



IEEE

IEC/IEEE 60079-30-1

Edition 2.0 2025-09

INTERNATIONAL STANDARD

REDLINE VERSION

Explosive atmospheres -

Part 30-1: Electrical resistance trace heating - General and testing requirements

ICS 29.260.20

ISBN 978-2-8327-0727-2



Documents

Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on February 25, 2026 at 19:28:39 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEC/IEEE 60079-30-1-2025



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2025 IEC, Geneva, Switzerland

Copyright © 2025 IEEE

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing being secured. Requests for permission to reproduce should be addressed to either IEC at the address below or IEC's member National Committee in the country of the requester or from IEEE.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue
New York, NY 10016-5997
United States of America
stds.ipr@ieee.org
www.ieee.org

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About the IEEE

IEEE is the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity. IEEE and its members inspire a global community through its highly cited publications, conferences, technology standards, and professional and educational activities.

About IEC/IEEE publications

The technical content of IEC/IEEE publications is kept under constant review by the IEC and IEEE. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.



Documents

Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on February 25, 2026 at 19:28:39 UTC from IEEE Xplore. Restrictions apply.

CONTENTS

FOREWORD	4
INTRODUCTION	1
1 Scope	9
2 Normative references	9
3 Terms and definitions	10
4 General requirements	14
4.1 Applicability of IEC 60079-0	17
4.2 General	27
4.3 Mechanical strength	28
4.4 Terminations and connections	28
4.5 Circuit protection requirements for branch circuits	28
4.6 Temperature requirements	29
4.6.1 General	29
4.6.2 Stabilized design	29
4.6.3 Controlled design	30
5 Testing	31
5.1 Type tests	33
5.1.1 General	33
5.1.2 Dielectric test	33
5.1.3 Electrical insulation resistance test	34
5.1.4 Flammability test	34
5.1.5 Impact test	36
5.1.6 Deformation test	39
5.1.7 Cold bend test	40
5.1.8 Water resistance test	42
5.1.9 Integral components' resistance to water test	43
5.1.10 Verification of rated output	43
5.1.11 Thermal stability of electrical insulating material	46
5.1.12 Thermal performance test	46
5.1.13 Determination of maximum sheath temperature	48
5.1.14 Verification of start-up current	54
5.1.15 Verification of the electrical resistance of electrically conductive covering	58
5.1.16 Outdoor exposure UV and condensation test	58
5.1.17 Connection Integrity (integral components)	59
5.2 Routine tests	61
5.2.1 Dielectric test	61
5.2.2 Verification of rated output	61
6 Marking	61
6.1 Product markings for trace heaters	61
6.2 Markings for Field assembled components	62
6.3 Product markings for high temperature limiters and temperature controllers	62
7 Documentation requirements	62
7.1 General	62
7.2 Circuit design documentation	63
7.3 Trace heating system documentation	63

7.3.1	General	63
7.3.2	For trace heating systems according to the product classification method	63
7.3.3	For trace heating systems according to stabilized design method	63
7.3.4	For trace heating systems according to controlled design method	63
7.4	Instructions for installation of trace heating system	64
7.5	Instructions for commissioning	65
7.6	Instructions for maintenance / repair or modification	65
Annex A (informative) Type test matrix for EPLs Gb/Gc/Db/Dc (refer to IEC 60079-14 for the relationship of EPLs to Zones)		66
Annex B (informative) Checklist for installation		68
Annex C (normative) Trace heater product design verification methodology		69
C.1	General	69
C.2	Design methodology and selection of trace heaters	69
C.3	Stabilized design calculations	69
C.4	Trace heater performance and equilibrium conditions	70
C.5	Heat loss calculations	72
C.6	Heat loss design safety factor	73
C.7	Maximum temperature determination	73
C.7.1	Theoretical pipe and sheath temperature calculations - Metallic applications	73
C.7.2	Theoretical vessel and sheath temperature calculations - Metallic applications	74
C.7.3	Sheath temperature - metallic applications utilizing a temperature limiter control sensing the trace heater sheath or an artificial hot spot	76
C.7.4	Theoretical sheath temperature calculations - Non-metallic applications	76
C.7.5	Sheath temperature - Non-metallic applications utilizing a temperature limiter control sensing the trace heater sheath or an artificial hot spot	78
Annex D (normative) Calculation methodology for coverage of electrically conductive covering		79
Annex E (normative) Applications of trace heating in empty conduit		80
E.1	General	80
E.2	Maximum sheath temperature - trace heating internal to conduit	80
E.3	Pull-strength test	80
E.4	Rated output	80
E.5	Verification of start-up current	81
Annex F (normative) Requirements for Division 1 and Division 2 trace heating systems		82
F.1	Application	82
F.2	General	82
F.3	Terminations and connections	82
F.4	Control and temperature requirements	82
F.4.1	General	82
F.4.2	Stabilized design	82
F.4.3	Controlled design	83
F.4.4	Requirements for protective device in Divisions 1 and 2	83
F.5	Type tests	83
F.5.1	Division 1 trace heating equipment	83
F.5.2	Division 2 trace heating equipment	84
F.6	Marking	84

F.7 Instructions - Installation requirements.....	84
Annex G (normative) Type test matrix for Division 1 and 2 explosive atmospheres	86
Bibliography.....	89
Figure 1 – Flammability test.....	36
Figure 2 – Example of room temperature impact test	38
Figure 3 – Example of minimum temperature impact test	39
Figure 4 – Cold bend test.....	42
Figure 5 – Integral components resistance to water test.....	43
Figure 6 – Verification of rated output	45
Figure 7 – Maximum sheath temperature using Product classification approach.....	49
Figure 8 – Verification of sheath temperatures using pipe sculpture	51
Figure 9 – Verification of sheath temperature, plate test	54
Figure 10 – Verification of sheath temperature - plate test with serpentine sample.....	55
Figure 11 – Plate test with two samples crossed over	56
Figure 12 – Plate test with a single sample crossed over	57
Figure 13 – Typical splice firm attachment apparatus.....	60
Figure C.1 – Equilibrium conditions for workpiece maintenance	70
Figure C.2 – Equilibrium conditions for upper limit evaluation	71
Table 1 – Application or exclusion of specific clauses of IEC 60079-0.....	17
Table 2 – Sheath temperature design conditions based on Equipment Protection Levels (EPLs) - Stabilized design approach	29
Table 3 – Sheath temperature design conditions based on Equipment Protection Levels - Controlled design approach	31
Table 4 – Test voltages for the dielectric test.....	33
Table A.1 – Determination of test samples	66
Table B.1 – Trace heater installation record - Example	68
Table F.1 – Division trace heating systems	82
Table F.2 - Sheath temperature design conditions - Stabilized design approach	83
Table F.3 – Sheath temperature design conditions - With temperature control device controller and/or high temperature limiter.....	83
Table G.1 – Applicable trace heater and trace heater pads and panels tests by installation location	86
Table G.2 – Applicable tests for integral components with trace heaters and trace heater pads and panels	87

Explosive atmospheres - Part 30-1: Electrical resistance trace heating - General and testing requirements

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC document(s)"). 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.

IEEE Standards documents are developed within IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of IEEE and serve without compensation. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards. Use of IEEE Standards documents is wholly voluntary. *IEEE documents are made available for use subject to important notices and legal disclaimers (see <https://standards.ieee.org/ipr/disclaimers.html> for more information).*

IEC collaborates closely with IEEE in accordance with conditions determined by agreement between the two organizations. This Dual Logo International Standard was jointly developed by the IEC and IEEE under the terms of that agreement.

- 2) The formal decisions of 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 IEC National Committees. The formal decisions of IEEE on technical matters, once consensus within IEEE Societies and Standards Coordinating Committees has been reached, is determined by a balanced ballot of materially interested parties who indicate interest in reviewing the proposed standard. Final approval of the IEEE standards document is given by the IEEE Standards Association (IEEE SA) Standards Board.
- 3) IEC/IEEE Publications have the form of recommendations for international use and are accepted by IEC National Committees/IEEE Societies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC/IEEE Publications is accurate, IEC or IEEE cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications (including IEC/IEEE Publications) transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC/IEEE Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC and IEEE do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC and IEEE are not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or IEEE or their directors, employees, servants or agents including individual experts and members of technical committees and IEC National Committees, or volunteers of IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board, for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC/IEEE Publication or any other IEC or IEEE Publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that implementation of this IEC/IEEE Publication may require use of material covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. IEC or IEEE shall not be held responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patent Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC/IEEE 60079-30-1:2015. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC/IEEE 60079-30-1 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres, in cooperation with the Petroleum & Chemical Industry Committee of the IEEE Industrial Applications Society under the IEC/IEEE Dual Logo Agreement.

This publication is published as an IEC/IEEE Dual Logo standard.

This second edition of IEC/IEEE 60079-30-1 cancels and replaces the first edition of IEC/IEEE 60079-30-1 published in 2015. This edition constitutes a technical revision.

Users of this document are advised that interpretation sheets clarifying the interpretation of this document can be published. Interpretation sheets are available from the IEC webstore and can be found in the "history" tab of the page for each document.

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

The significance of changes between IEC/IEEE 60079-30-1, Edition 1.0 (2015) and IEC/IEEE 60079-30-1, Edition 2.0 (this document) is as listed below:

		Type		
Changes	Clause	Minor and editorial changes	Extension	Major technical changes
Redefined Maximum withstand temperature as it applies to the performance benchmark test.	3.20	X		
Separated maximum maintain temperature and maximum continuous operating temperature to clarify the meaning of both terms.	3.15 and 3.16	X		
Addition of requirements for controllers and high temperature limiters, added specific reference standards.	4.6.3			C1
Rewrite of the requirements for controlled design as it applies to the application of controllers and high temperature limiters as for use in EPL's.	4.6.3			C2
Addition of requirement for specifying various temperatures defined by the standard and including them in user documentation.	4.2 and 7			C3
Connection Integrity (integral components)	5.1.17		X	
Applications of Trace Heating in empty conduit	Annex E		X	

NOTE The technical changes referred to include the significance of technical changes in the revised IEC Standard, but they do not form an exhaustive list of all modifications from the previous version.

Explanations:

A) Definitions

Minor and editorial changes

clarification
decrease of technical requirements
minor technical change
editorial corrections

These are changes which modify requirements in an editorial or a minor technical way. They include changes of the wording to clarify technical requirements without any technical change, or a reduction in level of existing requirement.

Extension addition of technical options

These are changes which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore, these will not have to be considered for products in conformity with the preceding edition.

Major technical changes

addition of technical requirements
increase of technical requirements

These are changes to technical requirements (addition, increase of the level or removal) made in a way that a product in conformity with the preceding edition will not always be able to fulfil the requirements given in the later edition. These changes have to be considered for products in conformity with the preceding edition. For these changes additional information is provided in clause B) below.

NOTE 1 These changes represent current technological knowledge. However, these changes should not normally have an influence on equipment already placed on the market.

B) Information about the background of 'Major technical changes'

- C1 There are no additional requirements for temperature controllers and high temperature limiters beyond those of the general industrial standards.
- C2 The application of temperature controllers and high temperature limiters shall be as specified.
- C3 The documentation shall include the various temperatures specified in the standard.

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

Draft	Report on voting
31/1867/FDIS	31/1893/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications/.

This document is to be used in conjunction with IEC 60079-0, *Explosive atmospheres - Part 0: Equipment - General requirements* and IEC/IEEE 60079-30-2, *Explosive atmospheres - Part 30-2: Electrical resistance trace heating - Guidance on application for design, installation and maintenance*.

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

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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 (EPLs) 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 document has collated much of this existing work and ~~considerably~~ added to it. This document also contains the minimum requirements for users applying the Division method of area classification.

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 **Equipment Protection Levels (EPL) Ga, Da, Ma and Mb equipment**. This document covers trace heaters that comprise either factory or field (worksite) assembled units, and which ~~may~~ can 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 document also includes requirements for termination assemblies and control methods used with trace heating systems. The explosive atmospheres referred to in this document are those defined in IEC 60079-10-1 and IEC 60079-10-2.

Annex F and Annex G outline the application of this document 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.~~

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-151:~~2004~~, *International Electrotechnical Vocabulary (IEV) - Part 151: Electrical and magnetic devices*

~~IEC 60050-426:2008, International Electrotechnical Vocabulary — Part 426: Equipment for explosive atmospheres~~

IEC 60079-0:~~2014~~, *Explosive atmospheres - Part 0: Equipment - General requirements*

IEC 60079-7, *Explosive atmospheres - Part 7: Equipment protection by increased safety "e"*

IEC/IEEE 60079-30-2, *Explosive atmospheres - Part 30-2: Electrical resistance trace heating - Guidance on application for design, installation and maintenance*

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) and the following apply.

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

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~~ the object under consideration

Note 1 to entry: Where a trace heater or surface heater is enclosed in thermal insulation, the ambient temperature is the temperature external to the thermal insulation.

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

<trace heating> 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

connection

termination

termination or splice used to attach trace heaters or surface heaters to power wiring or to connect sections of these devices

3.3.1

cold lead

<trace heating> electrically insulated conductor or conductors that do not produce significant heat and are 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**

<trace heating> termination, which ~~may~~ can 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**

<trace heating> 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**

<trace heating> electrical connection of trace heaters, in series or in parallel, to accommodate a branch ~~or a branch circuit~~ of a trace heater

~~{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 and/or high ~~limit device~~ temperature limiter is used in establishing/limiting 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}~~

3.5**electrically conductive covering**

~~metallic sheath, metallic braid or other conductive material~~

metallic braid, metallic sheath, or alternative covering with sufficient conductivity so that, when bonded to ground, it will allow a ground fault protective device to operate under a fault condition

3.6**factory fabricated**

<trace heating> ~~assembled into units or sets, including the necessary terminations and connections~~ trace heater unit or set, including the necessary terminations and connections, assembled by the manufacturer

~~{SOURCE: IEC 60050-426:2008, 426-20-09}~~

3.7**field assembled**

<trace heating> trace heaters supplied ~~in bulk~~ unterminated with terminating components to be assembled at the work site

~~{SOURCE: IEC 60050-426:2008, 426-20-10}~~

3.8**heat loss**

<trace heating> energy flow from a workpiece, pipe, or vessel or equipment to its surroundings

~~{SOURCE: IEC 60050-426:2008, 426-20-11}~~

3.9**heat sink**

<trace heating> 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}~~

3.10**heat transfer aid**

<trace heating> thermally conductive material, such as metallic foil or heat transfer compound used to increase the heat transfer efficiency from trace heaters to the workpiece

~~{SOURCE: IEC 60050-426:2008, 426-20-13}~~

3.11**high limit temperature**

<trace heating> 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")}~~

3.12**high temperature limiter**

safety device, or combination of safety devices, incorporating a means of sensing temperature and a means of switching power to the trace heater before the maximum surface temperature is exceeded

3.13**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~~

component such as a heat shrink termination, a cold lead connection, a molded end seal, or a splice, which conforms to the general shape of the trace heater and is exposed to the same environment as the trace heater, which can be factory fabricated or field assembled, and is not intended to be re-used in the event of a repair or modification

3.14**maximum continuous exposure temperature** ~~(trace heater de-energized)~~

<trace heating> highest allowable continuous temperature to which the trace heating system ~~may~~ can be exposed while de-energized as declared by the manufacturer

3.15**maximum maintain temperature** ~~/ maximum continuous operating temperature (trace heater energized)~~

<trace heating> specified maximum workpiece or process temperature that the trace heater ~~operates at continuously~~ is able to maintain as declared by the manufacturer

3.16**maximum continuous operating temperature**

specified maximum workpiece temperature; at which, the trace heater, can operate continuously when energized as declared by the manufacturer

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

<trace heating> highest allowable intermittent temperature to which a trace heater ~~may~~ can be exposed, as declared by the manufacturer

3.18**maintain temperature**

<trace heating> specified temperature of a workpiece or process that the trace heaters shall be able to maintain continuously when energized as declared by the manufacturer

3.19**maximum sheath temperature**

<trace heating> maximum temperature of the outermost continuous 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}~~

<trace heating> maximum continuous exposure temperature or the maximum intermittent exposure temperature (energized or de-energized) whichever is higher, as declared by the manufacturer

3.21**minimum installation temperature**

<trace heating> minimum temperature at which the trace heating system ~~may~~ can be handled and installed

3.22**MI trace heater**

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

3.23**operating voltage**

<trace heating> actual voltage applied to the trace heater when in service

~~{SOURCE: IEC 60050-426:2008, 426-20-21}~~

3.24**outdoor exposure**

<trace heating> exposure to outdoor conditions of ultraviolet light and moisture

3.25**overjacket**

<trace heating> continuous layer of non-metallic material applied outside the ~~electrically conductive covering~~ metallic sheath or screen to protect against corrosion

3.26**parallel trace heater**

<trace heating> heating element that is electrically connected in parallel with another parallel trace heater, either continuously or in zones, so that the ~~watt density~~ power output 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~~

3.27**rated output**

<trace heating> 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")}~~

3.28**rated voltage**

<trace heating> rated value of the 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")}~~

3.29**routine test**

test that is carried out by the manufacturer of the trace heater on all trace heaters during or after the production process

3.30**series trace heater**

<trace heating> heating element electrically connected in series with another series trace heater 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, abrasion 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 (braid, sheath, or overjacket) that ~~may~~ can be exposed to the surrounding atmosphere

~~{SOURCE: IEC 60050-426:2008, 426-20-28}~~

3.33

stabilized design

<trace heating> 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

<trace heating> 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

surface heater

trace heater pad or trace heater panel

3.36

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

<trace heating> device or combination of devices incorporating a means of sensing temperature and of controlling the ~~power~~ energy 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~~

3.38**temperature sensor**~~(temperature sensing element)~~

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

3.39**thermal insulation**

<trace heating> 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]~~

3.40**trace heater**

device of linear geometry 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]~~

3.41**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

3.42**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

3.43**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

3.44**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")]~~

3.45**trace heating system**

<trace heating> usage of trace heating including all necessary design and installation documentation

~~**3.46**~~~~**trace heating system**~~

~~utilization of trace heating including all necessary design and installation documentation~~

3.46**trace ratio**

<trace heating> ratio of trace heater length to pipe length

3.47**type test**

conformity test made on one or more items representative of the production

3.48**weather barrier**

<trace heating> 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 Applicability of IEC 60079-0**

This document supplements and modifies the general requirements of IEC 60079-0, except as indicated in Table 1. Where a requirement of this document conflicts with a requirement of IEC 60079-0, the requirement of this document 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 (2014) (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

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2014) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
7.2	Thermal endurance	Replaced by requirements and tests of this standard	Replaced by requirements and tests of this standard	Applies
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

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2014) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
25	Compliance of prototype or sample with documents	Applies	Applies	Applies
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

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 6.0 (2014) (informative)	Clause / Subclause title (normative)	Group I and Group II	Group III	
29	Marking	Modified	Modified	Applies
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.				

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 7.0 (2017) (informative)	Clause / Subclause title (normative)	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			
4.1	General	Applies	Applies	Applies
4.2	Group I	Excluded	Excluded	Excluded
4.3	Group II	Applies	Excluded	Applies
4.4	Group III	Excluded	Applies	Applies
4.5	Equipment for a particular explosive gas atmosphere	Applies	Excluded	Applies
5	Temperatures			
5.1	Environmental influences			
5.1.1	Ambient temperature	Replaced by 4.6 and 6.1e)	Replaced by 4.6 and 6.1e)	Applies, see 3.1
5.1.2	External source of heating or cooling	Applies	Applies	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 7.0 (2017) (informative)	Clause / Subclause title (normative)	Group II	Group III	
5.2	Service temperature	Modified	Modified	Applies, special consideration is required in case of glands intended for direct entry of continuous type parallel trace heaters with regards to service temperature
5.3	Maximum surface temperature			
5.3.1	Determination of maximum surface temperature	Replaced by 4.6 in conjunction with 5.1.13	Replaced by 4.6 in conjunction with 5.1.13 only when tested in accordance with 5.1.13.3.	Applies
5.3.2	Limitation of maximum surface temperature			
5.3.2.1	Group I electrical equipment	Excluded	Excluded	Excluded
5.3.2.2	Group II electrical equipment	Applies	Excluded	Applies
5.3.2.3	Group III electrical equipment			
5.3.2.3.1	Maximum surface temperature for EPL Da	Excluded	Excluded	
5.3.2.3.2	Maximum surface temperature for EPL Db	Excluded	Applies, except the maximum sheath temperature shall be determined according to the clauses of IEC 60079-30-1.	Applies
5.3.2.3.3	Maximum surface temperature for EPL Dc	Excluded	Applies, except the maximum sheath temperature shall be determined according to the clauses of IEC 60079-30-1.	Applies
5.3.3	Small component temperature for Group I and Group II electrical equipment	Excluded	Excluded	Applies
5.3.4	Component temperature of smooth surfaces for Group I or Group II electrical equipment	Excluded	Excluded	Applies
6	Requirements for all equipment			
6.1	General	Applies	Applies	Applies
6.2	Mechanical strength of equipment	Replaced by 4.3	Replaced by 4.3	Applies
6.3	Opening times	Excluded	Excluded	Applies
6.4	Circulating currents in enclosures for example of large electrical machines)	Excluded	Excluded	Excluded
6.5	Gasket retention	Excluded	Excluded	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 7.0 (2017) (informative)	Clause / Subclause title (normative)	Group II	Group III	
6.6	Electromagnetic and ultrasonic radiating equipment	Excluded	Excluded	Applies
7	Non-metallic enclosures and non-metallic parts of enclosures			
7.1	General			
7.1.1	Applicability	Replaced by the last paragraph of 4.2	Replaced by the last paragraph of 4.2	Applies
7.1.2	Specification of materials			
7.1.2.1	General	Replaced by the last paragraph of 4.2	Replaced by the last paragraph of 4.2	Applies
7.1.2.2	Plastic materials	Replaced by the last paragraph of 4.2	Replaced by the last paragraph of 4.2	Applies
7.1.2.3	Elastomers	Replaced by the last paragraph of 4.2	Replaced by the last paragraph of 4.2	Applies
7.1.2.4	Materials used for cementing	Replaced by the last paragraph of 4.2	Replaced by the last paragraph of 4.2	Applies
7.2	Thermal endurance	Replaced by requirements and tests of this standard	Replaced by requirements and tests of this standard	Applies
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	Electrostatic charges on external non-metallic materials	Excluded	Excluded	Applies
7.5	Attached external conductive parts	Excluded	Excluded	Applies
8	Metallic enclosures and metallic parts of enclosures			
8.1	Material composition	Applies to trace heaters and integral components with metallic outer sheath or overjacket.	Applies to trace heaters and integral components with metallic outer sheath or overjacket.	Applies
8.2	Group I	Excluded	Excluded	Excluded
8.3	Group II	Applies to trace heaters and integral components with metallic outer sheath or overjacket.	Excluded	Applies
8.4	Group III	Excluded	Applies to trace heaters and integral components with metallic outer sheath or overjacket.	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 7.0 (2017) (informative)	Clause / Subclause title (normative)	Group II	Group III	
8.5	Copper Alloys	Applies to trace heaters and integral components with metallic outer sheath or overjacket.	Applies to trace heaters and integral components with metallic outer sheath or overjacket.	Applies
9	Fasteners	Excluded	Excluded	Applies
10	Interlocking devices	Excluded	Excluded	Applies
11	Bushings	Excluded	Excluded	Applies
12	(Reserved for future use)			
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	(Reserved for future use)			
20	Supplementary requirements for external plugs, socket outlets and connectors for field wiring connection	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 sample with documents	Applies	Applies	Applies
26	Type tests			
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			
26.4.1	Order of tests	Excluded	Excluded	Applies
26.4.2	Resistance to impact	Excluded	Excluded	Applies
26.4.3	Drop test	Excluded	Excluded	Excluded
26.4.4	Acceptance criteria	Excluded	Excluded	Applies
26.4.5	Degree of protection by enclosure	Excluded	Excluded	Applies

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 7.0 (2017) (informative)	Clause / Subclause title (normative)	Group II	Group III	
26.5	Thermal tests			
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 and 5.1.5.3	Replaced by 5.1.7 and 5.1.5.3	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	Excluded	Excluded	Excluded
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			
29.1	Applicability	Applies	Applies	Applies
29.2	Location	Applies	Applies	Applies
29.3	General	Modified	Modified	Applies
29.4	Ex marking for explosive gas atmospheres	Applies	Applies	Applies
29.5	Ex marking for explosive dust atmospheres	Applies	Applies	Applies
29.6	Combined types (or levels) of protection	Applies for complete trace heating systems	Applies for complete trace heating systems	Applies
29.7	Multiple types of protection	Applies for complete trace heating systems	Applies for complete trace heating systems	Applies
29.8	Ga equipment using two independent Gb types (or levels) of protection	Excluded	Excluded	Excluded
29.9	Boundary wall	Excluded	Excluded	Excluded

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 7.0 (2017) (informative)	Clause / Subclause title (normative)	Group II	Group III	
29.10	Ex Components	Applies	Applies	Applies
29.11	Small Ex Equipment and small Ex Components	Applies	Applies	Applies
29.12	Extremely small Ex Equipment and extremely small Ex Components	Applies	Applies	Applies
29.13	Warning markings	Applies for complete trace heating systems	Applies for complete trace heating systems	Applies
29.14	Cells and batteries	Excluded	Excluded	Applies
29.15	Electric machines operated with a converter	Excluded	Excluded	Excluded
29.16	Examples of marking	Applies	Applies	Applies
30	Instructions	Replaced	Replaced	Applies
Annex A	Supplementary requirements for Ex cable glands	Excluded for integral components	Excluded for integral components	Applies also to cable glands that are integral part of: <ul style="list-style-type: none"> - enclosures; - enclosure support devices with trace heater or cable entries; - connection-, splice-, and/or end termination kits.
Annex B	Requirements for Ex Components	Applies with above mentioned modifications	Applies with above mentioned modifications	Applies
Annex C	Example of rig for resistance to impact test	Replaced by 5.1.5	Replaced by 5.1.5	Applies
Annex D	Electric machines connected to converters	Excluded	Excluded	Excluded
Annex E	Temperature evaluation 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
Annex G	Guidance flowchart for tests of cable glands	Excluded for integral components	Excluded for integral components	Applies also to cable glands that are integral part of: <ul style="list-style-type: none"> - enclosures; - enclosure support devices with trace heater or cable entries; - connection-, splice-,

IEC 60079-0		Electrical resistance trace heaters and integral components		Terminations as separate components
Ed. 7.0 (2017) (informative)	Clause / Subclause title (normative)	Group II	Group III	
				and/or end termination kits.
Annex H	Shaft voltages resulting in motor bearing or shaft brush sparking Discharge energy calculation	Excluded	Excluded	Excluded

NOTE 1 Clause numbers in the three right-hand columns of this table refer to IEC/IEEE 60079-30-1.

NOTE 2 The Clause numbers in the above table are 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 document.

NOTE 3 The applicable Clauses / Subclauses of IEC 60079-0 are identified by the Clause / Subclause title which is normative. This document was written against the specific requirements of IEC 60079-0 Ed. 7.0. The Clause / Subclause numbers for the 7th and previous edition are shown for information only. This is to enable the general requirements of IEC 60079-0 Ed. 6.0 to be used where necessary with this part of IEC 60079. Where there were no requirements in the 6th edition but there are for the 7th edition (indicated by NR against the 6th edition only), or where there is a conflict between requirements, the later edition requirements take precedence.

NOTE 4 A shaded row in the above table indicates that this is a Clause / Subclause heading. In cases where the applicability is the same for all the Subclauses the 'Applies' or 'Excluded' is listed in the heading row and the Subclauses are not expanded. Where the application of the individual Subclauses may be different, these are expanded in the above table and the applicability for each is listed.

4.2 General

The requirements of this document confirm that electrical resistance trace heating within the scope of this document 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. The calculation methodology for coverage is given in Annex D. 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.

In the instructions prepared in accordance with IEC 60079-0, the manufacturer shall ~~declare~~ specify 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~~ schedule drawings shall ~~provide documentation of~~ include 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.

4.3 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 document 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.

4.4 Terminations and connections

Terminations and connections ~~may~~ shall be identified as an integral ~~part~~ component of a trace heater, or ~~may~~ shall be identified separately, as Ex Equipment or as Ex Components in accordance with IEC 60079-0. Integral terminations and connections ~~are~~ shall be tested as part of a representative trace heater unit in accordance with this document; see 5.1.

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

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.

Specific evaluation shall be given to the requirements of IEC 60079-0 for any external source of heating or cooling and service temperature profile of junction boxes and glands used with trace heaters.

4.5 Circuit protection requirements for branch circuits

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

Trace heating systems for use in explosive atmospheres shall as a minimum have:

- a) a means of isolating all ~~line~~ live 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~~ live 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: Regarding 4.5 c) 1) and c) 2), where the instructions prepared in accordance with IEC 60079-0 details conditions of maintenance and supervision to 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.

4.6 Temperature requirements

4.6.1 General

A trace heating system shall be designed so that the sheath temperature of the trace heaters ~~is limited to~~ shall not exceed the specified 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 4.6.2; or~~
- ~~3) a controlled design in accordance with 4.6.3.~~

~~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.~~

The maximum sheath temperature shall be determined either by:

- a) the product classification approach in accordance with 5.1.13.2 or
- b) a stabilized design in accordance with 4.6.2; or
- c) a controlled design in accordance with 4.6.3.

4.6.2 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 and design conditions as shown in Table 2.

~~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.~~

The design calculations, system parameters and methods for stabilized design shall be included in the documentation prepared in accordance with IEC 60079-0 and compared to the test results from 5.1.13.2 or 5.1.13.3.

NOTE It is not a requirement of this document that the manufacturer's design documentation be retained.

Table 2 – Sheath temperature design conditions based on Equipment Protection Levels (EPLs) - 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.		

4.6.3 Controlled design

4.6.3.1 General

The maximum sheath temperature obtained through controlled design is based on energy limitation by temperature controllers ~~or limiting devices~~ and/or high temperature limiters.

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:

- the predicted temperature difference (ΔT_{offset}) between the temperature ~~limiter's~~ controller and/or high temperature limiter set point and the maximum sheath temperature of the trace heater, and by
- the amount specified in 4.6.1.

There are three controlled design methods for limiting the maximum sheath temperature. These are only suitable for situations where the workpiece is not subjected to additional sources of heat:

- By limiting the maximum workpiece temperature. The temperature controller sensor and/or the high temperature limiter sensor is installed directly on the workpiece.
- By using a high temperature limiter with the sensor attached to the trace heater which is installed on the workpiece. Each application requires correlation for the specific trace heater, power output level, and the limiter/sensor characteristics.
- By creating an artificial hot spot where a high temperature limiter sensor is attached to the trace heater which is located on a thermal insulation spacer on the workpiece. Each application requires correlation for the specific trace heater, power output level, limiter/sensor characteristics, and insulation spacer.

~~The manufacturer predicts the offset (ΔT_{offset}) between the trace heating sheath temperature and the temperature control device's set point. For design conditions see Table 3. The manufacturer predicts ΔT_{offset} according to the design conditions in Table 3. The manufacturer shall support the calculation method for sheath temperature by comparing the predicted results to test results from 5.1.13.4.~~

NOTE For calculation of ΔT_{offset} ($= T_{\text{sh}} - T_{\text{L}}$) refer to Annex C. ΔT_{offset} is the empirically determined temperature difference between the sensor and the actual maximum tracer sheath temperature. ΔT_{offset} is a function of variables such as geometry and mass of trace heater and sensor, power output of the trace heater, heat transfer coefficient, and control system hysteresis.

Table 3 – Sheath temperature design conditions based on Equipment Protection Levels ~~EPLs~~ - Controlled design approach

Item	EPL Gb/Db	EPL Gc/Dc
Percent of operating voltage	110	110
Maximum workpiece temperature for calculation	--- ^a	--- ^a or b
Maximum wind speed for calculation	0	0
^a Use the set point of the high temperature limiter according to 4.5.3.2.5 .		
^b Use the set point of the temperature controller according to 4.5.3.3 -4.6.3.6		

4.6.3.2 Requirements for temperature controllers and high temperature limiters

Temperature controllers and high temperature limiter have to fulfil the requirements of general industrial standards and shall meet the requirements of 4.6.3.3 and 4.6.3.4 respectively.

NOTE Typical general industrial requirements for temperature controllers and high temperature limiters can be found in the following documents. It is not a requirement of this document that conformity to those standards be verified.

- a) IEC 61010-1, *Electrical Equipment for Measurement, Control, and Laboratory Use; Part 1: General Requirements*
- b) IEC 60730-2-9, *Automatic electrical controls - Part 2-9: Particular requirements for temperature sensing control*
- c) UL 508, *Industrial Controls*
- d) CSA C22.2 No. 14, *Industrial control equipment*
- e) CSA C22.2 No. 24, *Temperature Indicating and Regulating Equipment*

4.6.3.3 Requirements for high temperature limiters

The high temperature limiter or equivalent means device shall meet the capability and functional requirements as follows:

- a) the high temperature limiter actuator, control logic, and sensor shall be independent of the temperature controller switching means, control logic, and temperature sensor; both may operate from the same main power supply, utilize the same high temperature alarm annunciation relay, and have the same user interface;
- b) the high temperature limiter shall disconnect the trace heater and shall annunciate an alarm when the set point is reached only when the trace heater is energized.
- c) the high temperature limiter alarm shall be visible and/or audible to an operator;
- d) when the high temperature limiter alarm is activated, the alarm shall be manually reset by the operator only after normal operating conditions have been returned;
- e) the set point of the high temperature limiter shall be mechanically or electronically locked to prevent unauthorized access;
- f) the high temperature limiter shall detect a sensor(s) malfunction, disconnect the trace heater, and annunciate when such a malfunction occurs;
- g) in the event of malfunction, the high temperature limiter shall de-energize the trace heater;

NOTE 1 This might not be applicable to mechanical devices.

- h) the switching means for the high temperature limiter shall be evaluated for a minimum of 6 000 cycles of endurance.

The high temperature limiter shall be evaluated to this subclause and for the area where it is intended to be installed and marked corresponding to 6.3.

NOTE 2 The term disconnect refers to disconnected mode from IEC 60050-904. The application applies to phase conductors.

4.6.3.4 Requirements for temperature controllers

A temperature controller shall meet the capability and functional requirements as follows:

- a) the temperature controller shall disconnect the trace heater and shall annunciate an alarm when the high temperature alarm set point is reached;
- b) the temperature controller shall detect a temperature sensor malfunction, disconnect the trace heater, and annunciate an alarm when such a malfunction occurs;
- c) in the event of a loss of power to the temperature controller, disconnect the trace heater, and annunciate when such a malfunction occurs;
- d) the alarm or annunciation shall be visible and /or audible to an operator;
- e) the temperature controller load switching means shall be evaluated for a minimum of 250 000 cycles of endurance for a single device or 100 000 cycles for redundant devices.

The temperature controller shall be evaluated to this subclause and for the area where it is intended to be installed and marked corresponding to 6.3.

NOTE The term disconnect refers to disconnected mode from IEC 60050-904. The application applies to phase conductors.

4.6.3.5 Requirements ~~for temperature control devices~~ for EPLs Gb and Db

~~A temperature limiter or similar control device shall de-energize the system to prevent exceeding the maximum permissible sheath temperature. Any device used for temperature control shall satisfy requirements for EPLs Gb and/or Db.~~

~~Additionally a high temperature limit function shall:~~

- ~~1) operate independently from the temperature controller;~~
- ~~2) de-energize the trace heater when the set point of the high temperature limiter is reached;~~
- ~~3) annunciate when the high temperature limit function is activated;~~
- ~~4) have a high limit function that requires acknowledgement to be reset;~~
- ~~5) mechanically or electronically lock the high limit set point of the device to prevent unauthorized access;~~
- ~~6) have a safety function that de-energizes the circuit if the temperature sensor malfunctions;~~
- ~~7) be possible to re-set only after the normal operating conditions have been returned, or if the switching state is monitored continuously;~~
- ~~8) be evaluated to a minimum of 100,000 cycles of endurance when multiple devices are used for controlling and limiting.~~

If any portion of the trace heater passes through an area requiring EPL Gb or Db, in addition to the existing temperature controller, a high temperature limiter or equivalent means according to 4.6.3.3 shall ensure that the system does not exceed the maximum permissible sheath temperature.

4.6.3.6 Requirements ~~for temperature control devices~~ for EPLs Gc and Dc

~~A single temperature controller may be specified provided that it incorporates annunciation of failure conditions and has been evaluated for a minimum of 250 000 cycles of operation. Alternatively, temperature control devices according to 4.5.3.2 may be specified.~~

~~If a single temperature controller with failure annunciation is specified, provision of adequate monitoring of such an annunciation, such as 24 h surveillance, shall be made.~~

If any portion of the trace heater passes through an area requiring EPL Gc or Dc, a temperature controller according to 4.6.3.4 or a high temperature limiter according to 4.6.3.4 shall ensure that the system does not exceed the maximum permissible sheath temperature.

5 Testing

5.1 Type tests

5.1.1 General

The provisions of IEC 60079-0 as specified in Table 1 apply with the following additions.

Samples of trace heaters ~~at least~~ $(3,0 \pm 0,1)$ m in length, unless otherwise specified, shall be selected for testing. Tests shall be conducted at a temperature between 10 °C and 40 °C unless otherwise stated. Integral components shall be subjected to the same tests as the trace heater, except where otherwise noted. The test samples needed for the type tests are summarized in Annex A.

~~NOTE—As specified in IEC 60079-0, due to the safety factors incorporated in the types of protection, the uncertainty of measurement inherent in good quality, regularly calibrated measurement equipment is considered to have no significant detrimental effect and need not be taken into account when making the measurements necessary to verify compliance to this standard.~~

5.1.2 Dielectric test

The dielectric test shall be performed on trace heaters in accordance with Table 4 on test sample(s) prepared as described in 5.1.1.

Table 4 – Test voltages for the dielectric test

Rated voltage	Test voltage V a.c. (r.m.s.)
< 30 V a.c. (r.m.s.)	500
< 60 V d.c.	500
≥ 30 V a.c. (r.m.s.)	$2U + 1\,000$
≥ 60 V d.c.	$\sqrt{2}U + 1\,000$

Rated voltage	Minimum Test voltage V_{RMS}
< 30 VAC (RMS)	500
< 60 VDC	500
≥ 30 VAC (RMS)	$2U + 1\,000$ ^a
≥ 60 VDC	$\sqrt{2}U + 1\,000$ ^a
^a For MI trace heaters, the required test voltage shall be reduced to $2U + 500$ for products rated at or over 30 VAC, or to $\sqrt{2}U + 500$ for products rated at or over 60 VDC.	

The test voltage, where U is the rated voltage, shall be applied between the conductors and the electrically conductive covering at a rate of rise of neither less than 100 V/s nor more than 200 V/s and maintained for $(60 \frac{-0}{+5})$ s without dielectric breakdown. The test voltage waveform

shall be essentially sinusoidal, with a frequency of 45 Hz to 65 Hz. Alternatively, ~~for a trace heater without metallic covering or braid, the dielectric test may be conducted by submerging the trace heater in tap water at room temperature (resistivity typically 500 Ω m). The ground braid or sheath shall be bonded to the water and~~ The voltage shall be applied between the conductors and the water.

When determining U , the correct use of Phase to Phase or Phase to Neutral voltage levels shall be considered.

~~For type tests 5.1.5, 5.1.6, 5.1.7, 5.1.8, 5.1.9, 5.1.11, and the routine test in 5.2.1, for MI trace heaters the required test voltage is reduced to $2U + 500$ V a.c. for trace heaters rated over 30 V a.c., or to $\sqrt{2}U + 500$ V d.c. for trace heaters rated over 60 V d.c. due to the dielectric characteristics of the MI trace heater construction and electrical insulation materials.~~

5.1.3 Electrical insulation resistance test

The electrical insulation resistance test shall be conducted after the dielectric test specified in 5.1.2 on the same test sample(s). The resistance of the electrical insulation shall be measured between conductors and the electrically conductive covering, by means of a DC source voltage (nominal) of 500 V. The measured value shall be not less than 50 M Ω .

Alternatively, the insulation resistance test may be conducted by submerging the trace heater in tap water at room temperature (resistivity typically 500 $\Omega \times$ m). The ground braid or sheath shall be bonded to the water and the voltage shall be applied between the conductors and the water.

5.1.4 Flammability test

A flammability test shall be performed on trace heaters and on trace heaters with integral components. The full range of sizes shall be capable of complying with the test. The test shall be carried out in a room free from draughts and in a flame chamber or fume hood with a minimum volume of 0,5 cubic metres. For trace heaters, the sample shall be ~~at least~~ (450 $\pm$ 10) mm in length and shall be supported in a vertical position. For trace heater pads and panels (as applicable) the sample width shall be 80 mm.

A gummed unbleached paper indicator shall be wrapped once around the sample so that it projects (20 $\pm$ 2) mm from the sample. The paper indicator shall be positioned (250 $\pm$ 5) mm above the point at which the inner blue cone of the flame contacts the sample. A layer of dry, pure surgical cotton not more than 6 mm in depth shall be placed underneath the sample so that the distance from the cotton to the point of the flame application is approximately 250 mm.

A laboratory burner as described in IEC 60695-11-3 or in ASTM D 5025 shall be used for the test. The fuel shall be methane, natural gas, propane, or butane with the following properties:

- a) Methane or natural gas - For methane: technical grade, 98 % minimum purity; For methane or natural gas: heating value of (37 $\pm$ 1) MJ/m³ at 25 °C
- b) Propane - Technical grade, 98 % minimum purity, heating value of (94 $\pm$ 2) MJ/m³ at 25 °C
- c) Butane - CP grade, 99 % minimum purity, heating value of (120 $\pm$ 3) MJ/m³ at 25 °C

As shown in Figure 1, the flame shall be adjusted to a 130 mm height with a 40 mm inner blue cone. The burner shall be tilted to an angle of 20° $\pm$ 2° from the vertical and the flame applied to the trace heater so that the tip of inner blue cone of the flame touches the specimen at a point approximately 250 mm below the unbleached paper indicator and approximately 150 mm from the bottom of the sample.

~~For termination assemblies, the flame shall be set such that it contacts the material at the most vulnerable point. Clamps used to support the sample shall be above the paper indicator and at least 80mm below the point of flame application.~~

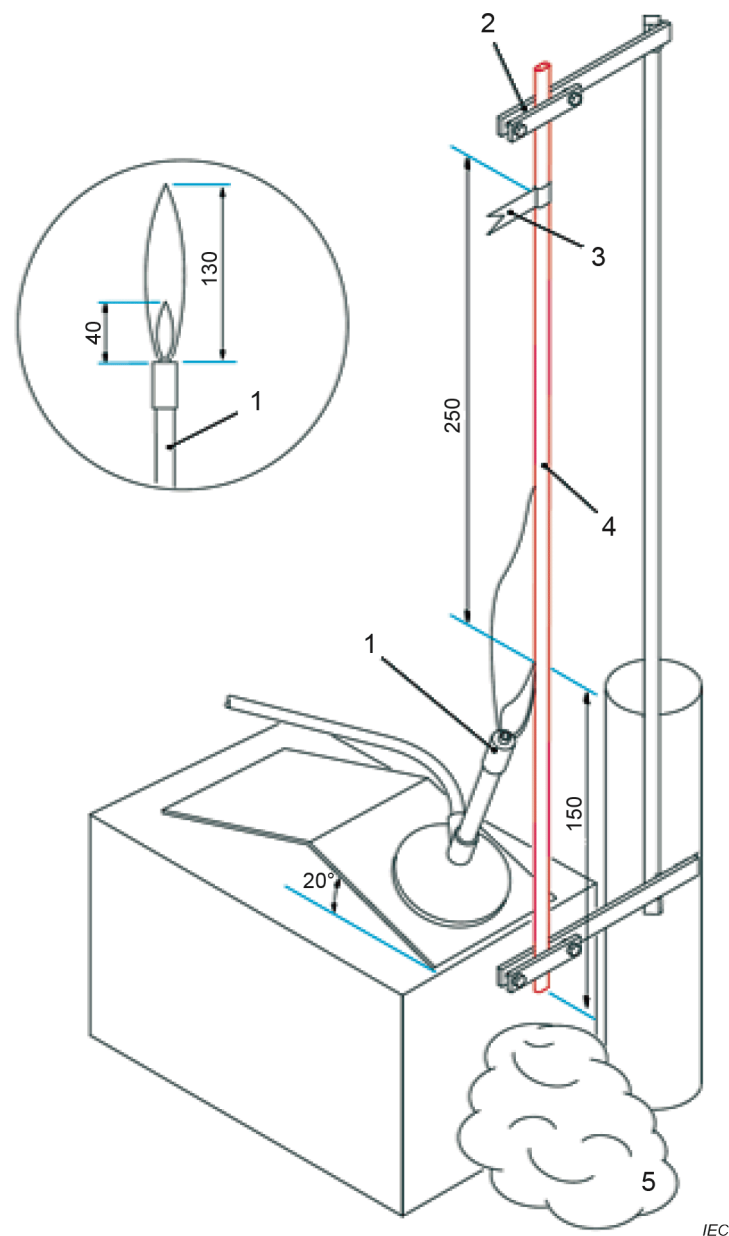
For integral components, the flame shall be set such that it contacts the component at the mid-point. Clamps used to support the sample shall be above the paper indicator and $(80 + \frac{+5}{0})$ mm below the point of flame application. If additional stability is needed for the testing of some integral components, then a steel wire and weight may be utilized to secure the component provided that the flame does not contact the steel wire or weight. Details of the test fixture required to achieve minimum influence on the test may vary based on heater and component properties and shall be agreed between manufacturer and test agency.

For trace heater pads and panels, the flame is applied at the horizontal mid-point of the sample, with the unbleached paper indicator vertically above the flame using dimensions as shown in Figure 1.

The laboratory burner shall be moved towards the sample until the inner blue cone touches the sample; see Figure 1. The flame shall be applied for (15 ± 1) s, then removed for (15 ± 1) s, until five such applications have been made.

The test results shall be considered satisfactory if the trace heater does not support combustion for more than 1 min after the fifth application of the flame, does not burn more than 25 % of the extended unbleached paper indicator, and does not ignite the cotton from burning falling particles.

NOTE This specification is equivalent to the ignition sources specified in IEC 60695-11-3 and ASTM D5207.



IEC

Key

- 1 Burner
- 2 Support
- 3 Unbleached paper flag
- 4 Test sample
- 5 Dry pure surgical cotton

Figure 1 – Flammability test**5.1.5 Impact test****5.1.5.1 General**

Impact test shall be conducted according to 5.1.5.2 and 5.1.5.3.

NOTE Electric trace heaters are, in the majority of applications, covered by thermal insulation and therefore afforded some mechanical protection. In some applications, however, trace heaters can be installed under conditions where they are not always protected by thermal insulation; for example, during installation before the thermal insulation is applied or where the trace heater exits from the thermal insulation into a junction box.

5.1.5.2 Room temperature impact test

A sample approximately 450 mm in length is placed on a rigid flat steel plate (with a mass equal to or greater than 20 kg, approximately 195 mm × 195 mm × 70 mm). The plate is positioned on a rigid substrate such that the impact energy absorbed by the substrate is negligible. The sample is then positioned underneath an intermediate piece of hardened steel in the shape of a horizontal half-cylinder with a diameter of $(25 + \frac{0}{-0,1})$ mm. This cylinder shall have a length of $(25 \pm 0,1)$ mm with smoothly rounded edges to a radius of approximately 5 mm when used to test trace heater pads and panels (see Figure 2). For the test, the cylinder is laid horizontally on the sample. A trace heater having a non-circular cross-section shall be so positioned that the impact is applied along the minor axis (the trace heater is positioned flat on the steel plate).

Other than in tests on electrical trace heaters intended for use in applications with low risk of mechanical damage, ~~a hammer with~~ a mass of $(1,0 + \frac{0,01}{-0})$ kg shall be allowed to fall once onto the horizontal cylinder from a height of $(0,7 + \frac{0,01}{-0})$ m (an impact load of 7 J).

For trace heaters intended for use in applications with a low risk of mechanical damage in accordance with 4.2, the height may be reduced to $(0,4 + \frac{0,01}{-0})$ m (an impact load of 4 J). Trace heaters submitted to such a test shall be clearly marked as specified in 7.4 e) to caution the user as to its reduced mechanical capability.

Immediately after impact, conformity is verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3 while the steel cylinder and hammer are still in place on the sample.

5.1.5.3 Minimum temperature impact test

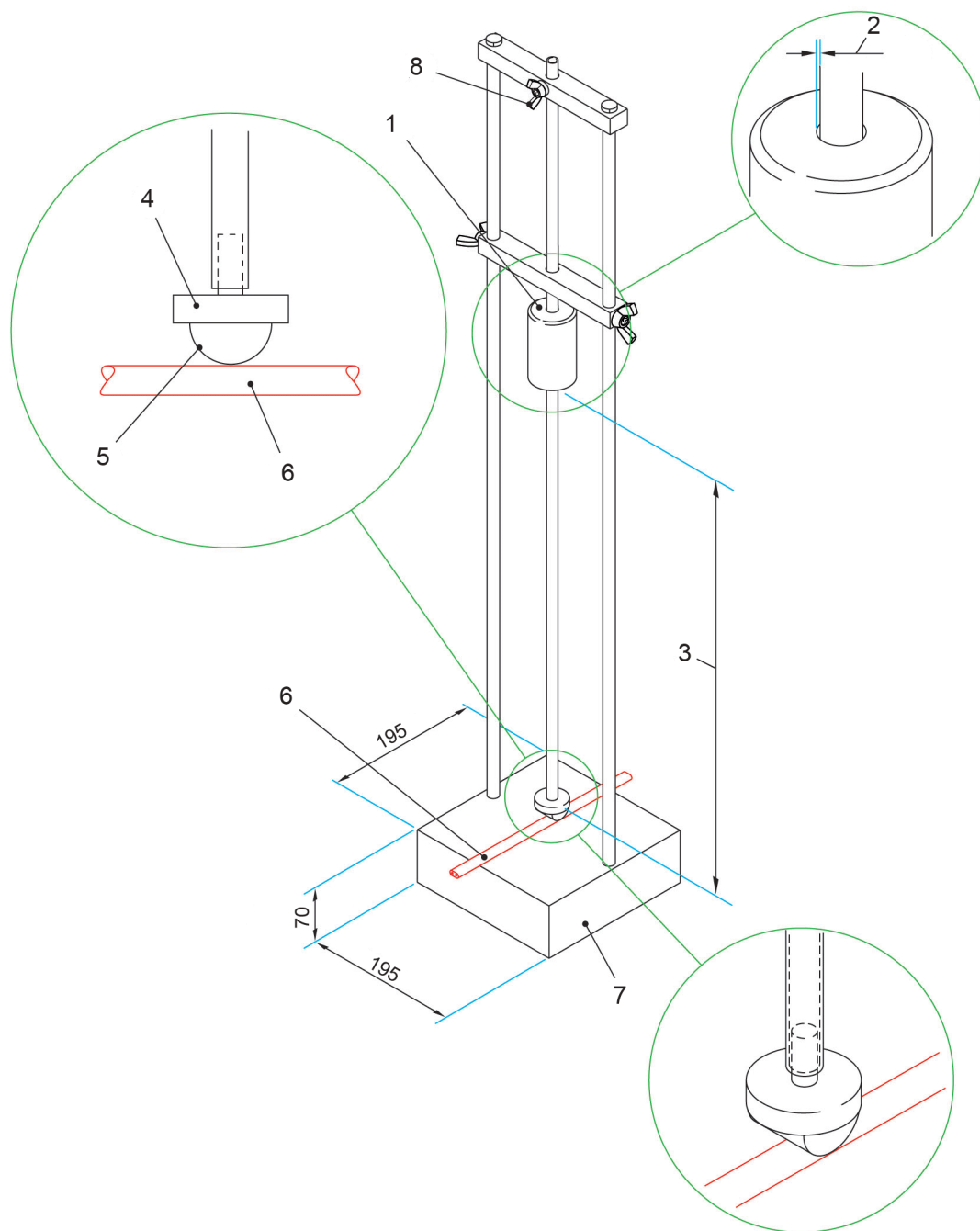
A sample approximately 450 mm in length is placed on a hardened steel plate (with a mass equal to or greater than 20 kg, 195 mm × 195 mm × 70 mm). The plate is positioned on a rigid substrate such that the impact energy absorbed by the substrate is negligible. The assembly is then conditioned for a minimum of 4 h at the manufacturer's specified minimum installation temperature. The apparatus used for this test is shown in Figure 3.

After conditioning, and other than in tests on electrical trace heaters intended for use in applications with low risk of mechanical damage, a sample, while at the minimum installation temperature, shall be subjected to a $(50,8 + \frac{0}{-0,1})$ mm diameter cylindrical steel plunger with smoothly rounded edges to a radius of approximately 5 mm, having a mass of $1,8 + \frac{0,02}{-0}$ kg and allowed to free fall from a height of $0,76 + \frac{0,01}{-0}$ m.

For trace heaters intended for use in applications with a low risk of mechanical damage in accordance with 4.2, the height may be reduced to $0,42 + \frac{0,01}{-0}$ m. Trace heaters submitted to such a test shall be clearly marked as specified in 7.4 e) to caution the user as to its reduced mechanical capability.

The impacted portion of the sample shall then be immersed in tap water at room temperature for ~~at least~~ 5 to 10 minutes, and the dielectric test 5.1.2 and insulation resistance test 5.1.3 shall be conducted. For trace heater pads and panels, both the heating region and cold leads shall be impacted.

Dimensions in millimetres

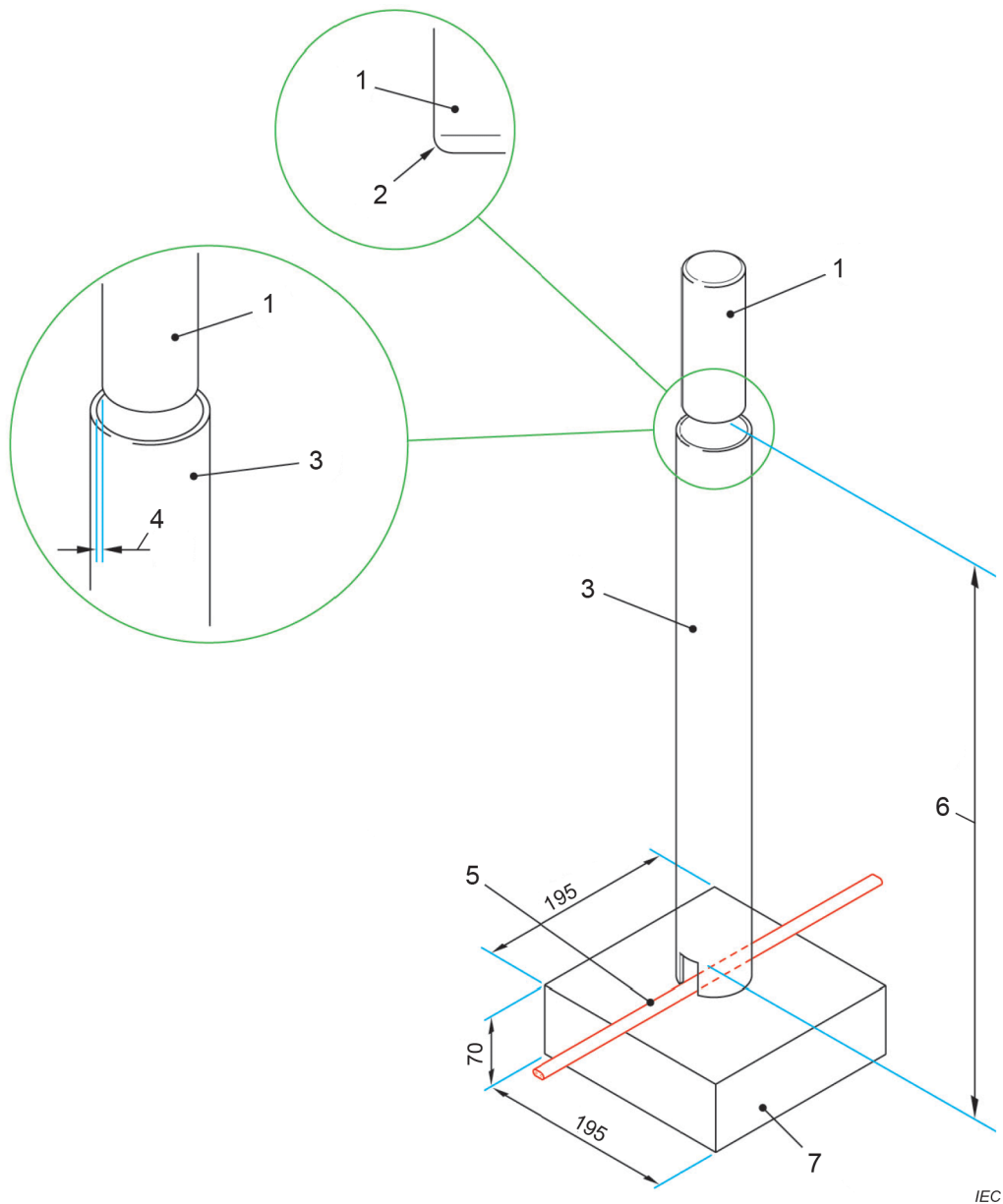


IEC

Key

- | | |
|---|---|
| 1 hammer with mass of 1 kg | 5 half-cylinder with 25 mm diameter and 25 mm overall length with 5 mm radius rounding on edges |
| 2 sufficient clearance from guide tube to allow for free-fall | 6 trace heater sample |
| 3 height of fall of hammer : 0,7 m or 0,4 m | 7 base with minimum 20 kg mass |
| 4 impact plate (loosely inserted in guide tube) | 8 set screw for guide tube - so guide tube does not rest on impact plate |

Figure 2 – Example of room temperature impact test



Key

- | | | | |
|---|--|---|--|
| 1 | 50,8 mm diameter hammer with mass of 1,8 kg | 5 | trace heater sample |
| 2 | smoothly rounded edges (~5 mm rounding) | 6 | height of fall of hammer : 0,76 m or 0,42 m |
| 3 | guide tube | 7 | base with minimum 20 kg mass |
| 4 | sufficient clearance to allow for free-fall | | |

Figure 3 – Example of minimum temperature impact test

5.1.6 Deformation test

A sample approximately 450 mm in length is placed on a rigid flat steel plate. A crushing force of $(1\,500 \frac{+100}{0})$ N is then applied for $(30 \frac{+10}{0})$ s, without shock, by means of a 6 mm diameter steel rod with h6 tolerance and hemispherical ends ~~and~~ having a total length of $(25 \pm 0,1)$ mm. For the test, the rod is laid flat on the sample at a right angle. In the case of a pad, the cylinder shall rest across the active element.

For electrical trace heaters intended for use in applications with low risk of mechanical damage, the crushing force may be reduced to $(800 \frac{+50}{0})$ N. Trace heaters submitted to such a test shall be clearly marked as specified in 7.4 e) to caution the user concerning its reduced mechanical capability.

After the deformation load is applied for ~~at least~~ $(30 \frac{+10}{0})$ s, conformity is verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3 while the horizontal steel rod is still in place on the sample and the load applied.

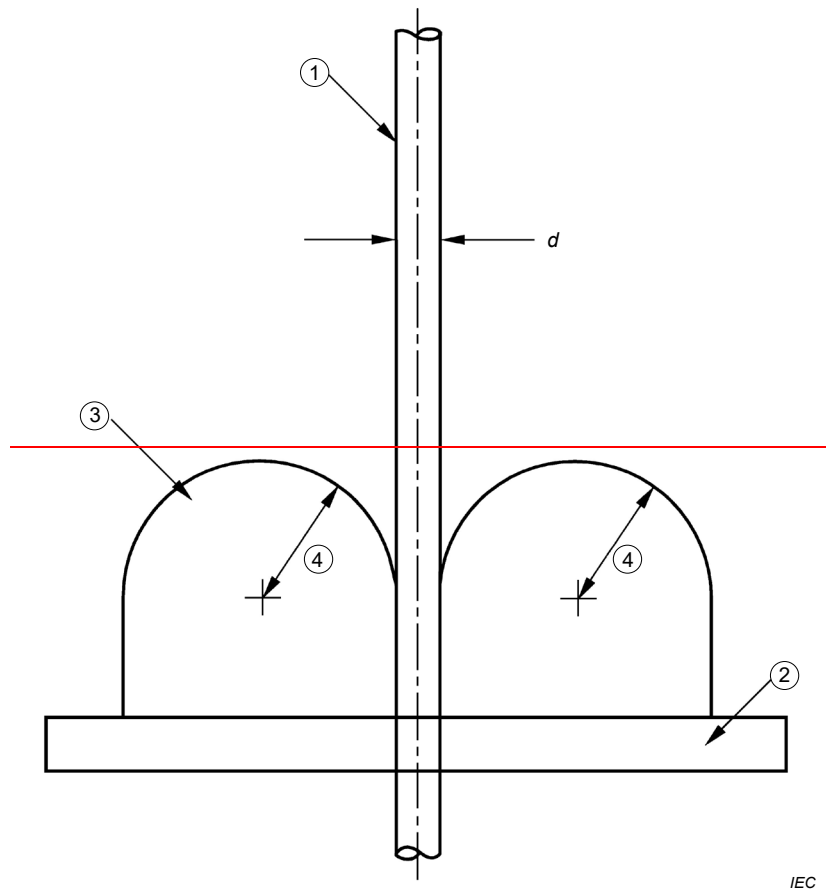
5.1.7 Cold bend test

This test applies only to trace heaters that have a stated minimum bend radius of less than 300 mm.

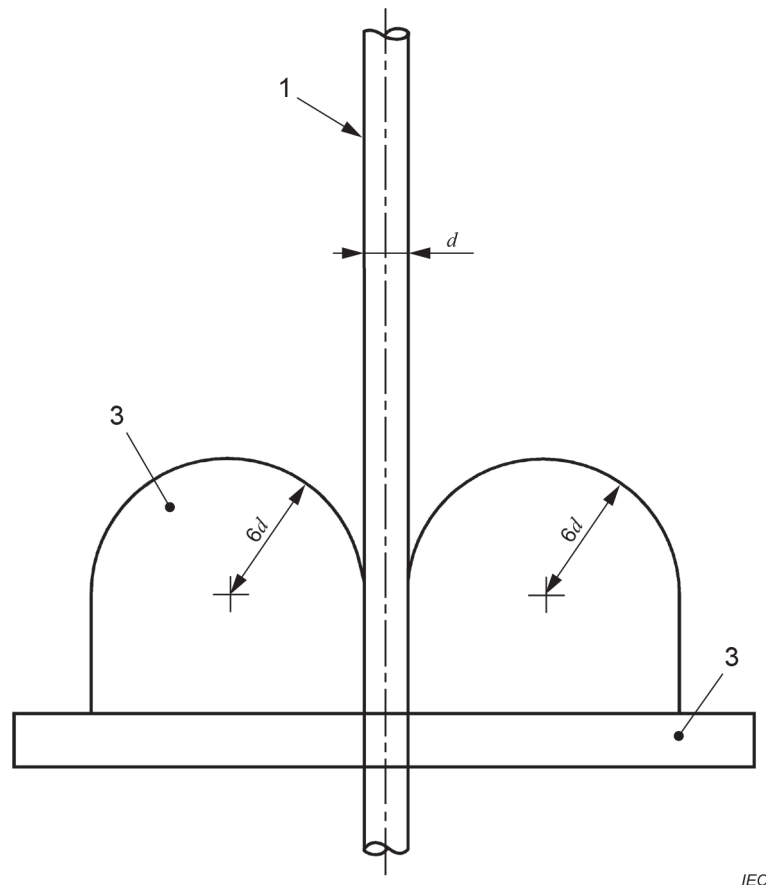
The system documentation shall state the minimum installation temperature and the minimum bending radius.

The apparatus used for the cold bend test is shown in Figure 4, with the radius of the metal mandrel equal to the manufacturer's stated minimum bend radius. A sample ~~at least~~ (450 ± 10) mm in length of trace heater, without integral terminations or connections, shall be fixed in the apparatus as shown. The apparatus and sample shall be placed in a refrigerated compartment and maintained at the manufacturer's specified minimum installation temperature for a period of not less than 4 h. At the end of this period and while still at the manufacturer's specified minimum installation temperature, the sample shall be bent through ~~at least 90°~~ $(90 \frac{+10}{0})^\circ$ around one of the mandrels, then bent through ~~at least 180°~~ $(180 \frac{+20}{0})^\circ$ in the opposite direction over the second mandrel and then straightened to its original position. All the bending operations shall be carried out in the same plane. This cycle of operations shall be performed three times and the rate of bend shall be approximately 5 s per cycle.

Conformity is verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3.



IEC



IEC

Key

- 1 trace heater sample
 - 2 steel base
 - 3 metal mandrel
 - 4 manufacturer's stated minimum bend radius
- d = trace heater diameter or primary bending plane

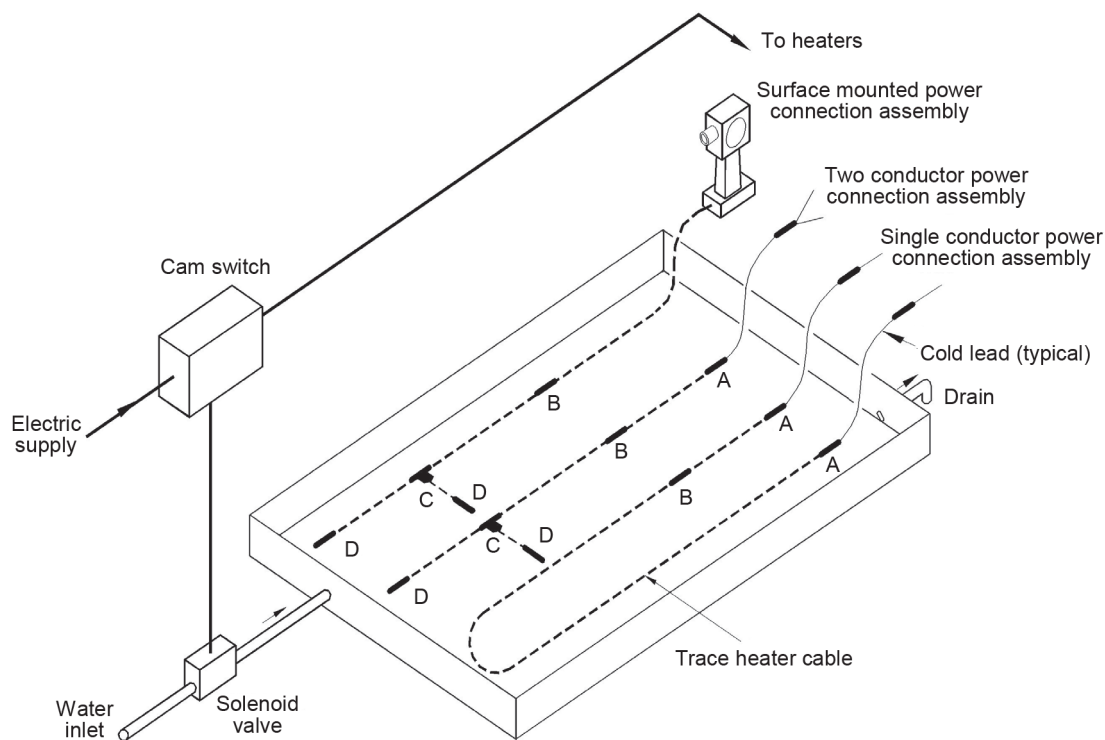
Figure 4 – Cold bend test**5.1.8 Water resistance test**

A sample as described in 5.1.1, excluding integral components shall be immersed in tap water for a period of ~~14 days~~ (336 + 48/0) h. Trace heater ends are not immersed.

~~Within 1 h after conditioning as above, and~~ While still immersed in the water, the sample shall be subjected to the dielectric test outlined in 5.1.2 and the insulation resistance test outlined in 5.1.3.

5.1.9 Integral components' resistance to water test

A sample of the trace heater with all integral components shall be placed in a tap water flow and drain apparatus as shown in Figure 5. For trace heater pads or panels, a unit with cold leads shall be used. Water flow shall be initiated, and the sample shall be completely immersed. At that point, the water flow is stopped, and the trace heater is energized. The apparatus is then drained. The total time from the initiation of water flow to the completion of draining shall be no greater than 4,5 min and no less than 2,5 min. The trace heater shall continue to be energized for ~~at least~~ $(30 \frac{+5}{0})$ s after the water has been drained. The trace heater is then de-energized and water flow is initiated for the next cycle. The test shall be continued for a period of $(24 \frac{+1}{0})$ h. After completion, the sample shall be subjected to the dielectric test outlined in 5.1.2 and the insulation resistance test outlined in 5.1.3. The immersed connections, **power terminations or end terminations** of the trace heater shall be inspected to verify no evidence of water ingress.



IEC

Key

- A integral power connection
- B integral splice connection
- C integral in-line tee
- D integral end termination

Figure 5 – Integral components resistance to water test

5.1.10 Verification of rated output

The rated output of the trace heater or heating panel or pad shall be verified by one of the following two methods:

- a) resistance: the measured DC resistance per unit length at a specified temperature shall be within the manufacturer's declared tolerance;

NOTE This method is appropriate for products with metallic heating elements.

- b) thermal: the ~~thermal~~ power output of trace heaters is measured by installation of a single sample, 3 m to 6 m in length, on a ~~carbon-steel~~ metal pipe of 50 mm diameter or greater, as shown in Figure 6. The sample is installed in accordance with the manufacturer's instructions. The test apparatus is completely covered with 25 mm thermal insulation ~~of at least 25 mm thickness~~ (for example, with fibreglass or mineral wool).

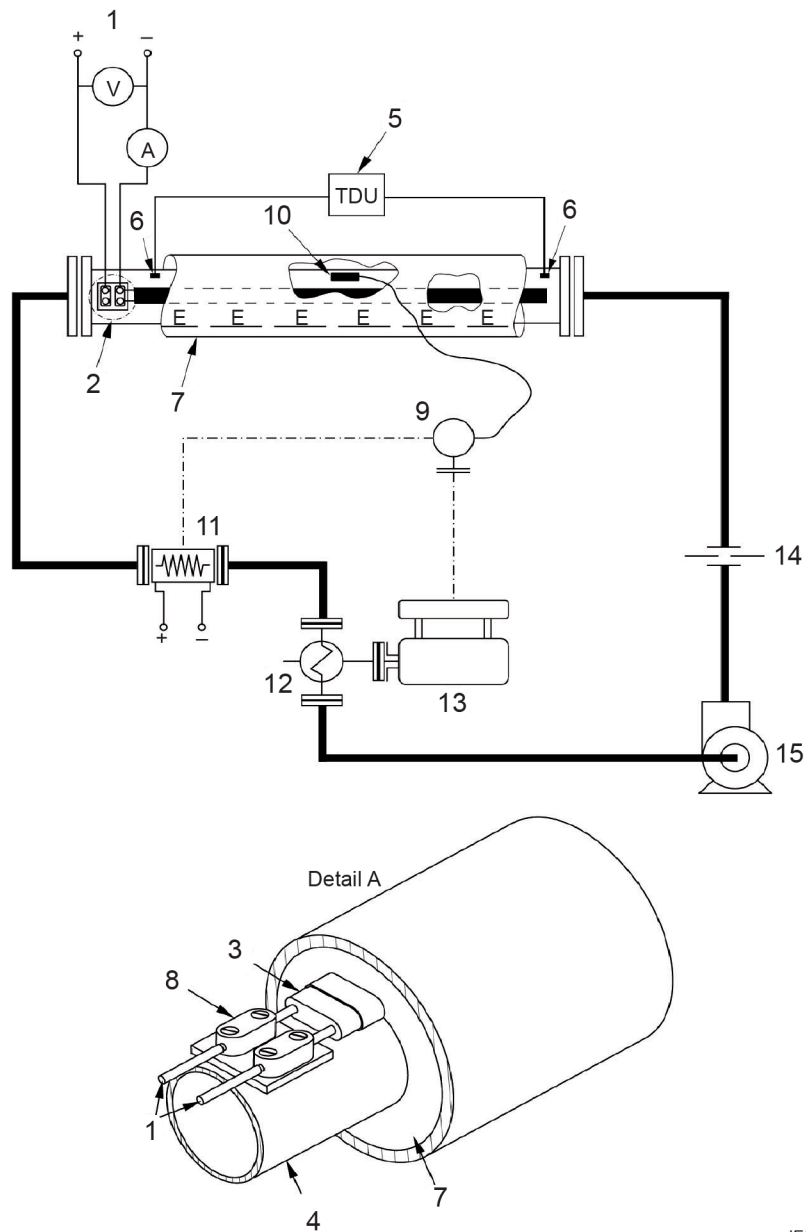
~~For trace heater pads and panels, the test is conducted on a liquid-cooled flat metal plate with at least 25 mm of thermal insulation installed over the surface of the trace heater pad or panel.~~

A suitable heat transfer fluid in the liquid phase ~~is~~ shall be circulated through the pipe at a sufficient rate to establish ~~turbulent flow such that there is~~ a negligible temperature difference between the fluid and the pipe. The heat transfer fluid ~~is~~ shall be maintained at a constant temperature for each test temperature. These parameters are verified by thermocouples placed at the entry and exit ends of the pipe. ~~Flow velocity shall be such that the fluid temperature does not differ by more than 2 K from end to end.~~ The pipe temperatures shall not differ by more than 2 K from end to end.

For trace heater pads and panels, the test is conducted on a liquid-cooled flat metal plate with 25 mm thermal insulation (for example with fibreglass or mineral wool) installed over the surface of the trace heater pad or panel.

A suitable heat transfer fluid in the liquid phase shall be circulated through the metal plate fixture at a sufficient rate to establish a negligible temperature difference between the fluid and the plate temperature. Sufficient means should be utilized to maintain constant temperature of the heat transfer fluid. These parameters shall be verified by thermocouples placed at the entry and exit ends of the pipe or plate. Flow velocity shall be sufficient that the fluid temperature does not differ more than 2 K from end to end.

The power output of the trace heater or surface heater is measured at three ~~workpiece~~ pipe or plate temperatures ~~representative of the full operating range~~. For freeze-protection products, the pipe temperatures shall be 10 °C, 25 °C, and 40 °C each with a tolerance of ± 2 K. For process-maintenance products, the pipe temperatures shall be 10 °C and 40 °C. Additionally, a pipe temperature of 70 °C or the maximum maintain temperature minus 20 K whichever is higher shall be used with a tolerance of ± 2 K. The trace heater is powered at its rated voltage and allowed to attain equilibrium. The voltage, current and liquid temperatures, and sample length are recorded at each test temperature. Three separate determinations are made on separate samples. The resulting values shall be within the manufacturer's declared tolerance.



IEC

Key

- | | | |
|---|---|-------------------|
| 1 controlled voltage source | 6 thermocouples | 11 in-line heater |
| 2 see detail A | 7 fibreglass or mineral fibre insulation, 25 mm minimum thickness and approximate density of 3,25 kg/m ³ | 12 heat exchanger |
| 3 trace heater sample | 8 electrical terminals | 13 chilling unit |
| 4 50 mm outside diameter or greater test pipe (workpiece) | 9 temperature controller | 14 flow meter |
| 5 TDU - temperature display unit | 10 temperature sensor | 15 pump |

Figure 6 – Verification of rated output

5.1.11 Thermal stability of electrical insulating material

A sample of the trace heater shall be placed in a forced air circulation ~~air~~ oven. The oven shall be heated to and maintained for a period of four weeks at a temperature of $(20 \frac{+3}{0})$ K above the maximum withstand temperature declared by the manufacturer.

The sample shall be removed from the air oven and cooled to room temperature. Trace heater samples shall be wound six close turns around a mandrel having a radius equal to six times the diameter or six times the thickness of the trace heater. Integral components and trace heater panels shall not be wound around the mandrel. Trace heater pads shall be wrapped on a mandrel with a radius equivalent to the manufacturer's minimum recommended bending radius. While still on the mandrel, the sample, except at terminations or ends where the conductor is exposed, shall be submerged in tap water for ~~at least~~ ~~between 5 and 10 min.~~ While still in the tap water, the dielectric test 5.1.2 and the insulation resistance test 5.1.3 shall be conducted. Upon completion of these procedures, the sample shall be removed from the water and the ~~outermost sheath~~ shall have no visible cracks when examined with normal vision.

Terminations that insure the vapour tightness of MI trace heaters with electrical insulation that is a hygroscopic material (for example the cold end seals) are subjected to a temperature of $(80 \pm 2) ^\circ\text{C}$ for ~~4 weeks~~ $(672 \frac{+10}{0})$ h at not less than 90 % relative humidity. Compliance of the sample or prototype shall be verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3.

NOTE The maximum withstand temperature in this test is not to be confused with or used in the application of the maximum sheath temperature determined from 5.1.13.

5.1.12 Thermal performance test

~~In explosive atmospheres, it is critical that the maximum sheath temperature of a trace heater is lower than the ignition temperature of the explosive atmosphere.~~ This test demonstrates the thermal safety by verifying the power output stability for all parallel trace heater products with respect to time.

The test apparatus shall consist of a heated metal platen maintained at the specified high-test temperatures and a cooled metal platen maintained at the specified low test temperatures with the test samples being alternated between the platens, or the test shall consist of a metal ~~platen~~ ~~plates~~ with built in heating and cooling capability to change the temperature within the specified levels. The apparatus is intended to be located in a room temperature environment. The platen(s) shall be sized to expose all parts of the trace heater samples, which would be exposed under normal installation conditions, to the temperature levels required by this procedure. The test apparatus shall insure that the trace heater samples are in intimate contact with the platen. The test apparatus may be supplied with a sample mounting fixture. Offsets may be built into the fixture or platen(s) to accommodate end termination/power transition fittings/boots, if provided, where their size profile exceeds the trace heater profile. The apparatus shall allow energizing of the trace heater samples as required during the test procedure.

The samples shall be thermally insulated on the side not facing the platen so as to assure effective heat transfer from the platen to the trace heater samples.

The temperatures of the platen(s) shall be uniformly controlled to a maximum tolerance of $\pm 5 ^\circ\text{C}$ for platen temperatures equal to or less than $100 ^\circ\text{C}$ ~~or 5 % of the maximum continuous operating temperature if above $100 ^\circ\text{C}$~~ , or ± 10 K for temperatures greater than $100 ^\circ\text{C}$.

The platen described above ~~may~~ ~~can~~ be a flat metal plate, a metal pipe, or a metal surface typical of the majority of applications for the trace heater being tested.

The trace heater samples shall be within the ~~upper half of the~~ manufacturer's declared ~~thermal~~ power output tolerance, as validated by 5.1.10. For trace heaters that are irregular in shape, and for trace heater pads and panels, the sample shall consist of at least one heating unit.

If the trace heaters are part of a trace heater product range, with common materials (with materials having the same performance ratings) and construction, which have different levels of rated voltages and power outputs, then three samples of each of the following shall be selected ~~(for a total of six samples):~~

- a) the lowest rated voltage level and the maximum rated power output;
- b) the highest rated voltage and the minimum rated power output.

If the trace heaters are rated for 300 VAC or higher, an additional three samples of the highest power output and highest voltage shall be selected and tested.

Trace heater samples may be conditioned, at the maximum rated voltage for up to 150 h at the manufacturer's declared maximum continuous operating temperature prior to starting the test.

The trace heater samples, having a minimum length of at least 0,30 m, shall be installed on the sample mounting fixture or directly applied to the platen. For zone type parallel construction a minimum of a single zone with at least one contact point shall be directly applied to the platen. The samples shall be powered at the maximum rated voltage. The temperature of the platen shall be $(23 \pm 5) ^\circ\text{C}$. The initial power output of the samples shall be determined by measuring voltage and current after the fixture has reached equilibrium.

The trace heater samples of continuous parallel construction, while still installed on the sample mounting fixture or platen and energized at the maximum rated voltage, shall be temperature cycled by alternately exposing the samples to platen(s) temperatures corresponding to $(23 \pm 5) ^\circ\text{C}$ and the maximum continuous operating temperature. The samples may be de-energized during the cool down period.

The trace heater samples of zone type parallel construction shall be temperature cycled in the same manner with the exception that the samples shall be de-energized when not being held at the maximum continuous operating temperature.

If the cycle temperature range exceeds $350 ^\circ\text{C}$, the lower temperature may be set at $350 ^\circ\text{C}$ below the maximum continuous operating temperature.

The energized samples shall be exposed to each of these temperature extremes for a minimum of 15 min and a transition time between extremes shall not exceed 15 min with a cycle being one complete exposure at both temperature extremes.

The trace heater samples shall be subjected to a pre-conditioning period of 5 continuous temperature cycles. In case of heater samples of continuous parallel construction, a cycle reference value of the power output of the samples shall be determined by measuring voltage and current during the final 300 s of the cold phase of the last pre-conditioning cycle. A minimum of 1 500 cycles shall then be performed. The trace heater samples' power output shall be continuously monitored, with measurements recorded during the final 300 s of the cold cycle, at intervals not exceeding 50 thermal cycles. In the case of samples having a zone type parallel construction, the power output shall be measured during the final 300 s of the hot cycle.

Following the temperature cycling, the temperature of the platen(s) shall be raised to the maximum continuous exposure temperature or the maximum intermittent temperature if higher, declared by the manufacturer and held for a period of no less than 250 h.

Where the ~~maximum~~ intermittent exposure temperature ~~is declared as "energized"~~ relates to a temperature while energized, the samples shall be energized at the maximum rated voltage.

Where the intermittent exposure temperature relates to a temperature while de-energized, the samples shall not be energized.

After completion of the maximum exposure testing, the trace heater samples' power output shall be measured, using the same method and platen temperature as used during the initial ~~measurements~~ power output determination. ~~The trace heater samples shall maintain a power level within plus 25 % or minus 25 % of the initial measured output. This applies at the end point as well as the intermediate measurements.~~ All trace heater samples shall have a final power output within plus 25 % or minus 25 % of the initial power output. All trace heater samples shall also maintain a power measured during the cycles within plus 25 % or minus 25 % of the initial power output, or in the case of heater samples of continuous parallel construction, of the cycle reference value.

5.1.13 Determination of maximum sheath temperature

5.1.13.1 General

~~In explosive atmospheres, it is critical that the maximum sheath temperature for trace heaters is less than the ignition temperature of the explosive atmosphere.~~ The maximum sheath temperature is dependent on the trace heater power ~~density~~ output, overall heat transfer coefficient, and the maximum possible temperature of the surface to be heated. These factors are used to verify the temperature classification of particular trace heaters and to verify the manufacturer's ability to predict the maximum sheath temperatures of trace heaters.

At least one of the following two methods shall be used for verifying a trace heater's sheath temperature or temperature class as declared by the manufacturer:

- a) Product classification approach in which the maximum sheath temperature is determined in an artificial environment simulating adverse conditions.
- b) Systems method in which the manufacturer demonstrates the ability to design and predict sheath temperatures of trace heaters by conducting tests on representative installations representing adverse design and operating conditions when installed according to the manufacturer's installation instructions.

Both methods above are subject to the limits provided in 4.6.1.

5.1.13.2 Product classification approach

A sample of the trace heater at least $(1\,500 \pm 10)$ mm in length is placed loosely coiled in a forced air circulation oven (~~not touching itself and not located on the bottom of the oven~~). For a trace heater pad or panel, a representative sample is placed horizontally in the oven. The sample shall be within the upper half of the trace heater's ~~thermal~~ power output tolerance. Representative thermocouples are used to monitor sample sheath temperatures and are placed approximately 500 mm from each end. One additional thermocouple is used to monitor oven ambient temperature. The trace heater shall be powered at 110 % of rated voltage as specified in Table 2, Table 3, Table F.2, and Table F.3 of Annex F. The oven ambient temperature is incrementally raised from room ambient in approximately 15 K increments. Sufficient time is permitted at each temperature for the oven ambient and heater sheath temperatures to stabilize and attain thermal equilibrium. Oven ambient and heater sheath temperatures are recorded at each successive level until the difference (ΔT) between the two approaches 5 K or less. A curve is drawn from the test data, and a straight line is drawn tangent to the curve at 5 K temperature difference point and extended to the X-axis (oven temperature). The temperature read at this intercept is taken as the maximum sheath temperature, as shown in Figure 7.