INTERNATIONAL STANDARD

IEC 60079-11

Fourth edition
1999-02

Electrical apparatus for explosive gas atmospheres –

Part 11: Intrinsic safety "i"

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

Reference number
IEC 60079-11:1999(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**

- **Catalogue of IEC publications**

  The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

  This summary of recently issued publications (www.iec.ch/online_news/ justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

  If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

  Email: custserv@iec.ch
  Tel: +41 22 919 02 11
  Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

IEC 60079-11

Fourth edition
1999-02

Electrical apparatus for explosive gas atmospheres –

Part 11: Intrinsic safety "i"

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE XD

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES – Part 11: Intrinsic safety "i"

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60079-11 has been prepared by subcommittee 31G: Intrinsically safe apparatus, of IEC technical committee 31: Electrical apparatus for explosive atmospheres.

This fourth edition cancels and replaces the third edition published in 1991 and constitutes a technical revision.

Annex B contains details of the spark test apparatus for intrinsically safe circuits and replaces IEC 60079-3, 1990.

This International Standard is to be read in conjunction with the third edition of IEC 60079-0:1998, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements.*

The text of this standard is based on the following documents:

FDIS	Report on voting
31G/65/FDIS	31G/68/RVD

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

Annexes A, B and D form an integral part of this standard.

Annex C is for information only.

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES – Part 11: Intrinsic safety "i"

1 Scope

1.1 This part of IEC 60079 specifies the construction and testing of intrinsically safe apparatus, intended for use in potentially explosive atmospheres and for associated apparatus, which is intended for connection to intrinsically safe circuits which enter such atmospheres. It also contains details of the test apparatus previously published as IEC 60079-3.

1.2 This standard supplements IEC 60079-0:1998, the requirements of which apply to intrinsically safe apparatus and to associated apparatus except as indicated in the following list.

If associated apparatus is protected by a type of protection listed in IEC 60079-0 then the requirements of that method of protection together with the relevant parts of IEC 60079-0 also apply to the associated apparatus. The list of exclusions which follows is directly applicable to associated apparatus intended for use in situations where there is no potentially explosive atmosphere and in other circumstances should be used in combination with the requirements of the other methods of protection.

Clause of IEC 60079-0:1998		Clause or subclause excluded	
		Intrinsically safe apparatus	Associated apparatus
3.1	Electrical apparatus	Yes	Yes
4.2.2	Marking of maximum surface temperature	No	Yes
5.1	Maximum surface temperature	No	Yes
5.3	Surface temperature and ignition temperature	No	Yes
6.2	Enclosure opening delay	Yes	Yes
7.1.1	Definition of plastics material	No	Yes
7.1.2	Requirement of plastics material	Yes	Yes
7.1.3	Verification of plastics material compliance	No	Yes
7.2	Thermal endurance	Yes	Yes
7.3	Electrostatic charges on plastics enclosures	No	Yes
7.3.1	Electrical apparatus of Group I (notes 1 and 2 only)	Yes	Yes
7.3.2	Electrical apparatus of Group II (notes 1 and 2 only)	Yes	Yes
7.4	Threaded holes in plastics	Yes	Yes
8.1	Light metal enclosure materials	No	Yes
8.2	Threaded holes in light metals	Yes	Yes
9	Fasteners	Yes	Yes
10	Interlocking devices	Yes	Yes
11	Bushings	Yes	Yes
12	Materials used for cementing	Yes	Yes
14	Connection facilities and terminal compartments	Yes	Yes

Clause of IEC 60079-0:1998		Clause or subclause excluded	
		Intrinsically safe apparatus	Associated apparatus
15	Connection facilities for earthing or bonding conductors	Yes	Yes
16	Cable and conduit entries	Yes	Yes
17 to 22	Supplementary requirements for certain electrical apparatus	Yes	Yes
23.4.3.1	Test for resistance to impact	Yes	Yes
23.4.3.2	Drop test (no prior impact test necessary)	No	Yes
23.4.3.3	Required results	No	Yes
23.4.5	Torque test for bushings	Yes	Yes
23.4.6.1	Temperature measurement	No	Yes
23.4.6.2	Thermal shock test	Yes	Yes
23.4.7.1 to 23.4.7.7	Tests on non-metallic enclosures	Yes	Yes
23.4.7.8	Insulation resistance test of parts of enclosures of plastics materials	No	Yes
27.7	Examples of marking	Yes	Yes
Annex B	Ex cable entries	Yes	Yes

1.3 This standard is applicable to electrical apparatus in which the electrical circuits themselves are incapable of causing an explosion in the surrounding explosive atmospheres.

1.4 This standard is also applicable to electrical apparatus or parts of electrical apparatus located outside the potentially explosive atmosphere or protected by another type of protection listed in IEC 60079-0, where the intrinsic safety of the electrical circuits in the potentially explosive atmosphere may depend upon the design and construction of such electrical apparatus or parts of such electrical apparatus. The electrical circuits exposed to the potentially explosive atmosphere are evaluated for use in such an atmosphere by applying this standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60079. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 6079 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60079-0:1998, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-7:1990, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety "e"*

IEC 60085:1984, *Thermal evaluation and classification of electrical insulation*

IEC 60112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

IEC 60127-1:1988, *Miniature fuses – Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links*

IEC 60127-2:1989, *Miniature fuses – Part 2: Cartridge fuse-links*

IEC 60127-3:1988, *Miniature fuses – Part 3: Sub-miniature fuse-links*

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

3 Definitions

For the purpose of this part of IEC 60079, the definitions in IEC 60079-0 and the following definitions apply:

3.1
intrinsically safe circuit
circuit in which any spark or any thermal effect produced in the conditions specified in this standard, which include normal operation and specified fault conditions, is not capable of causing ignition of a given explosive gas atmosphere

3.2
electrical apparatus
assembly of electrical components, electrical circuits or parts of electrical circuits normally contained in a single enclosure

NOTE 1 – The term "normally" has been introduced to indicate that an apparatus may occasionally be in more than one enclosure, for example, a telephone or a radio transceiver with a hand microphone.

NOTE 2 – This definition is more precise than that contained in IEC 60079-0.

3.3
intrinsically safe apparatus
electrical apparatus in which all the circuits are intrinsically safe circuits

3.4
associated apparatus
electrical apparatus which contains both intrinsically safe circuits and non-intrinsically safe circuits and is constructed so that the non-intrinsically safe circuits cannot adversely affect the intrinsically safe circuits

NOTE – Associated apparatus may be either

a) electrical apparatus which has another type of protection listed in IEC 60079-0 for use in the appropriate explosive gas atmosphere, or

b) electrical apparatus not so protected and which, therefore, shall not be used within an explosive gas atmosphere, for example a recorder which is not itself in an explosive gas atmosphere, but is connected to a thermocouple situated within an explosive atmosphere where only the recorder input circuit is intrinsically safe.

3.5
normal operation
operation of intrinsically safe apparatus or associated apparatus such that it conforms electrically and mechanically with the design specification produced by its manufacturer

3.6
fault
any defect of any component, separation, insulation or connection between components, not defined as infallible by this standard, upon which the intrinsic safety of a circuit depends

3.7
countable fault
fault which occurs in parts of electrical apparatus conforming to the constructional requirements of this standard

3.8
non-countable fault
fault which occurs in parts of electrical apparatus not conforming to the constructional requirements of this standard

3.9
infallible component or infallible assembly of components
component or assembly of components that is considered as not subject to certain fault modes as specified in this standard

The probability of such fault modes occurring in service or storage is considered to be so low that they are not to be taken into account.

3.10
infallible separation or insulation
separation or insulation between electrically conductive parts that is considered as not subject to short circuits

The probability of such fault modes occurring in service or storage is considered to be so low that they are not to be taken into account.

3.11
simple apparatus
electrical component or combination of components of simple construction with well-defined electrical parameters which is compatible with the intrinsic safety of the circuit in which it is used

3.12
internal wiring
wiring and electrical connections that are made within the apparatus by its manufacturer

3.13
minimum igniting current (MIC)
minimum current in resistive or inductive circuits that causes the ignition of the explosive test mixture in the spark-test apparatus according to annex B

3.14
minimum igniting voltage
minimum voltage of capacitive circuits that causes the ignition of the explosive test mixture in the spark test apparatus described in annex B

3.15
maximum r.m.s. a.c. or d.c. voltage (U_m)
maximum voltage that can be applied to the non-intrinsically safe connection facilities of associated apparatus without invalidating intrinsic safety

NOTE – The value of U_m may be different at different sets of connection facilities, and may be different for a.c. and d.c. voltages.

3.16
maximum input voltage (U_i)
maximum voltage (peak a.c. or d.c.) that can be applied to the connection facilities for intrinsically safe circuits without invalidating intrinsic safety

3.17
maximum output voltage (U_o)
maximum output voltage (peak a.c. or d.c.) in an intrinsically safe circuit that can appear under open circuit conditions at the connection facilities of the apparatus at any applied voltage up to the maximum voltage, including U_m and U_i

NOTE – Where there is more than one applied voltage, the maximum output voltage is that occurring under the most onerous combination of applied voltages.

3.18
maximum input current (I_i)
maximum current (peak a.c. or d.c.) that can be applied to the connection facilities for intrinsically safe circuits without invalidating intrinsic safety

3.19
maximum output current (I_o)
maximum current (peak a.c. or d.c.) in an intrinsically safe circuit that can be taken from the connection facilities of the apparatus

3.20
maximum input power (P_i)
maximum input power in an intrinsically safe circuit that can be dissipated within an apparatus when it is connected to an external source without invalidating intrinsic safety

3.21
maximum output power (P_o)
maximum electrical power in an intrinsically safe circuit that can be taken from the apparatus

3.22
maximum external capacitance (C_o)
maximum capacitance in an intrinsically safe circuit that can be connected to the connection facilities of the apparatus without invalidating intrinsic safety

3.23
maximum internal capacitance (C_i)
total equivalent internal capacitance of the apparatus which is considered as appearing across the connection facilities of the apparatus

3.24
maximum external inductance (L_o)
maximum value of inductance in an intrinsically safe circuit that can be connected to the connection facilities of the apparatus without invalidating intrinsic safety

3.25
maximum internal inductance (L_i)
total equivalent internal inductance of the apparatus which is considered as appearing at the connection facilities of the apparatus

3.26
maximum external inductance to resistance ratio (L_o/R_o)
maximum value of ratio of inductance (L_o) to resistance (R_o) of any external circuit that can be connected to the connection facilities of the electrical apparatus without invalidating intrinsic safety

3.27
maximum internal inductance to resistance ratio (L_i/R_i)
maximum value of ratio of inductance (L_i) to resistance (R_i) which is considered as appearing at the external connection facilities of the electrical apparatus

3.28
clearance
shortest distance in air between two conductive parts

NOTE – This distance applies only to parts that are exposed to the atmosphere and not to parts which are insulated parts or covered with casting compound.

3.29
distance through casting compound
shortest distance through a casting compound between two conductive parts

3.30
distance through solid insulation
shortest distance through solid insulation between two conductive parts

3.31
creepage distance in air
shortest distance along the surface of an insulating medium in contact with air between two conductive parts

3.32
creepage distance under coating
shortest distance between conductive parts along the surface of an insulating medium covered with insulating coating

3.33
fuse rating (I_n)
current rating of a fuse according to IEC 60127 or to its manufacturer's specification

3.34
sealed gas tight cell or battery
cell or battery which remains closed and does not release either gas or liquid when operated within the limits of charge or temperature specified by the manufacturer

NOTE – Such cells and batteries may be equipped with a safety device to prevent dangerously high internal pressure. The cell or battery does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

3.35
sealed valve-regulated cell or battery
cell or battery which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell or battery cannot normally receive an addition to the electrolyte

3.36
diode safety barrier
assemblies incorporating shunt diodes or diode chains (including Zener diodes) protected by fuses or resistors or a combination of these, manufactured as an individual apparatus rather than as part of a larger apparatus

4 Grouping and classification of intrinsically safe apparatus and associated apparatus

Intrinsically safe apparatus and associated apparatus shall be grouped and classified in accordance with clauses 4 and 5 of IEC 60079-0:1998.

5 Categories of electrical apparatus

5.1 General

Intrinsically safe apparatus and intrinsically safe parts of associated apparatus shall be placed in category "ia" or "ib".

The requirements of this standard shall apply to both categories unless otherwise stated. In the determination of category "ia" or "ib", failure of components and connections shall be considered in accordance with 7.6.

NOTE – Apparatus may be specified as both "ia" and "ib", and may have different parameters for each category.

5.2 Category "ia"

With U_m and U_i applied, the intrinsically safe circuits in electrical apparatus of category "ia" shall not be capable of causing ignition in each of the following circumstances:

a) in normal operation and with the application of those non-countable faults which give the most onerous condition;
b) in normal operation and with the application of one countable fault plus those non-countable faults which give the most onerous condition;
c) in normal operation and with the application of two countable faults plus those non-countable faults which give the most onerous condition.

The non-countable faults applied may differ in each of the above circumstances.

In testing or assessing the circuits for spark ignition, the following safety factors shall be applied in accordance with 10.4.2:

– for both a) and b) 1,5
– for c) 1,0

The safety factor applied to voltage or current for determination of surface temperature classification shall be 1,0 in all cases.

If only one countable fault can occur, the requirements of b) are considered to give a category of "ia" if the test requirements for "ia" can then be satisfied. If no countable faults can occur the requirements of a) are considered to give a category of "ia" if the test requirements for "ia" can then be satisfied.

5.3 Category "ib"

With U_m and U_i applied, the intrinsically safe circuits in electrical apparatus of category "ib" shall not be capable of causing ignition in each of the following circumstances:

a) in normal operation and with the application of those non-countable faults which give the most onerous condition;

b) in normal operation and with the application of one countable fault plus the application of those non-countable faults which give the most onerous condition.

The non-countable faults applied may differ in each of the above circumstances.

In testing or assessing the circuits for spark ignition, a safety factor of 1,5 shall be applied in accordance with 10.4.2. The safety factor applied to the voltage or current for the determination of surface temperature classification shall be 1,0 in all cases. If no countable fault can occur the requirements of a) are considered to give a category of "ib" if the test requirements for "ib" can be satisfied.

NOTE – Guidance on the assessment of intrinsically safe circuits for spark ignition is contained in annex A. Details of the spark test apparatus are given in annex B.

5.4 Simple apparatus

The following apparatus shall be considered to be simple apparatus:

a) passive components, for example switches, junction boxes, resistors and simple semiconductor devices;

b) sources of stored energy with well-defined parameters, for example capacitors or inductors, whose values shall be considered when determining the overall safety of the system;

c) sources of generated energy, for example thermocouples and photocells, which do not generate more than 1,5 V, 100 mA and 25 mW. Any inductance or capacitance present in these sources of energy shall be considered as in b).

Simple apparatus shall conform to all relevant requirements of this standard but need not be certified and need not comply with clause 12. In particular, the following aspects shall always be considered:

1) simple apparatus shall not achieve safety by the inclusion of voltage and/or current-limiting and/or suppression devices;

2) simple apparatus shall not contain any means of increasing the available voltage or current, for example circuits for the generation of ancillary power supplies;

3) where it is necessary that the simple apparatus maintains the integrity of the isolation from earth of the intrinsically-safe circuit, it shall be capable of withstanding the test voltage to earth in accordance with 6.4.12. Its terminals shall conform to 6.3.1;

4) non-metallic enclosures and enclosures containing light metals when located in the hazardous area shall conform to 7.3 and 8.1 of IEC 60079-0:1998;

5) when simple apparatus is located in the hazardous area, it shall be temperature classified. When used in an intrinsically safe circuit within their normal rating and at a maximum ambient temperature of 40 °C, switches, plugs, sockets and terminals are allocated a T6 temperature classification for Group II applications and considered as having a maximum surface temperature of 85 °C for Group I applications. Other types of simple apparatus shall be temperature classified in accordance with clauses 4 and 6 of this standard.

Where simple apparatus forms part of an apparatus containing other electrical circuits, the whole shall be certified.

NOTE – Sensors which utilize catalytic reaction or other electro-chemical mechanisms are not normally simple apparatus. Specialist advice on their application should be sought.

6 Apparatus construction

NOTE – The requirements given in this clause apply, unless otherwise stated in the relevant subclauses, only to those features of intrinsically safe apparatus and associated apparatus which contribute to this type of protection and they are additional to the general requirements of IEC 60079-0 except for those excluded in 1.2.

For example, the requirements for encapsulation with casting compound apply only if encapsulating is required to satisfy 6.4.4 or 6.7.

6.1 Enclosures

In principle, intrinsically safe apparatus and associated apparatus do not require an enclosure as the method of protection is embodied within the circuits themselves. However, where intrinsic safety can be impaired by access to conducting parts, for example if the circuits contain infallible creepage distances in air, an enclosure of at least IP20 in accordance with IEC 60529 shall be provided as part of the apparatus under test.

The degree of protection required will vary according to the intended use; for example, a degree of protection of IP54 in accordance with IEC 60529 will in general be required for Group I apparatus.

The "enclosure" may not be physically the same for protection against contact with live parts and the ingress of solid foreign bodies and liquids.

The designation of the surfaces which form the boundaries of the enclosure shall be the responsibility of the manufacturer and shall be recorded in the definitive documentation (see clause 13).

6.2 Wiring and small component temperatures

6.2.1 Dust layers on Group I equipment

For the purposes of this clause where reference is made to T4 and Group I, the Group I equipment shall be equipment in which coal dust cannot form a layer in the location of or on the component being considered.

6.2.2 Wiring within apparatus

The maximum permissible current corresponding to the maximum wire temperature due to self-heating shall either be taken from table 1 for copper wires or can be calculated from the following equation for metals in general

$$I = I_f \left[\frac{t}{T} \frac{(1 + aT)}{(1 + at)} \right]^{1/2}$$

where

a is the temperature coefficient of resistance of the wire material (0,004265 K^{-1} for copper);

I is the maximum permissible current r.m.s., in amperes;

I_f is the current at which the wire melts in an ambient temperature of 40 °C, in amperes;

T is the melting temperature of the wire material in degrees Celsius (1 083 °C for copper);

t is the wire temperature due to self-heating and ambient temperature, in degrees Celsius.