductors** of the **electric fence**;
- **secure area** means an area where a person is not separated from **pulsed conductors** below 1,5 m by a **physical barrier**;
- **public access area** means any area where persons are protected from inadvertent contact with **pulsed conductors** by a **physical barrier**;
- **pulsed conductors** means conductors that are subjected to high voltage pulses by the **energizer**.

Electric security fences and their ancillary equipment shall be installed, operated and maintained in a manner that minimizes danger to persons, and reduces the risk of persons receiving an electric shock unless they attempt to penetrate the **physical barrier**, or are in the **secure area** without authority.

Electric security fence constructions that are likely to lead to the entanglement of persons shall be avoided.

Gates in **electric security fences** shall be capable of being opened without the person receiving an electric shock.

An **electric security fence** shall not be supplied from two separate **energizers** or from independent **fence circuits** of the same **energizer**.

For any two separate **electric security fences**, each supplied from a separate **energizer** ~~independently timed~~, the distance between the wires of the two **separate electric security fences** shall be at least 2,5 m. If this gap is to be closed, this shall be effected by means of ~~electrically non-conductive material or an isolated metal barrier~~ a physical barrier of high voltage insulating material or earthed conducting material such that the two separate **electric security fences** cannot be contacted at the same time.

A spacing of 2,5 m shall be maintained between uninsulated **connecting leads** supplied from separate **energizers**. This spacing may be less where

- the connecting leads are covered by insulating sleeving rated to at least 10 kV at mains frequency; or
- the connecting leads consist of insulated cables rated to at least 10 kV at mains frequency.

Barbed wire or razor wire shall not be electrified by an **energizer**.

For earthing recommendations, follow the relevant national standard for **electric security fence** earthing. If this does not exist then follow the **energizer** manufacturer's instructions and recommendations ~~regarding earthing~~.

The distance between any **electric security fence earth electrode** and other earth systems shall be not less than 2 m, except when associated with a graded earth mat.

NOTE Where possible, the distance between any electric **security fence earth electrode** and other earth systems should preferably be at least 10 m.

Exposed conductive parts of the **physical barrier** shall be effectively earthed.

Where an **electric security fence** passes below bare power line conductors, the highest metallic element shall be effectively earthed for a distance of not less than 5 m on either side of the crossing point.

Connecting leads that are run inside buildings shall be effectively insulated from the earthed structural parts of the building. This may be achieved by using insulated high voltage cable.

Connecting leads that are run underground shall be run in conduit of insulating material or else insulated high voltage cable shall be used. Care ~~must~~ **shall** be taken to avoid damage to the **connecting leads** due to the effects of vehicle wheels sinking into the ground.

Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables.

Connecting leads and **electric security fence** wires shall not cross above overhead power or communication lines.

Crossings with overhead power lines shall be avoided wherever possible. If such a crossing cannot be avoided, it shall be made underneath the power line and as nearly as possible at right angles to it.

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, the clearances shall not be less than those shown in Table BB.2.

Table BB.2 – Minimum clearances from power lines for electric security fences not supplied from a security energizer group

Power line voltage V	Clearance m
≤ 1 000	3
> 1 000 and ≤ 33 000	4
> 33 000	8

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, their height above the ground shall not exceed 3 m.

This height applies to either side of the orthogonal projection of the outermost conductors of the power line on the ground surface, for a distance of

- 2 m for power lines operating at a nominal voltage not exceeding 1 000 V;
- 15 m for power lines operating at a nominal voltage exceeding 1 000 V.

~~A spacing of 2,5 m shall be maintained between uninsulated **electric security fence** conductors or uninsulated **connecting leads** supplied from separate **energizers**. This spacing may be less where conductors or connecting leads are covered by insulating sleeving, or consist of insulated cables rated to at least 10 kV.~~

~~This requirement need not apply where the separately energized conductors are separated by a **physical barrier** that does not have any openings greater than 50 mm.~~

~~A vertical separation of not less than 2 m shall be maintained between **pulsed conductors** fed from separate **energizers**.~~

Electric security fences shall be identified by prominently placed warning signs.

The warning signs shall be legible from the **secure area** and the **public access area**.

Each side of the **electric security fence** shall have at least one warning sign.

Warning signs shall be placed

- at each gate;
- at each access point;
- at intervals not exceeding 10 m;
- adjacent to each sign relating to chemical hazards for the information of the emergency services.

Any part of an **electric security fence** that is installed along a public road or pathway shall be identified at frequent intervals by warning signs securely fastened to the **fence** posts or firmly clamped to the **fence** wires.

The size of the warning sign shall be at least 100 mm × 200 mm.

The background colour of both sides of the warning sign shall be yellow. The inscription on the sign shall be black and shall be either

- the symbol of Figure BB.1, or
- the substance of “CAUTION: **Electric security fence**”.

The inscription shall be indelible, inscribed on both sides of the warning sign and have a height of at least 25 mm.

Ensure that all mains operated, ancillary equipment connected to the **electric security fence circuit** provides a degree of isolation between the **fence circuit** and the supply mains equivalent to that provided by the **energizer**.

NOTE 2 Ancillary equipment that complies with the requirements relating to isolation between the **fence circuit** and the supply mains in Clauses 14, 16 and 29 of the standard for the **electric fence energizer** is considered to provide an adequate level of isolation.

Mains supply wiring shall not be installed in the same conduit as signalling leads associated with the **electric security fence** installation.

Protection from the weather shall be provided for the ancillary equipment unless this equipment is certified by the manufacturer as being suitable for use outdoors, and is of a type with a minimum degree of protection IPX4.

BB.3 Instructions for electric security fences supplied from a security energizer group

For the purpose of these instructions the term:

- **connecting leads** means electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**;
- **physical barrier** means a barrier not less than 1,5 m high intended to prevent inadvertent contact with the **pulsed conductors** of the **electric fence**;
- **secure area** means an area where a person is not separated from **pulsed conductors** below 1,5 m by a **physical barrier**;
- **public access area** means any area where persons are protected from inadvertent contact with **pulsed conductors** by a **physical barrier**;
- **pulsed conductors** means conductors that are subjected to high voltage pulses by the **energizer**.

Electric security fences and their ancillary equipment shall be installed, operated and maintained in a manner that minimizes danger to persons, and reduces the risk of persons receiving an electric shock unless they attempt to penetrate the **physical barrier**, or are in the **secure area** without authority.

Electric security fence constructions that are likely to lead to the entanglement of persons shall be avoided.

Gates in **electric security fences** shall be capable of being opened without the person receiving an electric shock.

An **electric security fence** shall not be supplied from two separate **energizers** unless they are **type R security energizers** or **type S security energizers** configured and connected to operate in a **type R security energizer group** or **type S security energizer group**.

For any two separate **electric security fences**, each supplied from a separate **energizer**, the distance between the wires of the two separate **electric security fences** shall be at least 2,5 m. If this gap is to be closed, this shall be effected by means of a physical barrier of high voltage insulating material or earthed conducting material such that the two separate security fences cannot be contacted at the same time.

This gap can also be closed if the **electric security fences** are supplied by **type R security energizers** or **type S security energizers** that are part of a **type R security energizer group** or **type S security energiser group** configured and connected in accordance with the instructions.

A spacing of 2,5 m shall be maintained between uninsulated **connecting leads** supplied from separate **energizers**. This spacing may be less where

- the **connecting leads** are covered by insulating sleeving rated to at least 10 kV at mains frequency; or
- the **connecting leads** consist of insulated cables rated to at least 10 kV at mains frequency; or
- the **connecting leads** are powered by **energizers** that are part of a **type R security energizer group** or **type S security energizer group** configured and connected in accordance with the instructions.

Barbed wire or razor wire shall not be electrified by an **energizer**.

For earthing recommendations, follow the relevant national standard for **electric security fence** earthing. If this does not exist then follow the **energizer** manufacturer's instructions and recommendations.

The distance between any **electric security fence earth electrode** and other earth systems shall be not less than 2 m, except when associated with a graded earth mat.

Where possible, the distance between any electric **security fence earth electrode** and other earth systems should preferably be at least 10 m.

Exposed conductive parts of the **physical barrier** shall be effectively earthed.

Where an **electric security fence** passes below bare power line conductors, the highest metallic element shall be effectively earthed for a distance of not less than 5 m on either side of the crossing point.

Connecting leads that are run inside buildings shall be effectively insulated from the earthed structural parts of the building. This may be achieved by using insulated high voltage cable.

Connecting leads that are run underground shall be run in conduit of insulating material or else insulated high voltage cable shall be used. Care shall be taken to avoid damage to the **connecting leads** due to the effects of vehicle wheels sinking into the ground.

Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables.

Connecting leads and **electric security fence wires** shall not cross above overhead power or communication lines.

Crossings with overhead power lines shall be avoided wherever possible. If such a crossing cannot be avoided, it shall be made underneath the power line and as nearly as possible at right angles to it.

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, the clearances shall not be less than those shown in Table BB.3.

Table BB.3 – Minimum clearances from power lines for electric security fences supplied from a security energizer group

Power line voltage V	Clearance m
≤ 1 000	3
> 1 000 and ≤ 33 000	4
> 33 000	8

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, their height above the ground shall not exceed 3 m.

This height applies to either side of the orthogonal projection of the outermost conductors of the power line on the ground surface, for a distance of

- 2 m for power lines operating at a nominal voltage not exceeding 1 000 V;
- 15 m for power lines operating at a nominal voltage exceeding 1 000 V.

Electric security fences shall be identified by prominently placed warning signs.

The warning signs shall be legible from the **secure area** and the **public access area**.

Each side of the **electric security fence** shall have at least one warning sign.

Warning signs shall be placed

- at each gate;
- at each access point;
- at intervals not exceeding 10 m;
- adjacent to each sign relating to chemical hazards for the information of the emergency services.

Any part of an **electric security fence** that is installed along a public road or pathway shall be identified at frequent intervals by warning signs securely fastened to the fence posts or firmly clamped to the fence wires.

The size of the warning sign shall be at least 100 mm × 200 mm.

The background colour of both sides of the warning sign shall be yellow. The inscription on the sign shall be black and shall be either

- the symbol of Figure BB.1, or
- the substance of “CAUTION: **Electric fence**”.

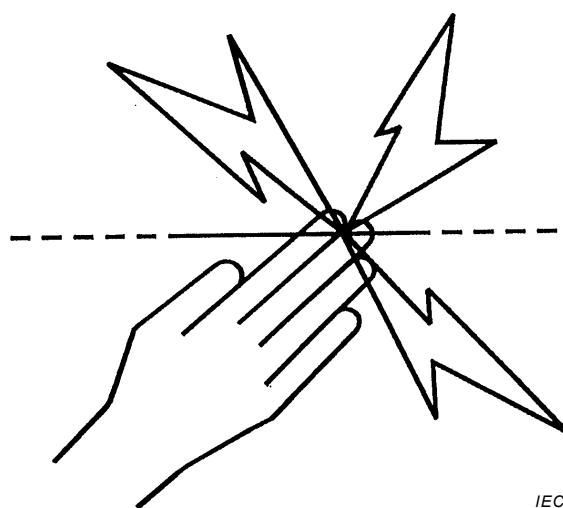
The inscription shall be indelible, inscribed on both sides of the warning sign and have a height of at least 25 mm.

Ensure that all mains operated, ancillary equipment connected to the **electric security fence circuit** provides a degree of isolation between the **fence circuit** and the supply mains equivalent to that provided by the **energizer**.

NOTE 2 Ancillary equipment that complies with the requirements relating to isolation between the **fence circuit** and the supply mains in Clauses 14, 16 and 29 of the standard for the **electric fence energizer** is considered to provide an adequate level of isolation.

Mains supply wiring shall not be installed in the same conduit as signalling leads associated with the **electric security fence** installation.

Protection from the weather shall be provided for the ancillary equipment unless this equipment is certified by the manufacturer as being suitable for use outdoors, and is of a type with a minimum degree of protection IPX4.



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Figure BB.1 – Symbol for warning sign

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

NOTE When selecting the type of **physical barrier**, the likely presence of young children should be a factor in considering the size of openings and a risk assessment shall be made prior to installation.

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~~ should not be installed within the shaded zone shown in Figure CC.1.

NOTE 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 Typical **electric security fence** installations are shown in Figure CC.2 and Figure CC.3.

CC.4 Separation between electric fence and physical barrier

Where a **physical barrier** is installed in compliance with Clause 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~~ **can** be expected to fall from a surface if contact is made with **pulsed conductors**.

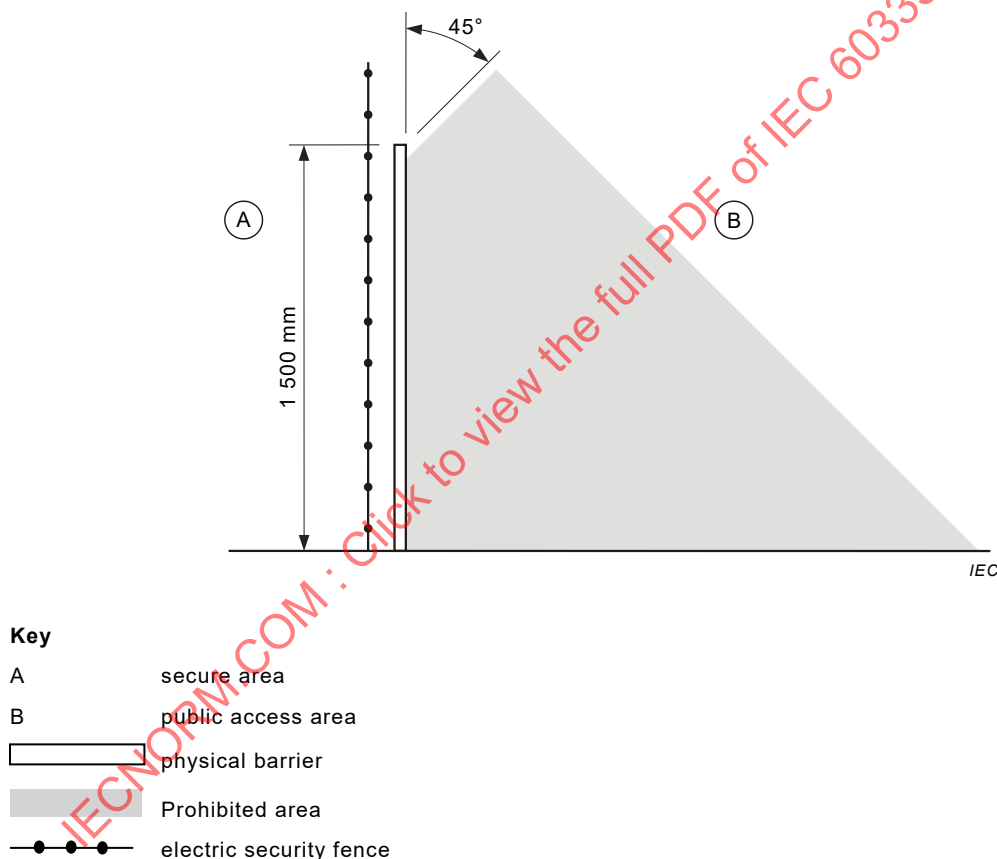
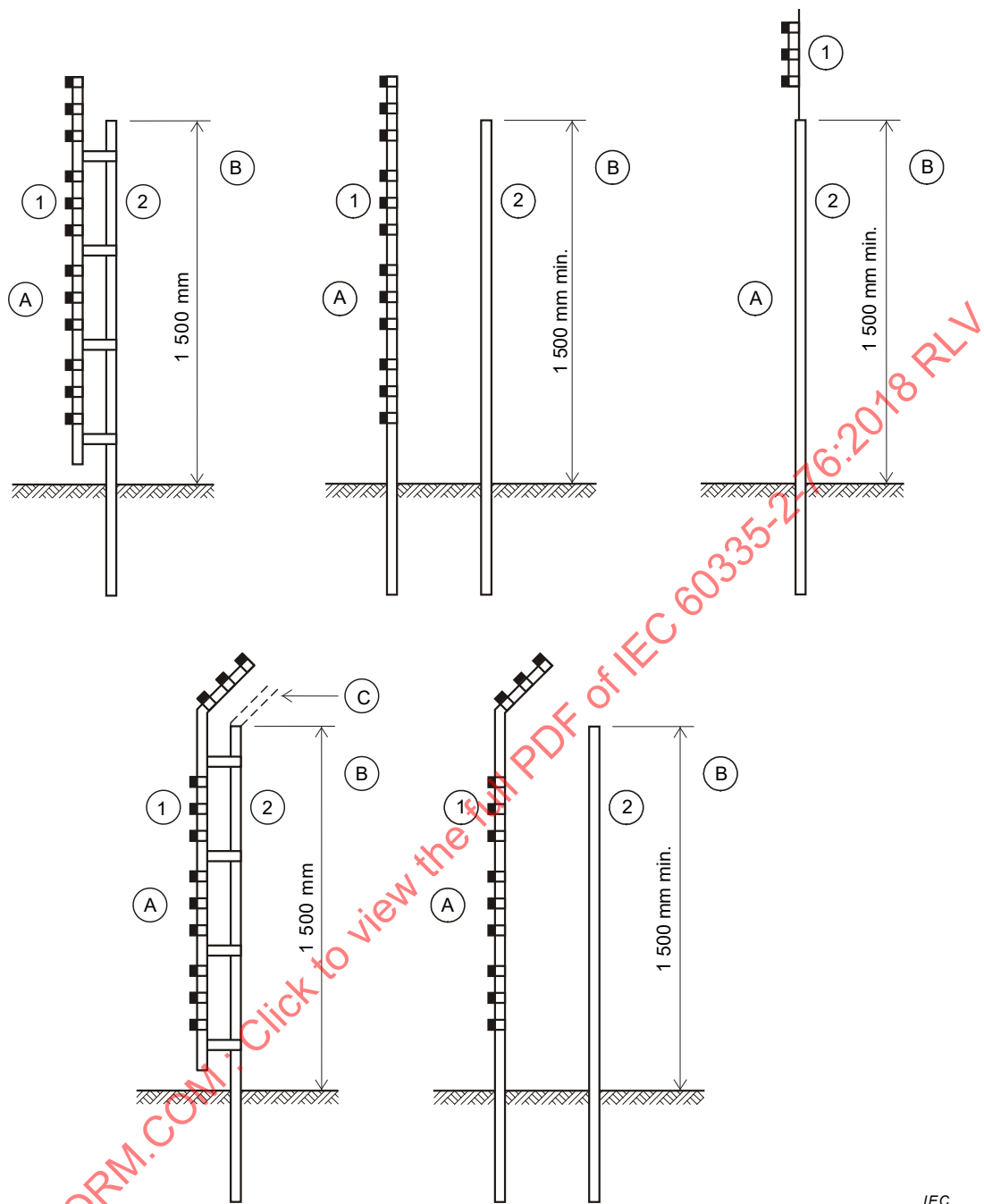


Figure CC.1 – Prohibited area for pulse conductors

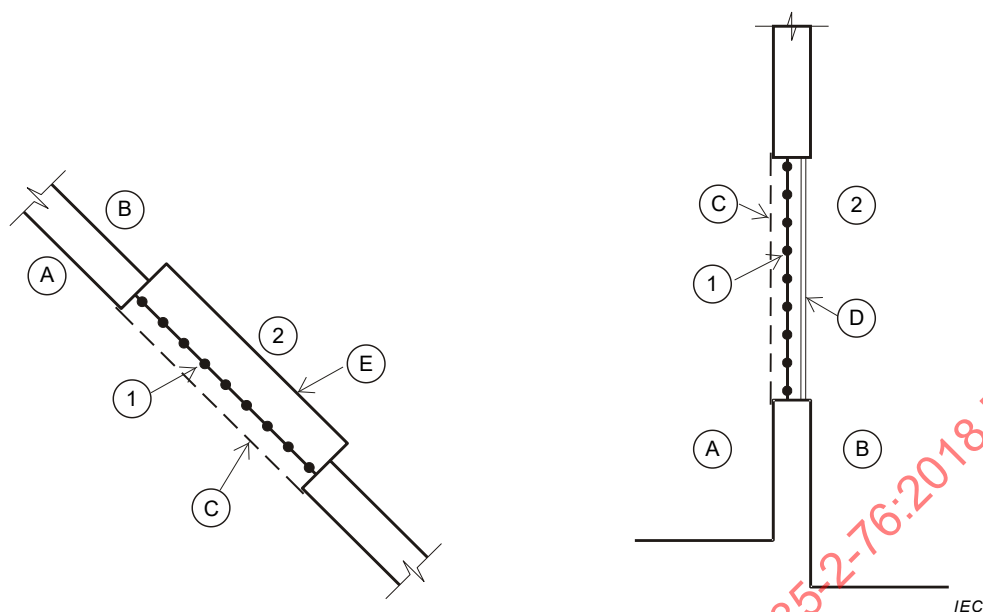


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Key

- 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*

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INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Appareils électrodomestiques et analogues – Sécurité
Partie 2-76: Exigences particulières pour les électrificateurs de clôtures**

CONTENTS

FOREWORD	4
INTRODUCTION	7
1 Scope	8
2 Normative references	8
3 Terms and definitions	9
4 General requirement	13
5 General conditions for the tests	13
6 Classification	14
7 Marking and instructions	15
8 Protection against access to live parts	18
9 Starting of motor-operated appliances	18
10 Power input and current	18
11 Heating	18
12 Void	20
13 Leakage current and electric strength at operating temperature	20
14 Transient overvoltages	21
15 Moisture resistance	22
16 Leakage current and electric strength	22
17 Overload protection of transformers and associated circuits	23
18 Endurance	23
19 Abnormal operation	24
20 Stability and mechanical hazards	26
21 Mechanical strength	26
22 Construction	27
23 Internal wiring	31
24 Components	32
25 Supply connection and external flexible cords	32
26 Terminals for external conductors	32
27 Provision for earthing	33
28 Screws and connections	33
29 Clearances, creepage distances and solid insulation	33
30 Resistance to heat and fire	33
31 Resistance to rusting	34
32 Radiation, toxicity and similar hazards	34
Annexes	40
Annex A (informative) Routine tests	40
Annex B (normative) Appliances powered by rechargeable batteries that are recharged in the appliance	41
Annex S (normative) Battery-operated appliances powered by batteries that are non-rechargeable or not recharged in the appliance	43
Annex AA (informative) Circuit for the independent control of the switching speed of the major impulse-switching device	47

Annex BB (normative) Instructions for installation and connection of electric fences	48
BB.1 Instructions for electric animal fences	48
BB.2 Instructions for electric security fences not supplied from a security energizer group.....	50
BB.3 Instructions for electric security fences supplied from a security energizer group	52
Annex CC (informative) Installation of electric security fences	56
CC.1 General.....	56
CC.2 Location of electric security fence	56
CC.3 Prohibited zone for pulsed conductors	56
CC.4 Separation between electric fence and physical barrier.....	56
CC.5 Prohibited mounting	57
CC.6 Operation of electric security fence	57
Bibliography.....	60
Figure 101 – Schematic examples of type A energizers, type B energizers and type C energizers	35
Figure 102 – Schematic examples of the different types of type D energizers	36
Figure 103 – Current limited energizer characteristic limit line	37
Figure 104 – Type R security energizer group test configurations	38
Figure 105 – Type S security energizer group test configurations	39
Figure AA.1 – Circuit for the independent control of the switching speed of the major impulse-switching device	47
Figure BB.1 – Symbol for warning sign	55
Figure CC.1 – Prohibited area for pulse conductors	57
Figure CC.2 – Typical constructions where an electric security fence is exposed to the public.....	58
Figure CC.3 – Typical fence constructions where the electric security fence is installed in windows and skylights.....	59
Table 101 – Battery source impedance	19
Table 102 – Rated supply voltage maximum and minimum value multiplier factors.....	19
Table 103 – Supply voltage value test settings.....	20
Table 104 – Test supply sequence for different supply type	20
Table 105 – Additional test voltages	23
Table BB.1 – Minimum clearances from power lines for electric animal fences.....	49
Table BB.2 – Minimum clearances from power lines for electric security fences not supplied from a security energizer group	51
Table BB.3 – Minimum clearances from power lines for electric security fences supplied from a security energizer group	54

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –**Part 2-76: Particular requirements for electric fence energizers****FOREWORD**

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This part of International Standard IEC 60335 has been prepared by subcommittee 61H: Safety of electrically-operated farm appliances, of IEC technical committee 61: Safety of household and similar electrical appliances.

This bilingual version (2019-02) corresponds to the monolingual English version, published in 2018-06.

This third edition cancels and replaces the second edition published in 2002, Amendment 1:2006 and Amendment 2:2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- the text has been aligned with Edition 5.2 of Part 1;
- additional requirements for security fence energizers have been introduced (Clauses 3, 7, 19, 22, Figures and Annex BB);

- specific requirements for battery operated energizers have been moved to Annex S.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
61H/366/FDIS	61H/367/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60335 series, published under the general title *Household and similar electrical appliances – Safety*, can be found on the IEC website.

This Part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments. It was established on the basis of the fifth edition (2010) of that standard.

NOTE 1 When “Part 1” is mentioned in this standard, it refers to IEC 60335-1.

This Part 2 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert that publication into the IEC standard: Safety requirements for electric fence energizers.

When a particular subclause of Part 1 is not mentioned in this Part 2, that subclause applies as far as is reasonable. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 is to be adapted accordingly.

NOTE 2 The following numbering system is used:

- subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;
- unless notes are in a new subclause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
- additional Annexes are lettered AA, BB, etc.

NOTE 3 The following print types are used:

- requirements: in roman type
- *test specifications: in italic type*
- notes: in small roman type.

Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and associated noun are also in bold.

NOTE 4 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months or later than 36 months from the date of publication.

The following differences exist in the countries indicated below:

6.101: Only energy limited energizers are allowed (All EU and EFTA counties).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of November 2018 have been included in this copy.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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INTRODUCTION

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

This standard takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, national wiring rules may differ.

If an appliance within the scope of this standard also incorporates functions that are covered by another part 2 of IEC 60335, the relevant part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

NOTE 1 Throughout this publication, when "Part 1" is mentioned, it refers to IEC 60335-1.

When a part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 2 This means that the technical committees responsible for the part 2 standards have determined that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE 3 Horizontal and generic standards covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards. For example, in the case of temperature requirements for surfaces on many appliances, generic standards, such as ISO 13732-1 for hot surfaces, are not applicable in addition to Part 1 or part 2 standards.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-76: Particular requirements for electric fence energizers

1 Scope

This clause of Part 1 is replaced by the following.

This part of IEC 60335 deals with the safety of **electric fence energizers**, the **rated voltage** of which is not more than 250 V and by means of which **fence** wires in agricultural, domestic or feral animal control **fences** and **security fences** may be electrified or monitored.

NOTE 101 Examples of **electric fence energizers** coming within the scope of this standard are:

- **mains-operated energizers**;
- **battery-operated electric fence energizers suitable for connection to the mains**, as shown in Figure 101 and Figure 102;
- **electric fence energizers** operated by non-rechargeable batteries either incorporated or separate.

This standard does not in general take into account

- the use of appliances by young children or infirm persons without supervision;
- the playing with appliances by young children.

NOTE 102 Attention is drawn to the fact that

- for appliances intended to be used on board ships or aircraft, additional requirements can be necessary;
- in many countries, additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, the national water supply authorities and similar authorities.

NOTE 103 This standard does not apply to

- electromagnetically coupled animal trainer collars;
- appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas);
- separate battery chargers (IEC 60335-2-29);
- electric fishing machines (IEC 60335-2-86);
- electric animal-stunning equipment (IEC 60335-2-87);
- appliances for medical purposes (IEC 60601).

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60068-2-52:2017, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60320-3, *Appliance couplers for household and similar general purposes – Part 3: Standard sheets and gauges*

ISO 3864-1, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

3.1 Definitions relating to physical characteristics

3.1.1 Addition:

Note 1 to entry: For **type D energizers**, the **rated voltage** of the **energizer** is the **rated voltage** for battery supply.

Replacement:

3.1.9 normal operation

operation of the appliance under the following conditions: the **electric fence energizer** is operated as in normal use when connected to the supply, with no load connected to the output terminals

3.1.101 prospective peak voltage

peak output voltage of the impulse generator specified in Clause 14 that would be obtained with the **energizer** not connected to the test circuit

3.1.102 rated voltage for battery supply

voltage for battery supply, for **type A energizers**, **type B energizers**, **type C energizers** and **type D energizers** assigned to the **energizer** by the manufacturer

3.1.103 rated voltage range for battery supply

voltage range for battery supply, for **type A energizers**, **type B energizers**, **type C energizers** and **type D energizers** assigned to the **energizer** by the manufacturer, expressed by its lower and upper limits

3.1.104 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

Note 1 to entry: $i(t)$ is the impulse current as a function of time.

3.1.105 output current

RMS value of the **output current** per impulse calculated over the impulse duration

3.5 Definitions relating to types of appliances

3.5.101 electric fence energizer

appliance that is intended to deliver periodically voltage impulses to a **fence** connected to it

Note 1 to entry: **Electric fence energizers** are hereinafter also referred to as **energizers**.

3.5.102 mains-operated energizer

energizer designed for direct connection to the mains

3.5.103

battery-operated energizer suitable for connection to the mains energizer

- operated by batteries and having, or being designed for connection to, facilities for charging these batteries from the mains, or
- designed for operation from the mains and from batteries

3.5.104

type A energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit, a battery charging circuit and a battery, the impulse generating circuit being connected to the mains or the battery when the energizer is in operation

Note 1 to entry: **Type A energizers** are shown schematically in Figure 101.

3.5.105

type B energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit, a battery charging circuit and a battery, the impulse generating circuit being connected to the battery and disconnected from the battery charging circuit and the mains when the **energizer** is in operation.

Note 1 to entry: For recharging the battery, the impulse generating circuit is disconnected and rendered inoperable.

Note 2 to entry: **Type B energizers** are shown schematically in Figure 101.

3.5.106

type C energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit and a battery, the impulse generating circuit being connected to the mains or the battery when the energizer is in operation, and where it is necessary to remove the battery to recharge it using a battery charger or, in the case of a non-rechargeable battery, to replace it with a new battery

Note 1 to entry: **Type C energizers** are shown schematically in Figure 101.

3.5.107

type D energizer

battery-operated energizer suitable for connection to the mains consisting of an impulse generating circuit intended to be powered by a battery, or a **detachable supply unit**, when the **energizer** is in operation. The impulse generating circuit or the battery may be connected to a **detachable supply unit** with or without incorporated battery charging circuitry for recharging the battery when the **energizer** is in operation.

Note 1 to entry: Examples of **Type D energizers** are shown schematically in Figure 102.

3.5.108

battery-operated energizer

energizer deriving its energy solely from batteries or other sources of energy and not designed for connection to the mains

3.5.109

security electric fence energizer

energizer containing **fence circuits** that are intended to periodically deliver voltage impulses into **electric security fences**

Note 1 to entry: A **security electric fence energizer** is hereinafter also referred to as a **security energizer**.

3.5.110**independently timed security energizer**

security energizer that includes an internal **impulse timing signal source** to set the timing of the periodic voltage impulses it delivers to an **electric security fence**

Note 1 to entry: An **independently timed security energizer** is hereinafter also referred to as **an independent security energizer**.

3.5.111**dependently timed security energizer**

security energizer that is dependent on an external **impulse timing signal** to set the timing of the periodic voltage impulses it delivers to an **electric security fence**

Note 1 to entry: A **dependently timed security energizer** is hereinafter also referred to as **dependent security energizer**.

Note 2 to entry: Some types of **security energizer** may be configured either as an **independent security energizer** or a **dependent security energizer** at the time of installation.

3.5.112**security energizer group**

one or two **security energizers** with a group total of two **fence circuits** used to supply adjacent **electric security fences** in a **security energizer fence system** that allows the two **fence circuits** to be contacted at the same time

Note 1 to entry: The **fence circuits** in a **security energizer group** may be galvanically connected.

3.5.113**type R security energizer**

security energizer with one or two **fence circuits** that is suitable for use in a **type R security energizer group**

3.5.114**type R security energizer group**

security energizer group containing only **type R security energizers**

3.5.115**type S security energizer**

security energizer with one or two **fence circuits** that is suitable for use in a **type S security energizer group**

3.5.116**type S security energizer group**

security energizer group containing at least one **type S security energizer**

Note 1 to entry: A **type S security energizer group** may contain a **type R security energizer**.

3.6 Definitions relating to parts of an appliance**3.6.3 Addition:**

Note 101 to entry: It also includes terminals for the connection of the battery and other metal parts in a battery compartment that become accessible when replacing batteries even with the aid of a **tool**.

Replacement:

3.6.4**live part**

conductive part that may cause an electric shock

3.6.101

fence circuit

all conductive parts or components within an **energizer**, that are connected or intended to be connected galvanically to the output terminals

3.6.102

security energizer impulse timing signal

signal that is used to determine the timing of the periodic voltage impulses delivered by a **security energizer** to an **electric security fence**

Note 1 to entry: A **security energizer impulse timing signal** is hereinafter also referred to as an **impulse timing signal**.

Note 2 to entry: Examples of a **security energizer impulse timing signal** include wired (RS-485), wired with latency (internet clock, secure TCP/IP), wireless with latency (LAN, PAN), optical, GPS.

3.6.103

impulse timing signal source

signal source that generates the **impulse timing signal** required by a **dependent security energizer** to set the timing of the periodic voltage impulses it delivers to an **electric security fence**

Note 1 to entry: An **impulse timing signal source** may be used by one or more **dependent security energisers**.

Note 2 to entry: An example of an **impulse timing signal source** is an impulse signal from an adjacent **electric security fence** that is powered by an **independent security energizer** that belongs to the same **security energizer fence system**.

Note 3 to entry: An impulse signal from an adjacent **electric security fence** powered by an **independent security energizer** not belonging to the same **security energizer fence system** is not an example of a possible **impulse timing signal source**.

3.8 Definitions relating to miscellaneous matters

3.8.101

standard load

load consisting of a non-inductive resistor of $500\ \Omega \pm 2,5\ \Omega$ and a variable resistor that is adjusted so as to maximize for

- **energy limited energizers**, the energy per impulse in the $500\ \Omega$ resistor;
- **current limited energizers**, the **output current** in the $500\ \Omega$ resistor.

Note 1 to entry: The variable resistor is connected in series or parallel with the $500\ \Omega$ resistor, whichever gives the more unfavourable result.

3.8.102

earth electrode

metal structure that is driven into the ground near an **energizer** and connected electrically to the output earth terminal of the **energizer**, and that is independent of other earthing arrangements

3.8.103

pulsed conductors

conductors that are subjected to high voltage pulses by the **energizer**

3.8.104

connecting lead

electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**

3.8.105

fence

barrier for animals or for security purposes, comprising one or more conductors, such as metal wires, rods or rails

3.8.106**electric fence**

barrier that includes one or more electric conductors, insulated from earth, to which electric pulses are applied by an **energizer**

3.8.107**electric animal fence**

electric fence used to contain animals within or exclude animals from a particular area

3.8.108**electric security fence**

fence used for security purposes that comprises an **electric fence** and a physical barrier electrically isolated from the **electric fence**

3.8.109**physical barrier**

barrier not less than 1,5 m high intended to prevent inadvertent contact with the **pulsed conductors** of the **electric fence**

Note 1 to entry: **Physical barriers** are typically constructed from vertical sheeting, rigid vertical bars, rigid mesh, rods or chain-wire mesh.

3.8.110**public access area**

any area where persons are protected from inadvertent contact with **pulsed conductors** by a **physical barrier**

3.8.111**secure area**

area where a person is not separated from **pulsed conductors** below 1,5 m by a **physical barrier**

3.8.112**security energizer fence system**

electric security fence installation where the **fences** are energized by one or more **security energizers** containing one or more **security energizer groups** that can be **type R security energizer groups** or **type S security energizers groups**

Note 1 to entry: An **independent impulse timing signal source** used in a **security energizer fence system** may be used to set the timing of **dependent security energizers** in multiple **security energizer groups**.

4 General requirement

This clause of Part 1 is applicable.

5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

5.2 Modification:

Replace the test specification by the following:

*The tests are made on two **energizers** as delivered, one being subjected to all the tests with the exception of that of Clause 18, and the other to the tests of 22.108 and Clause 18. However, the tests of Clauses 22 to 28 may be made on separate samples.*

*For **type A energizers** and **type C energizers**, an additional sample is required for the test of Clause 18.*

Addition:

NOTE 101 Where **electronic circuits**, **electronic components** or other devices are normally encapsulated, specially prepared samples can be used for the tests of 19.11 and 19.101.

5.3 Addition:

The measurements of 22.108 shall be carried out before the tests of Clause 14.

*If any **electronic component** has been damaged during the tests of Clause 14, the tests of Clause 19 are made twice, once before and once after the damaged **electronic components** have been replaced by new **electronic components**.*

5.5 Addition:

*The **energizer** is mounted in a normal position such that the deviation from the position for which it is designed does not exceed 15°. However, if the **energizer** is provided with means for adjustment to the normal position, such as a spirit level, the **energizer** shall be adjusted to within ±2° of the normal position.*

*The earthing terminal of the **fence circuit** is connected to earth. However, if there is no indication as to which of the output terminals is to be connected to earth, the terminal that gives the most unfavourable result is earthed.*

5.8.1 Addition:

*For **type A energizers**, **type B energizers**, **type C energizers** and **type D energizers** where the terminals for the connection of the battery have no indication of polarity, the more unfavourable polarity of the voltage source replacing the battery shall be applied.*

*For **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**, the reference source impedance of the mains supply shall be $0,4 \Omega + j0,25 \Omega$.*

5.101 *All **energizers** are tested as **motor-operated appliances**.*

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 Replacement:

Mains-operated energizers and **battery-operated energizers suitable for connection to the mains** shall be **class II** with respect to protection against electric shock.

Compliance is checked by inspection and by the relevant tests.

6.2 Addition:

Energizers shall be of at least IPX4.

6.101 Energizers are classified as being either **energy limited energizers** or **current limited energizers**.

Compliance is checked by the appropriate tests.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 Addition:

Type A energizers, type B energizers and type C energizers shall be marked with the **rated voltage for battery supply** or **rated voltage range for battery supply**, in volts.

Energy limited energizers that are marked with a maximum energy/impulse exceeding 5 J shall also be marked with the corresponding load resistance at which maximum energy/impulse is obtained.

Energizers shall be marked with symbol ISO 7000-0790 (2004-01).

Type R security energizers shall be marked with symbol IEC 60417-6406 (2018-02).

Type S security energizers shall be marked with symbol IEC 60417-6407 (2018-02).

7.6 Addition:



[symbol IEC 60417-5036
(2002-10)]

dangerous voltage



[symbol IEC 60417-5017
(2006-08)]

earth; ground



[symbol IEC 60417-6406
(2018-02)]

time synchronized type R security energizer



[symbol IEC 60417-6407
(2018-02)]

time synchronized type S security energizer

The symbols for output (**fence**) and output (earth) shall be in accordance with symbols IEC 60417-5036 (2002-10) and IEC 60417-5017 (2006-08) respectively.

7.12 Addition:

Instructions for battery-operated energizers suitable for connection to the mains shall

- include a warning against using non-rechargeable batteries while the **energizer** is powered by mains;
- state that, during charging, vented rechargeable-batteries shall be placed in a well-ventilated area.

Instructions for **type D energizers** shall list accessories made available by the manufacturer.

7.14 Addition:

The outer diameter of the circle of symbol IEC 60417-6406 (2018-02) and symbol IEC 60417-6407 (2018-02) shall be at least 15 mm.

7.101 Unless the correct mode of connection is obvious or irrelevant, the output terminals of the **energizer**, other than dedicated output earth terminals, shall be clearly and indelibly identified using symbol IEC 60417-5036 (2002-10). Dedicated output earth terminals shall be clearly and indelibly identified using symbol IEC 60417-5017 (2006-08).

Where alternative output terminals are provided, they shall be similarly marked, or marked with the words FULL POWER, REDUCED POWER or REDUCED VOLTAGE, as appropriate.

If a switch to control the output energy is provided, the various positions of the switch shall be marked with the appropriate symbols, or with the words FULL POWER, REDUCED POWER or REDUCED VOLTAGE, as appropriate.

The height of characters in the marking shall not be less than that given by an 18 point font and the symbols shall have a height of at least 6 mm.

Compliance is checked by inspection and measurement.

7.102 For **battery-operated energizers suitable for connection to the mains**, the supply terminals for connection of the battery shall be clearly indicated by symbol IEC 60417-5005 (2002-10) for positive polarity, and by symbol IEC 60417-5006 (2002-10) for negative polarity, unless the polarity is irrelevant.

Compliance is checked by inspection.

7.103 Energizers shall be supplied with instructions that contain the information given in Annex BB regarding

- the installation of **electric fences**;
- the means of connecting the **energizer** to the **electric fence**.

Such information shall contain the substance of the wording given in Clause BB.1 (electric animal fences), Clause BB.2 (electric security fences not supplied from a security energizer group) or Clause BB.3 (electric security fences supplied from a security energizer group), as appropriate.

Energizers intended for use with **electric security fences** may also be supplied with the information given in Annex CC.

Compliance is checked by inspection.

7.104 The instructions for a **security energizer** that is suitable for use in a **security energizer group** shall contain the substance of the following:

- only type R security energizers or type S security energizers can be used in security energizer groups;
- a type S security energizer shall not be used in a type R security energizer group;
- a type R security energizer may be used in a type S security energizer group;
- identification of the model or type reference of security energizers that are permitted to be used in the security energizer group;
- security energizer groups shall only include security energizers that are identified in the instructions;
- the permitted configurations and connections of security energizers that may be used in the security energizer groups;

- identification of the model or type reference of the device producing the impulse timing signal source that is suitable for use in the security energizer group;
- a security energizer fence system must be configured and installed by, or under the responsibility of an authorized installer;
- a security energizer fence system shall be serviced and maintained by, or under the responsibility of an authorized installer;
- after installation, a label shall be attached to each energizer in a security energizer group that provides the authorized installer's name, contact details and the installation date;
- after servicing, a label shall be attached to each energizer in a security energizer group that provides the authorized installer's name, contact details and the service date;
- an authorised installer is a person suitably trained by the manufacturer to be able to safely configure, install and maintain a **security energizer fence system** on the basis of professional training, knowledge, experience and familiarity of the relevant equipment.

The instructions for a **security energizer** that is suitable for use in a **security energizer group** shall

- provide an explanation of the hazards of not using **security energizer groups** in locations where two electric security fences can be contacted at the same time;
- provide an explanation of the hazards of not correctly configuring a **security energizer** when used in a **security energizer group**. These hazards include:
 - receiving a too large impulse;
 - receiving consecutive two impulses that are not spaced apart enough in time;
 - touching an electric security fence whose isolation from the supply mains has been compromised;
- explain the meaning of the time synchronized symbols IEC 60417-6406 (2018-02) and IEC 60417-6407 (2018-02), if they are used;
- provide a general explanation of the safety objectives and technical requirements of a **security energizer group** that can be properly understood by an authorized installer;
- provide a general explanation of the safety objectives and technical requirements of a **security energizer fence system** that can be correctly understood by an authorized installer.

The front section of the instructions shall include the substance of the following warnings:

IMPORTANT WARNINGS

WARNING: These instructions must be fully complied with in every respect

WARNING: A security energizer group must be used at any point where two electric security fences can be contacted by a person at the same time

WARNING: Give special attention to the correct type selection and connection of security energizers used in a security energizer group

WARNING: A security energizer fence system should be checked for safety by an authorized installer prior to operation

DANGER: Failure to comply fully with the instructions could lead to a fatal electric shock

Compliance is checked by inspection.

8 Protection against access to live parts

This clause of Part 1 is applicable except as follows.

8.1.4 Addition:

*The means for the connection of the **fence** is not considered to be a **live part**.*

9 Starting of motor-operated appliances

This clause of Part 1 is not applicable.

10 Power input and current

This clause of Part 1 is applicable except as follows.

10.101 For **energy limited energizers** that are marked with a maximum energy/impulse exceeding 5 J, the value so marked shall not deviate from that delivered by more than $\pm 10\%$ and the load resistance at which it is obtained shall not deviate from the value marked on the **energizer** by more than $\pm 5\%$.

Compliance is checked by the following test.

*The **energizer** is supplied at **rated voltage** or **rated voltage for battery supply**, as appropriate, under conditions of **normal operation** but with a variable resistive load connected across its output terminals.*

*The energy per impulse dissipated in the resistive load connected across the **energizer** output terminals is measured using the measuring arrangement described in 22.108. The resistive load value is measured after it is adjusted to maximize the energy per impulse measured.*

11 Heating

This clause of Part 1 is applicable except as follows.

11.2 Addition:

*For **type A energizers** when connected for mains supply, **type D energizers** when connected for battery charging supply and **type B energizers** when connected for mains supply with battery charge operation, a battery of the largest capacity for which the **energizer** is designed is connected to the terminals for the connection of the battery supply. Before starting the test, the battery is discharged to such an extent that the voltage delivered by the battery does not exceed 0,75 times its nominal value.*

11.5 Replacement:

*The **energizer** is operated under **normal operation**, supplied as follows.*

*A **mains-operated energizer** is supplied with the most unfavourable supply voltage between 0,85 and 1,1 times **rated voltage**.*

Type A energizers and type C energizers, when they are connected for mains supply, are supplied with the most unfavourable supply voltage between 0,85 and 1,1 times **rated voltage**.

A **type B energizer**, when it is connected for mains supply with battery charge operation, is supplied with the most unfavourable supply voltage between 0,85 and 1,1 times **rated voltage**.

Type A energizers, type B energizers, type C energizers and type D energizers, when they are connected for battery supply, are supplied at the terminals for the connection of the battery with the most unfavourable supply voltage between

- 0,55 and 1,1 times **rated voltage for battery supply**, if the **energizer** can be used with non-rechargeable batteries;
- 0,75 and 1,1 times **rated voltage for battery supply**, if the **energizer** is designed for use with rechargeable batteries only.

The values specified in Table 101 for the internal resistance per cell of the battery shall be taken into account.

Table 101 – Battery source impedance

Supply to the terminals for the connection of the battery	Internal resistance per cell Ω	
	Non-rechargeable batteries	Rechargeable batteries
1,1 times rated voltage for battery supply	0,08	0,001 2
1,0 times rated voltage for battery supply	0,10	0,001 5
0,75 times rated voltage for battery supply	0,75	0,006 0
0,55 times rated voltage for battery supply	2,00	–
NOTE When determining the internal resistance of a battery, two or more cells connected in parallel are considered to be one cell.		

Type D energizers are supplied from a source incorporating a series resistance of 1 Ω and having the form of

- a half-wave rectified sine-wave with an RMS value equal to the **rated voltage for battery supply**,
- a full-wave rectified sine-wave with an RMS value equal to the **rated voltage for battery supply**,

whichever is the more unfavourable.

Security energizers used in a **security energizer group** shall be tested together in any permitted configuration and connection that may be allowed in the group.

The maximum and minimum supply voltage values are set in accordance with Table 102 using multiplier factors based on the **rated voltage** or **rated voltage range** of the appliance.

Table 102 – Rated supply voltage maximum and minimum value multiplier factors

Supply voltage value	Mains	Battery (rechargeable)	Battery (non-rechargeable)
Minimum	0,85	0,75	0,55
Maximum	1,1	1,1	1,1

The **security energizer** feeding the first **fence circuit** is operated, for a given supply voltage type, on three supply voltage value settings in turn, the minimum value, the maximum value and one freely selected value between the minimum and maximum values, while the **security energizer** feeding the second **fence circuit** is supplied, for a given supply voltage type, with any supply voltage varied between the maximum and minimum values that is selected to produce the most unfavourable result.

The above tests are repeated, but with the first and second **security energizer** settings reversed. Refer to Table 103.

Table 103 – Supply voltage value test settings

Test	First fence circuit supply	Second fence circuit supply
1	Maximum value	Selected for worst case
2	Minimum value	Selected for worst case
3	Freely selected value	Selected for worst case
4	Selected for worst case	Maximum value
5	Selected for worst case	Minimum value
6	Selected for worst case	Freely selected value

The above tests are repeated for both mains and battery supply voltage operation as applicable in accordance with Table 104.

Table 104 – Test supply sequence for different supply type

Test	First fence circuit supply	Second fence circuit supply
MM	Mains	Mains
MB	Mains	Battery
BM	Battery	Mains
BB	Battery	Battery

NOTE 101 For a typical **security energizer group**, based on two **security energizers** that both can run on mains or rechargeable battery, there would be a total of twenty four tests performed. However in some cases where only mains or battery operation is indicated, the number can be less or in the case where a non-rechargeable battery option is also included, the number of tests could be doubled.

11.7 Replacement:

The **energizer** is operated until steady conditions are established.

12 Void

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is applicable except as follows.

13.1 Modification:

Compliance is checked by the tests of 13.2 and 13.3 for **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains** only.

Addition:

The **energizer** is operated under **normal operation** when supplied as specified in 11.5 for mains operation.

14 Transient overvoltages

14.101 Energizers shall be resistant to atmospheric surges entering from the **fence**.

*Compliance is checked by the tests of 14.102 to 14.104 for **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**.*

NOTE The value of U_0 is the peak value of the **energizer** output voltage obtained during the test of 22.111.

Unless otherwise specified, during the tests, no disruptive discharges shall occur but surge protection devices are allowed to operate.

Mains-operated energizers and battery-operated energizers suitable for connection to the mains are fixed to a metal plate having dimensions that are at least 150 mm in excess of those of the orthogonal projection of the **energizer** on the plate, and are then installed as in normal use.

The tests are made by means of an impulse generator producing positive and negative full lightning impulses having a front time of 1,2 μ s and a time to half-value of 50 μ s, the tolerances being

- ± 5 % for the peak value;
- ± 30 % for the front time;
- ± 20 % for the time to half-value.

Small oscillations in the impulse are allowed, provided their amplitude near the peak of the impulse is less than 5 % of the peak value. For oscillations during the first half of the front time, amplitudes up to 10 % of the peak value are allowed.

*The shape of the impulses is adjusted with the **energizer** connected to the impulse generator. The adjustment shall be made at approximately 50 % of the test voltage specified. If, for the test of 14.104, it is not possible to obtain the correct shape of the impulses, it is only necessary to ascertain that the front time has the required value at approximately 50 % of the **prospective peak voltage** specified.*

The impulse generator to be used for the tests shall have an energy content of at least 125 J at the test voltage.

14.102 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between

- the output terminals and AC input terminals connected together and the metal plate, for **mains-operated energizers** and **type A energizers**, **type B energizers** and **type C energizers**,
- the output terminals and the metal plate, for **type D energizers**,

the interval between consecutive impulses being at least 10 s.

Type D energizers are further tested as follows.

*Each specified **detachable supply unit** is connected to the impulse generating circuit of the **energizer** in turn. The impulse voltages are applied between the **energizer** output terminals and the AC input terminals of the specified **detachable supply unit** connected together and the metal plate.*

14.103 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between the output terminals connected together and

- the AC input terminals connected together, for **mains-operated energizers** and **type A energizers**, **type B energizers** and **type C energizers**,
- the terminals for connection of the external battery charger, for **type D energizers**,

the interval between consecutive impulses being at least 10 s.

If, during this test, a surge protection device operates, the test is repeated with the surge protection device rendered inoperative. During the repeat test no disruptive discharges are allowed.

If the **energizer** has more than one **fence circuit**, each **fence circuit** is subjected to this test in turn, the other **fence circuits** being open-circuited.

Type D energizers are further tested as follows.

Each specified **detachable supply unit** is connected to the impulse generating circuit of the **energizer** in turn. The impulse voltages are applied between the **energizer** output terminals and the AC input terminals of the specified **detachable supply unit** connected together and the metal plate.

14.104 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between the output terminals, the interval between the impulses being at least 10 s. The input terminals are open-circuited. For **type D energizers**, the input terminals of the impulse generating circuit are open-circuited.

15 Moisture resistance

This clause of Part 1 is applicable.

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.1 Modification:

Compliance is checked by the tests of 16.2, 16.3 and 16.101 for **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**.

16.2 Modification:

The test voltage is the upper limit of the voltage in 11.5.

16.3 Addition:

Other values of the test voltages and the points of application are shown in Table 105.

Table 105 – Additional test voltages

<i>Points of application</i>	<i>Test voltage^a</i>
<i>Between the mains supply circuit and accessible parts for metal-encased class II energizers</i>	$2U_0$ but not less than 10 000 V
<i>Between the fence circuit and accessible parts^b</i>	$2U_0$ but not less than 10 000 V
<i>Between the mains supply circuit and the fence circuit</i>	$2U_0$ but not less than 10 000 V
^a The value $2U_0$ is a peak value equal to twice the maximum peak value of the output voltage measured in 22.111. ^b A gap of 50 mm around the output terminal shall be provided in the metal foil in contact with accessible parts.	

16.101 Immediately after the tests of 16.3, the output characteristics are measured as specified in 22.108.

The values measured shall be within the limits specified in 22.108.

17 Overload protection of transformers and associated circuits

This clause of Part 1 is not applicable.

18 Endurance

This clause of Part 1 is replaced by the following.

Mains-operated energizers and **battery-operated energizers** suitable for connection to the mains shall be so constructed that they are able to endure extreme temperatures that may be encountered in normal use. Moreover, overload **protection devices** shall not operate under these conditions.

Compliance is checked by the following test.

Mains-operated energizers, type A energizers and type C energizers when they are connected for mains supply are operated under conditions of **normal operation**. The voltage applied is the **rated voltage**.

Type D energizers are operated under conditions of **normal operation**. The voltage applied is as specified in 11.5.

Type B energizers connected for battery operation are placed in their normal position and are fitted with a battery having a nominal voltage equal to the **rated voltage for battery supply** of the **energizer**. The battery shall be of the largest capacity for which the **energizer** is designed. The battery shall be fully charged at the beginning of the test and shall be replaced by a fresh one as soon as, during the test, the voltage of the battery decreases to 0,75 times its nominal voltage for a rechargeable battery or to 0,55 times its nominal voltage for a non-rechargeable battery or until the **energizer** ceases to function due to low battery voltage.

For **type A energizers**, a battery of the largest capacity for which the **energizer** is designed is connected and placed in the battery compartment. Before starting the test, the battery is discharged to such an extent that the voltage delivered does not exceed 0,75 times its nominal value.

The other sample, for **type A energizers** and **type C energizers**, is to be connected for battery supply and supplied from a battery of the largest capacity for which the **energizer** is designed. The battery shall be fully charged at the beginning of the test, and shall be replaced by a fresh one as soon as, during the test, the voltage of the battery decreases to 0,75 times its nominal voltage for a rechargeable battery or to 0,55 times its nominal voltage for a non-rechargeable battery.

The **energizer** is operated continuously for 168 h (seven days) at an ambient temperature of $-15\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and then for 168 h (seven days) at an ambient temperature of $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

The output terminals are loaded with a non-inductive resistor of $500\text{ }\Omega \pm 2,5\text{ }\Omega$ during the first 84 h of each period of 168 h and the load is removed for the remainder of these periods.

At the end of each of the periods of 168 h, the output characteristics are measured, as specified in 22.108, at the ambient temperature prescribed for the relevant period.

The values measured shall be within the limits specified in 22.108.

During the test, the **energizer** shall show no change impairing its further use, the sealing compound, if any, shall not flow out to such an extent that **live parts** are exposed and the **energizer** shall still meet the requirements of Clause 8.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.1 Addition:

The **energizer** is mounted as in 11.2, except that the battery, where applicable, is fully charged.

During the tests, fuses that are accessible to the user are short-circuited.

Energizers are also subjected to the tests of 19.101, 19.102, 19.103, 19.104 and 19.105.

Security energizer groups are also subjected to the tests of 19.106 and 19.107 as if they were an **energizer** supplied in one or more parts.

19.12 Addition:

If, for any of the fault conditions, the impulse repetition rate is greater than 1 Hz and the safety of the **energizer** depends upon the operation of a non-self-resetting **protective device** incorporating an internal fuse, the test is carried out three times to ensure that this fuse operates reliably and that internal parts are not damaged at the increased impulse repetition rate.

19.13 Addition:

The temperature rises of the windings shall not exceed the values shown in Table 8.

For a **type R security energizer**, during the tests the output characteristics of each **fence circuit** shall be as specified in 22.108 except for the impulse repetition rate and 22.113. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into a load consisting of a non-inductive resistor of $500\text{ }\Omega$ shall not exceed 1,25 J/s after 3 min.

For all other **energizers**, during the tests the output characteristics of each **fence circuit** shall be as specified in 22.108 except for the impulse repetition rate. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into a load consisting of a non-inductive resistor of 500 Ω shall not exceed 2,5 J/s after 3 min.

For a **type R security energizer group**, during the tests the impulse synchronisation shall be as specified in 22.114. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into a replacement load consisting of a non-inductive resistor of 500 Ω shall not exceed 2,5 J/s after 3 min.

For a **type S security energizer group**, during the tests the combined **fence circuit** output characteristics measured in the 500 Ω resistor R_T shall be as specified in 22.115 for test configurations 5 and 6 except for the impulse repetition rate. If the impulse repetition rate is greater than 1,34 Hz, the discharge energy per second into the 500 Ω load R_T shall not exceed 2,5 J/s after 3 min.

19.101 Energizers are subjected to each of the following conditions in turn, while being supplied with the voltage specified in 11.5, including those associated with such other fault conditions that are an actual consequence of the condition chosen:

- the **energizer** is placed in its most unfavourable position even if it is not likely to be installed in this position in normal use;
- parts intended for adjusting the **energizer**, other than those that are adjustable from the outside of the **energizer** without the aid of a **tool**, are adjusted to their most unfavourable position, even if these parts are not intended to be adjusted by the user, unless they are effectively sealed against further adjustment;
- the earthing conductor is removed from the earthing terminal of the **fence circuit** and connected to any other output terminal;
- the output terminals are short-circuited;
- switches, relay-contacts and the like, that form part of the impulse generating circuit, are short-circuited or open-circuited, whichever is the more unfavourable;
- fuses that are accessible without the aid of **tools**, series spark gaps in the **fence circuit**, discharging valves and thermal relays are short-circuited;
- except for **electronic circuits**, any **creepage distance** or **clearance** between **live parts** of different potential that is less than 5 mm for the **fence circuit**, or 2 mm or less for other circuits, is short-circuited, and any unlocked connection is loosened;
- the switching speed of an **electronic component** used as the major impulse-switching device shall be varied in the range 0,1 Hz to twice the **rated frequency**, in approximately a 1:2:5 progression sequence over three decades, by referencing the gate signal of this device to the voltage across it using an external independent control.

NOTE Details of a simple comparator circuit that has been found suitable for controlling the switching speed of the major impulse-switching device are given in Annex AA.

19.102 Type A energizers, type C energizers and type D energizers are subjected to each of the following conditions in turn, while being supplied with the voltage specified in 11.5:

- with the **energizer** connected for battery supply, terminals for the connection of the battery having an indication of polarity are connected to the opposite polarity, unless such a connection is unlikely to occur in normal use;
- with the **energizer** connected for mains operation, terminals for the connection of the battery supply are connected to the most unfavourable resistive load, including a short circuit.

19.103 Type B energizers connected for mains supply with battery charge operation are subjected to each of the following conditions in turn, while being supplied with the voltage specified in 11.5:

- the terminals for the connection of the battery having an indication of polarity are connected to the opposite polarity, unless such a connection is unlikely to occur in normal use;
- the terminals for the connection of the battery supply are connected to the most unfavourable resistive load, including a short circuit.

19.104 Type B energizers connected for battery supply are supplied with the voltage specified in 11.5. The supply terminals having an indication of polarity are connected to the opposite polarity, unless such a connection is unlikely to occur in normal use.

19.105 Battery operated energizers suitable for connection to the mains having a **rated voltage for battery supply** of less than 12 V are operated under **normal operation** when supplied with an input voltage of 13,2 V DC.

During the test, the **energizer** shall be connected to the voltage source via a 1 Ω series resistor.

This test is only applicable if the supply may be connected without modification of the **energizer**.

19.106 Type S security energizer groups are tested for every permitted configuration and connection specified in the instructions. As such, during the tests only a single fault is applied at a time in any one of the parts.

19.107 Security energizer groups are subjected to fault testing of the **impulse timing signal source**. All possible **impulse timing signal** outputs are considered for faults occurring within the **impulse timing signal source** such as stopping, intermittent operation, low level, high level, variable rate, high rate. Whenever possible when an external **impulse timing signal source** is used, a fault shall be introduced such that the **impulse timing signal source** is no longer a viable method of synchronization. However if it can be shown that a particular fault condition is unlikely to occur then it should not be considered.

20 Stability and mechanical hazards

This clause of Part 1 is not applicable.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.101 The **energizer** shall withstand the effect of being dropped.

Compliance is checked by the following test.

The **energizer** is bolted centrally to a board 1 000 mm $\pm$ 5 mm long by 225 mm $\pm$ 5 mm wide and approximately 25 mm thick. The board is supported at each end on a rigid table by baulks of timber of such a size that the **energizer** is held clear of the table surface. One end of the board is lifted through a distance of 200 mm $\pm$ 5 mm and allowed to fall freely. The test is repeated 20 times. This procedure is then repeated with the board placed on each of its other longitudinal edges in turn.

After the test, the **energizer** shall show no damage within the meaning of this standard.

22 Construction

This clause of Part 1 is applicable except as follows.

22.12 Addition:

The requirement is not applicable to the **energizer** output terminal assembly including the terminal knob and washers.

22.31 Addition:

The requirement applies only to **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**.

22.32 Addition:

The requirement applies only to **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**.

22.46 Addition:

If programmable **protective electronic circuits** alone are used to ensure compliance with the output characteristics specified in 19.13, the software shall contain measures to control the fault/error conditions specified in Table R.2.

22.56 Replacement:

For **type D energizers**, a **detachable supply unit** shall be a listed accessory made available by the manufacturer.

Compliance is checked by inspection.

22.101 For **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**, internal connections shall be so fixed or protected, and **energizers** shall be so designed that, even in the event of the loosening or breaking of wires, a conductive connection cannot be formed between the mains supply and the **fence circuit**, and no other hazardous condition shall arise.

The input winding and the output windings of transformers used to isolate the **fence circuit** from the supply circuit shall be separated by an insulating barrier, and the construction shall be such that there is no possibility of any connection between these windings, either directly or indirectly through other metal parts.

In particular, precautions shall be taken to prevent

- displacement of input or output windings, or the turns thereof;
- undue displacement of parts of windings, or of internal wiring, in the event of a rupture or loosening of connections.

Isolation between the mains and the **fence circuit** may be achieved by the incorporation of a double-wound transformer situated either in the input circuit or in the **fence circuit**. If such transformers are incorporated in both circuits, at least one of these transformers shall provide the required degree of isolation.

Compliance is checked by inspection and by the tests of the other clauses of this standard.

NOTE 1 Circuits connected between the input terminals and the primary side of the transformer providing the required degree of isolation are considered to be connected to the mains, and circuits connected between the output terminals and the secondary side of this transformer are considered to belong to the **fence circuit**.

NOTE 2 Examples of constructions that comply with the requirements of this subclause for windings are

- windings on separate spools of adequate insulating material, rigidly fixed with respect to each other and to the core of the transformer;
- windings on a single spool with a partition wall, both of adequate insulating material, provided that the spool and partition wall are pressed or moulded in one piece, or that, in the case of a pushed-on partition wall, there is an intermediate sheath or covering over the joint between the spool and the partition wall;
- concentric windings on cheekless formers, provided that
 - each layer of the winding is interleaved with adequate insulating material projecting beyond the end turns of each layer,
 - one or more separate sheets of insulating material of adequate thickness are provided between the input winding and the output windings, and
 - the windings are impregnated with a hard-baked or other suitable material that fully penetrates the interstices and effectively seals off the end turns.

NOTE 3 It is not to be expected that two independent fixings will become loose at the same time.

22.102 For **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**, transformers in the **fence circuit** shall be placed in a separate compartment. This compartment shall not contain any part that is, or can come, in contact with the mains, with the exception of the input winding of the transformer.

Compliance is checked by inspection and by the tests of the other clauses of this standard.

22.103 For metal-encased **class II energizers**, the output terminals shall be placed so that external conductors connected to these terminals are not likely to come into contact with the enclosure.

Compliance is checked by inspection.

22.104 **Energizers** shall be so designed that

- the conductors for the connection of the **fence** and the **earth electrode** can be easily connected;
- it is possible to actuate switches and other controls, if this is necessary in normal use, after the **energizer** has been mounted and connected to the supply, without opening or removing any enclosure that provides protection against harmful ingress of water or unintended electric shock.

Compliance is checked by inspection.

22.105 For **mains-operated energizers** and **battery-operated energizers suitable for connection to the mains**, any assembly gap in **supplementary insulation** shall not be co-incidental with any such gap in **basic insulation**, neither shall any such gap in **reinforced insulation** give straight access to **live parts**.

Compliance is checked by inspection.

22.106 In **type A energizers**, **type B energizers** and **type C energizers**, terminals for the connection of the battery and other metal parts in a battery compartment that become accessible when replacing batteries, even with the aid of a **tool**, shall be insulated from **live parts** by **double insulation** or **reinforced insulation**.

In **type D energizers**, parts in a battery compartment that become accessible when replacing batteries, even with the aid of a **tool**, shall not be **live parts**.

*Compliance is checked by inspection, measurement and by the tests specified for **double insulation** or **reinforced insulation**.*

22.107 Battery-operated energizers suitable for connection to the mains shall be provided with means to prevent the user from being subjected to an electric shock due to the **energizer** output voltage, when connecting a battery to the **energizer**.

Compliance is checked by inspection.

NOTE Examples of such means are:

- a switch that isolates the terminals for the connection of the battery;
- a control that enables the output voltage to be reduced to zero;
- insulated crocodile clips or similar devices.

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;

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 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 103;
 - an **impulse duration** of less than or equal to 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. For **energizers** with more than one set of output terminals, the **standard load** is connected to each set of output terminals in turn. 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 Ω in parallel with a capacitance of not more than 100 pF.

22.109 If the **energizer** is provided with more than one set of output terminals, the output characteristics shall be within the limits specified in 22.108 for any possible configuration of the output terminals connected to the **standard load**.

The impulses for the individual sets of output terminals shall be synchronized and

- the **impulse duration** shall not exceed the value specified in 22.108;
- the impulse repetition rate shall not exceed the value specified in 22.108

for any possible combination of individual impulses.

Compliance is checked by the measurements specified in 22.108.

22.110 For **type A energizers** and **type B energizers** that have terminals for the connection of the battery, the no-load DC output voltage shall not exceed 42,4 V.

Compliance is checked by measuring the no-load DC output voltage appearing at the terminals for the connection of the battery when the **energizer** is connected for mains supply and is supplied at **rated voltage**.

22.111 The peak value of the output voltage, U_0 , shall be measured and recorded to enable the tests and measurements of 14.102, 14.103, 14.104 and 16.3 to be carried out.

Compliance is checked by the following tests:

When the **energizer** is a **security energizer** marked as being permitted for use in a **security energizer group**, the peak value of the output voltage, U_0 , should be the highest value of voltage measured when it is connected in a **security energizer group** and tested in any permitted configuration and connection of **security energizers** that may be used in the **security energizer group** given in the instructions. The **security energizer group** is supplied with the voltage in 11.5 under conditions of **normal operation**, but with a load connected to the output terminals of the **security energizer** or **security energizer group** consisting of a capacitor having a capacitance that can be varied between 0 nF and 200 nF in steps of approximately 10 nF.

These **security energizer group** tests are not applicable to a **type R security energizer group** where all the **type R energizers** in the group are exactly the same model.

For all other **energizers**, the peak value of the output voltage, U_0 , is measured, using an arrangement described in 22.108 with the **energizer** supplied with the voltage in 11.5 under conditions of **normal operation**, but with a load connected to the output terminals consisting of a capacitor having a capacitance that can be varied between 0 nF and 200 nF in steps of approximately 10 nF.

22.112 The **clearance** between parts of opposite polarity for connecting the battery in **battery operated energizers suitable for connections to the mains** shall not be less than 2 mm, when the **energizer** is fitted with conductors as in normal use.

Compliance is checked by measurement.

22.113 For a **type R security energizer**, the energy per impulse delivered by each **fence circuit** into the **standard load** shall not exceed 2,5 J.

Compliance is checked by measuring the energy/impulse over the **impulse duration** with 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 each **fence circuit**.

When measuring the energy per impulse into the **standard load**, the variable resistor shall be adjusted to maximize the energy into the **standard load** and not the energy in the 500 Ω component of the **standard load**.

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

22.114 **Type R security energizer group** output characteristics measured in the 500 Ω component of the **standard load** shall be such that

- the impulse repetition rate shall not exceed 1 Hz;
- the **impulse duration** of the impulse shall not exceed 10 ms.

Compliance is checked by measurement when the **type R security energizer group** is supplied with the voltage in 11.5, being operated under conditions of **normal operation** but with the **standard load** connected to the output terminals as shown in Figure 104, Test

configuration A and the test repeated with the **standard load** connected to the output terminals as shown in Figure 104, Test configuration B.

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

22.115 Type S security energizer group output characteristics measured in the 500 Ω resistor R_T shall be such that

- the impulse repetition rate shall not exceed 1 Hz;
- the **impulse duration** of the impulse shall not exceed 10 ms;
- for **energy limited energizers**, the energy/impulse 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** shall not exceed for
 - an **impulse duration** of greater than 0,1 ms, the value specified by the characteristic limit line detailed in Figure 103;
 - an **impulse duration** less than or equal to 0,1 ms, 15 700 mA.

Compliance is checked with the **type S security energizer group** supplied with the voltage specified in 11.5, and operated with the six test configurations shown in Figure 105, in turn. For each configuration, the test loads are varied as follows.

- a) With resistor R_T connected, for test configurations 1 to 6, vary resistor R_A and resistor R_B to maximise the group output characteristics measured in resistor R_T ;
- b) With resistor R_T disconnected, for test configuration 1, vary resistor R_B to maximize the output characteristics measured in resistor R_B then reconnect resistor R_T and measure the group output characteristics in resistor R_T ;
- c) With resistor R_T disconnected, for test configuration 2, vary resistor R_A to maximize the output characteristics measured in resistor R_A then reconnect resistor R_T and measure the group output characteristics in resistor R_T ;
- d) With resistor R_T disconnected, for test configuration 6, vary resistor R_A and resistor R_B to maximize the output characteristics measured in resistor R_A and resistor R_B then reconnect resistor R_T and measure the group output characteristics in resistor R_T ;
- e) With resistor R_T disconnected, for test configurations 3, 4 and 5, vary resistor R_A and resistor R_B to maximize the output characteristics measured in resistor R_A and resistor R_B then reconnect resistor R_T and measure the group output characteristics in resistor R_T .

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

For each test, the **type S security energizer group** output characteristics measured in the 500 Ω resistor R_T shall not be exceeded.

23 Internal wiring

This clause of Part 1 is applicable except as follows.

23.7 Replacement:

For **mains-operated energizers and battery-operated energizers suitable for connection to the mains**, conductors identified by the colour combination green/yellow shall not be used.

Compliance is checked by inspection.

24 Components

This clause of Part 1 is applicable.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.1 Addition:

For **Type D energizers** that are provided with a non-detachable flexible cord, the connecting means shall not be suitable for connection to the mains.

An appliance inlet, on a **type D energizer**, shall have at least the same degree of protection against moisture as required for the **energizer** and shall not be compatible with appliance couplers complying with the standard sheets of IEC 60320-3.

Compliance is checked by inspection.

25.7 Replacement:

Supply cords shall not be lighter than

- ordinary polyvinyl chloride sheathed cord (code designation 60227 IEC 53);
- ordinary polychloroprene sheathed cord (code designation 60245 IEC 57).

The ordinary polychloroprene sheathed cord shall be used where, for climatic reasons, the ordinary polyvinyl chloride sheathed cord is not suitable.

Compliance is checked by inspection.

25.8 Addition:

The conductors in flexible leads or flexible cords used to connect the battery in **type D energizers** shall have a nominal cross-sectional area of not less than 0,75 mm².

25.13 Addition:

This requirement is not applicable to the flexible leads or flexible cord connecting external batteries or a **battery box** with an **energizer**.

25.23 Addition:

In **battery-operated energizers suitable for connection to the mains**, if the battery is placed in a separate box, the flexible lead or flexible cord connecting the box with the **energizer** is considered to be an **interconnection cord**.

26 Terminals for external conductors

This clause of Part 1 is applicable except as follows.

26.1 Addition:

The second sentence of the requirement does not apply to the **energizer** output terminals.

26.5 Addition:

Terminal devices in an **energizer** for the connection of the flexible leads or flexible cord with **type X attachment** connecting an external battery or **battery box** shall be so located or shielded that there is no risk of accidental connection between supply terminals.

26.9 Addition:

The requirement does not apply to the **energizer** output terminals.

26.101 Output terminals shall be so designed or located that it is not possible to connect the **fence** or the **earth electrode** to the **energizer** by means of a plug that is designed for connection to a socket-outlet for mains supply.

Compliance is checked by inspection and by manual test.

26.102 Output terminals shall be fixed so that they will not work loose when external conductors are connected or disconnected.

Compliance is checked by inspection and by manual test.

26.103 Devices for clamping the conductors connecting the **fence** or the **earth electrode** to the **energizer** shall not serve to fix any other component.

Compliance is checked by inspection.

27 Provision for earthing

This clause of Part 1 is applicable except as follows.

27.1 Addition:

NOTE 101 In **class II energizers**, provision can be made for connecting at least one of the output terminals to the **earth electrode**.

28 Screws and connections

This clause of Part 1 is applicable.

29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable.

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.2.1 Modification:

The glow-wire test is made at a temperature of 650 °C.

30.2.2 Not applicable.

31 Resistance to rusting

This clause of Part 1 is replaced by the following.

The enclosure of metal-encased **class II energizers** shall be adequately protected against corrosion.

Compliance is checked by the salt mist test of IEC 60068-2-52. Test method 2 is applicable.

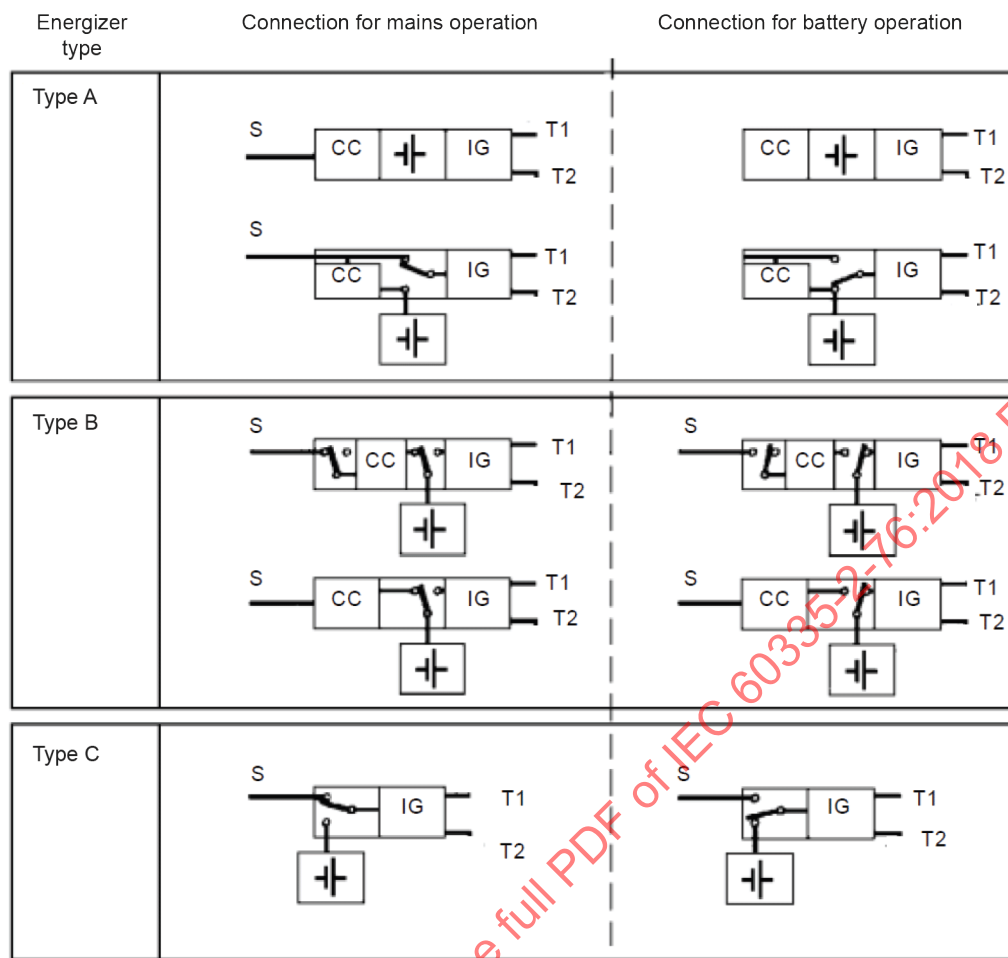
Before the test, coatings are scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of 0,25 mm ± 0,02 mm. The pin is loaded so that the force exerted along its axis is 10 N ± 0,5 N. The scratches are made by drawing the pin along the surface of the coating at a speed of approximately 20 mm/s. Five scratches are made at least 5 mm apart and at least 5 mm from the edge.

After the test, the appliance shall not have deteriorated to such an extent that compliance with this standard is impaired. The coating shall not have broken and shall not have loosened from the metal surface.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is applicable.

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IEC

Key

S supply mains

CC battery charging circuit

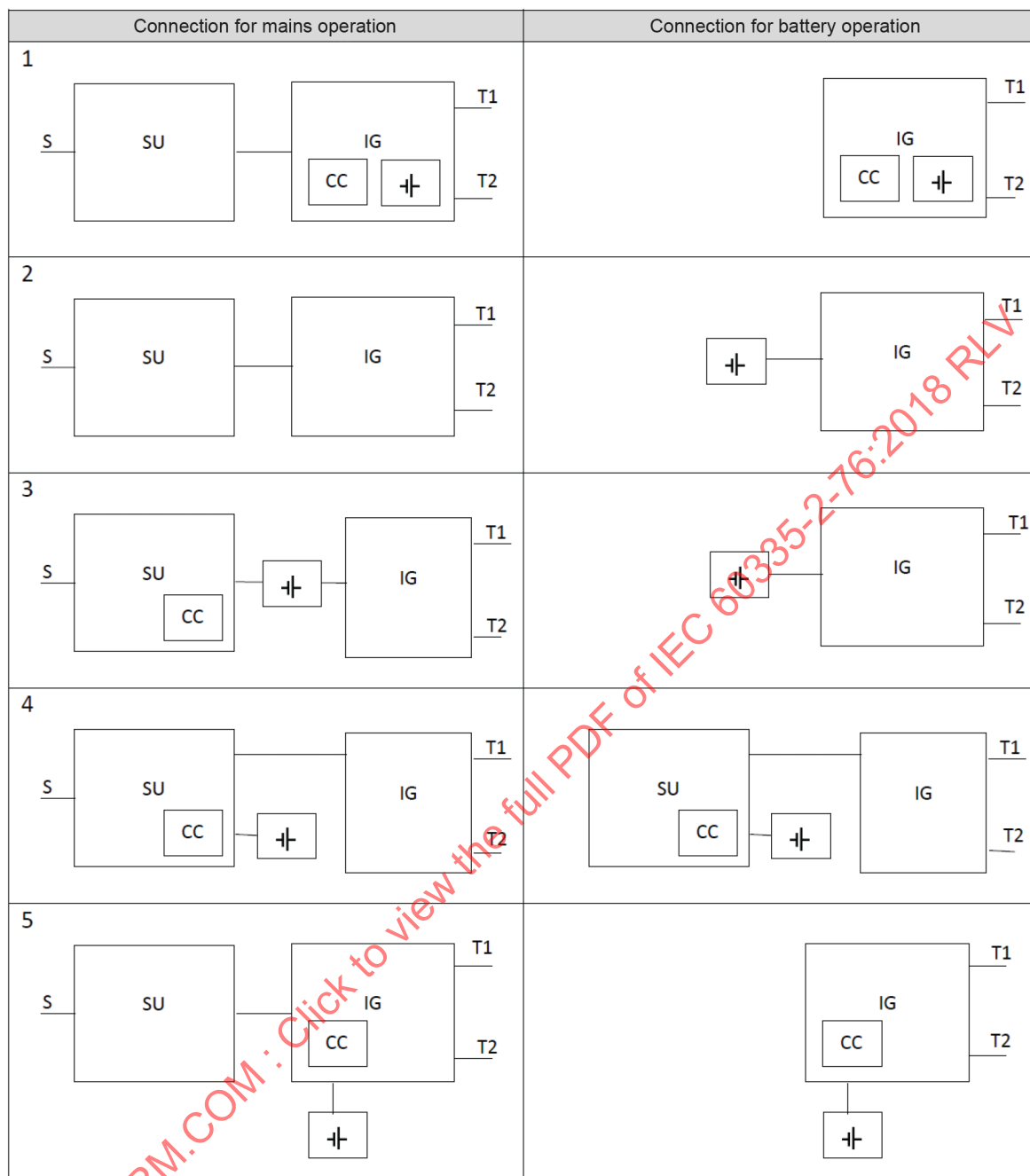
IG impulse generating circuit



battery

T1, T2 output terminals

Figure 101 – Schematic examples of type A energizers, type B energizers and type C energizers

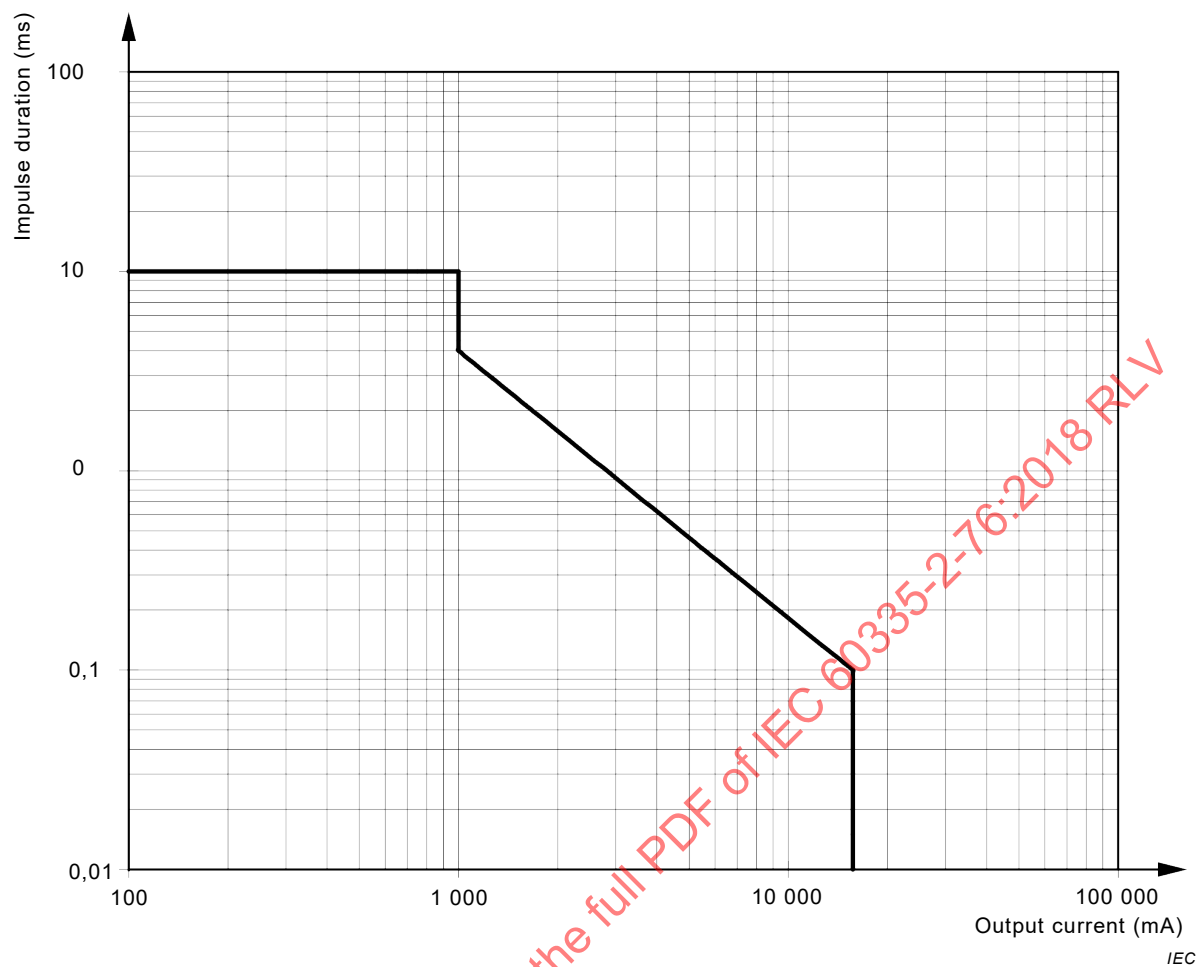


IEC

Key

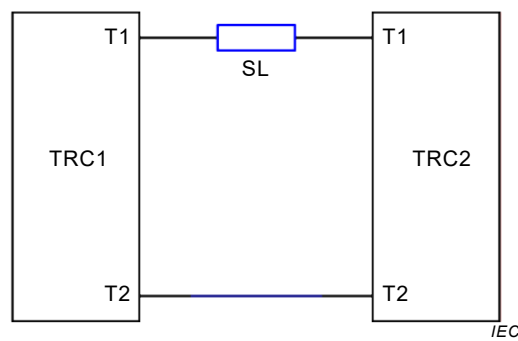
- S supply mains
 SU detachable supply unit
 CC battery charging circuit
 IG impulse generating circuit
 battery
 T1, T2 output terminals

Figure 102 – Schematic examples of the different types of type D energizers

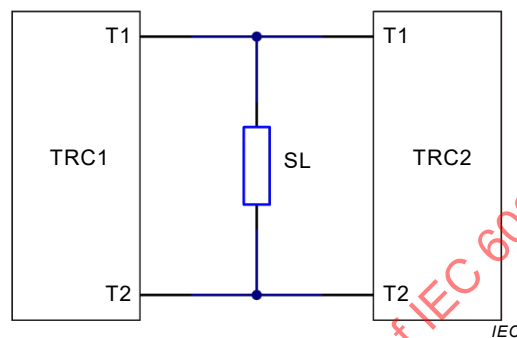


NOTE The equation of the line relating impulse duration (ms) to output current (mA) for 1 000 mA < output current < 15 700 mA, is given by $\text{impulse duration} = 41,885 \times 10^3 \times (\text{output current})^{-1,34}$.

Figure 103 – Current limited energizer characteristic limit line



Test configuration A



Test configuration B

Key

TRC1 type R fence circuit 1

TRC2 type R fence circuit 2

SL **standard load**

T1, T2 **type R security energizer group** output terminals

Figure 104 – Type R security energizer group test configurations

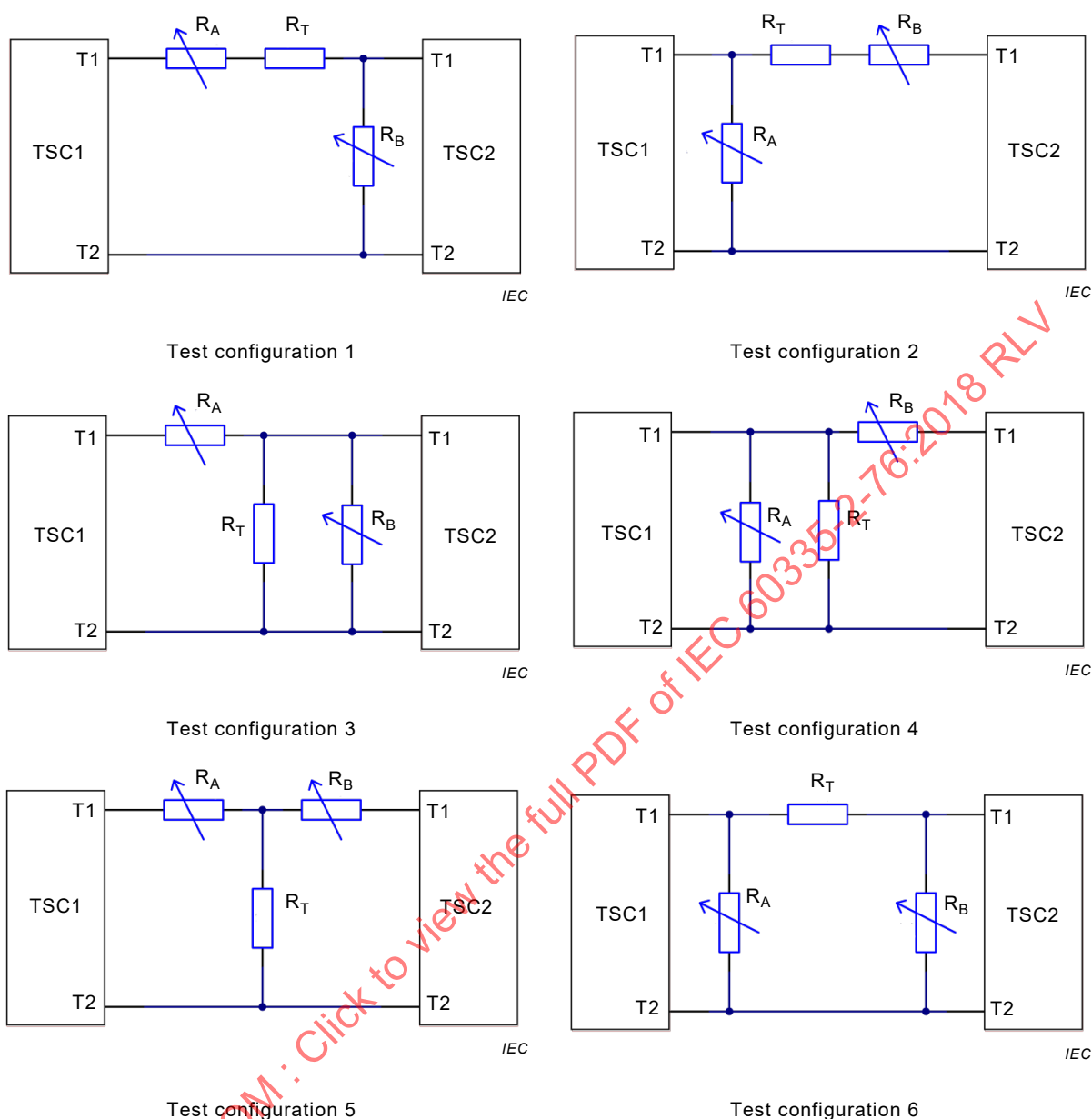


Figure 105 – Type S security energizer group test configurations

Annexes

The annexes of Part 1 are applicable except as follows.

Annex A (informative)

Routine tests

This annex of Part 1 is applicable except as follows.

A.2 Electric strength test

Addition:

For mains-operated energizers and battery-operated energizers suitable for connection to the mains, an electric strength test is carried out between the supply circuit and the fence circuit, the test voltage being 10 000 V AC, 50 Hz or 60 Hz, or 15 000 V DC for 1 s.

A.3 Functional test

Addition:

The energizer output characteristic shall be checked by operating the energizer at rated voltage with a 500 Ω load connected across the output terminals.

The energizer output characteristic shall be such that

- *the impulse repetition rate shall not exceed 1 Hz;*
- *the impulse duration of the impulse shall not exceed 10 ms;*
- *for energy limited energizers, the energy/impulse shall not exceed 5 J;*
- *for current limited energizers, the output current shall not exceed*
 - *the value specified by the characteristic limit line detailed in Figure 103;*
 - *for an impulse duration of less than 0,1 ms, 15 700 mA.*

Annex B (normative)

Appliances powered by rechargeable batteries that are recharged in the appliance

This annex of Part 1 is applicable along with the following additions and modifications.

NOTE B.101 Rechargeable batteries that are recharged while connected to the appliance are considered to be recharged in the appliance.

7 Marking and instructions

7.1 Addition:

Energizers supplied by other sources of energy and not suitable for connection to the supply mains shall be marked with the symbol for “connection to mains-operated equipment prohibited” or with the substance of the following warning:

WARNING: Do not connect to mains-operated equipment such as battery chargers.

The rules for a prohibition sign in ISO 3864-1, except for colours, apply to the symbol for connection to mains-operated equipment prohibited.

Modification:

The text referring to the **detachable supply unit** is not applicable.

7.6 Addition:



connection to mains-operated equipment prohibited

7.12 Addition:

If the symbol for “connection to mains-operated equipment prohibited” is used, its meaning shall be explained.

Modification:

The warning referring to the **detachable supply unit** is replaced by the substance of the following.

WARNING: Use only a detachable supply unit that is listed as an accessory made available by the manufacturer.

Add the following subclause:

7.14 Addition:

If the symbol for “connection to mains-operated equipment prohibited” is marked on the appliance, the outer diameter of the circle shall be at least 15 mm.

7.15 Not applicable.

30 Resistance to heat and fire

30.2 This subclause of Part 1 is not applicable.

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Annex S (normative)

Battery-operated appliances powered by batteries that are non-rechargeable or not recharged in the appliance

This annex of Part 1 is applicable along with the following additions and modifications.

7 Marking and instructions

7.1 Addition:

Battery-operated energizers shall be marked with the symbol for “connection to mains operated equipment prohibited” or with the substance of the following warning:

WARNING: Do not connect to mains-operated equipment such as battery chargers.

The rules for a prohibition sign in ISO 3864-1, except for colours, apply to the symbol for connection to mains-operated equipment prohibited.

7.6 Addition:



connection to mains-operated equipment prohibited

7.12 Addition:

If the symbol for “connection to mains-operated equipment prohibited” is used, its meaning shall be explained.

Add the following subclause

7.14 Addition:

If the symbol for “connection to mains-operated equipment prohibited” is marked on the appliance, the outer diameter of the circle shall be at least 15 mm.

Add the following clause.

14 Transient voltages

14.1 Addition:

Battery-operated energizers having a **rated voltage** exceeding 42,4 V are installed as in normal use and are then subjected to the test of 14.S.101.

14.S.101 Five positive and five negative impulses, each having a **prospective peak voltage** of $2U_0$ but not less than 25 kV, are applied between the output terminals, the interval between the impulses being at least 10 s. The input terminals are open-circuited.

Add the following clause.

16 Leakage current and electric strength

16.1 Addition:

Battery-operated energizers are subjected to the tests of 16.S.101.

16.S.101 For **battery-operated energizers**, the supply terminals are connected for 10 min to a voltage between 1,1 and 1,5 times **rated voltage for battery supply**, that is so chosen that the output voltage, without a load connected, has the maximum value, protective spark gaps, if any, being disconnected.

No breakdown shall occur during the test.

Immediately after the tests, the output characteristics are measured as specified in 22.108.

The values measured shall be within the limits specified in 22.108.

Add the following clause.

18 Endurance

Addition:

Battery-operated energizers shall be so constructed that they are able to endure extreme temperatures that may be encountered in normal use. Moreover, overload **protection devices** shall not operate under these conditions.

Compliance is checked by the following test.

Battery-operated energizers are placed in their normal position and are fitted with a battery having a nominal voltage equal to the **rated voltage** of the energizer. The battery shall be of the largest capacity for which the energizer is designed. The battery shall be fully charged at the beginning of the test and shall be replaced by a fresh one as soon as, during the test, the voltage of the battery decreases to 0,75 times its nominal voltage for a rechargeable battery or to 0,55 times its nominal voltage for a non-rechargeable battery or until the **energizer** ceases to function due to low battery voltage.

The **energizer** is operated continuously for 168 h (seven days) at an ambient temperature of $-15\text{ °C} \pm 2\text{ °C}$ and then for 168 h (seven days) at an ambient temperature of $50\text{ °C} \pm 2\text{ °C}$.

The output terminals are loaded with a non-inductive resistor of $500\ \Omega \pm 2,5\ \Omega$ during the first 84 h of each period of 168 h and the load is removed for the remainder of these periods.

At the end of each of the periods of 168 h, the output characteristics are measured, as specified in 22.108, at the ambient temperature prescribed for the relevant period.

The values measured shall be within the limits specified in 22.108.

During the test, the **energizer** shall show no change impairing its further use, the sealing compound, if any, shall not flow out to such an extent that live parts are exposed and the **energizer** shall still meet the requirements of Clause 8.

19 Abnormal operation

19.S.103 Battery operated energizers having a rated voltage of less than 12 V are operated under **normal operation** when supplied with an input voltage of 13,2 V DC.

*During the test, the **energizer** shall be connected to the voltage source via a 1 Ω series resistor.*

*This test is only applicable if the supply may be connected without modification of the **energizer**.*

Add the following clause.

22 Construction

22.S.101 For **battery-operated energizers**, parts in a battery compartment that become accessible when replacing batteries, even with the aid of a **tool**, shall not be **live parts**.

*Compliance is checked by inspection, measurement and by the tests specified for **double insulation** or **reinforced insulation**.*

22.S.102 Battery-operated energizers shall be provided with means to prevent the user from being subjected to an electric shock due to the **energizer** output voltage, when connecting a battery to the **energizer**.

Compliance is checked by inspection.

NOTE Examples of such means are:

- a switch that isolates the terminals for the connection of the battery;
- a control that enables the output voltage to be reduced to zero;
- insulated crocodile clips or similar devices.

22.S.103 The **clearance** between parts of opposite polarity for connecting the battery in **battery operated energizers** shall not be less than 2 mm, when the **energizer** is fitted with conductors as in normal use.

Compliance is checked by measurement.

25 Supply connection and external flexible cords

Add the following new subclauses.

25.7 Addition:

This requirement is not applicable to the flexible leads or flexible cord connecting external batteries or a **battery box** to a **battery-operated energizer**.

25.23 *Addition:*

In **battery-operated energizers**, if the battery is placed in a box, the flexible lead or flexible cord connecting the box with the **energizer** is considered to be an **interconnection cord**.

25.S.101 *Addition:*

The conductors in flexible leads or flexible cords used to connect the battery in **battery-operated energizers** shall have a nominal cross-sectional area of not less than 0,75 mm².

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Annex AA (informative)

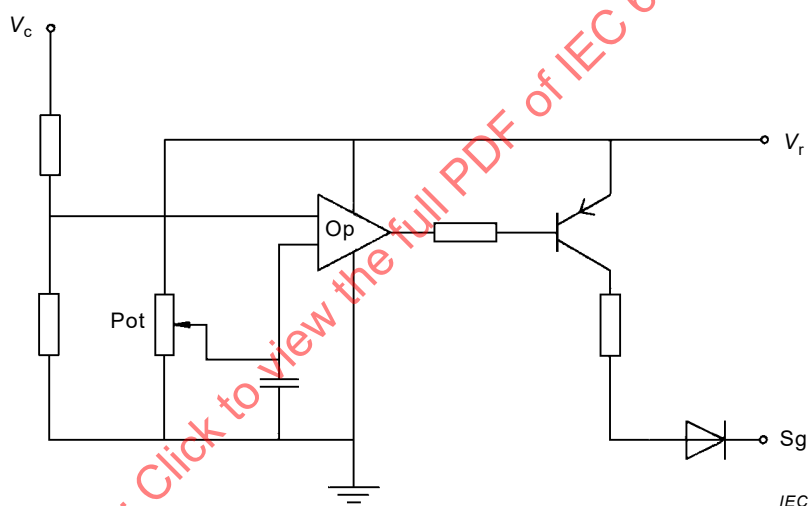
Circuit for the independent control of the switching speed of the major impulse-switching device

A suitable circuit for external independent control of the switching speed of semiconductor devices used as the major impulse-switching device in the **energizer**, in accordance with the eighth dashed item of 19.101, is shown in Figure AA.1.

The circuit is used to reference the gate signal of the major impulse-switching device to the voltage across this device so that it can be triggered at the same point in the charging cycle.

The reference voltage should be of such a value that the comparator is adjustable over the whole range of the **energizer** charging voltage, thereby allowing the switching speed to be set at any desired frequency.

The input impedance of the comparator circuit should be such that it does not influence the results of the test.



Key

- V_c charging voltage
- V_r reference voltage
- S_g gate signal
- Pot switching speed adjustor
- Op comparator

**Figure AA.1 – Circuit for the independent control of the switching speed
of the major impulse-switching device**

Annex BB (normative)

Instructions for installation and connection of electric fences

BB.1 Instructions for electric animal fences

For the purpose of these instructions, the term **connecting leads** means electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**.

Electric animal fences and their ancillary equipment shall be installed, operated and maintained in a manner that minimizes danger to persons, animals or their surroundings.

Electric animal fence constructions that are likely to lead to the entanglement of animals or persons shall be avoided.

WARNING: Avoid contacting electric fence wires especially with the head, neck or torso. Do not climb over, through or under a multi-wire electric fence. Use a gate or a specially designed crossing point.

An **electric animal fence** shall not be supplied from two separate **energizers** or from independent **fence circuits** of the same **energizer**.

For any two separate **electric animal fences**, each supplied from a separate **energizer** independently timed, the distance between the wires of the two **electric animal fences** shall be at least 2,5 m. If this gap is to be closed, this shall be effected by means of electrically non-conductive material or an isolated metal barrier.

Barbed wire or razor wire shall not be electrified by an **energizer**.

A non-electrified **fence** incorporating barbed wire or razor wire may be used to support one or more off-set electrified wires of an **electric animal fence**. The supporting devices for the electrified wires shall be constructed so as to ensure that these wires are positioned at a minimum distance of 150 mm from the vertical plane of the non-electrified wires. The barbed wire and razor wire shall be earthed at regular intervals.

Follow the energizer manufacturer's recommendations regarding earthing.

A distance of at least 10 m shall be maintained between the **energizer earth electrode** and any other earthing system connected parts such as the power supply system protective earth or the telecommunication system earth.

Connecting leads that are run inside buildings shall be effectively insulated from the earthed structural parts of the building. This may be achieved by using insulated high voltage cable.

Connecting leads that are run underground shall be run in conduit of insulating material or else insulated high voltage cable shall be used. Care shall be taken to avoid damage to the **connecting leads** due to the effects of animal hooves or tractor wheels sinking into the ground.

Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables.

Connecting leads and **electric animal fence** wires shall not cross above overhead power or communication lines.

Crossings with overhead power lines shall be avoided wherever possible. If such a crossing cannot be avoided it shall be made underneath the power line and as nearly as possible at right angles to it.

If **connecting leads** and **electric animal fence** wires are installed near an overhead power line, the clearances shall not be less than those shown in Table BB.1.

Table BB.1 – Minimum clearances from power lines for electric animal fences

Power line voltage V	Clearance m
≤ 1 000	3
> 1 000 and ≤ 33 000	4
> 33 000	8

If **connecting leads** and **electric animal fence** wires are installed near an overhead power line, their height above the ground shall not exceed 3 m.

This height applies to either side of the orthogonal projection of the outermost conductors of the power line on the ground surface, for a distance of

- 2 m for power lines operating at a nominal voltage not exceeding 1 000 V;
- 15 m for power lines operating at a nominal voltage exceeding 1 000 V.

Electric animal fences intended for deterring birds, household pet containment or training animals such as cows need only be supplied from low output **energizers** to obtain satisfactory and safe performance.

In **electric animal fences** intended for deterring birds from roosting on buildings, no **electric fence** wire shall be connected to the **energizer earth electrode**. A warning sign shall be fitted to every point where persons may gain ready access to the conductors.

Where an **electric animal fence** crosses a public pathway, a non-electrified gate shall be incorporated in the **electric animal fence** at that point or a crossing by means of stiles shall be provided. At any such crossing, the adjacent electrified wires shall carry warning signs.

Any part of an **electric animal fence** that is installed along a public road or pathway shall be identified at frequent intervals by warning signs securely fastened to the **fence** posts or firmly clamped to the **fence** wires.

The size of the warning sign shall be at least 100 mm × 200 mm.

The background colour of both sides of the warning sign shall be yellow. The inscription on the sign shall be black and shall be either

- the symbol of Figure BB.1, or
- the substance of “CAUTION: **Electric fence**”.

The inscription shall be indelible, inscribed on both sides of the warning sign and have a height of at least 25 mm.

Ensure that all mains-operated, ancillary equipment connected to the **electric animal fence circuit** provides a degree of isolation between the **fence circuit** and the supply mains equivalent to that provided by the **energizer**.

NOTE Ancillary equipment that complies with the requirements relating to isolation between the **fence circuit** and the supply mains in Clauses 14, 16 and 29 of the standard for the **electric fence energizer** is considered to provide an adequate level of isolation.

Protection from the weather shall be provided for the ancillary equipment unless this equipment is certified by the manufacturer as being suitable for use outdoors, and is of a type with a minimum degree of protection IPX4.

BB.2 Instructions for electric security fences not supplied from a security energizer group

For the purpose of these instructions, the term:

- **connecting leads** means electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**;
- **physical barrier** means a barrier not less than 1,5 m high intended to prevent inadvertent contact with the **pulsed conductors** of the **electric fence**;
- **secure area** means an area where a person is not separated from **pulsed conductors** below 1,5 m by a **physical barrier**;
- **public access area** means any area where persons are protected from inadvertent contact with **pulsed conductors** by a **physical barrier**;
- **pulsed conductors** means conductors that are subjected to high voltage pulses by the **energizer**.

Electric security fences and their ancillary equipment shall be installed, operated and maintained in a manner that minimizes danger to persons, and reduces the risk of persons receiving an electric shock unless they attempt to penetrate the **physical barrier**, or are in the **secure area** without authority.

Electric security fence constructions that are likely to lead to the entanglement of persons shall be avoided.

Gates in **electric security fences** shall be capable of being opened without the person receiving an electric shock.

An **electric security fence** shall not be supplied from two separate **energizers** or from independent **fence circuits** of the same **energizer**.

For any two separate **electric security fences**, each supplied from a separate **energizer**, the distance between the wires of the two separate **electric security fences** shall be at least 2,5 m. If this gap is to be closed, this shall be effected by means of a physical barrier of high voltage insulating material or earthed conducting material such that the two separate **electric security fences** cannot be contacted at the same time.

A spacing of 2,5 m shall be maintained between uninsulated **connecting leads** supplied from separate **energizers**. This spacing may be less where

- the connecting leads are covered by insulating sleeving rated to at least 10 kV at mains frequency; or
- the connecting leads consist of insulated cables rated to at least 10 kV at mains frequency.

Barbed wire or razor wire shall not be electrified by an **energizer**.

For earthing recommendations, follow the relevant national standard for **electric security fence** earthing. If this does not exist then follow the **energizer** manufacturer's instructions and recommendations.

The distance between any **electric security fence earth electrode** and other earth systems shall be not less than 2 m, except when associated with a graded earth mat.

Where possible, the distance between any electric **security fence earth electrode** and other earth systems should preferably be at least 10 m.

Exposed conductive parts of the **physical barrier** shall be effectively earthed.

Where an **electric security fence** passes below bare power line conductors, the highest metallic element shall be effectively earthed for a distance of not less than 5 m on either side of the crossing point.

Connecting leads that are run inside buildings shall be effectively insulated from the earthed structural parts of the building. This may be achieved by using insulated high voltage cable.

Connecting leads that are run underground shall be run in conduit of insulating material or else insulated high voltage cable shall be used. Care shall be taken to avoid damage to the **connecting leads** due to the effects of vehicle wheels sinking into the ground.

Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables.

Connecting leads and **electric security fence** wires shall not cross above overhead power or communication lines.

Crossings with overhead power lines shall be avoided wherever possible. If such a crossing cannot be avoided, it shall be made underneath the power line and as nearly as possible at right angles to it.

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, the clearances shall not be less than those shown in Table BB.2.

Table BB.2 – Minimum clearances from power lines for electric security fences not supplied from a security energizer group

Power line voltage V	Clearance m
≤ 1 000	3
> 1 000 and ≤ 33 000	4
> 33 000	8

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, their height above the ground shall not exceed 3 m.

This height applies to either side of the orthogonal projection of the outermost conductors of the power line on the ground surface, for a distance of

- 2 m for power lines operating at a nominal voltage not exceeding 1 000 V;
- 15 m for power lines operating at a nominal voltage exceeding 1 000 V.

Electric security fences shall be identified by prominently placed warning signs.

The warning signs shall be legible from the **secure area** and the **public access area**.

Each side of the **electric security fence** shall have at least one warning sign.

Warning signs shall be placed

- at each gate;
- at each access point;
- at intervals not exceeding 10 m;
- adjacent to each sign relating to chemical hazards for the information of the emergency services.

Any part of an **electric security fence** that is installed along a public road or pathway shall be identified at frequent intervals by warning signs securely fastened to the **fence** posts or firmly clamped to the **fence** wires.

The size of the warning sign shall be at least 100 mm × 200 mm.

The background colour of both sides of the warning sign shall be yellow. The inscription on the sign shall be black and shall be either

- the symbol of Figure BB.1, or
- the substance of “CAUTION: **Electric fence**”.

The inscription shall be indelible, inscribed on both sides of the warning sign and have a height of at least 25 mm.

Ensure that all mains operated, ancillary equipment connected to the **electric security fence circuit** provides a degree of isolation between the **fence circuit** and the supply mains equivalent to that provided by the **energizer**.

NOTE 2 Ancillary equipment that complies with the requirements relating to isolation between the **fence circuit** and the supply mains in Clauses 14, 16 and 29 of the standard for the **electric fence energizer** is considered to provide an adequate level of isolation.

Mains supply wiring shall not be installed in the same conduit as signalling leads associated with the **electric security fence** installation.

Protection from the weather shall be provided for the ancillary equipment unless this equipment is certified by the manufacturer as being suitable for use outdoors, and is of a type with a minimum degree of protection IPX4.

BB.3 Instructions for electric security fences supplied from a security energizer group

For the purpose of these instructions the term:

- **connecting leads** means electric conductor, used to connect the **energizer** to the **electric fence** or the **earth electrode**;
- **physical barrier** means a barrier not less than 1,5 m high intended to prevent inadvertent contact with the **pulsed conductors** of the **electric fence**;
- **secure area** means an area where a person is not separated from **pulsed conductors** below 1,5 m by a **physical barrier**;
- **public access area** means any area where persons are protected from inadvertent contact with **pulsed conductors** by a **physical barrier**;
- **pulsed conductors** means conductors that are subjected to high voltage pulses by the **energizer**.

Electric security fences and their ancillary equipment shall be installed, operated and maintained in a manner that minimizes danger to persons, and reduces the risk of persons receiving an electric shock unless they attempt to penetrate the **physical barrier**, or are in the **secure area** without authority.

Electric security fence constructions that are likely to lead to the entanglement of persons shall be avoided.

Gates in **electric security fences** shall be capable of being opened without the person receiving an electric shock.

An **electric security fence** shall not be supplied from two separate **energizers** unless they are **type R security energizers** or **type S security energizers** configured and connected to operate in a **type R security energizer group** or **type S security energizer group**.

For any two separate **electric security fences**, each supplied from a separate **energizer**, the distance between the wires of the two separate **electric security fences** shall be at least 2,5 m. If this gap is to be closed, this shall be effected by means of a physical barrier of high voltage insulating material or earthed conducting material such that the two separate security fences cannot be contacted at the same time.

This gap can also be closed if the **electric security fences** are supplied by **type R security energizers** or **type S security energizers** that are part of a **type R security energizer group** or **type S security energiser group** configured and connected in accordance with the instructions.

A spacing of 2,5 m shall be maintained between uninsulated **connecting leads** supplied from separate **energizers**. This spacing may be less where

- the **connecting leads** are covered by insulating sleeving rated to at least 10 kV at mains frequency; or
- the **connecting leads** consist of insulated cables rated to at least 10 kV at mains frequency; or
- the **connecting leads** are powered by **energizers** that are part of a **type R security energizer group** or **type S security energizer group** configured and connected in accordance with the instructions.

Barbed wire or razor wire shall not be electrified by an **energizer**.

For earthing recommendations, follow the relevant national standard for **electric security fence** earthing. If this does not exist then follow the **energizer** manufacturer's instructions and recommendations.

The distance between any **electric security fence earth electrode** and other earth systems shall be not less than 2 m, except when associated with a graded earth mat.

Where possible, the distance between any electric **security fence earth electrode** and other earth systems should preferably be at least 10 m.

Exposed conductive parts of the **physical barrier** shall be effectively earthed.

Where an **electric security fence** passes below bare power line conductors, the highest metallic element shall be effectively earthed for a distance of not less than 5 m on either side of the crossing point.

Connecting leads that are run inside buildings shall be effectively insulated from the earthed structural parts of the building. This may be achieved by using insulated high voltage cable.

Connecting leads that are run underground shall be run in conduit of insulating material or else insulated high voltage cable shall be used. Care shall be taken to avoid damage to the **connecting leads** due to the effects of vehicle wheels sinking into the ground.

Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables.

Connecting leads and **electric security fence wires** shall not cross above overhead power or communication lines.

Crossings with overhead power lines shall be avoided wherever possible. If such a crossing cannot be avoided, it shall be made underneath the power line and as nearly as possible at right angles to it.

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, the clearances shall not be less than those shown in Table BB.3.

Table BB.3 – Minimum clearances from power lines for electric security fences supplied from a security energizer group

Power line voltage V	Clearance m
≤ 1 000	3
> 1 000 and ≤ 33 000	4
> 33 000	8

If **connecting leads** and **electric security fence** wires are installed near an overhead power line, their height above the ground shall not exceed 3 m.

This height applies to either side of the orthogonal projection of the outermost conductors of the power line on the ground surface, for a distance of

- 2 m for power lines operating at a nominal voltage not exceeding 1 000 V;
- 15 m for power lines operating at a nominal voltage exceeding 1 000 V.

Electric security fences shall be identified by prominently placed warning signs.

The warning signs shall be legible from the **secure area** and the **public access area**.

Each side of the **electric security fence** shall have at least one warning sign.

Warning signs shall be placed

- at each gate;
- at each access point;
- at intervals not exceeding 10 m;
- adjacent to each sign relating to chemical hazards for the information of the emergency services.

Any part of an **electric security fence** that is installed along a public road or pathway shall be identified at frequent intervals by warning signs securely fastened to the fence posts or firmly clamped to the fence wires.

The size of the warning sign shall be at least 100 mm × 200 mm.

The background colour of both sides of the warning sign shall be yellow. The inscription on the sign shall be black and shall be either

- the symbol of Figure BB.1, or
- the substance of “CAUTION: **Electric fence**”.

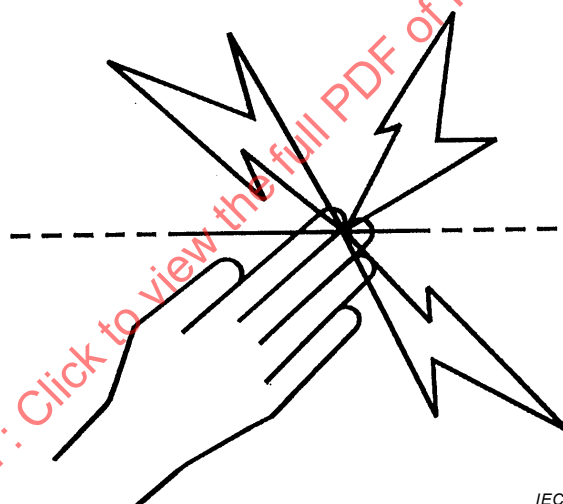
The inscription shall be indelible, inscribed on both sides of the warning sign and have a height of at least 25 mm.

Ensure that all mains operated, ancillary equipment connected to the **electric security fence circuit** provides a degree of isolation between the **fence circuit** and the supply mains equivalent to that provided by the **energizer**.

NOTE 2 Ancillary equipment that complies with the requirements relating to isolation between the **fence circuit** and the supply mains in Clauses 14, 16 and 29 of the standard for the **electric fence energizer** is considered to provide an adequate level of isolation.

Mains supply wiring shall not be installed in the same conduit as signalling leads associated with the **electric security fence** installation.

Protection from the weather shall be provided for the ancillary equipment unless this equipment is certified by the manufacturer as being suitable for use outdoors, and is of a type with a minimum degree of protection IPX4.



IEC

Figure BB.1 – Symbol for warning sign

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**.

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

When selecting the type of **physical barrier**, the likely presence of young children should be a factor in considering the size of openings and a risk assessment shall be made prior to installation.

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 should not be installed within the shaded zone shown in Figure CC.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.

Typical **electric security fence** installations are shown in Figure CC.2 and Figure CC.3.

CC.4 Separation between electric fence and physical barrier

Where a **physical barrier** is installed in compliance with Clause 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;
- 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 can be expected to fall from a surface if contact is made with **pulsed conductors**.

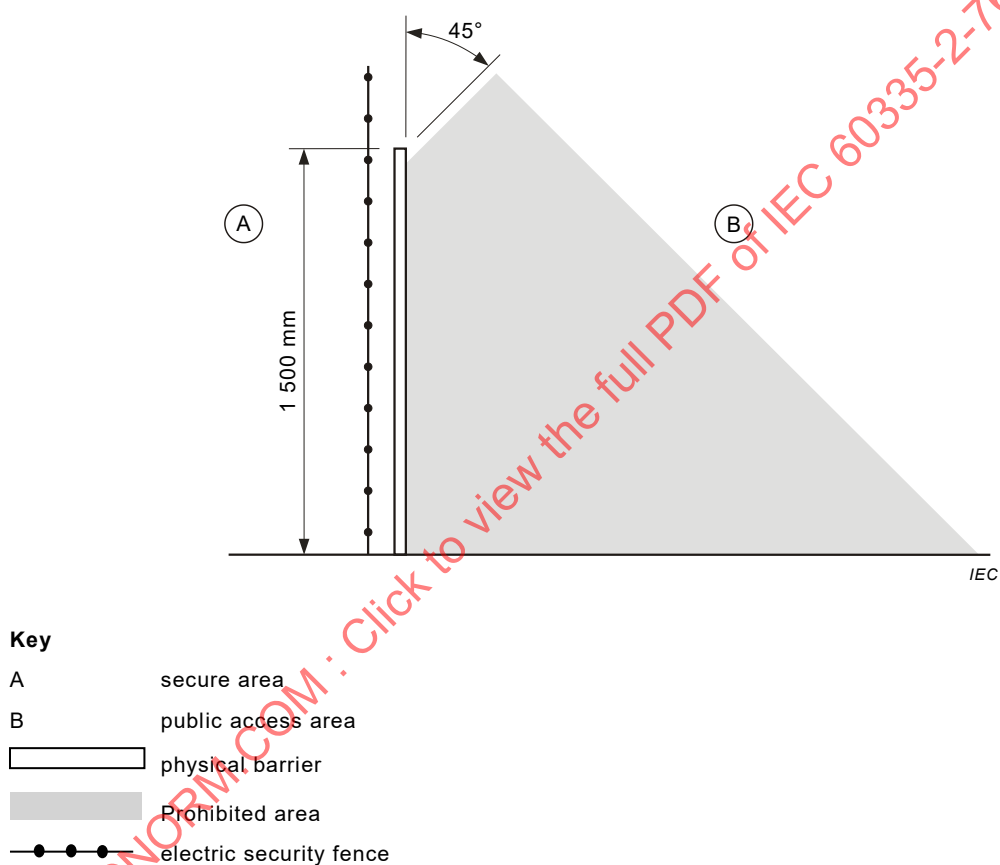
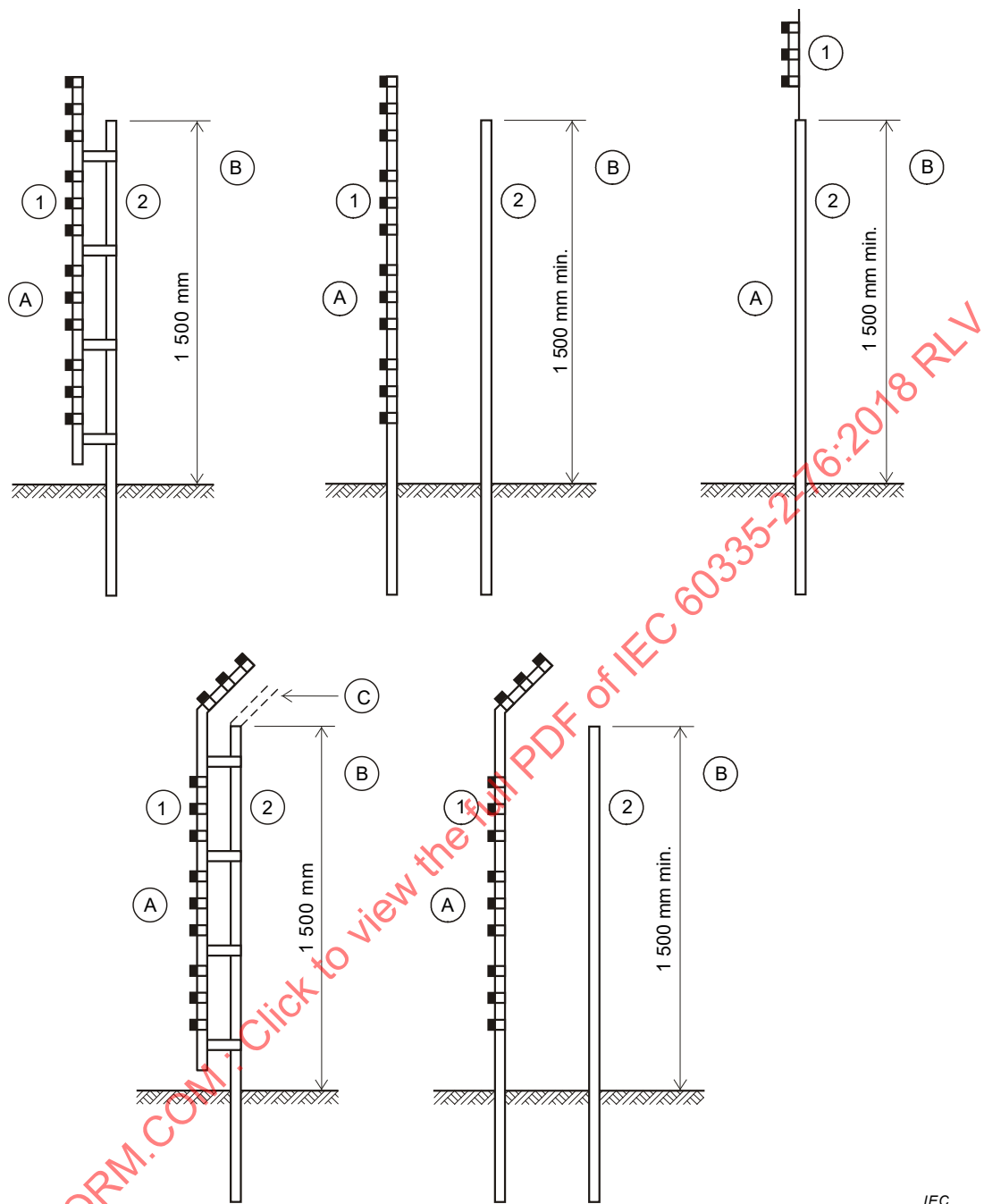


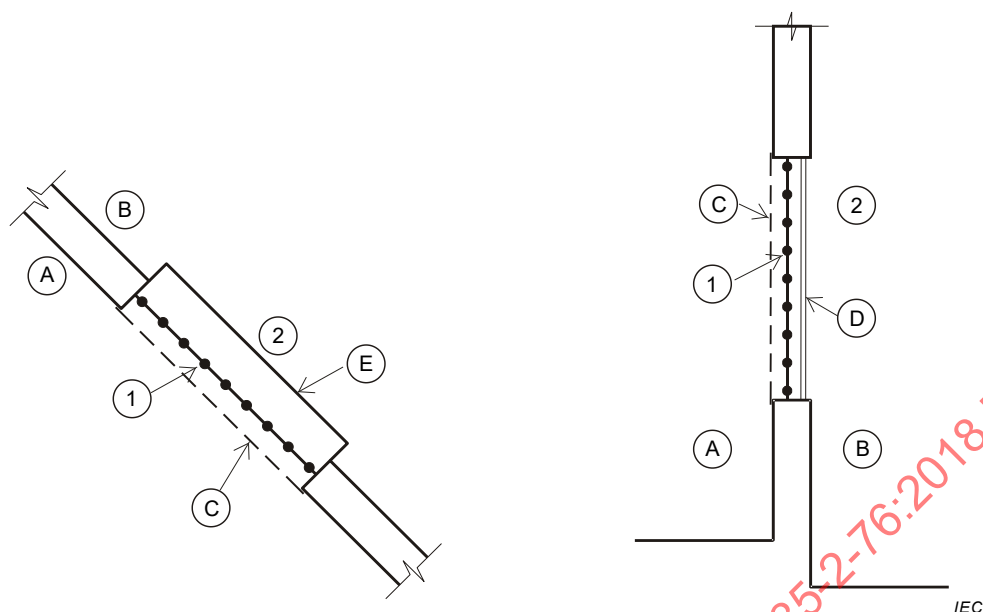
Figure CC.1 – Prohibited area for pulse conductors



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*

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SOMMAIRE

AVANT-PROPOS	64
INTRODUCTION.....	67
1 Domaine d'application	68
2 Références normatives	68
3 Termes et définitions	69
4 Exigence générale	74
5 Conditions générales d'essais	74
6 Classification	75
7 Marquage et instructions	75
8 Protection contre l'accès aux parties actives.....	78
9 Démarrage des appareils à moteur	79
10 Puissance d'entrée et courant d'entrée	79
11 Échauffements.....	79
12 Vide.....	82
13 Courant de fuite et rigidité diélectrique à la température de régime	82
14 Surtensions transitoires	82
15 Résistance à l'humidité.....	83
16 Courant de fuite et rigidité diélectrique	84
17 Protection contre la surcharge des transformateurs et des circuits associés	84
18 Endurance	84
19 Fonctionnement anormal	85
20 Stabilité et dangers mécaniques	88
21 Résistance mécanique.....	88
22 Construction	88
23 Conducteurs internes.....	94
24 Composants	94
25 Raccordement au réseau et câbles souples extérieurs	94
26 Bornes pour conducteurs externes	95
27 Dispositions de mise à la terre.....	96
28 Vis et connexions	96
29 Distances d'isolement, lignes de fuite et isolation solide	96
30 Résistance à la chaleur et au feu.....	96
31 Résistance à la rouille	96
32 Rayonnement, toxicité et dangers analogues	96
Annexes	102
Annexe A (informative) Essais de série.....	102
Annexe B (normative) Appareils alimentés par batteries rechargées dans l'appareil	103
Annexe S (normative) Appareils alimentés par des batteries non rechargeables ou non rechargées dans l'appareil.....	105
Annexe AA (informative) Circuit pour la commande indépendante de la vitesse d'interruption du dispositif principal d'interruption d'impulsions.....	109
Annexe BB (normative) Instructions pour l'installation et le raccordement des clôtures électriques	110

BB.1	Instructions relatives aux clôtures électriques pour animaux	110
BB.2	Instructions relatives aux clôtures électriques de sécurité non alimentées par un groupe d'électrificateurs de sécurité	112
BB.3	Instructions relatives aux clôtures électriques de sécurité alimentées par un groupe d'électrificateurs de sécurité	115
Annexe CC (informative)	Installation des clôtures électriques de sécurité	119
CC.1	Généralités	119
CC.2	Emplacement de la clôture électrique de sécurité	119
CC.3	Zone interdite pour les conducteurs pulsés	119
CC.4	Séparation entre la clôture électrique et la séparation physique	119
CC.5	Montage interdit	120
CC.6	Fonctionnement de la clôture électrique de sécurité	120
Bibliographie		123
Figure 101	Exemples schématiques d'électrificateurs de type A, d'électrificateurs de type B et d'électrificateurs de type C	97
Figure 102	Exemples schématiques de différents types d'électrificateurs de type D	99
Figure 103	Limite caractéristique des électrificateurs à courant limité	99
Figure 104	Configurations d'essai du groupe d'électrificateurs de sécurité de type R	100
Figure 105	Configurations d'essai du groupe d'électrificateurs de sécurité de type S	101
Figure AA.1	Circuit pour la commande indépendante de la vitesse d'interruption du dispositif principal d'interruption d'impulsions	109
Figure BB.1	Symbole pour signal de mise en garde	118
Figure CC.1	Zone interdite pour conducteurs pulsés	120
Figure CC.2	Constructions classiques dans lesquelles une clôture électrique de sécurité est exposée au public	121
Figure CC.3	Constructions classiques de clôture dans lesquelles la clôture électrique de sécurité est installée dans des fenêtres et des lucarnes	122
Tableau 101	Impédance de la source d'alimentation par piles ou accumulateurs	80
Tableau 102	Multiplicateurs de valeur maximale et minimale de tension d'alimentation assignée	81
Tableau 103	Réglages d'essai de la valeur de tension d'alimentation	81
Tableau 104	Séquence d'alimentations d'essai pour différents types d'alimentations	81
Tableau 105	Tensions d'essai supplémentaires	84
Tableau BB.1	Distances d'isolement minimales par rapport aux lignes électriques pour les clôtures électriques pour animaux	111
Tableau BB.2	Distances d'isolement minimales par rapport aux lignes électriques pour les clôtures électriques de sécurité non alimentées par un groupe d'électrificateurs de sécurité	114
Tableau BB.3	Distances d'isolement minimales par rapport aux lignes électriques pour les clôtures électriques de sécurité alimentées par un groupe d'électrificateurs de sécurité	117

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

APPAREILS ÉLECTRODOMESTIQUES ET ANALOGUES – SÉCURITÉ

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

AVANT-PROPOS

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- 9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La présente partie de la Norme internationale IEC 60335 a été établie par le sous-comité 61H: Sécurité des appareils électriques employés à la ferme, du comité d'études 61 de l'IEC: Sécurité des appareils électrodomestiques et analogues.

La présente version bilingue (2019-02) correspond à la version anglaise monolingue publiée en 2018-06.

Cette troisième édition annule et remplace la deuxième édition publiée en 2002, son Amendement 1 (2006) et son Amendement 2 (2013). Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques significatives suivantes par rapport à l'édition précédente:

- le texte a été aligné sur celui de l'Édition 5.2 de la Partie 1;
- des exigences supplémentaires relatives aux électrificateurs de clôtures ont été introduites (Article 3, Article 7, Article 19, Article 22, Figures et Annexe BB);
- les exigences spécifiques relatives aux électrificateurs de clôture fonctionnant sur piles ou accumulateurs ont été déplacées vers l'Annexe S.

Le texte anglais de cette norme est issu des documents 61H/366/FDIS et 61H/367/RVD.

Le rapport de vote 61H/367/RVD donne toute information sur le vote ayant abouti à l'approbation de cette norme.

La version française de cette norme n'a pas été soumise au vote.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60335, publiées sous le titre général *Appareils électrodomestiques et analogues – Sécurité*, peut être consultée sur le site web de l'IEC.

La présente Partie 2 doit être utilisée conjointement avec la dernière édition de l'IEC 60335-1 et ses amendements. Elle a été établie sur la base de la cinquième édition (2010) de cette norme.

NOTE 1 L'expression "Partie 1" utilisée dans la présente Norme fait référence à l'IEC 60335-1.

La présente Partie 2 complète ou modifie les articles correspondants de l'IEC 60335-1 de façon à transformer cette publication en norme IEC: Exigences de sécurité relatives aux électrificateurs de clôtures.

Lorsqu'un paragraphe particulier de la Partie 1 n'est pas mentionné dans cette Partie 2, ledit paragraphe s'applique pour autant qu'il est raisonnable. Lorsque la présente Norme spécifie "addition", "modification" ou "remplacement", le texte correspondant de la Partie 1 doit être adapté en conséquence.

NOTE 2 Le système de numérotation suivant est utilisé:

- les paragraphes, tableaux et figures qui sont numérotés à partir de 101 viennent en supplément de ceux de la Partie 1;
- à l'exception de celles qui sont dans un nouveau paragraphe ou de celles qui concernent des notes de la Partie 1, les notes sont numérotées à partir de 101, y compris celles des articles ou paragraphes qui sont remplacés;
- les annexes supplémentaires sont appelées AA, BB, etc.

NOTE 3 Les caractères d'imprimerie suivants sont utilisés:

- exigences: caractères romains
- *spécifications d'essais: en italique*
- notes: en petits caractères romains.

Les termes en **gras** dans le texte sont définis à l'Article 3. Lorsqu'une définition concerne un adjectif, l'adjectif et le nom associé figurent également en gras.

NOTE 4 L'attention des comités nationaux est attirée sur le fait que les fabricants d'appareils et les organismes d'essais peuvent avoir besoin d'une période de transition après la publication d'une nouvelle publication IEC, ou d'une publication amendée ou révisée, pour fabriquer des produits satisfaisant aux nouvelles exigences et pour adapter leurs équipements aux nouveaux essais ou aux essais révisés.

Le comité recommande que le contenu de la présente publication soit entériné au niveau national au plus tôt 12 mois et au plus tard 36 mois après la date de publication.

Les différences suivantes existent dans les pays indiqués ci-après:

6.101: Seuls les électrificateurs à énergie limitée sont autorisés (tous les pays de l'UE et de l'AELE).

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

Le contenu du corrigendum de novembre 2018 a été pris en considération dans cet exemplaire.

IMPORTANT - Le logo "colour inside" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer ce document en utilisant une imprimante couleur.

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INTRODUCTION

Il a été considéré en établissant la présente Norme internationale que l'exécution de ses dispositions était confiée à des personnes expérimentées et ayant une qualification appropriée.

La présente norme reconnaît le niveau de protection accepté au niveau international contre les dangers (électriques, mécaniques, thermiques, liés au feu et au rayonnement, par exemple) des appareils, lorsqu'ils fonctionnent dans des conditions normales, en tenant compte des instructions du fabricant. Elle couvre également les situations anormales auxquelles on peut s'attendre dans la pratique et prend en considération la manière dont les phénomènes électromagnétiques peuvent affecter la sécurité de fonctionnement des appareils.

La présente norme tient compte autant que possible des exigences de l'IEC 60364, de façon à garantir la compatibilité avec les règles d'installation quand l'appareil est raccordé au réseau d'alimentation. Cependant, des règles nationales d'installation peuvent être différentes.

Si un appareil compris dans le domaine d'application de la présente norme comporte également des fonctions qui sont couvertes par une autre Partie 2 de l'IEC 60335, la Partie 2 correspondante est appliquée à chaque fonction séparément, pour autant qu'il est raisonnable. Si cela est applicable, l'influence d'une fonction sur les autres fonctions est prise en compte.

NOTE 1 Dans la présente publication, l'expression "Partie 1" fait référence à l'IEC 60335-1.

Lorsqu'une Partie 2 ne comporte pas d'exigences complémentaires pour couvrir les dangers traités dans la Partie 1, la Partie 1 s'applique.

NOTE 2 Ceci signifie que les comités d'études responsables pour les parties 2 ont déterminé qu'il n'était pas nécessaire de spécifier des exigences particulières pour l'appareil en question en plus des exigences générales.

La présente norme est une norme de famille de produits traitant de la sécurité d'appareils et prévaut sur les normes horizontales et génériques couvrant le même sujet.

NOTE 3 Les normes horizontales et génériques couvrant un danger ne sont pas applicables puisqu'elles ont été prises en considération lors du développement des exigences générales et particulières pour la série de normes IEC 60335. Par exemple, dans le cas des exigences de température de surface pour de nombreux appareils, des normes génériques, comme l'ISO 13732-1 pour les surfaces chaudes, ne sont pas applicables en plus de la Partie 1 ou des Parties 2.

APPAREILS ÉLECTRODOMESTIQUES ET ANALOGUES – SÉCURITÉ

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

1 Domaine d'application

Le présent article de la Partie 1 est remplacé par l'article ci-après.

La présente partie de l'IEC 60335 traite de la sécurité des **électrificateurs de clôtures**, dont la **tension assignée** n'est pas supérieure à 250 V et au moyen desquels des fils de **clôtures** pour **clôtures** agricoles, de contrôle des animaux domestiques ou sauvages et **clôtures de sécurité** peuvent être électrifiés ou commandés.

NOTE 101 Les éléments suivant sont des exemples d'**électrificateurs de clôtures** entrant dans le domaine d'application de la présente norme:

- **électrificateurs fonctionnant sur le réseau;**
- **électrificateurs de clôtures fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau** (voir la Figure 101 et la Figure 102);
- **électrificateurs de clôtures** alimentés par piles incorporées ou séparées.

La présente norme ne tient en général pas compte

- de l'utilisation des appareils par de jeunes enfants ou des personnes handicapées sans surveillance;
- de l'emploi de l'appareil comme jouet par de jeunes enfants.

NOTE 102 L'attention est attirée sur le fait que

- pour les appareils destinés à être utilisés à bord de navires ou d'avions, des exigences supplémentaires peuvent être nécessaires;
- dans de nombreux pays, des exigences supplémentaires sont spécifiées par les organismes nationaux de la santé, par les organismes nationaux responsables de la protection des travailleurs, par les organismes nationaux responsables de l'alimentation en eau et par des organismes similaires.

NOTE 103 La présente norme ne s'applique pas

- aux colliers de dressage pour animaux couplés électromagnétiquement;
- aux appareils destinés à être utilisés dans des locaux présentant des conditions particulières, telles que la présence d'une atmosphère corrosive ou explosive (poussière, vapeur ou gaz);
- aux chargeurs de batteries séparés (IEC 60335-2-29);
- aux équipements électriques de pêche (IEC 60335-2-86);
- aux appareils électriques d'insensibilisation des animaux (IEC 60335-2-87);
- aux appareils électromédicaux (IEC 60601).

2 Références normatives

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

Addition:

IEC 60068-2-52:2017, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)* (disponible en anglais seulement)

IEC 60320-3, *Connecteurs pour usages domestiques et usages généraux analogues – Partie 3: Feuilles de norme et calibres*

ISO 3864-1, *Symboles graphiques – Couleurs de sécurité et signaux de sécurité – Partie 1: principes de conception pour les signaux de sécurité et les marquages de sécurité*

3 Termes et définitions

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

3.1 Définitions relatives aux caractéristiques physiques

3.1.1 *Addition:*

Note 1 à l'article: Pour les **électrificateurs de type D**, la **tension assignée** de l'**électrificateur** est la **tension assignée** pour l'alimentation par piles ou accumulateurs.

Remplacement:

3.1.9

fonctionnement normal

fonctionnement de l'appareil dans les conditions suivantes: l'**électrificateur de clôture** est mis en fonctionnement comme en usage normal lorsqu'il est raccordé au réseau, sans aucune charge connectée aux bornes de sortie

3.1.101

tension de crête présumée

tension crête de sortie du générateur d'impulsions spécifié à l'Article 14, qui serait obtenue en ne connectant pas l'**électrificateur** au circuit d'essai

3.1.102

tension assignée pour l'alimentation par piles ou accumulateurs

pour les **électrificateurs de type A**, **électrificateurs de type B**, **électrificateurs de type C** et **électrificateurs de type D**, tension pour alimentation par piles ou accumulateurs attribuée à l'**électrificateur** par le fabricant

3.1.103

plage assignée de tensions pour l'alimentation par piles ou accumulateurs

pour les **électrificateurs de type A**, **électrificateurs de type B**, **électrificateurs de type C** et **électrificateurs de type D**, plage de tensions pour alimentation par piles ou accumulateurs attribuée à l'**électrificateur** par le fabricant, exprimée par ses limites inférieure et supérieure

3.1.104

durée de l'impulsion

durée de la partie de l'impulsion qui comprend 95 % de l'énergie totale et qui est l'intervalle le plus court de l'intégration $I^2(t)$ qui donne 95 % de l'intégration de $I^2(t)$ sur l'impulsion totale

Note 1 à l'article: $I(t)$ est le courant d'impulsion, fonction du temps.

3.1.105

courant de sortie

valeur efficace du **courant de sortie** par impulsion, calculée pendant la durée de l'impulsion

3.5 Définitions relatives aux types d'appareils

3.5.101

électrificateur de clôture

appareil destiné à fournir régulièrement des impulsions de tension à une **clôture** qui lui est raccordée

Note 1 à l'article: Dans la suite du texte, les **électrificateurs de clôtures** sont ci-après également appelés **électrificateurs**.

3.5.102

électrificateur fonctionnant sur le réseau

électrificateur conçu pour être raccordé directement au réseau d'alimentation électrique

3.5.103

électrificateur fonctionnant sur piles ou accumulateurs et destiné à être raccordé au réseau

électrificateur

- fonctionnant sur accumulateurs et comportant, ou étant conçu pour être raccordé à, des dispositifs pour charger ces accumulateurs à partir du réseau d'alimentation électrique, ou
- conçu pour fonctionner soit à partir du réseau d'alimentation électrique, soit sur piles ou accumulateurs

3.5.104

électrificateur de type A

électrificateur fonctionnant sur piles ou accumulateurs et destiné à être raccordé au réseau constitué d'un circuit générateur d'impulsions, d'un circuit de charge de l'accumulateur et d'un accumulateur, le circuit générateur d'impulsions étant connecté au réseau d'alimentation électrique ou à l'accumulateur lorsque l'électrificateur est en fonctionnement

Note 1 à l'article: Des **électrificateurs de type A** sont représentés schématiquement à la Figure 101.

3.5.105

électrificateur de type B

électrificateur fonctionnant sur piles ou accumulateurs et destiné à être raccordé au réseau constitué d'un circuit générateur d'impulsions, d'un circuit de charge de l'accumulateur et d'un accumulateur, le circuit générateur d'impulsions étant connecté à l'accumulateur, et déconnecté du circuit de charge de l'accumulateur et du réseau d'alimentation électrique lorsque l'**électrificateur** est en fonctionnement

Note 1 à l'article: Pour recharger l'accumulateur, le circuit générateur d'impulsions est déconnecté et rendu inopérant.

Note 2 à l'article: Des **électrificateurs de type B** sont représentés schématiquement à la Figure 101.

3.5.106

électrificateur de type C

électrificateur fonctionnant sur piles ou accumulateurs et destiné à être raccordé au réseau constitué d'un circuit générateur d'impulsions et de piles ou d'accumulateurs, le circuit générateur d'impulsions étant connecté au réseau d'alimentation électrique ou à la pile ou à l'accumulateur lorsque l'électrificateur est en fonctionnement et où il est nécessaire d'enlever les piles ou les accumulateurs pour les recharger à l'aide d'un chargeur de batteries ou, dans le cas de piles, d'enlever les piles pour les remplacer par des piles neuves

Note 1 à l'article: Des **électrificateurs de type C** sont représentés schématiquement à la Figure 101.

3.5.107

électrificateur de type D

électrificateur fonctionnant sur piles ou accumulateurs et destiné à être raccordé au réseau se composant d'une unité génératrice d'impulsions destinée à être alimentée par une pile ou accumulateur, ou une **unité d'alimentation amovible**, lorsque l'**électrificateur** est en fonctionnement. L'unité génératrice d'impulsions ou l'accumulateur peut être relié(e) à une **unité d'alimentation amovible** avec ou sans circuit de charge de l'accumulateur intégré pour recharger l'accumulateur lorsque l'**électrificateur** est en fonctionnement

Note 1 à l'article: Des exemples d'**électrificateurs de type D** sont représentés schématiquement à la Figure 102.

3.5.108

électrificateur de clôture fonctionnant sur piles ou accumulateurs

électrificateur dont l'énergie provient uniquement de piles, d'accumulateurs ou d'autres sources d'énergie, et qui n'est pas conçu pour être raccordé au réseau

3.5.109**électrificateur de clôture de sécurité**

électrificateur contenant des **circuits de clôture** destinés à régulièrement fournir des impulsions de tension à des **clôtures électriques de sécurité**

Note 1 à l'article: Un **électrificateur de clôture de sécurité** est ci-après également appelé **électrificateur de sécurité**.

3.5.110**électrificateur de sécurité à synchronisation indépendante**

électrificateur de sécurité incluant une **source de signal de commande temporelle à impulsions** interne permettant de définir la synchronisation des impulsions de tension périodiques fournies à une **clôture électrique de sécurité**

Note 1 à l'article: Un **électrificateur de sécurité à synchronisation indépendante** est ci-après également appelé **électrificateur de sécurité indépendant**.

3.5.111**électrificateur de sécurité à synchronisation dépendante**

électrificateur de sécurité qui dépend d'un **signal de commande temporelle à impulsions** externe pour définir la synchronisation des impulsions de tension périodiques fournies à une **clôture électrique de sécurité**

Note 1 à l'article: Un **électrificateur de sécurité à synchronisation dépendante** est ci-après également appelé **électrificateur de sécurité dépendant**.

Note 2 à l'article: Certains types d'**électrificateurs de sécurité** peuvent être configurés comme un **électrificateur de sécurité indépendant** ou un **électrificateur de sécurité dépendant** au moment de l'installation.

3.5.112**groupe d'électrificateurs de sécurité**

un ou deux **électrificateur(s) de sécurité** avec deux **circuits de clôture** utilisés pour alimenter les **clôtures électriques de sécurité** adjacentes d'un **système de clôtures électriques de sécurité**, permettant aux deux **circuits de clôture** d'être reliés en même temps

Note 1 à l'article: Les **circuits de clôture** d'un **groupe d'électrificateurs de sécurité** peuvent faire l'objet d'une connexion galvanique.

3.5.113**électrificateur de sécurité de type R**

électrificateur de sécurité comportant un ou deux **circuits de clôture** adaptés à une utilisation dans un **groupe d'électrificateurs de sécurité de type R**

3.5.114**groupe d'électrificateurs de sécurité de type R**

groupe d'électrificateurs de sécurité ne contenant que des **électrificateurs de sécurité de type R**

3.5.115**électrificateur de sécurité de type S**

électrificateur de sécurité comportant un ou deux **circuits de clôture** adaptés à une utilisation dans un **groupe d'électrificateurs de sécurité de type S**

3.5.116**groupe d'électrificateurs de sécurité de type S**

groupe d'électrificateurs de sécurité contenant au moins un **électrificateur de sécurité de type S**

Note 1 à l'article: Un **groupe d'électrificateurs de sécurité de type S** peut contenir un **électrificateur de sécurité de type R**.

3.6 Définitions relatives aux parties d'un appareil

3.6.3 Addition:

Note 101 à l'article: Cela inclut également les bornes ou connexions prévues pour le raccordement des piles ou accumulateurs et les autres parties métalliques dans le compartiment des piles ou accumulateurs qui deviennent accessibles lors du remplacement des piles ou accumulateurs, même avec l'aide d'un **outil**.

Remplacement:

3.6.4

partie active

partie conductrice qui peut être la cause d'un choc électrique

3.6.101

circuit de clôture

toutes les parties conductrices ou tous les composants à l'intérieur de l'**électrificateur**, qui sont connectés ou destinés à être raccordés par connexion galvanique aux bornes de sortie

3.6.102

signal de commande temporelle à impulsions de l'électrificateur de sécurité

signal permettant de déterminer la synchronisation des impulsions de tension périodiques fournies par un **électrificateur de sécurité** à une **clôture électrique de sécurité**

Note 1 à l'article: Un **signal de commande temporelle à impulsions de l'électrificateur de sécurité** est ci-après également appelé **signal de commande temporelle à impulsions**.

Note 2 à l'article: Des exemples de **signaux de commande temporelle à impulsions de l'électrificateur de sécurité** sont les signaux câblés (RS-485), les signaux câblés avec latence (horloge Internet, TCP/IP sécurisé), les signaux sans fil avec latence (LAN, PAN), les signaux optiques, GPS.

3.6.103

source de signal de commande temporelle à impulsions

source de signal qui génère le **signal de commande temporelle à impulsions** exigé par un **électrificateur de sécurité dépendant** pour définir la synchronisation des impulsions de tension périodiques fournies à une **clôture électrique de sécurité**

Note 1 à l'article: Une **source de signal de commande temporelle à impulsions** peut être utilisée par un ou plusieurs **électrificateurs de sécurité dépendants**.

Note 2 à l'article: Une **source de signal de commande temporelle à impulsions** est, par exemple, un signal à impulsions provenant d'une **clôture électrique de sécurité** adjacente alimentée par un **électrificateur de sécurité dépendant** appartenant au même **système de clôtures électriques de sécurité**.

Note 3 à l'article: Un signal à impulsions provenant d'une **clôture électrique de sécurité** adjacente alimentée par un **électrificateur de sécurité indépendant** n'appartenant pas au même **système de clôtures électriques de sécurité** n'est pas un exemple de **source de signal de commande temporelle à impulsions** possible.

3.8 Définitions relatives à différents domaines

3.8.101

charge normalisée

charge constituée d'une résistance non inductive de $500\ \Omega \pm 2,5\ \Omega$ et d'une résistance variable qui est réglée de façon à optimiser pour

- des **électrificateurs à énergie limitée**, l'énergie par impulsion dans la résistance de $500\ \Omega$;
- des **électrificateurs à courant limité**, le **courant de sortie** dans la résistance de $500\ \Omega$.

Note 1 à l'article: La résistance variable est connectée en série ou en parallèle avec la résistance de $500\ \Omega$, suivant la condition qui conduit au résultat le plus défavorable.

3.8.102**prise de terre**

structure métallique enfoncée dans le sol près de l'**électrificateur**, reliée électriquement à la borne de terre de sortie de ce dernier et qui est indépendante des autres systèmes de mise à la terre

3.8.103**conducteurs pulsés**

conducteurs soumis aux impulsions à haute tension par l'**électrificateur**

3.8.104**fil de raccordement**

conducteur électrique, utilisé pour relier l'**électrificateur** à la **clôture électrique** ou à l'**électrode de terre**

3.8.105**clôture**

barrière pour animaux ou de sécurité, comportant un ou plusieurs conducteurs, tels que fils, barreaux ou grillages métalliques

3.8.106**clôture électrique**

séparation comprenant au moins un conducteur électrique, isolé de la terre, à laquelle sont appliquées des impulsions électriques au moyen d'un **électrificateur**

3.8.107**clôture électrique pour animaux**

clôture électrique utilisée pour maintenir les animaux dans une zone donnée ou pour leur en barrer l'accès

3.8.108**clôture électrique de sécurité**

clôture utilisée dans un but de sécurité qui comporte une **clôture électrique** et une séparation physique électriquement isolée de la **clôture électrique**

3.8.109**séparation physique**

barrière d'une hauteur d'au moins 1,5 m destinée à prévenir un contact involontaire avec les **conducteurs pulsés** de la **clôture électrique**

Note 1 à l'article: Les **séparations physiques** sont généralement construites à l'aide de feuilles verticales, de barres verticales rigides, de mailles rigides, de tiges ou de treillis métallique.

3.8.110**zone d'accès public**

toute zone où des personnes sont protégées d'un contact involontaire avec des **conducteurs pulsés** par une **séparation physique**

3.8.111**zone protégée**

zone où une personne n'est pas séparée des **conducteurs pulsés** situés à une hauteur inférieure à 1,5 m par une **séparation physique**

3.8.112**système de clôtures électriques de sécurité**

installation de **clôture électrique de sécurité** dont les **clôtures** sont alimentées par au moins un **électrificateur de sécurité** contenant au moins un **groupe d'électrificateurs de sécurité** qui peut être un **groupe d'électrificateurs de sécurité de type R** ou un **groupe d'électrificateurs de sécurité de type S**

Note 1 à l'article: Une **source de signal de commande temporelle à impulsions indépendante** utilisée dans un **système de clôtures électriques de sécurité** peut être utilisée pour définir la synchronisation des **électrificateurs de sécurité dépendants** dans plusieurs **groupes d'électrificateurs de sécurité**.

4 Exigence générale

L'article de la Partie 1 est applicable.

5 Conditions générales d'essais

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

5.2 Modification:

Remplacer la spécification d'essai par ce qui suit:

*Les essais sont effectués sur deux **électrificateurs** en l'état de livraison, l'un étant soumis à tous les essais à l'exception de celui de l'Article 18, et l'autre étant soumis aux essais de 22.108 et de l'Article 18. Toutefois, les essais de l'Article 22 à l'Article 28 peuvent être effectués sur des échantillons séparés.*

*Pour les **électrificateurs de types A** et les **électrificateurs de types C**, un échantillon supplémentaire est exigé pour l'essai de l'Article 18.*

Addition:

NOTE 101 Lorsque des **circuits électroniques**, des **composants électroniques** ou autres dispositifs sont normalement encapsulés, des échantillons spécialement préparés peuvent être utilisés pour les essais de 19.11 et 19.101.

5.3 Addition:

Les mesurages de 22.108 doivent être effectués avant les essais de l'Article 14.

*Si un **composant électronique** a été endommagé pendant les essais de l'Article 14, les essais de l'Article 19 sont effectués deux fois, une fois avant et une fois après le remplacement des **composants électroniques** endommagés par des **composants électroniques** neufs.*

5.5 Addition:

*L'**électrificateur** est monté en position normale de façon telle que l'angle avec la position pour laquelle il est conçu n'excède pas 15°. Si, toutefois, l'**électrificateur** comporte des moyens de réglage pour le mettre en position normale, tels qu'un niveau à bulle, l'**électrificateur** doit être réglé à $\pm 2^\circ$ de sa position normale.*

*La borne de terre du **circuit de clôture** est raccordée à la terre. Toutefois, s'il n'est pas indiqué quelle borne de sortie doit être raccordée à la terre, la borne qui conduit au résultat le plus défavorable est mise à la terre.*

5.8.1 Addition:

*Pour les **électrificateurs de type A**, **électrificateurs de type B**, **électrificateurs de type C** et **électrificateurs de type D** dont les bornes pour le raccordement des piles ou accumulateurs ne portent pas d'indication de polarité, la polarité la plus défavorable de la source de tension qui remplace la pile ou l'accumulateur doit être appliquée.*

*Pour les **électrificateurs fonctionnant sur le réseau** et les **électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau**, l'impédance de référence de la source d'alimentation doit être de $0,4 \, \Omega + j0,25 \, \Omega$.*

5.101 *Tous les **électrificateurs** sont soumis à essai comme des **appareils à moteur**.*

6 Classification

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

6.1 Remplacement:

Les **électrificateurs fonctionnant sur le réseau** et les **électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau** doivent être de la **classe II** d'après la protection contre les chocs électriques.

La conformité est vérifiée par examen et par les essais applicables.

6.2 Addition:

Les **électrificateurs** doivent être au moins de construction IPX4.

6.101 Les **électrificateurs** sont classés soit comme **électrificateurs à énergie limitée** soit comme **électrificateurs à courant limité**.

La conformité est vérifiée par les essais correspondants.

7 Marquage et instructions

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

7.1 Addition:

Les **électrificateurs de type A**, **électrificateurs de type B** et **électrificateurs de type C** doivent porter l'indication de la **tension assignée pour l'alimentation par piles ou accumulateurs** ou de la **plage assignée de tensions pour l'alimentation par piles ou accumulateurs**, en volts.

Les **électrificateurs à énergie limitée** qui portent l'indication d'une valeur d'énergie maximale par impulsion supérieure à 5 J doivent également porter l'indication de la valeur de la charge résistive pour laquelle l'énergie maximale par impulsion est obtenue.

Les **électrificateurs** doivent porter le marquage du symbole ISO 7000-0790 (2004-01).

Les **électrificateurs de sécurité de type R** doivent porter le symbole IEC 60417-6406 (2018-02).

Les **électrificateurs de sécurité de type S** doivent porter le symbole IEC 60417-6407 (2018-02).

7.6 Addition:

	[symbole IEC 60417-5036 (2002-10)]	tension dangereuse
	[symbole IEC 60417-5017 (2006-08)]	terre
	[symbole IEC 60417-6406 (2018-02)]	électrificateur de sécurité de type R à synchronisation temporelle
	[symbole IEC 60417-6407 (2018-02)]	électrificateur de sécurité de type S à synchronisation temporelle

Les symboles pour la sortie (**clôture**) et pour la sortie (terre) doivent être conformes, respectivement, aux symboles IEC 60417-5036 (2002-10) et IEC 60417-5017 (2006-08).

7.12 Addition:

Les instructions d'emploi pour les électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau doivent

- comporter une mise en garde contre l'utilisation de piles pendant que l'**électrificateur** est alimenté par le réseau;
- indiquer que, pendant l'opération de charge, accumulateurs ventilés doivent être placés dans un espace bien ventilé.

Les instructions relatives aux **électrificateurs de type D** doivent répertorier les accessoires mis à disposition par le fabricant.

7.14 Addition:

Le diamètre externe du cercle du symbole IEC 60417-6406 (2018-02) et du symbole IEC 60417-6407 (2018-02) doit être d'au moins 15 mm.

7.101 Sauf si le mode de raccordement correct est évident ou indifférent, les bornes de sortie de l'**électrificateur**, autres que les bornes de terre dédiées, doivent être identifiées de façon claire et indélébile à l'aide du symbole IEC 60417-5036 (2002-10). Les bornes de terre dédiées doivent être identifiées de façon claire et indélébile à l'aide du symbole IEC 60417-5017 (2006-08).

En présence d'autres bornes de sortie, elles doivent être marquées de façon similaire, ou marquées avec les mots PUISSANCE TOTALE, PUISSANCE RÉDUITE ou TENSION RÉDUITE, suivant le cas.

En présence d'un commutateur de commande de la puissance de sortie, les diverses positions du commutateur doivent être marquées avec les symboles appropriés, ou avec les mots PUISSANCE TOTALE, PUISSANCE RÉDUITE ou TENSION RÉDUITE, suivant le cas.

La hauteur des caractères de marquage ne doit pas être inférieure à celle définie par une police de taille 18, et les symboles doivent avoir une hauteur d'au moins 6 mm.

La conformité est vérifiée par examen et par des mesures.

7.102 Pour les **électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau**, les bornes prévues pour le raccordement des piles ou accumulateurs doivent être clairement indiquées par le symbole IEC 60417-5005 (2002-10), pour la polarité positive, et par le symbole IEC 60417-5006 (2002-10), pour la polarité négative, à moins que la polarité soit indifférente.

La conformité est vérifiée par examen.

7.103 Les **électrificateurs** doivent être fournis avec des indications contenant les informations de l'Annexe BB concernant

- l'installation des **clôtures électriques**;
- les moyens de raccordement de l'**électrificateur** à la **clôture électrique**.

Ces informations doivent contenir en substance le texte de l'Article BB.1 (clôtures électriques pour animaux), de l'Article BB.2 (clôtures électriques de sécurité non alimentées par un groupe d'électrificateurs de sécurité) ou de l'Article BB.3 (clôtures électriques de sécurité alimentées par un groupe d'électrificateurs de sécurité), selon le cas.

Les **électrificateurs** destinés à être utilisés avec des **clôtures électriques de sécurité** peuvent également être fournis avec des informations de l'Annexe CC.

La conformité est vérifiée par examen.

7.104 Les instructions relatives à un **électrificateur de sécurité** adapté à une utilisation dans un **groupe d'électrificateurs de sécurité** doivent contenir en substance ce qui suit:

- seuls les électrificateurs de sécurité de type R ou les électrificateurs de sécurité de type S peuvent être utilisés dans les groupes d'électrificateurs de sécurité;
- un électrificateur de sécurité de type S ne doit pas être utilisé dans un groupe d'électrificateurs de sécurité de type R;
- un électrificateur de sécurité de type R peut être utilisé dans un groupe d'électrificateurs de sécurité de type S;
- l'identification du modèle ou de la référence du type d'électrificateurs de sécurité qui peut être utilisé dans le groupe d'électrificateurs de sécurité;
- les groupes d'électrificateurs de sécurité doivent uniquement inclure des électrificateurs de sécurité identifiés dans les instructions;
- les configurations et connexions admises des électrificateurs de sécurité qui peuvent être utilisés dans les groupes d'électrificateurs de sécurité;
- l'identification du modèle ou de la référence du type de dispositifs générant la source de signal de commande temporelle à impulsions adaptée à une utilisation dans le groupe d'électrificateurs de sécurité;
- un système de clôtures électriques de sécurité doit être configuré et installé par un installateur agréé ou sous la responsabilité de ce dernier;
- un système de clôtures électriques de sécurité doit faire l'objet d'opérations d'entretien et de maintenance réalisées par un installateur agréé ou sous la responsabilité de ce dernier;
- après l'installation, une étiquette doit être fixée à chaque électrificateur d'un groupe d'électrificateurs de sécurité et indiquer le nom de l'installateur agréé, les informations de contact et la date d'installation;

- après une opération d'entretien, une étiquette doit être fixée à chaque électrificateur d'un groupe d'électrificateurs de sécurité et indiquer le nom de l'installateur agréé, les informations de contact et la date d'entretien;
- un installateur agréé est une personne correctement formée par le fabricant pour pouvoir configurer, installer et entretenir en toute sécurité un **système de clôtures électriques de sécurité** en s'appuyant sur une formation professionnelle, sur les connaissances, sur l'expérience et sur la familiarité du matériel concerné.

Les instructions relatives à un **électrificateur de sécurité** adapté à une utilisation dans un **groupe d'électrificateurs de sécurité** doivent

- expliquer les risques liés au fait de ne pas utiliser un **groupe d'électrificateurs de sécurité** dans des lieux où deux clôtures électriques de sécurité peuvent être touchées en même temps;
- expliquer les risques liés au fait de ne pas configurer correctement un **électrificateur de sécurité** utilisé dans un **groupe d'électrificateurs de sécurité**. Ces risques comprennent:
 - la réception d'impulsions trop importantes;
 - la réception de deux impulsions consécutives qui ne sont pas suffisamment espacées dans le temps;
 - le contact avec une clôture électrique de sécurité dont l'isolation par rapport au réseau d'alimentation a été compromise;
- l'explication de la signification des symboles à synchronisation temporelle IEC 60417-6406 (2018-02) et IEC 60417-6407 (2018-02), s'ils sont utilisés;
- une explication générale des objectifs de sécurité et des exigences techniques d'un **groupe d'électrificateurs de sécurité** qui peuvent être correctement compris par un installateur agréé;
- une explication générale des objectifs de sécurité et des exigences techniques d'un **système de clôtures électriques de sécurité** qui peuvent être correctement compris par un installateur agréé.

La première section des instructions doit inclure en substance les mises en garde suivantes:

MISES EN GARDE IMPORTANTES

MISE EN GARDE: Ces instructions doivent être intégralement respectées à tous les égards

MISE EN GARDE: Un groupe d'électrificateurs de sécurité doit être utilisé partout où deux clôtures électriques de sécurité peuvent être touchées simultanément par une personne

MISE EN GARDE: Accorder une attention particulière au choix du type et à la connexion des électrificateurs de sécurité utilisés dans un groupe d'électrificateurs de sécurité

MISE EN GARDE: Il convient qu'un installateur agréé vérifie la sécurité du système de clôtures électriques de sécurité avant de le mettre en fonctionnement

DANGER: L'incapacité à satisfaire aux instructions peut provoquer des chocs électriques mortels

La conformité est vérifiée par examen.

8 Protection contre l'accès aux parties actives

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

8.1.4 Addition:

Les moyens de raccordement de la **clôture** ne sont pas considérés comme des **parties sous tension**.

9 Démarrage des appareils à moteur

L'article de la Partie 1 n'est pas applicable.

10 Puissance d'entrée et courant d'entrée

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

10.101 Pour les **électrificateurs à énergie limitée** qui portent l'indication d'une valeur d'énergie maximale par impulsion supérieure à 5 J, la valeur indiquée ne doit pas différer de l'énergie fournie de plus de $\pm 10\%$ et la valeur de la charge résistive à laquelle elle est obtenue ne doit pas s'écarter de la valeur indiquée sur l'**électrificateur** de plus de $\pm 5\%$.

La conformité est vérifiée par l'essai suivant.

L'électrificateur est alimenté sous la tension assignée ou sous la tension assignée pour l'alimentation par piles ou accumulateurs, suivant le cas, dans les conditions de fonctionnement normal, mais avec une charge résistive variable connectée aux bornes de sortie.

L'énergie par impulsion dissipée dans la charge résistive connectée aux bornes de sortie de l'électrificateur est mesurée en utilisant l'appareillage de mesure décrit en 22.108. La valeur de la charge résistive est mesurée après avoir été réglée pour optimiser la quantité d'énergie par impulsion mesurée.

11 Échauffements

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

11.2 Addition:

*Pour les **électrificateurs de type A**, lorsqu'ils sont raccordés au réseau, les **électrificateurs de type D**, lorsqu'ils sont raccordés à une alimentation par un chargeur de batterie, et pour les **électrificateurs de type B**, lorsqu'ils sont raccordés au réseau avec une fonction chargeur de batterie, un accumulateur présentant la capacité la plus importante pour laquelle l'électrificateur est conçu est connecté aux bornes prévues pour le raccordement à l'accumulateur. Avant de commencer l'essai, l'accumulateur est déchargé à un point tel que la tension délivrée ne dépasse pas 0,75 fois sa valeur nominale.*

11.5 Remplacement:

L'électrificateur est mis en fonctionnement dans les conditions de fonctionnement normal comme suit.

*Un **électrificateur fonctionnant sur le réseau** est alimenté à la tension d'alimentation la plus défavorable comprise entre 0,85 fois et 1,1 fois la **tension assignée**.*

Les **électrificateurs de type A** et les **électrificateurs de type C**, lorsqu'ils sont raccordés au réseau, sont alimentés à la tension d'alimentation la plus défavorable comprise entre 0,85 fois et 1,1 fois la **tension assignée**.

Un **électrificateur de type B**, lorsqu'il est raccordé au réseau avec une fonction chargeur de batterie, est alimenté à la tension la plus défavorable comprise entre 0,85 fois et 1,1 fois la **tension assignée**.

Les **électrificateurs de type A**, **électrificateurs de type B**, **électrificateurs de type C** et **électrificateurs de type D**, lorsqu'ils sont raccordés pour alimentation par piles ou accumulateurs, sont alimentés aux bornes prévues pour le raccordement de la pile ou accumulateur à la tension d'alimentation la plus défavorable comprise entre

- 0,55 fois et 1,1 fois la **tension assignée pour l'alimentation par piles ou accumulateurs**, si l'**électrificateur** peut être utilisé avec des piles;
- 0,75 fois et 1,1 fois la **tension assignée pour l'alimentation par piles ou accumulateurs**, si l'**électrificateur** est conçu pour une utilisation avec des accumulateurs uniquement.

Les valeurs spécifiées dans le Tableau 101 pour la résistance interne par élément de pile ou d'accumulateur doivent être prises en compte.

Tableau 101 – Impédance de la source d'alimentation par piles ou accumulateurs

Tension d'alimentation appliquée aux bornes pour le raccordement des piles ou accumulateurs	Résistance interne par élément Ω	
	Piles	Accumulateurs
1,1 fois la tension assignée pour l'alimentation par piles ou accumulateurs	0,08	0,001 2
1,0 fois la tension assignée pour l'alimentation par piles ou accumulateurs	0,10	0,001 5
0,75 fois la tension assignée pour l'alimentation par piles ou accumulateurs	0,75	0,006 0
0,55 fois la tension assignée pour l'alimentation par piles ou accumulateurs	2,00	–
NOTE Lors de la détermination de la résistance interne des piles ou accumulateurs, deux ou plusieurs éléments raccordés en parallèle sont considérés comme constituant un seul élément.		

Les **électrificateurs de type D** sont alimentés par une source comportant une résistance série de 1 Ω et ayant la forme

- d'une onde sinusoïdale redressée simple alternance, de valeur efficace égale à la **tension assignée pour l'alimentation par piles ou accumulateurs**,
- d'une onde sinusoïdale redressée double alternance, de valeur efficace égale à la **tension assignée pour l'alimentation par piles ou accumulateurs**,

suivant la configuration la plus défavorable.

Les **électrificateurs de sécurité** utilisés dans un **groupe d'électrificateurs de sécurité** doivent être soumis à essai ensemble dans une configuration admise et une connexion qui peut être autorisée dans le groupe.

Les valeurs maximale et minimale de tension d'alimentation sont définies selon le Tableau 102 en utilisant des multiplicateurs reposant sur la **tension assignée** ou la **plage assignée de tensions** de l'appareil.

Tableau 102 – Multiplicateurs de valeur maximale et minimale de tension d'alimentation assignée

<i>Valeur de tension d'alimentation</i>	<i>Réseau</i>	<i>Accumulateur</i>	<i>Pile</i>
<i>Minimum</i>	<i>0,85</i>	<i>0,75</i>	<i>0,55</i>
<i>Maximum</i>	<i>1,1</i>	<i>1,1</i>	<i>1,1</i>

L'**électrificateur de sécurité** qui alimente le premier **circuit de clôture** fonctionne, pour un type de tensions d'alimentation donné, tour à tour sur trois réglages de valeur de tension d'alimentation: la valeur minimale, la valeur maximale et une valeur choisie librement comprise entre la valeur minimale et la valeur maximale, alors que l'**électrificateur de sécurité** qui alimente le second **circuit de clôture** est alimenté, pour un type de tensions d'alimentation donné, avec une tension d'alimentation qui varie entre la valeur minimale et la valeur maximale choisies pour produire le résultat le plus défavorable.

Les essais ci-dessus sont répétés, mais en inversant le premier et le second réglage de l'**électrificateur de sécurité**. Voir le Tableau 103.

Tableau 103 – Réglages d'essai de la valeur de tension d'alimentation

<i>Essai</i>	<i>Alimentation du premier circuit de clôture</i>	<i>Alimentation du second circuit de clôture</i>
<i>1</i>	<i>Valeur maximale</i>	<i>Choisie pour le cas le plus défavorable</i>
<i>2</i>	<i>Valeur minimale</i>	<i>Choisie pour le cas le plus défavorable</i>
<i>3</i>	<i>Valeur choisie librement</i>	<i>Choisie pour le cas le plus défavorable</i>
<i>4</i>	<i>Choisie pour le cas le plus défavorable</i>	<i>Valeur maximale</i>
<i>5</i>	<i>Choisie pour le cas le plus défavorable</i>	<i>Valeur minimale</i>
<i>6</i>	<i>Choisie pour le cas le plus défavorable</i>	<i>Valeur choisie librement</i>

Les essais ci-dessus sont répétés pour la tension du réseau et la tension d'alimentation de la pile ou accumulateur, selon le cas, conformément au Tableau 104.

Tableau 104 – Séquence d'alimentations d'essai pour différents types d'alimentations

<i>Essai</i>	<i>Alimentation du premier circuit de clôture</i>	<i>Alimentation du second circuit de clôture</i>
<i>MM</i>	<i>Réseau</i>	<i>Réseau</i>
<i>MB</i>	<i>Réseau</i>	<i>Pile ou accumulateur</i>
<i>BM</i>	<i>Pile ou accumulateur</i>	<i>Réseau</i>
<i>BB</i>	<i>Pile ou accumulateur</i>	<i>Pile ou accumulateur</i>

NOTE 101 Pour un **groupe d'électrificateurs de sécurité** classique, composé de deux **électrificateurs de sécurité** qui peuvent fonctionner sur le réseau d'alimentation ou sur accumulateur, vingt-quatre essais sont réalisés au total. Toutefois, dans certains cas, lorsque seul le fonctionnement sur réseau d'alimentation ou pile ou accumulateur est indiqué, le nombre peut être inférieur ou, si une option de pile est incluse, le nombre d'essais peut être doublé.

11.7 Remplacement:

Les **électrificateurs** sont mis en fonctionnement jusqu'à établissement des conditions de régime.

12 Vide

13 Courant de fuite et rigidité diélectrique à la température de régime

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

13.1 Modification:

*La conformité est vérifiée par les essais de 13.2 et 13.3 uniquement pour les **électrificateurs fonctionnant sur le réseau et les électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau.***

Addition:

*L'**électrificateur** est mis en fonctionnement dans les conditions de **fonctionnement normal** lorsqu'il est alimenté, comme spécifié en 11.5, pour le fonctionnement raccordé au réseau.*

14 Surtensions transitoires

14.101 Les **électrificateurs** doivent être résistants aux ondes de choc d'origine atmosphérique provenant de la **clôture**.

*La conformité est vérifiée par les essais de 14.102 à 14.104 pour les **électrificateurs fonctionnant sur le réseau et les électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau.***

NOTE La valeur de U_0 est la valeur crête de la tension de sortie de l'**électrificateur**, obtenue au cours de l'essai de 22.111.

Sauf spécification contraire, aucune décharge disruptive ne doit se produire au cours des essais, mais les dispositifs de protection contre les ondes de choc peuvent fonctionner.

*Les **électrificateurs fonctionnant sur le réseau et les électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau** sont fixés sur une plaque métallique dont les dimensions dépassent de 150 mm au moins celles de la projection orthogonale de l'**électrificateur** sur la plaque, puis sont installés comme en usage normal.*

Les essais sont effectués à l'aide d'un générateur d'impulsions produisant des chocs de foudre pleins positifs et négatifs ayant une durée du front de 1,2 μ s et une durée jusqu'à la mi-valeur de 50 μ s, les tolérances étant de

- ± 5 % pour la valeur crête;
- ± 30 % pour la durée du front;
- ± 20 % pour la durée jusqu'à la mi-valeur.

De petites oscillations de l'impulsion sont autorisées à condition que leur amplitude près de la crête de l'impulsion soit inférieure à 5 % de la valeur crête. Pour les oscillations se produisant pendant la première moitié de la durée du front, des amplitudes jusqu'à 10 % de la valeur crête sont admises.

*La forme des impulsions est réglée avec l'**électrificateur** raccordé au générateur d'impulsions. Le réglage doit être effectué à environ 50 % de la tension d'essai spécifiée. Si, pour l'essai de 14.104, une forme correcte des impulsions ne peut pas être obtenue, il faut seulement s'assurer que la durée du front a la valeur exigée à environ 50 % de la **tension de crête présumée** spécifiée.*

Le générateur d'impulsions à utiliser pour les essais doit avoir une capacité énergétique d'au moins 125 J à la tension d'essai.

14.102 Cinq impulsions négatives et cinq impulsions positives, ayant chacune une **tension de crête présumée** de $2U_0$ mais non inférieure à 25 kV, sont appliquées entre

- les bornes de sortie et les bornes d'entrée en courant alternatif raccordées ensemble et la plaque métallique, pour les **électrificateurs fonctionnant sur le réseau** et les **électrificateurs de types A, électrificateurs de type B et électrificateurs de type C**,
- les bornes de sortie et la plaque métallique, pour les **électrificateurs de type D**,

l'intervalle entre deux impulsions successives étant d'au moins 10 s.

Les **électrificateurs de type D** sont en outre soumis à l'essai suivant.

Chaque **unité d'alimentation amovible** spécifiée est reliée à son tour à l'unité génératrice d'impulsions de l'**électrificateur**. Les tensions de choc sont appliquées entre les bornes de sortie de l'**électrificateur** et les bornes d'entrée en courant alternatif de l'**unité d'alimentation amovible** spécifiée raccordées entre elles et la plaque métallique.

14.103 Cinq impulsions négatives et cinq impulsions positives, ayant chacune une **tension de crête présumée** de $2U_0$ mais non inférieure à 25 kV, sont appliquées entre les bornes de sortie raccordées entre elles et

- les bornes d'entrée en courant alternatif raccordées entre elles, pour les **électrificateurs fonctionnant sur le réseau** et les **électrificateurs de types A, électrificateurs de type B et électrificateurs de type C**,
- les bornes de raccordement du **chargeur de batterie** externe, pour les **électrificateurs de type D**,

l'intervalle entre deux impulsions successives étant d'au moins 10 s.

Si, au cours de cet essai, un dispositif de protection contre les surtensions fonctionne, l'essai est répété avec le dispositif de protection contre les surtensions rendu inopérant. Au cours de ce nouvel essai, aucune décharge disruptive n'est admise.

Si l'**électrificateur** comporte plusieurs **circuits de clôture**, chaque **circuit de clôture** est soumis à cet essai à tour de rôle, les autres **circuits de clôture** étant en circuit ouvert.

Les **électrificateurs de type D** sont en outre soumis à l'essai suivant.

Chaque **unité d'alimentation amovible** spécifiée est reliée à son tour à l'unité génératrice d'impulsions de l'**électrificateur**. Les tensions de choc sont appliquées entre les bornes de sortie de l'**électrificateur** et les bornes d'entrée en courant alternatif de l'**unité d'alimentation amovible** spécifiée raccordées entre elles et la plaque métallique.

14.104 Cinq impulsions négatives et cinq impulsions positives, ayant chacune une **tension de crête présumée** de $2U_0$ mais non inférieure à 25 kV, sont appliquées entre les bornes de sortie, l'intervalle entre deux impulsions successives étant d'au moins 10 s. Les bornes d'entrée sont en circuit ouvert. Pour les **électrificateurs de type D**, les bornes d'entrée de l'unité génératrice d'impulsions sont en circuit ouvert.

15 Résistance à l'humidité

L'article de la Partie 1 est applicable.

16 Courant de fuite et rigidité diélectrique

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

16.1 Modification:

*La conformité est vérifiée par les essais de 16.2, 16.3 et 16.101 pour les **électrificateurs fonctionnant sur le réseau** et les **électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau**.*

16.2 Modification:

La tension d'essai est la limite supérieure de la tension spécifiée en 11.5.

16.3 Addition:

D'autres valeurs des tensions d'essai et les points d'application sont indiqués dans le Tableau 105.

Tableau 105 – Tensions d'essai supplémentaires

<i>Points d'application</i>	<i>Tension d'essai^a</i>
<i>Entre le circuit d'alimentation secteur et les parties accessibles des électrificateurs de classe II à enveloppe métallique</i>	<i>2U₀ mais non inférieure à 10 000 V</i>
<i>Entre le circuit de clôture et les parties accessibles^b</i>	<i>2U₀ mais non inférieure à 10 000 V</i>
<i>Entre le circuit d'alimentation secteur et le circuit de clôture</i>	<i>2U₀ mais non inférieure à 10 000 V</i>
^a La valeur 2U ₀ est une valeur crête égale à deux fois la valeur crête maximale de la tension de sortie mesurée en 22.111. ^b Un espace de 50 mm doit être prévu autour des bornes de sortie dans la feuille métallique en contact avec les parties accessibles .	

16.101 *Immédiatement après les essais de 16.3, les caractéristiques de sortie sont mesurées comme spécifié 22.108.*

Les valeurs mesurées doivent être dans les limites indiquées en 22.108.

17 Protection contre la surcharge des transformateurs et des circuits associés

L'article de la Partie 1 n'est pas applicable.

18 Endurance

Le présent article de la Partie 1 est remplacé par l'article ci-après.

Les **électrificateurs fonctionnant sur le réseau** et les **électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau** doivent être conçus de manière à pouvoir supporter des températures extrêmes auxquelles ils peuvent être confrontés dans le cadre d'une utilisation normale. De plus, des **dispositifs de protection** contre les surcharges ne doivent pas fonctionner dans ces conditions.

La conformité est vérifiée par l'essai suivant.

Les **électrificateurs fonctionnant sur le réseau**, les **électrificateurs de types A et électrificateurs de types C** lorsqu'ils sont raccordés pour alimentation par le réseau sont mis en fonctionnement dans les conditions de **fonctionnement normal**. La tension appliquée est la **tension assignée**.

Les **électrificateurs de type D** sont mis en fonctionnement dans les conditions de **fonctionnement normal**. La tension appliquée est celle spécifiée en 11.5.

Les **électrificateurs de type B** connectés pour une alimentation par accumulateurs sont placés dans leur position normale et équipés d'accumulateurs dont la tension nominale égale à la **tension assignée pour l'alimentation par piles ou accumulateurs de l'électrificateur**. Les piles ou accumulateurs doivent présenter la plus grande capacité pour laquelle l'**électrificateur** est conçu. Les piles ou accumulateurs doivent être entièrement chargés au début de l'essai et doivent être remplacés dès que, au cours de l'essai, la tension a diminué jusqu'à 0,75 fois la tension nominale pour les accumulateurs et 0,55 fois la tension nominale pour les piles ou avant que l'**électrificateur** cesse de fonctionner en raison d'une faible tension des piles ou accumulateurs.

Pour les **électrificateurs de type A**, une pile ou un accumulateur présentant la capacité la plus grande pour laquelle l'**électrificateur** est conçu est raccordé(e) et placé(e) dans le compartiment à piles ou accumulateurs. Avant de commencer l'essai, la pile ou l'accumulateur est déchargé(e) à un point tel que la tension fournie n'excède pas 0,75 fois sa tension nominale.

L'autre échantillon des **électrificateurs de type A** et **électrificateurs de type C** doit être raccordé pour l'alimentation par piles ou accumulateurs et alimenté par des piles ou accumulateurs présentant la capacité la plus grande pour laquelle l'**électrificateur** est conçu. Les piles ou accumulateurs doivent être entièrement chargés au début de l'essai et doivent être remplacés dès que, au cours de l'essai, la tension a diminué jusqu'à 0,75 fois la tension nominale pour les accumulateurs et 0,55 fois la tension nominale pour les piles.

L'**électrificateur** est mis en fonctionnement continu pendant 168 h (sept jours) à une température ambiante de $-15\text{ °C} \pm 2\text{ °C}$, puis pendant 168 h (sept jours) à une température ambiante de $50\text{ °C} \pm 2\text{ °C}$.

Les bornes de sortie sont chargées avec une résistance non inductive de $500\ \Omega \pm 2,5\ \Omega$ au cours des premières 84 h de chaque période de 168 h, et la charge est retirée pour la suite de ces périodes.

A la fin de chacune des périodes de 168 h, les caractéristiques de sortie sont mesurées, comme spécifié en 22.108, à la température ambiante spécifiée pour la période considérée.

Les valeurs mesurées doivent être dans les limites indiquées en 22.108.

Au cours de l'essai, l'**électrificateur** ne doit présenter aucune modification affectant son usage ultérieur, le matériau d'étanchéité éventuel ne doit pas couler à un point tel que des **parties actives** deviennent accessibles et l'**électrificateur** doit encore satisfaire aux exigences de l'Article 8.

19 Fonctionnement anormal

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

19.1 Addition:

L'**électrificateur** est monté comme en 11.2, sauf que les piles ou accumulateurs éventuels sont complètement chargés.

Au cours des essais, les fusibles accessibles à l'utilisateur sont court-circuités.

Les **électrificateurs** sont également soumis aux essais de 19.101, 19.102, 19.103, 19.104 et 19.105.

Les **groupes d'électrificateurs de sécurité** sont également soumis aux essais de 19.106 et 19.107 comme s'il s'agissait d'un **électrificateur** fourni en une ou plusieurs parties.

19.12 Addition:

Si, pour l'une des conditions de défaut, la fréquence de répétition des impulsions est supérieure à 1 Hz et si la sécurité de l'**électrificateur** dépend du fonctionnement d'un **dispositif de protection** sans réarmement automatique comportant un fusible interne, l'essai est effectué trois fois pour s'assurer que ce fusible fonctionne de façon sûre et que les parties internes ne sont pas endommagées à une fréquence supérieure de répétition d'impulsions.

19.13 Addition:

Les échauffements des enroulements ne doivent pas excéder les valeurs indiquées dans le Tableau 8.

Pour un **électrificateur de sécurité de type R**, pendant les essais, les caractéristiques de sortie de chaque **circuit de clôture** doivent être telles que spécifiées en 22.108, sauf pour la fréquence de répétition des impulsions et 22.113. Si la fréquence de répétition des impulsions est supérieure à 1,34 Hz, l'énergie de décharge par seconde dans une charge constituée d'une résistance non inductive de 500 Ω ne doit pas excéder 1,25 J/s après 3 min.

Pour tous les autres **électrificateurs**, pendant les essais, les caractéristiques de sortie de chaque **circuit de clôture** doivent être telles que spécifiées en 22.108, sauf pour la fréquence de répétition des impulsions. Si la fréquence de répétition des impulsions est supérieure à 1,34 Hz, l'énergie de décharge par seconde dans une charge constituée d'une résistance non inductive de 500 Ω ne doit pas excéder 2,5 J/s après 3 min.

Pour un **groupe d'électrificateurs de sécurité de type R**, pendant les essais, la synchronisation des impulsions doit être telle que spécifiée en 22.114. Si la fréquence de répétition des impulsions est supérieure à 1,34 Hz, l'énergie de décharge par seconde dans une charge de remplacement constituée d'une résistance non inductive de 500 Ω ne doit pas excéder 2,5 J/s après 3 min.

Pour un **groupe d'électrificateurs de type S**, pendant les essais, les caractéristiques combinées du **circuit de clôture** mesurées dans la résistance 500 Ω R_T doivent être telles que spécifiées en 22.115 pour les configurations d'essai 5 et 6, sauf pour la fréquence de répétition des impulsions. Si la fréquence de répétition des impulsions est supérieure à 1,34 Hz, l'énergie de décharge par seconde dans la charge 500 Ω R_T ne doit pas excéder 2,5 J/s après 3 min.

19.101 Les **électrificateurs** alimentés sous la tension spécifiée en 11.5, sont successivement soumis à chacune des conditions suivantes, y compris celles qui sont associées aux autres conditions de défaut qui sont la conséquence logique de la condition de défaut choisie:

- l'**électrificateur** est placé dans la position la plus défavorable, même s'il est peu probable qu'il soit placé dans cette position en usage normal;

- les parties destinées à régler l'**électrificateur**, autres que celles qui sont réglables de l'extérieur sans l'aide d'un **outil**, sont placées dans leur position la plus défavorable, même si ces parties ne sont pas destinées à être réglées par l'utilisateur, à moins qu'elles ne soient scellées de façon efficace pour éviter tout réglage ultérieur;
- le conducteur de terre est déconnecté de la borne de terre du **circuit de clôture** et raccordé à une autre borne de sortie;
- les bornes de sortie sont court-circuitées;
- les interrupteurs, les contacts de relais et les éléments analogues constituant une partie de l'unité génératrice d'impulsions sont court-circuités ou déconnectés, suivant le cas le plus défavorable;
- les fusibles qui sont accessibles sans l'aide d'un **outil**, les éclateurs en série dans le **circuit de clôture**, les vannes à décharge et les relais thermiques sont court-circuités;
- à l'exception des **circuits électroniques**, toutes les **lignes de fuite** ou **distances dans l'air** entre les **parties actives** de potentiel différent inférieures à 5 mm pour le **circuit de clôture** ou inférieures ou égales à 2 mm pour les autres circuits, sont court-circuitées et toute connexion non verrouillée est desserrée;
- la vitesse d'interruption d'un **composant électronique** utilisé comme dispositif principal d'interruption d'impulsions doit varier dans la plage de 0,1 Hz à deux fois la **fréquence assignée**, avec une séquence de progression d'environ 1:2:5 sur trois décades, par comparaison du signal de pause de ce dispositif à la tension le traversant, en utilisant un dispositif de commande extérieur indépendant.

NOTE Les détails d'un circuit simple de comparaison considéré comme approprié pour la commande de la vitesse d'interruption du dispositif principal d'interruption d'impulsions sont donnés à l'Annexe AA.

19.102 Les **électrificateurs de type A**, **électrificateurs de type C** et **électrificateurs de type D** alimentés sous la tension spécifiée en 11.5, sont successivement soumis à chacune des conditions suivantes:

- l'**électrificateur** étant raccordé pour alimentation par piles ou accumulateurs, les bornes pour le raccordement des piles ou accumulateurs ayant une indication de polarité sont connectées avec la polarité opposée, sauf si une telle connexion n'est pas susceptible de se produire en usage normal;
- l'**électrificateur** étant raccordé pour alimentation par le réseau, les bornes pour le raccordement des piles ou accumulateurs sont raccordées à la charge résistive la plus défavorable, y compris un court-circuit.

19.103 Les **électrificateurs de type B** raccordés pour alimentation par le réseau avec une fonction chargeur de batterie et alimentés sous la tension spécifiée en 11.5, sont soumis successivement à chacune des conditions suivantes:

- les bornes pour le raccordement des piles ou accumulateurs ayant une indication de polarité sont connectées avec la polarité opposée, sauf si une telle connexion n'est pas susceptible de se produire en usage normal;
- les bornes pour le raccordement des piles ou accumulateurs sont raccordées à la charge résistive la plus défavorable, y compris un court-circuit.

19.104 Les **électrificateurs de type B** raccordés pour alimentation par piles ou accumulateurs sont alimentés sous la tension spécifiée en 11.5. Les bornes d'alimentation ayant une indication de polarité sont connectées avec la polarité opposée, sauf si une telle connexion n'est pas susceptible de se produire en usage normal.

19.105 Les **électrificateurs fonctionnant sur piles ou accumulateurs et destinés à être raccordés au réseau** dont la **tension assignée pour l'alimentation par piles ou accumulateurs** est inférieure à 12 V fonctionnent dans les conditions de **fonctionnement normal** lorsqu'ils sont alimentés avec une tension d'entrée de 13,2 V en courant continu.