

Australian/New Zealand Standard™

Explosive atmospheres

Part 30.1: Electrical resistance trace heating—General and testing requirements



AS/NZS 60079.30.1:2016

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-014, Equipment for Explosive Atmospheres. It was approved on behalf of the Council of Standards Australia on 1 February 2016 and on behalf of the Council of Standards New Zealand on 28 January 2016.

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This Standard was issued in draft form for comment as DR AS/NZS 60079.30.1:2015.

Australian/New Zealand Standard™

Explosive atmospheres

Part 30.1: Electrical resistance trace heating—General and testing requirements

Originated as AS/NZS 62086.1:2002.
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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee, EL-014 Equipment for Explosive Atmospheres, to supersede AS/NZS 60079.30.1:2007.

The objective of this Standard is to specify general and testing requirements for electrical resistance trace heaters for application in explosive gas atmospheres. The Standard covers trace heaters that may comprise either factory- or field- (work-site) assembled units, and which may be series heating cables, parallel heating cables or heating pads and heating panels that have been assembled and/or terminated in accordance with the manufacturer's instructions.

The objective of the revision is to adopt the current edition of IEC/IEEE 60079-30-1.

This Standard is identical with, and has been reproduced from IEC/IEEE 60079-30-1, Ed 1.0 (2015), *Explosive atmospheres, Part 30-1: Electrical resistance trace heating—General and testing requirements*.

As this Standard is reproduced from an International Standard, the following applies:

- (a) In the source text 'this part of IEC 60079' should read 'this Australian/New Zealand standard'.
- (b) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>		<i>Australian/New Zealand Standard</i>	
IEC		AS/NZS	
60079	Explosive atmospheres	60079	Explosive atmospheres
60079-0	Part 0: Equipment—General requirements	60079.0	Part 0: Equipment—General requirements

Only normative references that have been adopted as Australian or Australian/New Zealand Standards have been listed.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the annex to which they apply. A 'normative' annex is an integral part of a Standard, whereas an 'informative' annex is only for information and guidance.

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INTRODUCTION

IEC/IEEE 60079-30-1 is intended to provide a comprehensive overview of the essential requirements and testing appropriate to electric surface heating equipment used in explosive atmospheres. The requirements of this part of IEC 60079 are considered to be the minimum requirements for equipment protection levels Gb, Gc, Db, and Dc in explosive atmospheres for gases, dusts, and fibres/flyings. While some of this work already exists in national standards or international standards, this standard has collated much of this existing work and considerably added to it. This standard also contains the minimum requirements for users applying the Division method of area classification.

AUSTRALIAN/NEW ZEALAND STANDARD

Explosive atmospheres**Part 30.1:****Electrical resistance trace heating—General and testing requirements****1 Scope**

This part of IEC 60079 specifies general and testing requirements for electrical resistance trace heaters for application in explosive atmospheres with the exclusion of those for EPL Ga and Da. This standard covers trace heaters that comprise either factory or field (work-site) assembled units, and which may be series trace heaters, parallel trace heaters, trace heater pads, or trace heater panels that have been assembled and/or terminated in accordance with the manufacturer's instructions.

This standard also includes requirements for termination assemblies and control methods used with trace heating systems. The explosive atmospheres referred to in this standard are those defined in IEC 60079-10-1 and IEC 60079-10-2.

Annexes D and E outline the application of this standard for those users applying the Division method of area classification.

This standard supplements and modifies the general requirements of IEC 60079-0, except as indicated in Table 1. Where a requirement of this standard conflicts with a requirement of IEC 60079-0, the requirement of this standard takes precedence.

Table 1 – Application or exclusion of specific clauses of IEC 60079-0

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2011) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
1	Scope	Applies	Applies	Applies
2	Normative references	Applies	Applies	Applies
3	Terms and definitions	Applies, except ambient temperature, see 3.1	Applies, except ambient temperature, see 3.1	Applies, except ambient temperature, see 3.1
4	Equipment grouping	Applies	Applies	Applies
4.1	Group I	Applies	Excluded	Applies
4.2	Group II	Applies, always IIC	Excluded	Applies
4.3	Group III	Excluded	Applies, outside of thermal insulation only, always IIIC	Applies, outside of thermal insulation only
4.4	Equipment for a particular explosive atmosphere	Excluded	Excluded	Applies
5.1	Environmental influences	Applies	Applies	Applies
5.1.1	Ambient temperature	Replaced by 6.1e)	Replaced by 6.1e)	Applies, see 3.1
5.1.2	External source of heating or cooling	Applies	Applies	Applies
5.2	Service temperature	Modified	Modified	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2011) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
5.3.1	Determination of maximum surface temperature	Replaced by 4.5 in conjunction with 5.1.13	Replaced by 4.5 in conjunction with 5.1.13 only when tested in accordance with 5.1.13.3.	Applies
5.3.2.1	Group I electrical equipment	Applies	Excluded	Applies
5.3.2.2	Group II electrical equipment	Applies	Excluded	Applies
5.3.2.3.1	Group III electrical equipment, Maximum surface temperature determined without a dust layer	Excluded	Applies, where the maximum sheath temperatures determined by IEC/IEEE 60079-30-1 are used in place of the method for temperature determination from IEC 60079-0.	Applies
5.3.2.3.2	Group III electrical equipment Maximum surface temperature with respect to dust layers	Excluded	Applies, where the maximum sheath temperature is determined only for those surfaces that are specified to be exposed to layers of combustible dust. Does not apply for trace heaters specified to be covered by thermal insulation.	Applies
5.3.3	Small component temperature for Group I and Group II electrical equipment	Excluded	Excluded	Applies
6.1	Requirements for all electrical equipment – General	Applies	Applies	Applies
6.2	Mechanical strength	Replaced by 4.2	Replaced by 4.2	When in direct contact with the trace heater, may be substituted by 4.2
6.3	Opening times	Excluded	Excluded	Applies
6.4	Circulating currents in enclosures (e.g. of large electrical machines)	Excluded	Excluded	Excluded
6.5	Gasket retention	Excluded	Excluded	Applies
6.6	Electromagnetic and ultrasonic radiating equipment	Excluded	Excluded	Applies
7.1.1	Non-metallic enclosures and non-metallic parts of enclosures – Applicability	Replaced by the last paragraph of 4.1	Replaced by the last paragraph of 4.1	Applies
7.1.2.1	Specification of materials, General	Replaced by the last paragraph of 4.1	Replaced by the last paragraph of 4.1	Applies
7.1.2.2	Specification of materials, plastic materials	Replaced by the last paragraph of 4.1	Replaced by the last paragraph of 4.1	Applies
7.1.2.3	Elastomers	Replaced by the last paragraph of 4.1	Replaced by the last paragraph of 4.1	Applies
7.2	Thermal endurance	Replaced by requirements and tests	Replaced by requirements and	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2011) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
		of this standard	tests of this standard	
7.3	Resistance to light	Replaced by 5.1.16 for trace heaters and integral components specified for outdoor exposure	Replaced by 5.1.16 for trace heaters and integral components specified for outdoor exposure	Applies
7.4.1	Electrostatic charges on external non-metallic materials, Applicability	Excluded	Excluded	Applies
7.4.2	Avoidance of a build-up of electrostatic charge on Group I or Group II electrical equipment	Excluded	Excluded	Applies
7.4.3	Avoidance of a build-up of electrostatic charge on equipment for Group III	Excluded	Excluded	Applies
7.5	Accessible metal parts	Excluded	Excluded	Applies
8.1	Material composition	Excluded	Excluded	Applies
8.2	Group I	Excluded	Excluded	Applies
8.3	Group II	Excluded	Excluded	Applies
8.4	Group III	Excluded	Excluded	Applies
9	Fasteners	Excluded	Excluded	Applies
10	Interlocking devices	Excluded	Excluded	Applies
11	Bushings	Excluded	Excluded	Applies
12	Materials used for cementing	Replaced by the last paragraph of 4.1	Replaced by the last paragraph of 4.1	Applies
13	Ex Components	Applies	Applies	Applies
14	Connection facilities and termination compartments	Covered by the requirements of this standard	Covered by the requirements of this standard	Applies
15	Connection facilities for earthing and bonding conductors	Replaced by 5.1.15	Replaced by 5.1.15	Applies
16	Entries into enclosures	Excluded	Excluded	Applies
17	Supplementary requirements for rotating electrical machines	Excluded	Excluded	Excluded
18	Supplementary requirements for switchgear	Excluded	Excluded	Excluded
19	Supplementary requirements for fuses	Excluded	Excluded	Applies
20	Supplementary requirements for plugs and sockets	Excluded	Excluded	Applies
21	Supplementary requirements for luminaires	Excluded	Excluded	Excluded
22	Supplementary requirements for caplights and handlights	Excluded	Excluded	Excluded
23	Equipment incorporating cells and batteries	Excluded	Excluded	Applies
24	Documentation	Applies	Applies	Applies
25	Compliance of prototype or	Applies	Applies	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2011) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
	sample with documents			
26.1	General	Applies	Applies	Applies
26.2	Test configuration	Applies	Applies.	Applies
26.3	Tests in explosive test mixtures	Excluded	Excluded	Applies
26.4	Tests of enclosures	Excluded	Excluded	Applies
26.4.1	Order of tests	Excluded	Excluded	Applies
26.4.1.1	Metallic enclosures, metallic parts of enclosures and glass parts of enclosures	Excluded	Excluded	Applies
26.4.1.2	Non-metallic enclosures or non-metallic parts of enclosures	Excluded	Excluded	Applies
26.4.2	Resistance to impact	Replaced by 5.1.5	Replaced by 5.1.5	Applies
26.4.3	Drop test	Excluded	Excluded	Excluded
26.4.4	Acceptance criteria	Replaced by 5.1.5	Replaced by 5.1.5	Applies
26.4.5	Degree of protection by enclosure	Replaced by 5.1.8 and/or 5.1.9	Replaced by 5.1.8 and/or 5.1.9.	Applies
26.5	Thermal tests	Modified.	Modified	Applies
26.5.1	Temperature measurement	Replaced by 5.1.13	Replaced by 5.1.13	Applies
26.5.2	Thermal shock test	Excluded	Excluded	Applies
26.5.3	Small component ignition test	Excluded	Excluded	Applies
26.6	Torque test for bushings	Excluded	Excluded	Applies
26.7	Non-metallic enclosures or non-metallic parts of enclosures	Excluded	Excluded	Applies
26.8	Thermal endurance to heat	Replaced by 5.1.11	Replaced by 5.1.11	Applies
26.9	Thermal endurance to cold	Replaced by 5.1.7	Replaced by 5.1.7	Applies
26.10	Resistance to light	Replaced by 5.1.16 for trace heaters and integral components specified for outdoor exposure	Replaced by 5.1.16 for trace heaters and integral components specified for outdoor exposure	Applies
26.11	Resistance to chemical agents for Group I electrical equipment	Applies for Group I	Excluded	Applies
26.12	Earth continuity	Excluded	Excluded	Applies
26.13	Surface resistance test of parts of enclosures of non-metallic materials	Excluded	Excluded	Applies
26.14	Measurement of capacitance	Excluded	Excluded	Applies
26.15	Verification of ratings of ventilating fans	Excluded	Excluded	Excluded
26.16	Alternative qualification of elastomeric sealing O-rings	Excluded	Excluded	Applies
27	Routine tests	Applies	Applies	Applies
28	Manufacturers responsibility	Applies	Applies	Applies
29	Marking	Modified	Modified	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2011) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
30	Instructions	Modified	Modified	Applies
Annex A	Supplementary requirements for Ex cable glands	Excluded	Excluded	Applies
Annex B	Requirements for Ex components	Excluded	Excluded	Applies
Annex C	Example of rig for resistance to impact test	Replaced by 5.1.5	Replaced by 5.1.5	Applies
Annex D	Motors supplied by converters	Excluded	Excluded	Excluded
Annex E	Temperature rise testing of electric machines	Excluded	Excluded	Excluded
Annex F	Guideline flowchart for tests of non-metallic enclosures or non-metallic parts of enclosures (26.4)	Excluded	Excluded	Applies
NOTE 1 Clause numbers in the three right-hand columns of this table refer to IEC/IEEE 60079-30-1				
NOTE 2 The clause number in the above table is shown for information only. The applicable requirements of IEC 60079-0 are identified by the clause title which is normative.				
Applies: this requirement of IEC 60079-0 is applied without change.				
Excluded: this requirement of IEC 60079-0 does not apply.				
Modified: this requirement of IEC 60079-0 is modified as detailed in this standard.				

2 Normative references

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

IEC 60050-151:2001, *International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices*

IEC 60050-426:2008, *International Electrotechnical Vocabulary – Part 426: Equipment for explosive atmospheres*

IEC 60079-0:2011, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60695-11-3, *Fire hazard testing – Part 11-3: Test flames – 500 W flames – Apparatus and confirmational test methods*

ISO 4582, *Plastics – Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or laboratory light sources*

ISO 4892-1, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ASTM D5025, *Standard specification for laboratory burner used for small-scale burning tests on plastic materials*

ASTM G155, *Standard practice for operating xenon arc light apparatus for exposure of non-metallic materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0, IEC 60079-7, IEC 60050-151 and IEC 60050-426 (except as modified by this clause) as well as the following apply.

NOTE Definition 3.40 is identical to definition 3.16 of IEC 60079-7: 2006.

3.1

ambient temperature

<trace heating>

temperature surrounding the workpiece including the trace heater and any thermal insulation or weather barrier that may be applied

3.1.1

maximum ambient temperature

highest specified ambient temperature

3.1.2

minimum ambient temperature

<trace heating>

lowest ambient temperature specified at which trace heating is operable and performs according to specified requirements (and on which heat-loss calculations are based)

[SOURCE: IEC 60050-426:2008, 426-20-20]

3.2

branch circuit

portion of the wiring installation between the overcurrent device protecting the circuit and the trace heater unit(s)

[SOURCE: IEC 60050-426:2008, 426-20-02]

3.3

connections (terminations)

3.3.1

cold lead

electrically insulated conductor or conductors used to connect a trace heater to a branch circuit and designed so that it does not produce significant heat

[SOURCE: IEC 60050-426:2008, 426-20-03]

3.3.2

end termination

termination, which may be heat producing, applied to a trace heater at the end opposite to that where the power is supplied

[SOURCE: IEC 60050-426:2008, 426-20-04]

3.3.3**power termination**

termination applied to the end of a trace heater at which the power is supplied

[SOURCE: IEC 60050-426:2008, 426-20-05]

3.3.4**tee**

electrical connection of trace heaters, in series or in parallel, to accommodate a branch or a branch circuit

[SOURCE: IEC 60050-426:2008, 426-20-06, modified ("tee or branch" replaced by "branch or a branch circuit")]

3.4**controlled design**

design where the set point of the applicable temperature controller or high-limit device is used in establishing the maximum sheath temperature

3.5**dead leg**

<trace heating>

segment of process piping segregated from the normal flow pattern for the purpose of providing a heat loss reference

[SOURCE: IEC 60050-426:2008, 426-20-07]

3.6**design loading**

minimum power that meets the design requirements, in the specified adverse conditions (minimum ambient and maximum wind velocity), after voltage and resistance tolerances and appropriate safety factors have been considered

[SOURCE: IEC 60050-426:2008, 426-20-08]

3.7**electrically conductive covering**

metallic sheath, metallic braid or other conductive material

3.8**factory fabricated**

<trace heating>

assembled into units or sets, including the necessary terminations and connections

[SOURCE: IEC 60050-426:2008, 426-20-09]

3.9**field assembled**

<trace heating>

supplied in bulk with terminating components to be assembled at the work site

[SOURCE: IEC 60050-426:2008, 426-20-10]

3.10**heat loss**

energy flow from a pipe, vessel or equipment to its surroundings

[SOURCE: IEC 60050-426:2008, 426-20-11]

3.11

heat sink

part that conducts and dissipates heat away from a workpiece

Note 1 to entry: Typical heat sinks are pipe shoes, pipe supports and items of large mass such as valve actuators or pump bodies.

[SOURCE: IEC 60050-426:2008, 426-20-12]

3.12

heat transfer aids

thermally conductive materials, such as metallic foils or heat transfer compounds used to increase the heat transfer efficiency from trace heaters to the workpiece

[SOURCE: IEC 60050-426:2008, 426-20-13]

3.13

high limit temperature

maximum allowable temperature of the system, including piping, fluid and trace heating system

[SOURCE: IEC 60050-426:2008, 426-20-16, modified (addition of "trace")]

3.14

integral components

components such as heat shrink terminations, cold lead connections, moulded end seals, or splices, which may conform to the general shape of the trace heater and are exposed to the same environments (such as under the thermal insulation) as the trace heater, that are not intended to be re-used in the event of a repair or modification, which may be factory fabricated or field assembled

3.15

maximum continuous exposure temperature (trace heater de-energized)

highest allowable continuous temperature to which the trace heating system may be exposed as declared by the manufacturer

3.16

maximum maintain temperature / maximum continuous operating temperature (trace heater energized)

specified maximum workpiece temperature the trace heater operates at continuously as declared by the manufacturer

3.17

maximum intermittent exposure temperature (trace heater energized or de-energized)

highest allowable intermittent temperature to which a trace heater may be exposed, as declared by the manufacturer

3.18

maintain temperature

specified temperature of a workpiece or process that the trace heaters shall be able to maintain

3.19

maximum sheath temperature

maximum temperature of the outermost covering of a trace heater

3.20**maximum withstand temperature**

maximum operating or exposure temperature that will not adversely affect the thermal stability of the trace heater and its component parts

[SOURCE: IEC 60050-426:2008, 426-20-18]

3.21**minimum installation temperature**

minimum temperature at which the trace heating system may be handled and installed

3.22**MI trace heater**

mineral insulated metal sheathed trace heater typically containing one or more heating conductors

3.23**operating voltage**

actual voltage applied to the trace heater when in service

[SOURCE: IEC 60050-426:2008, 426-20-21]

3.24**outdoor exposure**

exposure to outdoor conditions of ultraviolet light and moisture

3.25**overjacket**

continuous layer of material applied outside the electrically conductive covering to protect against corrosion

3.26**parallel trace heater(s)**

heating elements that are electrically connected in parallel, either continuously or in zones, so that the watt density per lineal length is maintained, irrespective of any change in length for the continuous type or for any number of discrete zones

3.27**power density**

power output for a trace heater expressed in watts per linear length or in watts per unit surface area

3.28**rated output**

total power or power per unit length or unit surface area of a trace heater, at rated voltage, temperature and length or area

[SOURCE: IEC 60050-426:2008, 426-20-24, modified (removal of "which is normally expressed in watts, watts per metre or watts per square metre")]

3.29**rated voltage**

<trace heating>

voltage assigned by the manufacturer to which operating and performance characteristics of trace heaters are referred

[SOURCE: IEC 60050-426:2008, 426-20-25, modified (addition of "assigned by the manufacturer")]

3.30

series trace heater(s)

heating elements electrically connected in series with a single current path and with a specific resistance at a given temperature for a given length

[SOURCE: IEC 60050-426:2008, 426-20-26]

3.31

sheath

<trace heating>

uniform and continuous metallic or non-metallic outer covering enclosing the trace heater used to provide protection against influence from the surroundings (corrosion, moisture etc.)

Note 1 to entry: See overjacket, 3.25.

[SOURCE: IEC 60050-426:2008, 426-20-26, modified (addition of Note 1 to entry)]

3.32

sheath temperature

<trace heating>

temperature of the outermost continuous covering that may be exposed to the surrounding atmosphere

[SOURCE: IEC 60050-426:2008, 426-20-28]

3.33

stabilized design

design where the temperature of the trace heater, by design and use, stabilizes below the high limit temperature, under the most unfavourable conditions, without the need for a protective system to limit the temperature

[SOURCE: IEC 60050-426:2008, 426-20-29]

3.34

start-up current

current response of a trace heater following energization

[SOURCE: IEC 60050-426:2008, 426-20-30, modified ("immediately upon energizing" replaced by "following energization")]

3.35

system documentation

<trace heating>

information prepared by the manufacturer to allow satisfactory understanding, installation and safe use of the trace heating system

[SOURCE: IEC 60050-426:2008, 426-20-31]

3.36

temperature control device

device that serves to maintain the temperature within a specified temperature range

[SOURCE: IEC 60050-426:2008, 426-20-33]

3.37**temperature controller**

device or combination of devices incorporating a means of sensing temperature and of controlling the power to the trace heater

[SOURCE: IEC 60050-426:2008, 426-20-34]

3.38**temperature limiting device**

safety device that serves to switch off power to the trace heater before the maximum specified surface temperature is exceeded

3.39**temperature sensor****(temperature sensing element)**

device designed to respond to temperature providing an electrical signal or mechanical operation

3.40**thermal insulation**

material having air- or gas-filled pockets, voids, or heat reflecting surfaces that, when properly applied, retards the transfer of heat

[SOURCE: IEC 60050-426:2008, 426-20-36]

3.41**trace heater**

device designed for the purpose of producing heat on the principle of electrical resistance and typically composed of one or more metallic conductors and/or an electrically conductive material, suitably electrically insulated and protected

[SOURCE: IEC 60050-426:2008, 426-20-37]

3.42**trace heater pad**

trace heater comprising series or parallel connected elements having sufficient flexibility to conform to the shape of the surface to be heated

3.43**trace heater panel**

non-flexible trace heater comprising series or parallel connected elements fabricated to conform to the general shape of the surface to be heated

3.44**trace heater unit****(trace heater set)**

series trace heater, parallel trace heater, trace heater pad or trace heater panel suitably terminated in conformity with the manufacturer's instructions

3.45**trace heating**

utilization of electric trace heaters, trace heater pads, trace heater panels and support components, used to maintain or to raise the temperature of contents in piping, tanks and associated equipment

[SOURCE: IEC 60050-426:2008, 426-20-39, modified (removal of "externally applied")]

3.46**trace heating system**

utilization of trace heating including all necessary design and installation documentation

3.47**trace ratio**

ratio of trace heater length to pipe length

3.48**weather barrier**

material that, when installed on the outer surface of thermal insulation, protects the thermal insulation from water or other liquids, from physical damage caused by ice pellets, wind or mechanical abuse and from deterioration caused by solar radiation or atmospheric contamination

[SOURCE: IEC 60050-426:2008, 426-20-40, modified (replacement of "sleet" by "ice pellets")]

3.49**workpiece**

<trace heating>

object to which a trace heater is applied

Note 1 to entry: Examples include process equipment such as piping, vessels, tanks, valves, instruments and similar equipment.

[SOURCE: IEC 60050-426:2008, 426-20-41, modified (addition of Note 1 to entry)]

4 General requirements

4.1 General

The requirements of this standard confirm that electrical resistance trace heating within the scope of this standard has been designed and constructed so as to validate electrical, thermal and mechanical durability and reliable performance.

Electrical resistance trace heaters and integral components shall comply with or be excluded from the requirements of IEC 60079-0, as listed in Table 1.

Trace heaters shall be provided with an evenly-distributed electrically conductive covering that shall cover at least 70 % of the surface. Trace heater pads and panels shall be constructed such that the electrically conductive covering shall be opposite the surface to be heated. The electrically conductive covering shall either be suitable for use in the particular atmosphere(s) or have a suitable non-metallic overjacket over the covering. The manufacturer shall declare the maximum withstand temperature in degrees Celsius. The materials used in the trace heater and integral components shall withstand a temperature of no less than the manufacturer's declared maximum withstand temperature +20 K, when tested in accordance with 5.1.11. The manufacturer shall provide documentation of the specification of non-metallic materials on which the mechanical strength and the electrical insulation depend (between the heater and other conductive parts) which shall include identification of the material type.

4.2 Mechanical strength

The mechanical strength of trace heaters shall be determined by the tests in 5.1.5, 5.1.6, 5.1.7 and 5.1.11.

Trace heaters which are identified for use only in areas with a low risk of mechanical damage are subjected to a reduced energy in the impact tests in 5.1.5 and a reduced force in the deformation test in 5.1.6, and shall be clearly marked as specified in 7.4 e).

Trace heaters may be supplied with additional mechanical protection to meet the requirements of this standard if they are supplied as an integral assembly (prefabricated), and contain the following statement in the instructions: "This mechanical covering shall not be removed and the trace heaters shall not be operated without the mechanical covering being in place". In this case the tests in 5.1.5 and 5.1.6 shall be performed with the additional mechanical protection installed on the trace heater.

4.3 Terminations and connections

Terminations and connections may be identified as an integral part of a trace heater, or may be identified separately, as Ex equipment or as Ex components in accordance with IEC 60079-0. Integral terminations and connections are tested as part of a representative trace heater unit; see 5.1.1.

Electrical connectors supplied with integral components shall be certified for the current-carrying capacity of the trace heating conductors declared by the manufacturer and shall meet the other prescribed testing in this standard.

Electrical resistance trace heater terminations identified as separate components shall comply with the requirements of one or more of the types of protection listed in IEC 60079-0 suitable for the application, which may be supplemented and modified by the requirements of this standard. See also Table 1.

4.4 Circuit protection requirements for branch circuits

The minimum requirements for trace heating systems for use in explosive atmospheres are as follows:

- a) a means of isolating all line conductors from the supply;
- b) over-current protection provided for each branch circuit;
- c) a means of protecting against earth faults by disconnecting all line conductors.
 - 1) For TT and TN systems, each trace heater or trace heater branch circuit, the electrical protection shall be capable of interrupting high impedance earth faults as well as short-circuit faults. This shall be accomplished by an earth-fault protective device, or a controller with earth-fault interruption capability for use in conjunction with suitable circuit protection. The preferred trip level is nominal 30 mA or 30 mA above any inherent capacitive leakage characteristic of the heater as specified by the trace heater supplier.
 - 2) For IT systems, an electrical insulation monitoring device shall be installed to disconnect the supply whenever the electrical resistance is not greater than 50 Ω/V of rated voltage.

Exception: Where conditions of maintenance and supervision ensure that only qualified persons service the installed systems, and continued circuit operation is necessary for the safe operation of the equipment or processes, earth-fault detection without interruption is acceptable if alarmed in a manner to assure an acknowledged response.

The requirements of a), b), and c) may be performed by one device.

NOTE 1 The application of the above exception is intended to be at the discretion of the end user.

NOTE 2 This information is specified to be provided with the product documentation as indicated in Clause 7.

4.5 Temperature requirements

4.5.1 General

A trace heating system shall be designed so that the sheath temperature of the trace heaters is limited to the temperature class or ignition temperature, minus 5 K for temperatures less than or equal to 200 °C or minus 10 K for temperatures greater than 200 °C. The maximum

sheath temperature of the trace heater shall also be less than the maximum withstand temperature.

Maximum sheath temperatures of trace heaters shall be determined for the proper application of the heater. The sheath temperature is dependent on the heater power output density, overall heat transfer coefficient, and the temperature of the surface being heated.

This shall be achieved either by:

- 1) determining the trace heater's maximum sheath temperature according to the product classification method in accordance with 5.1.13.3;
- 2) a stabilized design in accordance with 4.5.2; or
- 3) a controlled design in accordance with 4.5.3.

For 2) and 3) above, when multiple trace heaters (especially on pipes with different flow conditions) are grouped together under a single temperature control device, each design condition shall be analyzed.

Requirements for equipment for use in facilities using the Division method of area classification are given in Annex D.

4.5.2 Stabilized design

The maximum sheath temperature obtained by stabilized design is based on the energy balance of heat loss and heat production of a system. The energy balance is determined by calculations based on system parameters.

The design calculations, system parameters and methods for stabilized design shall be demonstrated to the certification body by the manufacturer by comparison to the test results from 5.1.13.2. Table 2 gives the design conditions for various equipment protection levels for the stabilized design approach.

Design conditions of no-wind, the maximum ambient temperature and the system heat transfer coefficient shall be used to calculate the maximum workpiece temperature and maximum sheath temperature. Guidance for the design calculations is provided in Annex C.

Table 2 – Sheath temperature design conditions based on equipment protection levels – Stabilized design approach

Item	EPL Gb/Db	EPL Gc/Dc
Percent of operating voltage	110	110
Maximum workpiece temperature for calculation	--- ^a	--- ^a
Maximum wind speed for calculation	0	0
^a The workpiece temperature (T_{pr} or T_{pm} , whichever is greater) is used to calculate the maximum sheath temperature- see Annex C.		

4.5.3 Controlled design

4.5.3.1 General

The maximum sheath temperature obtained through controlled design is based on energy limitation by temperature controllers or limiting devices. These protective temperature limiting devices are to be set to a temperature no greater than the maximum allowable sheath temperature corresponding to the temperature class reduced by;

- (1) the predicted temperature difference between the temperature limiter's set point and the maximum sheath temperature of the trace heater, and by