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Eksplozivi za civilno uporabo – Detonatorji in zakasnilniki – 26. del: Definicije, metode in zahteve za naprave in sredstva za zanesljivo in varno delovanje detonatorjev in zakasnilnikov

Explosives for civil uses - Detonators and relays - Part 26: Definitions, methods, and requirements for devices and accessories for reliable and safe function of detonators and relays

Explosivstoffe für zivile Zwecke - Zünder und Verzögerungselemente - Teil 26: Definitionen, Verfahren und Anforderungen für Geräte und Zubehör für die zuverlässige und sichere Funktion von Zündern und Verzögerern

Explosifs a usage civil - Détonateurs et relais - Partie 26: Définitions, méthodes et exigences relatives aux dispositifs et accessoires pour la fiabilité et la sécurité de fonctionnement des détonateurs et relais

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Foreword

This document (EN 13763-26:2004) has been prepared by Technical Committee CEN/TC 321 "Explosives for civil uses", the Secretariat of which is held by AENOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

This document is one of a series of standards with the generic title *Explosives for civil uses – Detonators and relays.* The other parts of this series are listed below:

EN 13763-1 Part 1: *Requirements*

EN 13763-2 Part 2: *Determination of thermal stability*

EN 13763-3 Part 3: *Determination of sensitiveness to impact*

EN 13763-4 Part 4: *Determination of resistance to abrasion of leading wires and shock tubes*

EN 13763-5 Part 5: *Determination of resistance to cutting damage of leading wires and shock tubes*

EN 13763-6 Part 6: *Determination of resistance to cracking in low temperatures of leading wires*

EN 13763-7 Part 7: *Determination of the mechanical strength of leading wires, shock tubes, connections, crimps and closures*

EN 13763-8 Part 8: *Determination of resistance to vibration of plain detonators*

EN 13763-11 Part 11: *Determination of resistance to damage by dropping of detonators and relays*

EN 13763-12 Part 12: *Determination of resistance to hydrostatic pressure*

EN 13763-13 Part 13: *Determination of resistance of electric detonators against electrostatic discharge*

prEN 13763-15 Part 15: *Determination of equivalent initiating capability*

EN 13763-16 Part 16: *Determination of delay accuracy*

EN 13763-17 Part 17: *Determination of no-fire current of electric detonators*

EN 13763-18 Part 18: *Determination of series firing current of electric detonators*

EN 13763-19 Part 19: *Determination of firing impulse of electric detonators*

EN 13763-20 Part 20: *Determination of total electrical resistance of electric detonators*

EN 13763-21 Part 21: *Determination of flash-over voltage of electric detonators*

EN 13763-22 Part 22: *Determination of capacitance, insulation resistance and insulation breakdown of leading wires*

EN 13763-23 Part 23: *Determination of the shock-wave velocity of shock tube*

EN 13763-24 Part 24: *Determination of the electrical non-conductivity of shock tube*

EN 13763-25 Part 25*: Determination of transfer capability of surface connectors, relays and coupling accessories*

CEN/TS 13763-27 Part 27: *Definitions, methods and requirements for electronic initiation systems*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

1.1 This document specifies the constructional and functional requirements and methods for testing of devices and accessories needed for the reliable and safe initiation of detonators and relays, under normal working conditions. It covers the following six types of equipment:

— blasting machines for initiating electric detonators;

— blasting machine checkers;

— initiating circuit field testers;

— shot firing cables for use with electric blasting machines;

— detonator connecting wires;

— shock tube initiators for non-electric systems.

1.2 Equipment indented only for use indoors is excluded from the environmental testing in Annex B.

1.3 Blasting machines for use with electronic detonators and magnetically coupled detonators are outside the scope of this document.

NOTE This document does not meet all of the requirements of all relevant European Directives, such as the ATEX Directive 94/9/EC and the low voltage Directive 73/23/EEC. For example, EN 61010 (Safety requirements for electrical equipment for measurement, control and laboratory use) might also be relevant for some devices and accessories described in this document.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13857-1:2003, *Explosives for civil uses – Part 1: Terminology.*

EN 13763-4:2003, *Explosives for civil uses – Detonators and relays – Part 4: Determination of resistance to abrasion of leading wires and shock tubes.*

EN 13763-5, *Explosives for civil uses – Detonators and relays – Part 5: Determination of resistance to cutting damage of leading wires and shock tubes.*

EN 13763-6, *Explosives for civil uses – Detonators and relays – Part 6: Determination of resistance to cracking in low temperatures of leading wires.*

EN 13763-22:2003, *Explosives for civil uses – Detonators and relays – Part 22: Determination of capacitance, insulation resistance and insulation breakdown of leading wires.*

EN 55011:1998, *Industrial, scientific and medical (ISM) radio-frequency equipment – Radio disturbance characteristics – Limits and methods of measurement (CISPR 11:1997, modified).*

EN 60068-2-1:1993, *Environmental testing – Part 2: Tests – Tests A: Cold (IEC 60068-2-1:1990).*

EN 60068-2-2:1993, *Basic environmental testing procedures – Part 2: Tests – Tests B: Dry heat (IEC 600-2-2:1976).*

EN 60068-2-14:1999, *Environmental testing – Part 2: Tests – Test N: Change of temperature (IEC 60068-2-14:1984 + A1:1986).*

EN 60068-2-29:1993, *Basic environmental testing procedures – Part 2: Tests – Test Eb and guidance: Bump (IEC 60068-2-29:1987).*

EN 60068-2-30:2004, *Environmental testing – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle) (IEC 60068-2-30:1980 + A1: 1985).*

EN 60068-2-32, *Basic environmental testing procedures – Part 2: Tests – Test Ed: Free fall (IEC 60068-2-32:1975 + A1: 1982 + A2: 1990).*

EN 60068-2-64:1994, *Environmental testing – Part 2: Test methods – Test Fh: Vibration, broad band random (digital control) and guidance (IEC 60068-2-64:1993 + Corrigendum:1993).*

EN 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state (IEC 60068-2-78:2001).*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989).*

EN 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test – Basic EMC publication (IEC 61000-4-2:1995).*

EN 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques;Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3:2002).*

EN 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test – Basic EMV publication (IEC 61000-4-4:1995).*

EN 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test (IEC 61000-4-5:1995)*

EN 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:1996).*

EN 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity test (IEC 61000-4-11:1994).*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:1999).*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13857-1:2003 and the following apply.

3.1
blasting machine
equipment intended to supply electrical energy to a circuit of electric detonators to initiate them

3.2
sequential blasting machine
blasting machine incorporating a means to control the sequence of firing of the electric detonators connected to it

3.3
blasting machine checker
equipment specifically designed for connection to a blasting machine's output terminals to verify that the machine's output performance is within the operating limits specified by its manufacturer and that it is capable of initiating the maximum number of detonators claimed

NOTE Blasting machine checkers are usually supplied by the blasting machine manufacturer and are designed for use with a particular type of machine. They are designed to allow the blasting machine user to perform periodic checks to verify that the machine is functioning correctly before it is used on site. The indication provided by checkers may vary from one type to another. For example, some have a simple "Go/No-Go" indicator lamp and others have analogue or digital displays capable of indicating the blasting machine's actual output energy. In some E.U. member state countries, the regular use of such checkers is required by national legislation as part of a users "blasting machine maintenance scheme".

3.4
initiating circuit
electrical circuit intended to be connected to a blasting machine, consisting of shot firing cable, electric detonators, detonator leading wires and any extensions to them by connecting wires

3.5
field circuit tester
instrument intended for measuring, checking, or testing an initiating circuit outdoors on site, usually before an attempt is made to initiate the detonators with a blasting machine

3.6
continuity and resistance tester
type of field circuit tester, intended for measuring, checking or testing the continuity and resistance of an initiating circuit

3.7
continuity and impedance tester
type of field circuit tester, intended for measuring, checking or testing the continuity and impedance of an alternating current initiating circuit at a frequency specified by the manufacturer

3.8
circuit insulation tester
type of field circuit tester, intended to measure, check or test the electrical resistance of the insulation between the main electrical conductors in an initiating circuit and the general mass of earth

3.9
connecting wires
electrically insulated conductors that can be connected between the shot-firing cable and the detonator leading wire

NOTE Connecting wires are normally used only once in service because they are located so close to the explosive devices that they are usually damaged by the explosive blast.

3.10
maximum initiating circuit resistance
(R_e)
maximum electrical resistance of a particular configuration of an electrical detonator initiating circuit.

NOTE The maximum initiating circuit resistance is given by the equation.

$$R_e = R_t + \frac{NR_s}{n^2}$$

where

Rt is the shot firing cable electrical resistance in Ω;

N is the total number of electric detonators;

Rs is the total resistance in Ω of one electric detonator;

n is the number of parallel circuits

3.11
shock tube initiator
equipment intended to supply a spark or a similar energy impulse to the explosive coating material inside a non electric shock tube so as to initiate it

4 General requirements for Testing

4.1

Unless otherwise specified in the test instructions, testing shall be performed within an ambient temperature range of (20 ± 5) °C, a relative humidity of (60 ± 15) % and an air pressure of (960 ± 100) hPa. If these conditions cannot be achieved or maintained, the actual conditions shall be recorded in the test report.

4.2

The order of checking and testing of each device or accessory shall be in the same order as they appear in this document.

NOTE If there are no influences to the test results, tests may also be carried out in parallel using more than one test piece.

4.3

Equipment and devices intended for use outdoors shall be subjected to the environmental tests in Annex B.

5 Blasting machines for initiating electric detonators

5.1 Requirements for blasting machines to be verified by visual examination of the machine, simple measurement and reference to the manufacturer's parts list and scale drawings

5.1.1 Every blasting machine shall have output terminals or outlets incorporating means to securely attach the type of shot firing cable intended to be used with them. The area of electrical contact of each terminal shall be a least twice the cross sectional area of the shot firing cable intended to be used with it. The blasting machine's output terminals shall have a barrier of insulating material between them which protrudes at least 4 mm higher than the conductive part.

5.1.2 Every blasting machine shall contain a means for the operator to control the instant of firing, or control the commencement of the firing sequence.

5.1.3 Every blasting machine not designed to be carried in the hand at all times by the operator, shall incorporate a device, e.g. a key operated key-switch or removable operating handle, which prevents the machine being operated when it is removed from the machine.

5.1.4 Capacitor blasting machines with a selectable initiating circuit output voltage shall include a suitable indicator to show that the required voltage has been achieved (for example a meter or a LED indicator).

5.1.5 Blasting machines shall not produce their output energy by direct manual operation of a speed dependent generating mechanism.

5.1.6 Blasting machines intended for use in coal mines shall contain a two-pole switch (which may be electrical, mechanical or electronic) initiated by the firing mechanism for connecting the internal energy source (e.g. generator, capacitor, battery) to the output terminals.

5.1.7 Blasting machines intended for use in potentially explosive atmospheres of gas (e.g. in coal mines, or tunnels in coal/oil bearing strata), shall not have any part of their exposed surface made of alloys containing more than 15 %, by mass in total, of aluminium, magnesium or titanium and not more than 6 %, by mass in part, of magnesium and titanium.

NOTE This requirement is to prevent incendive sparking by thermite reaction when such light metals impact with rusty iron/steel.

5.2 Test for insulation resistance between exposed conducting parts

5.2.1 Requirements

The insulation resistance between exposed electrically conducting parts (including the output terminals) and the blasting machine outer enclosure, or outer case, or container, shall be at least 2 MΩ when tested at 500 V DC.

5.2.2 Test pieces

One complete blasting machine of each type.

5.2.3 Apparatus

Electrical insulation test meter, capable of applying 500 V with a tolerance of ± 10 V and measuring the insulation resistance over a range between 0 MΩ to 3 MΩ, within a tolerance of ± 0,1 MΩ.

5.2.4 Procedure

Short circuit the terminals of the blasting machine and apply the test voltage of 500 V between the terminals and the casing of the equipment. Measure and record the insulation resistance in MΩ.

5.2.5 Test report

The test report shall conform to EN ISO/IEC 17025. In addition, the following information shall be given:

a) the insulation resistance in MΩ;

b) whether or not the insulation is ≥ 2 MΩ.

5.3 Electrical voltage resistance of insulated parts

5.3.1 Requirements

The insulated parts of the blasting machine shall be capable of withstanding twice the peak output voltage of the machine, or 1 000 V AC RMS whichever is the greater for a period of 60 s without flashover or breakdown of the insulation.

Where fitted, any mechanically operated switch, provided to disconnect the output circuit after a pre-determined interval shall be bridged to allow the machine's internal components to be subjected to the insulation test.

5.3.2 Test pieces

One complete blasting machine of each type.

5.3.3 Apparatus

5.3.3.1 A variable high voltage AC 50 Hz source capable of applying (with a tolerance of ± 5 %) up to twice the blasting machine's peak output voltage, or 1 000 V AC RMS which ever is the greater and a voltage rise time of 10 s maximum.

5.3.3.2 An ammeter.

5.3.4 Procedure

Short circuit the terminals of the blasting machine and apply the test voltage, in series with the ammeter, between the terminals and the conductive parts of the enclosure or casing for a time period of 1 min.

In the case of blasting machines designed to disconnect the output voltage after a predetermined time, the disconnecting device or switch shall be bypassed in such a way as to enable the internal components of the blasting machine to be exposed to the applied test voltage.

Record whether or not the insulation breaks down during the test.

NOTE A breakdown of insulation is usually indicated by a sudden increase in the flow of electrical current on the ammeter.

5.3.5 Test report

The test report shall conform to EN ISO/IEC 17025. In addition, the following information shall be given:

— whether or not the insulation breaks down.

5.4 Test to determine the output energy of the blasting machine

5.4.1 Requirements

The output current and output energy of blasting machines shall:

a) be capable of reliably providing enough firing energy (KR_e) to initiate the maximum number of electric detonators, with the allowed resistance of shot firing cable in circuit, in all permissible configurations of initiating circuits specified by the blasting machine manufacturer;

NOTE 1 The maximum number of electric detonators in a particular initiating circuit configuration is information provided by the blasting machine manufacturer.

b) include a safety factor (S), to ensure that (a) above takes account of variations in the electrical resistance of leading wire connections made on site by the operator;

c) deliver the required amount of energy, specified in (a) above, before the first detonator in any series/parallel configuration explodes to open the electrical circuit, thereby preventing further flow of electrical current and delivery of initiating energy.

NOTE 2 The duration for the delivery of energy in (c) above, is normally the time taken for the output current *(I)* to reduce from its initial value at the commencement of initiation, to a value equal to or greater than the electric detonator series firing current (I_{series}) and safety factor $(I \geq nSI_{series})$. In the case of blasting machines intended for use in potentially explosive atmospheres (e.g. coal mines), the duration is determined by the 4 ms maximum output time of the blasting machine (see 5.13).

NOTE 3 For example, a capacitor type blasting machine with a maximum circuit resistance (R_e) connected across its output terminals needs to provide an initiating energy of at least KR_e for the required duration. Also an output current greater than the all fire series firing current of the particular detonators intended for use with the blasting machine. Where K is equal to, or greater than $"n^2S^2W_{af}"$ for the required duration. This is shown in Figure 1 which is a graph below, of the blasting machine's output current *(I)* against time from the commencement of firing, to the time where the machine's output current reduces to a value equal to the detonator's series firing current. The energy delivered by the blasting machine during this period is derived the shaded area under the graph. The energy is calculated from the integral of the current squared over this period multiplied by the maximum initiating circuit resistance (R_e).

and where:

W_{af} is the all fire impulse of detonator claimed by the manufacturer, in J/Ω or Ws/Ω;

I is the blasting machine output current in A;

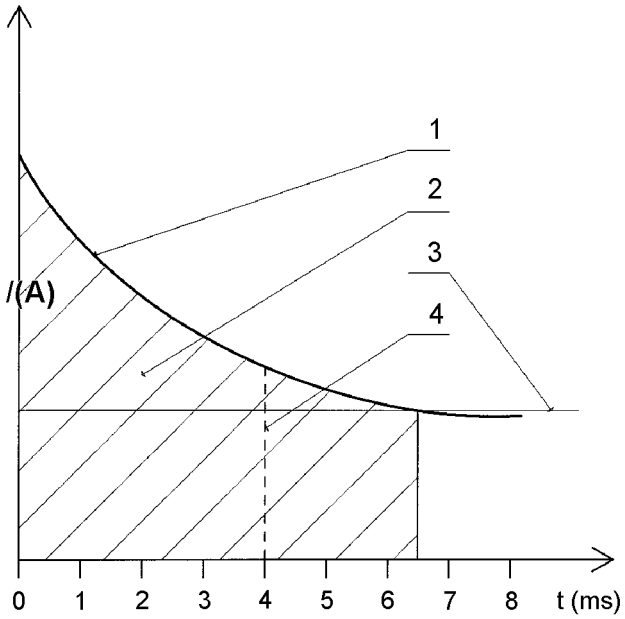
I_{series} is the series firing current in A for the detonator;

n is the number of parallel circuits (see Table 1);

S is the safety factor (see Table 1);

R_e maximum initiating circuit resistance (see definition 3.10);

K is the blasting machine firing impulse in J/Ω or Ws/Ω.



Key

1 Discharge curve

2 Area used to calculate the blasting machine output energy

3 Electric detonator series firing current and safety factor (nSI_{series})

4 The output energy cut-off time for blasting machines intended for use in potentially explosive atmospheres of gas (see 5.13)

Figure 1 — Discharge curve

Table 1 — Safety factor

n	1	2	3	≥4
S	1,15	1,25	1,35	1,4

5.4.2 Test pieces

One complete blasting machine of each type.

5.4.3 Apparatus

a) Resistances $R_1 + R_2$ corresponding to the maximum circuit resistance R_e and capable of withstanding the highest output voltage of the blasting machine. R_2 shall be low ohmic (less than 2 Ω).