IEC 60079-25

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Explosive atmospheres –
Part 25: Intrinsically safe electrical systems

Atmosphères explosives –
Partie 25: Systèmes électriques de sécurité intrinsèque

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FOREWORD

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International Standard IEC 60079-25 has been prepared by subcommittee 31G: Intrinsically safe apparatus, of IEC technical committee 31: Equipment for explosive atmospheres.

This second edition cancels and replaces the first edition published in 2003 and constitutes a thorough technical revision.

The significant changes with respect to the previous edition are listed below:

- extension of the scope from Group II to Groups I, II and III;
- introduction of level of protection "ic";
- addition of requirements for cables and multi-core cables;
- reference to IEC 60079-11 regarding the termination of intrinsically safe circuits
- requirements for the assessment of an expanded and clarified intrinsically safe system regarding level of protection "ic", simple apparatus and faults in multi-core cables;

- introduction of predefined systems and merging of the system requirements for FISCO from IEC 60079-27;
- addition of requirements for simple intrinsically safe systems containing both lumped inductance and lumped capacitance;
- addition of a method for testing the electrical parameters of cables;
- additional information for the use of simple apparatus in systems.

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

FDIS	Report on voting
31G/202/FDIS	31G/203/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.

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

A list of all parts of IEC 60079 series, under the general title *Explosive atmospheres*, can be found on the IEC website.

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

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- withdrawn,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

EXPLOSIVE ATMOSPHERES –

Part 25: Intrinsically safe electrical systems

1 Scope

This part of IEC 60079 contains the specific requirements for construction and assessment of intrinsically safe electrical systems, type of protection “i”, intended for use, as a whole or in part, in locations in which the use of Group I, II or III apparatus is required.

NOTE 1 This standard is intended for use by the designer of the system who may be a manufacturer, a specialist consultant or a member of the end-user’s staff.

This standard supplements and modifies the general requirements of IEC 60079-0 and the intrinsic safety standard IEC 60079-11. Where a requirement of this standard conflicts with a requirement of IEC 60079-0 or IEC 60079-11, the requirement of this standard takes precedence.

This standard supplements IEC 60079-11, the requirements of which apply to electrical apparatus used in intrinsically safe electrical systems.

The installation requirements of Group II or Group III systems designed in accordance with this standard are specified in IEC 60079-14.

NOTE 2 Group I installation requirements are presently not provided in IEC 60079-14.

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.

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-11:2006, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety “i”*

IEC 60079-14:2007, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 60079-15, *Electrical apparatus for explosive gas atmospheres – Part 15: Construction, test and marking of type of protection "n" electrical apparatus*

IEC 60079-27:2008, *Explosive atmospheres – Part 27: Fieldbus intrinsically safe concept (FISCO)*

IEC 61158-2, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61241-0, *Electrical apparatus for use in the presence of combustible dust – Part 0: General requirements*

IEC 61241-11, *Electrical apparatus for use in the presence of combustible dust – Part 11: Protection by intrinsic safety 'iD'*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions, specific to intrinsically safe electrical systems, apply. They supplement the terms and definitions which are given in IEC 60079-0 and IEC 60079-11.

3.1.1
intrinsically safe electrical system
assembly of interconnected items of electrical apparatus, described in a descriptive system document, in which the circuits or parts of circuits, intended to be used in an explosive atmosphere, are intrinsically safe circuits

3.1.2
certified intrinsically safe electrical system
intrinsically safe electrical system conforming to 3.1.1 for which a certificate has been issued confirming that the electrical system complies with IEC 60079-25

3.1.3
uncertified intrinsically safe electrical system
intrinsically safe electrical system conforming to 3.1.1 for which the knowledge of the electrical parameters of the items of certified intrinsically safe electrical apparatus, certified associated apparatus, simple apparatus and the knowledge of the electrical and physical parameters of the interconnecting wiring permit the unambiguous deduction that intrinsic safety is preserved

3.1.4
descriptive system document
document in which the items of electrical apparatus, their electrical parameters and those of the interconnecting wiring are specified

3.1.5
system designer
person who is responsible for the descriptive system document, has the necessary competence to fulfil the task and who is empowered to enter into the commitments on behalf of his employer

3.1.6
maximum cable capacitance
C_c
maximum capacitance of the interconnecting cable that can be connected into an intrinsically safe circuit without invalidating intrinsic safety

3.1.7
maximum cable inductance
L_c
maximum inductance of the interconnecting cable that can be connected into an intrinsically safe circuit without invalidating intrinsic safety

3.1.8
maximum cable inductance to resistance ratio
L_C/R_C
maximum value of the ratio inductance (L_C) to resistance (R_C) of the interconnecting cable that can be connected into an intrinsically safe circuit without invalidating intrinsic safety

3.1.9
linear power supply
power source from which the available output current is determined by a resistor; the output voltage decreases linearly as the output current increases.

3.1.10
non-linear power supply
power supply where the output voltage and output current have a non-linear relationship

NOTE For example, a supply with a constant voltage output that can reach a constant current limit controlled by semiconductors.

3.2 Abbreviations

FISCO Fieldbus Intrinsically Safe Concept
FNICO Fieldbus Non-Incendive Concept

4 Descriptive system document

A descriptive system document shall be created for all systems. The descriptive system document shall provide an adequate analysis of the safety achieved by the system.

NOTE Annex E comprises examples of typical diagrams, which illustrate the requirements of the descriptive system document.

The minimum requirements are as follows:

a) block diagram of the system listing all the items of apparatus within the system including simple apparatus and the interconnecting wiring. An example of such a diagram is shown in Figure E.1;

b) a statement of the group subdivision (for Groups II and III), the level of protection for each part of the system, the temperature classification, and the ambient temperature rating in accordance with Clauses 5, 6 and 7;

c) the requirements and permitted parameters of the interconnecting wiring in accordance with Clause 8;

d) details of the earthing and bonding points of the systems in accordance with Clause 11. When surge protection devices are used, an analysis in accordance with Clause 12 shall also be included;

e) where applicable, the justification of the assessment of apparatus as simple apparatus in accordance with IEC 60079-11 shall be included;

f) where the intrinsically safe circuit contains several pieces of intrinsically safe apparatus the analysis of the summation of their parameters shall be available. This shall include all simple apparatus and certified intrinsically safe apparatus;

g) a unique identification of the descriptive system document shall be created;

h) the system designer shall sign and date the document.

NOTE The descriptive system's drawing is not the same as the Control Drawing referred to in IEC 60079-11.

5 Grouping and classification

Intrinsically safe electrical systems shall be placed in a Group I, Group II or Group III as defined in IEC 60079-0. Groups II and III intrinsically safe electrical systems as a whole or parts thereof shall be given a further subdivision of the Group as appropriate.

Apparatus within Groups II and III intrinsically safe electrical system, intended for use in explosive gas or dust atmospheres, shall be given a temperature class or maximum surface temperature in accordance with IEC 60079-0, IEC 60079-11, IEC 61241-0 and IEC 61241-11 as applicable.

NOTE 1 In Group II and Group III intrinsically safe electrical systems, or parts thereof, the subdivisions A, B, C may be different from those of the particular intrinsically safe electrical apparatus and associated electrical apparatus included in the system.

NOTE 2 Different parts of the same intrinsically safe electrical system may have different subdivisions (A, B, C). The apparatus used may have different temperature classes and different ambient temperature ratings.

6 Levels of protection

6.1 General

Each part of an intrinsically safe electrical system intended for use in an explosive atmosphere will have a level of protection of “ia”, “ib” or “ic” in accordance with IEC 60079-11. The complete system need not necessarily have a single level of protection.

NOTE 1 For example, where an instrument is primarily an “ib” instrument but which is designed for the connection of an “ia” sensor, such as a pH measuring instrument with its connected probe, the part of the system up to the instrument is “ib” and the sensor and its connections “ia”.

NOTE 2 An “ia” field instrument powered via an “ib” associated apparatus would be considered as an “ib” system.

NOTE 3 A system may be “ib” in normal operation with external power, but when power is removed under defined safety circumstances (ventilation failure) then the system could become “ia” under back up battery power. The level of protection will be clearly defined for foreseeable circumstances.

Clause 13 contains details of the required assessment.

6.2 Level of protection “ia”

Where the requirements applicable to electrical apparatus of level of protection “ia” (see IEC 60079-11) are satisfied by an intrinsically safe system or part of a system considered as an entity, then that system or part of a system shall be placed in level of protection “ia”.

6.3 Level of protection “ib”

Where the requirements applicable to electrical apparatus of level of protection “ib” (see IEC 60079-11) are satisfied by an intrinsically safe system or part of a system considered as an entity, then that system or part of a system shall be placed in level of protection “ib”.

6.4 Level of protection “ic”

Where the requirements applicable to electrical apparatus level of protection “ic” (see IEC 60079-11) are satisfied by an intrinsically safe system or part of a system considered as an entity, then the system or part of a system shall be placed in level of protection “ic”.

7 Ambient temperature rating

Where part or all the intrinsically safe system is specified as being suitable for operation outside the normal operating temperature range of –20 °C and +40 °C, this shall be specified in the descriptive system document.

8 Interconnecting wiring / cables used in an intrinsically safe electrical system

The electrical parameters of the interconnecting wiring upon which intrinsic safety depends and the derivation of these parameters shall be specified in the descriptive system document. Alternatively, a specific type of cable shall be specified and the justification for its use included in the documentation. Cables for the interconnecting wiring shall comply with the relevant requirements of Clause 9.

Where relevant, the descriptive system document shall also specify the permissible types of multi-core cables as specified in Clause 9, which each particular circuit may utilize. In the particular case where faults between separate circuits have not been taken into account, then a note shall be included on the block diagram of the descriptive system document stating the following: "where the interconnecting cable utilizes part of a multi-core cable containing other intrinsically safe circuits, then the multi-core cable shall be in accordance with the requirements of a multi-core cable type A or B, as specified in Clause 9 of IEC 60079-25".

A multi-core cable containing circuits classified as level of protection "ia", "ib" or "ic" shall not contain non-intrinsically safe circuits.

"ic" multi-core cables may contain more than one intrinsically safe "ia", "ib" or "ic" circuit subject to the applicable faults specified in Clause 13.

NOTE Multi-core cables not complying with type A or B are permitted if the specific combination of circuits is examined against the requirements of IEC 60079-11.

Intrinsically safe "ic" circuits shall only be run together with intrinsically safe "ia" and "ib" circuits provided they are run in a multi-core cable of type A or type B specified in 9.5.

9 Requirements of cables and multi-core cables

9.1 General

The diameter of individual conductors or strands of multi-stranded conductors within the hazardous area shall not be less than 0,1 mm.

Only insulated cables with insulation capable of withstanding a dielectric test of at least 500 V a.c. or 750 V d.c. shall be used in intrinsically safe circuits.

NOTE This clause is not intended to prevent the use of bare conductors in a signalling system and these should be considered as simple apparatus and not interconnecting wiring.

9.2 Multi-core cables

The radial thickness of the insulation of each core shall be appropriate to the conductor diameter and the nature of the insulation with a minimum of 0,2 mm.

Multi-core cables shall be capable of withstanding a dielectric test of at least:

a) 500 V r.m.s. a.c. or 750 V d.c. applied between any armouring and/or screen(s) joined together and all the cores joined together.
b) 1 000 V r.m.s. a.c. or 1 500 V d.c. applied between a bundle comprising one half of the cable cores joined together and a bundle comprising the other half of the cores joined

together. This test is not applicable to multi-core cables with conducting screens for individual circuits.

The dielectric strength test shall be carried out in accordance with an appropriate cable standard or dielectric strength tests of IEC 60079-11.

9.3 Electrical parameters of cables

The electrical parameters (C_c and L_c or C_c and L_c/R_c) for all cables used within an intrinsically safe system shall be determined according to a), b) or c):

a) the most onerous electrical parameters provided by the cable manufacturer;

b) electrical parameters determined by measurement of a sample, with the method of testing electrical parameters of cables given in Annex G;

c) where the interconnection comprises two or three cores of a conventionally constructed cable (with or without screen): 200 pF/m and either 1 µH/m or an inductance to resistance ratio (L_c/R_c) calculated by dividing 1 µH by the manufacturers specified loop resistance per meter. Alternatively, for currents up to I_o = 3 A an L/R ratio of 30 µH/Ω may be used.

Where a FISCO or FNICO system is used, the requirements for the cable parameters shall comply with Annex I.

9.4 Conducting screens

Where conducting screens provide protection for separate intrinsically safe circuits in order to prevent such circuits becoming connected to one another, the coverage of those screens shall be at least 60 % of the surface area.

9.5 Types of multi-core cables

9.5.1 General

Multi-core cables shall be classified as either type A, type B or type C for the purposes of applying faults and assessing the safety of the cabling within an intrinsically safe system. The cable types are specified in 9.5.2, 9.5.3, and 9.5.4.

The use of multi-core cables that do not comply with the requirements for types A, B, or C is not permitted.

9.5.2 Type A cable

A cable whose construction complies with 9.1, 9.2, 9.3 and has conducting screens providing individual protection for each intrinsically safe circuit according to 9.4.

9.5.3 Type B cable

A cable whose construction complies with 9.1, 9.2 and 9.3, is fixed and effectively protected against damage and does not contain any circuit with a maximum voltage U_o exceeding 60 V.

9.5.4 Type C cable

A cable whose construction complies with 9.1, 9.2 and 9.3.

10 Termination of intrinsically safe circuits

Intrinsically safe systems that contain junction boxes or marshalling cubicles where intrinsically safe circuits are terminated shall comply with the terminal requirements in the facilities for the connection of external circuits of IEC 60079-11.

11 Earthing and bonding of intrinsically safe systems

In general, an intrinsically safe circuit shall either be fully floating or bonded to the reference potential associated with a hazardous area at one point only. The level of isolation required (except at that one point) is to be designed to withstand a 500 V insulation test in accordance with the dielectric strength requirement of IEC 60079-11. Where this requirement is not met, the circuit shall be considered to be earthed at that point. More than one earth connection is permitted on a circuit, provided that the circuit is galvanically separated into sub-circuits, each of which has only one earth point.

Screens shall be connected to earth or the structure in accordance with IEC 60079-14. Where a system is intended for use in an installation where significant potential differences (greater than 10 V) between the structure and the circuit can occur, the preferred technique is to use a circuit galvanically isolated from external influences such as changes in ground potential at some distance from the structure. Particular care is required where part of the system is intended to be used in Zone 0 or Zone 20 locations or when the system has a very high level of protection so as to conform to EPL Ma requirements.

The descriptive system document should clearly indicate which point or points of the system are intended to be connected to the plant reference potential and any special requirements of such a bond. This may be achieved by adding a reference to IEC 60079-14 in the descriptive system document.

NOTE IEC 60079-14 does not apply to electrical installations in mines susceptible to firedamp.

12 Protection against lightning and other electrical surges

Where a risk analysis shows that an installation is particularly susceptible to lightning or other surges, precautions shall be taken to avoid the possible hazards.

If part of an intrinsically safe circuit is installed in Zone 0 in such a way that there is a risk of developing hazardous or damaging potential differences within Zone 0, a surge protection device shall be installed. Surge protection is required between each conductor of the cable including the screen and the structure where the conductor is not already bonded to the structure. The surge protection device shall be installed outside but as near to the boundary of Zone 0 as is practicable, preferably within 1 m.

Surge protection for apparatus in Zones 1 and 2 shall be included in the system design for highly susceptible locations.

The surge protection device shall be capable of diverting a minimum peak discharge current of 10 kA (8/20 µs impulse according to IEC 60060-1 for 10 operations). The connection between the protection device and the local structure shall have a minimum cross-sectional area equivalent to 4 mm^2 copper. The cable between the intrinsically safe apparatus in Zone 0 and the surge protection device shall be installed in such a way that it is protected from lightning. Any surge protection device introduced into an intrinsically safe circuit shall be suitably explosion protected for its intended location.

The use of surge protection devices which interconnect the circuit and the structure via non-linear devices such as gas discharge tubes and semiconductors is not considered to adversely affect the intrinsic safety of a circuit, provided that in normal operation the current through the device is less than 10 µA.

NOTE If insulation testing at 500 V is carried out under well-controlled conditions, then it may be necessary to disconnect the surge suppression devices to prevent them invalidating the measurement.

Intrinsically safe systems utilizing surge suppression techniques shall be supported by an adequately documented analysis of the effect of indirect multiple earthing, taking into account

the criteria set out above. The capacitance and inductance of the surge suppression devices shall be considered in the assessment of the intrinsically safe system.

Annex F illustrates some aspects of the design of surge protection of an intrinsically safe system.

13 Assessment of an intrinsically safe system

13.1 General

Where a system contains apparatus which does not separately conform to IEC 60079-11, then that system shall be analysed as a whole, as if it were an apparatus. A level of protection “ia” system shall be analysed in accordance with the level of protection “ia” criteria of IEC 60079-11. A level of protection “ib” system shall be analysed in accordance with the level of protection “ib” criteria of IEC 60079-11. A level of protection “ic” system shall be analysed in accordance with the level of protection “ic” criteria of IEC 60079-11. In addition to the faults within the apparatus, the failures within the field wiring listed in 13.4 shall also be taken into account.

NOTE It is recognized that applying faults to the system as a whole is less stringent than applying faults to each piece of apparatus; nevertheless, this is considered to achieve an acceptable level of safety.

Where all the necessary information is available, it is permissible to apply the fault count to the system as a whole even when apparatus conforming to IEC 60079-11 is being used. This is an alternative solution to the more usual straightforward comparison of input and output characteristics of the separately analysed or tested apparatus. Where a system contains only separately analysed or tested apparatus conforming to IEC 60079-11, the compatibility of all the apparatus included in the system shall be demonstrated. Faults within the apparatus have already been considered and no further consideration of these faults is necessary. Where a system contains a single source of power, the output parameters of the power source take into account opening, shorting and earthing of the external interconnecting cable, and consequently these failures do not need to be further considered. Annex A contains further details of the analysis of these simple circuits.

When a system contains more than one linear source of power, then the effect of the combined sources of power shall be analysed. Annex B illustrates the analysis to be used in the most frequently occurring combinations.

If an intrinsically safe system contains more than one source of power, and one or more of these sources are non-linear, the assessment method described in Annex B cannot be used. For this kind of intrinsically safe system, Annex C explains how the system analysis can be conducted if the combination contains a single non-linear power supply.

Figure 1 illustrates the principles of the system’s analysis.