

ANSI/ISA-60079-0 (12.00.01)-2005

Supersedes ANSI/ISA-12.00.01-2002 (IEC 60079-0 Ed 3 Mod)



Electrical Apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified) Locations: General Requirements



ISA—The Instrumentation,
Systems, and
Automation Society

Approved 15 August 2005



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ISA
ANSI/ISA-60079-0
Second Edition

Underwriters Laboratories Inc.
ANSI/UL 60079-0
Fourth Edition



**ISA—The Instrumentation, Systems,
and Automation Society**



**Electrical Apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified)
Locations: General Requirements**

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General Notes

This is the common ISA and UL standard for Electrical apparatus for explosive gas atmospheres - Part 0: General requirements. It is the second edition of ANSI/ISA-60079-0 (superceding ANSI/ISA-12.00.01-2002 [IEC 60079-0 Mod]) and the fourth edition of ANSI/UL 60079-0. The document is a modification of the IEC document and includes U.S. deviations encompassing both additions and deletions of information.

ANSI/ISA-60079-0 and ANSI/UL 60079-0 contain identical requirements, and identical publication dates. The presentation and format of the standards material may differ between the two published standards.

This common standard was prepared by ISA and Underwriters Laboratories Inc. (UL).

Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of harmonization

This standard adopts the IEC text with deviations.

The requirements are presented in different formats. The ISA version of the standard illustrates the national differences from the IEC text through the use of legislative text (strike-out and underline). The UL version of the standard illustrates national differences immediately following the IEC text. National differences between the UL version and the ISA version shall be word for word except for editorial changes.

Interpretations

The interpretation by the SDO of an identical or equivalent standard shall be based on the literal text to determine compliance with the standard in accordance with the procedural rules of the SDO. If more than one interpretation of the literal text has been identified, a revision shall be proposed as soon as possible to each of the SDOs to more accurately reflect the intent.

UL Effective Date

The requirements in this standard are effective 15 August 2005 except for the following items which are effective 31 January 2009:

- 1DV.4.1 - Type of protection “n”: ANSI/UL 60079-15
- 8.1.2 bullet for Zone 2
- 29.2DV.1, b2), Zone 2
- 29.2DV.1, d), bullets for
 - “nA”: Type n, method of protection “nA”,
 - “nC”: Type n, method of protection “nC”,
 - “nR”: Type n, method of protection “nR”
- 29.12.1.1DV, reference to Zone 2
- 29.12.2.1DV, reference to Zone 2
- 29.12.3.1DV, reference to Zone 2
- 29.12.4.1DV, reference to Zone 2

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this standard will be required as a condition of continued Listing, Recognition, Classification, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.



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Preface (ISA)

This ISA standard is based on the 4th edition of IEC Publication 60079-0. It is the intention of the ISA SP12 Committee to develop an ANSI Standard that is harmonized with IEC 60079-0 to the fullest extent possible. This preface is included for informational purposes and is not part of ANSI/ISA-60079-0. The document is a modification of the IEC document and includes U.S. deviations encompassing both additions and deletions of information.

The standards referenced within this document may contain provisions which, through reference in this text, constitute requirements of this document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the standards indicated within this document. Members of IEC and ISO maintain registers of currently valid International Standards. ANSI maintains registers of currently valid U.S. National Standards.

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The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavour to introduce SI-acceptable metric units in all new and revised standards, recommended practices, and technical reports to the greatest extent possible. *Standard for Use of the International System of Units (SI): The Modern Metric System*, published by the American Society for Testing & Materials as IEEE/ASTM SI 10-97, and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

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National Differences

GENERAL

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60079-0, Electrical apparatus for explosive gas atmospheres – Part 0: General requirements, copyright 2004, are indicated by notations (differences) and are presented in bold text.

In the ISA publication of this standard, National Differences are presented using legislative text (strike-out and underline). The national difference type is identified in an informative annex.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

The UL printed standard includes the national difference types within the body of the text. The ISA printed standard includes the national difference types in an annex at the back of the standard.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences based on **safety practices**. These are differences for IEC requirements that may be acceptable, but adopting the IEC requirements would require considerable retesting or redesign on the manufacturer's part.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

DR – These are National Differences based on the **national regulatory requirements**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add – An addition entails adding a complete new numbered clause, subclause, table or figure. Addition is not meant to include adding select words to the base IEC text.

Deletion / Delete – A deletion entails complete deletion of an entire numbered clause, subclause, table or figure without any replacement text.

Modification / Modify – A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, or figure of the base IEC text.

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Foreword (ISA)

All text of IEC 60079-0:2004 (4th edition) is included. U.S. National Deviations are shown by ~~strikeout~~ through text deleted and underline under text added. Tables, or portions of tables, that are to be deleted are shown as shaded; figures to be deleted are marked with the overlay "X." There are nine annexes in this standard. Annexes C, D, E, F, G, H, and I are informative and are not considered part of this standard. Annexes A and B are normative and are considered part of this standard.

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

- Standard atmospheric conditions re-introduced
- All requirements for third-party certification removed
- New type of protection “n” introduced
- New apparatus standards for caplights, intrinsically safe systems, Zone 0 apparatus, and trace heating introduced
- Clarification of the status of symbol “s”
- Definitions for symbols “U” and “X” revised to align with current usage
- Definition for Ex component transferred from IEC 60079-18
- New definitions drafted for “energy limited” parameters to allow common usage by types of protection “i” and “n”
- New definitions for batteries transferred from IEC 60079-7
- Definition added for ambient temperature
- Definition added for continuous operating temperature (COT)
- Definition for certificate transferred from IEC 60079-15 and revised based on ISO/IEC 17000
- Definition added for cable gland
- Clause 5 for temperature re-written to address the influences of ambient temperature, internal sources of heat, and external sources of heating or cooling
- Small component ignition test transferred from IEC 60079-11 and IEC 60079-15
- Requirements for bonding transferred from IEC 60079-7 and IEC 60079-15
- Requirements for gasket retention transferred from IEC 60079-15 for wider applicability
- Relative thermal index (RTI) added as an alternative to thermal index (TI)
- Electrostatic requirements transferred and rationalized from IEC 60079-15 and IEC 60079-26 to apply to all of ~~Group I and~~ Group II
- Introduction of two additional test methods to evaluate the use of non-metallic materials with respect to the storage of electrostatic charges
- Light metal requirements transferred and rationalized from IEC 60079-15 and IEC 60079-26 to apply to all of ~~Group I and~~ Group II
- Introduction of an existing test to evaluate the use of a non-metallic enclosure wall in an earth bonding connection
- Clause 16 rewritten to align with industry usage of the terms *cable gland* and *conduit entry*
- Equipotential bonding requirements for machines transferred from IEC 60079-7 and IEC 60079-15
- Requirement for disconnectors in switchgear and luminaires revised to provide IP20 protection for live parts and include additional marking

- General requirements for cells and batteries transferred from IEC 60079-7 and IEC 60079-15
- Impact test revised to specify drop height in lieu of energy
- Clarification of application of 5°C K and 10°C K temperature margins to type-tested samples
- Clarification of order of tests for metallic materials
- Clarification of number of samples and order of tests for non-metallic materials
- Clarification of order of marking
- Clarification of marking details for associated apparatus
- Clarification of marking of specific gases
- Clarification of marking of temperature class
- Clarification of usage of compulsory certificate number
- Clarification of marking of small apparatus
- Compilation of all warning markings into a table
- Clarification of marking examples
- Addition of a clause on instructions
- Deletion of Annex A as information is available in more appropriate standards (IEC 60079-20)
- Revision and clarification of Annex A (previously B) to accommodate term *cable gland*



1 Scope

This ~~part of IEC 60079 standard~~ specifies the general requirements for construction, testing and marking of electrical apparatus and Ex components intended for use in ~~explosive gas atmospheres Class I, Zone 0, 1, or 2 hazardous (classified) locations as defined by the National Electrical Code, ANSI/NFPA 70.~~

Unless modified by one of the parts in ~~the IEC 60079 series of this standard~~, electrical apparatus complying with this standard is intended for use in hazardous areas in which explosive gas atmospheres, caused by mixtures of air and gases, vapours or mists, exist under normal atmospheric conditions of

- temperature $-20\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$;
- pressure 80 kPa (0.8 bar) to 110 kPa (1.1 bar); and
- air with normal oxygen content, typically 21 % v/v.

The application of electrical apparatus in atmospheric conditions outside this range may need special consideration.

NOTE 1 The determination of the maximum surface temperature is based on an operational ambient temperature of $-20\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$, if not otherwise specified by the manufacturer. See also 5.1.1.

NOTE 2 In designing apparatus for operation in explosive gas atmospheres under conditions other than the atmospheric conditions given above, this standard may be used as a guide. However, additional testing related specifically to the intended conditions of use is recommended. This is particularly important when the types of protection 'flameproof enclosures "d"' (~~IEC 60079-1~~) and 'intrinsic safety "i"' (~~IEC 60079-11~~) are applied.

NOTE 3 Requirements given in this standard result from an ignition hazard assessment made on electrical equipment. The ignition sources taken into account are those found associated with this type of equipment, such as hot surfaces, mechanically generated sparks, thermite reactions, electrical arcing and static electric discharge in normal industrial environments. For other ignition sources like adiabatic compression, shock waves, exothermic chemical reaction, self ignition of dust, naked flames, hot gases/liquids the apparatus are subjected to a hazard analysis that identifies and lists all of the potential sources of ignition by the electrical apparatus and the measures to be applied to prevent them becoming effective.

~~This standard does not specify requirements for safety, other than those directly related to the explosion risk.~~

This standard is supplemented or modified by the following ~~parts of IEC 60079 standards~~ concerning specific types of protection:

- ~~IEC 60079-1~~ ANSI/ISA-60079-1 (12.22.01)-2005: Flameproof enclosures "d";
- ~~IEC 60079-2~~ ANSI/ISA-60079-2 (12.04.01)-2003: Pressurized enclosures "p";
- ~~IEC 60079-5~~ ANSI/ISA-60079-5 (12.25.01)-1998: Powder filling "q";
- ~~IEC 60079-6~~ ANSI/ISA-60079-6 (12.26.01)-1998: Oil immersion "o";
- ~~IEC 60079-7~~ ANSI/ISA-60079-7 (12.16.01)-2002: Increased safety "e";
- ~~IEC 60079-11~~ ANSI/ISA-60079-11 (12.02.01)-2002: Intrinsic safety "i";
- ~~IEC 60079-15~~ ANSI/ISA-60079-15 (12.12.02)-2003: Type of protection "n";
- ~~IEC 60079-18~~ ANSI/ISA-60079-18 (12.23.01)-2005: Encapsulation "m".

This standard is supplemented or modified by the following apparatus standards:

- ~~IEC 60079-25~~;
- ~~IEC 60079-26~~;
- ~~IEC 62013-1~~;
- ~~IEC 62086-1~~.

- ANSI/IEEE 515: Standard for Testing, Design, Installation, and Maintenance of Electrical Heat Tracing for Industrial Applications.

NOTE Components such as power connections, splices, end terminations, as well as cable entries, fittings, and seals are to be evaluated according to the type of protection employed.

This ~~part of IEC 60079 standard~~ along with ~~other parts in the IEC 60079 Series~~ and the additional standards mentioned above are not applicable to the construction of electromedical apparatus, shot-firing exploders, test devices for exploders and for shot-firing circuits.

2 Normative References

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

ANSI/API RP505, Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, or Zone 2

ANSI/NFPA 70:2005, National Electrical Code

ANSI/NFPA 496: Pressurized Enclosures for Electrical Equipment

ANSI/NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapours and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

UL 50, Enclosures for Electrical Equipment

UL 347, High Voltage Industrial Control Equipment

UL 508, Industrial Control Equipment

UL 746B, Polymeric Materials – Long-Term Property Evaluations

UL 746C, Polymeric Materials – Use in Electrical Equipment Evaluations

IEC 60034-5, Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code—Classification)

~~IEC 60079-1, Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosures "d"~~

ANSI/ISA-60079-1 (12.22.01)-2005, Electrical Apparatus for Use in Hazardous (Classified) Locations: Type of Protection - Flameproof "d"

~~IEC 60079-2, Electrical apparatus for explosive gas atmospheres – Part 2: Pressurized enclosures "p"~~

ANSI/ISA-60079-2 (12.04.01)-2003, Electrical Apparatus for Explosive Gas Atmospheres – Part 2 Pressurized Enclosures "p"

IEC 60079-4, Electrical apparatus for explosive gas atmospheres – Part 4: Method of test for ignition temperature

~~IEC 60079-5, Electrical apparatus for explosive gas atmospheres — Part 5: Powder filling "q"~~

ANSI/ISA-60079-5 (12.25.01)-1998, Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations: Type of Protection – Powder filling "q"

~~IEC 60079-6, Electrical apparatus for explosive gas atmospheres — Part 6: Oil immersion "o"~~

ANSI/ISA-60079-6 (12.26.01)-1998, Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations: Type of Protection – Oil-Immersion "o"

~~IEC 60079-7, Electrical apparatus for explosive gas atmospheres — Part 7: Increased safety "e"~~

ANSI/ISA-60079-7 (12.16.01)-2002, Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations: Type of Protection – Increased Safety "e"

~~IEC 60079-10, Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas~~

ANSI/ISA-60079-10 (TR12.24.01)-1998, Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2

~~IEC 60079-11, Electrical apparatus for explosive gas atmospheres — Part 11: Intrinsic safety "i"~~

ANSI/ISA-60079-11 (12.02.01)-2002, Electrical Apparatus for Use in Class I, Zones 0, 1, & 2 Hazardous (Classified) Locations: Intrinsic Safety "i"

~~IEC 60079-15, Electrical apparatus for explosive gas atmospheres — Part 15: Type of protection "n"~~

ANSI/ISA-60079-15 (12.12.02)-2003, Electrical Apparatus for Use in Class I, Zone 2 Hazardous (Classified) Locations: Type of Protection "n"

~~IEC 60079-18, Electrical apparatus for explosive gas atmospheres — Part 18: Encapsulation "m"~~

ANSI/ISA-60079-18 (12.23.01)-2005, Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations: Type of Protection – Encapsulation "m"

~~IEC 60079-25: Electrical apparatus for explosive gas atmospheres — Part 25: Intrinsically safe systems¹~~

~~IEC 60079-26: Electrical apparatus for explosive gas atmospheres — Part 26: Construction, test and marking of zone 0 electrical apparatus²~~

IEC 60086-1, Primary batteries – Part 1: General

IEC 60095-1, Lead-acid starter batteries – Part 1: General requirements and methods of test

IEC 60192, Low-pressure sodium vapour lamps – Performance specifications

¹To be published

²In preparation

IEC 60216-1, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedure and evaluation of test results*

IEC 60216-2, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 2: Choice of test criteria*

IEC 60423, *Conduits for electrical purposes – Outside diameters of conduits for electrical installations and threads for conduits and fittings*

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

IEC 60622, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-cadmium prismatic rechargeable single cells*

IEC 60623, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells*

IEC 60662, *High-pressure sodium vapour lamps*

IEC 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 61056-1, *General-purpose lead-acid cells and batteries (valve-regulated types) – Part 1: General requirements, functional characteristics – Methods of test*

IEC 61150, *Alkaline secondary cells and batteries – Sealed nickel-cadmium rechargeable monobloc batteries in button cell design*

IEC 61436, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-metal hydride rechargeable single cells*

IEC 61951-1, *Secondary cells and batteries containing alkaline and other non-acid electrolytes – Portable sealed rechargeable single cells – Part 1: Nickel-cadmium*

~~IEC 62013-1, *Caplights for use in mines susceptible to firedamp – Part 1: General requirements – Construction and testing in relation to the risk of explosion*~~

~~IEC 62086-1: *Electrical apparatus for explosive gas atmospheres – Electrical resistance trace heating – Part 1: General and testing requirements*~~

~~ISO 48, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*~~

~~ISO 178, *Plastics – Determination of flexural properties*~~

ISO 179, *Plastics – Determination of Charpy impact properties*

~~ISO 262, *ISO general-purpose metric screw threads – Selected sizes for screws, bolts and nuts*~~

~~ISO 273, *Fasteners – Clearance holes for bolts and screws*~~

~~ISO 286-2, ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts~~

~~ISO 527-2, Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics~~

~~ISO 965-1, ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data~~

~~ISO 965-3, ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screw threads~~

~~ISO 1817, Rubber, vulcanized — Determination of the effect of liquids~~

~~ISO 4014, Hexagon head bolts — Product grades A and B~~

~~ISO 4017, Hexagon head screws — Product grades A and B~~

~~ISO 4026, Hexagon socket set screws with flat point~~

~~ISO 4027, Hexagon socket set screws with cone point~~

~~ISO 4028, Hexagon socket set screws with dog point~~

~~ISO 4029, Hexagon socket set screws with cup point~~

~~ISO 4032, Hexagon nuts, style 1 — Product grades A and B~~

~~ISO 4762, Hexagon socket head cap screws~~

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

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1

ambient temperature

temperature of the air or other media, in the immediate vicinity of the apparatus or component

NOTE This does not refer to the temperature of any process media, unless the apparatus or component is totally immersed in the process media. See 5.1.1.

3.2

associated apparatus

electrical apparatus which contains both energy-limited and non-energy-limited circuits and is constructed so that the non energy-limited circuits cannot adversely affect the energy-limited circuits

NOTE Associated apparatus may be either:

- a) electrical apparatus which has an alternative type of protection included in this standard for use in the appropriate explosive gas atmosphere;

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

3.3

cells and batteries

3.3.1

battery

assembly of two or more cells electrically connected to each other to increase the voltage or capacity

3.3.2

capacity

quantity of electricity or electric charge, which a fully charged battery can deliver under specified conditions

3.3.3

cell

assembly of electrodes and electrolyte which constitutes the smallest electrical unit of a battery

3.3.4

charging

act of forcing current through a secondary cell or battery in the opposite direction to the normal flow to restore the energy

3.3.5

deep discharge

event which reduces a cell voltage below that recommended by the cell or battery manufacturer

3.3.6

inherently safe (ihs) cell (or battery)

primary cell or battery in which the short-circuit current and maximum surface temperature are limited to a safe value by its internal resistance

3.3.7

maximum open-circuit voltage (of a cell or battery)

maximum attainable voltage under normal conditions, that is, from either a new primary cell, or a secondary cell just after a full charge

NOTE See Tables 6 and 7 which show the maximum open-circuit voltage for acceptable cells.

3.3.8

nominal voltage

(of a cell or battery) that specified by the manufacturer

3.3.9

open cell or battery

secondary cell, or battery, having a cover provided with an opening through which gaseous products may escape

[IEV 486-01-18]

3.3.10

primary cell or battery

electrochemical system capable of producing electrical energy by chemical reaction

3.3.11**reverse charging**

act of forcing current through either a primary cell or secondary cell in the same direction as the normal flow, for example, in an expired battery

3.3.12**sealed gas-tight cell or battery**

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

NOTE 1 Such cells and batteries may be equipped with a safety device to prevent dangerously high internal pressure. The cell or battery does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

NOTE 2 The above definition is taken from IEC 60079-11. It differs from the definitions in IEC 486-01-20 and IEC 486-01-21 by virtue of the fact that it applies to either a cell or battery.

3.3.13**sealed valve-regulated cell or battery**

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

[IEC 486-01-20 and IEC 486-01-21, modified]

3.3.14**secondary cell or battery**

electrically rechargeable electrochemical system capable of storing electrical energy and delivering it by chemical reaction

3.4**bushing**

insulating device carrying one or more conductors through an internal or external wall of an enclosure

3.5**cable gland**

device permitting the introduction of one or more electric and/or fibre optics cables into an electrical apparatus so as to maintain the relevant type of protection

3.5.1**clamping device**

element of a cable gland for preventing tension or torsion in the cable from being transmitted to the connections

3.5.2**compression element**

element of a cable gland acting on the sealing ring to enable the latter to fulfil its function

3.5.3**sealing ring**

ring used in a cable gland or with a conduit entry to ensure the sealing between the entry and the cable or conduit

3.5.4**Ex cable gland**

cable gland tested separately from the apparatus enclosure but certified as an apparatus and which can be fitted to the apparatus enclosure during installation

3.6**certificate**

document that assures the conformity of a product, process, system, person, or organization with specified requirements

NOTE The certificate may be either the supplier's declaration of conformity, or the purchaser's recognition of conformity or certification (as a result of action by a third party) as defined in ISO/IEC DIS 17000.

3.7**conduit entry**

means of introducing a conduit into an electrical apparatus so as to maintain the relevant type of protection

3.8**connection facilities**

terminals, screws or other parts, used for the electrical connection of conductors of external circuits

3.9**continuous operating temperature (COT)**

maximum temperature which ensures the stability and integrity of the material for the expected life of the apparatus, or part, in its intended application

3.10**degree of protection of enclosure (IP)**

numerical classification according to IEC 60529 preceded by the symbol IP applied to the enclosure of electrical apparatus to provide

- protection of persons against contact with, or approach to, live parts and against contact with moving parts (other than smooth rotating shafts and the like) inside the enclosure,
- protection of the electrical apparatus against ingress of solid foreign objects, and
- where indicated by the classification, protection of the electrical apparatus against harmful ingress of water

NOTE The enclosure which provides the degree of protection IP is not necessarily identical to the apparatus enclosure for the types of protection listed in Clause 1.

3.11**electrical apparatus**

items applied as a whole or in part for the utilization of electrical energy

NOTE These include, among others, items for the generation, transmission, distribution, storage, measurement, regulation, conversion and consumption of electrical energy and items for telecommunications.

3.12**electrical parameters – apparatus with energy limitation****3.12.1****maximum external capacitance**

C_o

maximum capacitance that can be connected to the connection facilities of the apparatus without invalidating the type of protection

3.12.2**maximum external inductance** L_o

maximum value of inductance that can be connected to the connection facilities of the apparatus without invalidating the type of protection

3.12.3**maximum input current** I_i

maximum current (peak a.c. or d.c.) that can be applied to the connection facilities of an apparatus without invalidating the type of protection

3.12.4**maximum input power** P_i

power that can be applied to the connection facilities of apparatus without invalidating the type of protection

3.12.5**maximum input voltage** U_i

maximum voltage (peak a.c. or d.c.) that can be applied to the connection facilities of apparatus without invalidating the type of protection

3.12.6**maximum internal capacitance** C_i

maximum equivalent internal capacitance of the apparatus which is considered as appearing across the connection facilities

3.12.7**maximum internal inductance** L_i

maximum equivalent internal inductance of the apparatus which is considered as appearing at the connection facilities

3.12.8**maximum output current** I_o

maximum current (peak a.c. or d.c.) in apparatus that can be taken from the connection facilities of the apparatus

3.12.9**maximum output power** P_o

maximum electrical power that can be taken from the apparatus

3.12.10**maximum output voltage** U_o

maximum voltage (peak a.c. or d.c.) that can appear at the connection facilities of the apparatus at any applied voltage up to the maximum voltage

3.12.11**maximum r.m.s. a.c. or d.c. voltage** U_m

maximum voltage that can be applied to the non energy-limited connection facilities of associated apparatus without invalidating the type of protection

3.13**enclosure**

all the walls, doors, covers, cable glands, rods, spindles, shafts, etc., which contribute to the type of protection and/or the degree of protection IP of the electrical apparatus

3.14**Ex component**

part of electrical apparatus or a module (other than an Ex cable gland), ~~marked with the symbol "U"~~, which is not intended to be used alone and requires additional consideration when incorporated into electrical apparatus or systems for use in explosive gas atmospheres

3.15**explosive gas atmosphere**

mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour, in which, after ignition, permits self-sustaining flame propagation

3.16**explosive test mixture**

specified explosive mixture used for the testing of electrical apparatus for explosive gas atmospheres

3.17**ignition temperature of an explosive gas atmosphere**

lowest temperature of a heated surface which, under specified conditions according to IEC 60079-4, will ignite a flammable substance in the form of a gas or vapour mixture with air

3.18**maximum surface temperature**

highest temperature which is attained in service under the most adverse conditions (but within the specified tolerances) by any part or surface of an electrical apparatus, which would be able to produce an ignition of the surrounding explosive atmosphere

NOTE 1 The manufacturer will prescribe the product standard and also, in their particular design, they should take into account the following other conditions:

- fault conditions specified in the standard for the type of protection concerned;
- all operating conditions specified in any other standard and specified by the manufacturer including recognized overloads;
- any other operating condition specified by the manufacturer.

NOTE 2 The relevant surface temperature may be internal or external depending upon the type of protection concerned.

3.19**normal operation**

operation of apparatus conforming electrically and mechanically with its design specification and used within the limits specified by the manufacturer

NOTE 1 The limits specified by the manufacturer may include persistent operational conditions, e.g. operation of a motor on a duty cycle.

NOTE 2 Variation of the supply voltage within stated limits and any other operational tolerance is part of normal operation.

3.20**rated value**

quantity value, assigned generally by the manufacturer, for a specified operating condition of a component, device or apparatus

3.21**rating**

set of rated values and operating conditions

3.22**service temperature**

temperature reached when the apparatus is operating at rated conditions

NOTE Each apparatus may reach different service temperatures in different parts.

3.23**symbol "U"**

~~symbol used to denote an Ex component.~~

3.24**symbol "X"**

~~symbol used to denote special conditions for safe use.~~

3.25**terminal compartment**

separate compartment, or part of a main enclosure, communicating or not with the main enclosure, and containing connection facilities

3.26**type of protection**

specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive atmosphere

4 Apparatus grouping and temperature classification

4.1 Apparatus grouping

Electrical apparatus for explosive gas atmospheres is divided into the following:

- ~~— Group I: electrical apparatus for mines susceptible to firedamp;~~
- Group II: electrical apparatus for places with an explosive gas atmosphere other than mines susceptible to firedamp.

~~Electrical apparatus intended for mines where the atmosphere, in addition to firedamp, may contain significant proportions of other flammable gases (i.e. other than methane), shall be constructed and tested in accordance with the requirements relating to Group I and also to the subdivision of Group II corresponding to the other significant flammable gases. This electrical apparatus shall then be marked appropriately (for example, "Ex d I/II B T3" or "Ex d I/II (NH₃)".)~~

4.2 Group II

Electrical apparatus of Group II may be subdivided according to the nature of the explosive gas atmosphere for which it is intended.

4.2.1 Group II subdivisions

For the types of protection "d", "i", and "nC", ~~and "nL"~~, electrical apparatus of Group II is subdivided into IIA, IIB and IIC, as required in the specific standards concerning these types of protection.

NOTE 1 This subdivision is based on the maximum experimental safe gap (MESG) for flameproof enclosures or the minimum ignition current ratio (MIC ratio) for intrinsically safe electrical apparatus (see IEC 60079-12 and IEC 60079-20).

NOTE 2 Apparatus marked IIB is suitable for applications requiring Group IIA apparatus. Similarly, apparatus marked IIC is suitable for applications requiring Group IIA or Group IIB apparatus.

4.2.2 Group II – Surface temperature marking

For all types of protection, apparatus of Group II shall be marked as a function of its maximum surface temperature according to 5.3.2.2.

4.2.3 Apparatus for a particular explosive atmosphere

The electrical apparatus may be tested for a particular explosive atmosphere. In this case, the information shall be recorded on the certificate and the electrical apparatus marked accordingly.

5 Temperatures

5.1 Environmental influences

5.1.1 Ambient temperature

Electrical apparatus shall normally be designed for use in an ambient temperature range between -20 °C and +40 °C; in this case, no additional ambient temperature marking is necessary.

Electrical apparatus designed for use in a different range of ambient temperatures is considered to be special, and the ambient temperature range shall then be stated by the manufacturer. The marking shall then include either the symbol T_a or T_{amb} together with the special range of ambient temperatures ~~or, if this is impracticable, the symbol "X" shall be used to indicate special conditions of use that include a special range of ambient temperature.~~ See item i) of 29.2 and Table 1.

Table 1 – Ambient temperatures in service and additional marking

Electrical apparatus	Ambient temperature in service	Additional marking
Normal	Maximum: +40 °C Minimum: -20 °C	None
Special	Stated by the manufacturer	T_a or T_{amb} with the special range, for example, $-30\text{ °C} \leq T_a \leq +40\text{ °C}$ or the symbol "X"

5.1.2 External source of heating or cooling

Where the electrical apparatus is intended to be physically connected to a separate external source of heating or cooling, such as a heated or cooled process vessel or pipeline, the ratings of this source shall be stated.

NOTE 1 The way in which these ratings are expressed will vary according to the nature of the source. For large body sources, the maximum or minimum temperature will usually be sufficient. For small body sources, or for heat conduction through thermal insulation, the rate of heat flow may be appropriate.

NOTE 2 The influence of radiated heat may need to be considered on the final installation. See IEC 60079-14.

5.2 Service temperature

Where this standard, or the standard for the specific type of protection, requires the service temperature to be determined at any place in the apparatus, the temperature shall be determined for rated duty of the electrical apparatus when the apparatus is subjected to maximum or minimum ambient temperature and, where relevant, the maximum rated external source of heating or cooling. Temperature testing, when required, shall be in accordance with 26.5.1.

5.3 Maximum surface temperature

5.3.1 Determination of maximum surface temperature

Maximum surface temperature shall be determined for rated duty of the electrical apparatus but with the voltage chosen according to 26.5.1 or the specific requirement of the standard for the type of protection, and when the apparatus is subjected to maximum ambient temperature and, where relevant, the maximum rated external source of heating.

5.3.2 Limitation of maximum surface temperature

5.3.2.1 Group I electrical apparatus

~~For electrical apparatus of Group I, the maximum surface temperature shall be specified in relevant documentation according to Clause 24.~~

~~This maximum surface temperature shall not exceed~~

~~— 150 °C on any surface where coal dust can form a layer,~~

~~— 450 °C where coal dust is not expected to form a layer (for example, due to sealing or ventilation), provided that the actual maximum surface temperature is marked on the apparatus.~~

~~NOTE When choosing Group I electrical apparatus, the user should take into account the influence and the smouldering temperature of coal dusts if they are likely to be deposited in a layer on surfaces with temperatures above 150 °C.~~

5.3.2.2 Group II electrical apparatus

Group II electrical apparatus shall be marked according to item f) of 29.2 and shall be either

- classified in a temperature class given in Table 2, or
- defined by the maximum surface temperature determined by 26.5.1, or
- if appropriate, restricted to the specific gas for which it is intended.

Table 2 – Classification of maximum surface temperatures for Group II electrical apparatus

Temperature class	Maximum surface temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

NOTE More than one temperature class may be established for different ambient temperatures and different external sources of heating and cooling.

5.4 Surface temperature and ignition temperature

The maximum surface temperature shall not exceed the lowest ignition temperature of the explosive atmospheres concerned unless subjected to the requirements of 5.5.

5.5 Small components

Small components, for example transistors or resistors, whose temperature exceeds that permitted for the temperature classification, shall be acceptable providing that they conform to one of the following:

- a) when tested in accordance with 26.5.3, small components shall not cause ignition of the flammable mixture and any deformation or deterioration caused by the higher temperature shall not impair the type of protection; or
- b) for T4 and Group I classification, small components shall conform to Table 3; or
- c) for T5 classification, the surface temperature of a component with a surface area smaller than 1,000 mm² (excluding lead wires) shall not exceed 150 °C.

Table 3 – Assessment for T4 classification according to component size and ambient temperature

Total surface area excluding wire terminations	Requirement for T4 classification
< 20 mm ²	Surface temperature ≤ 275 °C
≥ 20 mm ²	Power dissipation ≤ 1.3 W ^a
≥ 20 mm ² ≤ 1,000 mm ²	Surface temperature ≤ 200 °C
^a Reduced to 1,2 W with 60 °C ambient temperature or 1,0 W with 80 °C ambient temperature.	

For potentiometers, the surface to be considered shall be that of the resistance element and not the external surface of the component. The mounting arrangement and the heat-sinking and cooling effect of the overall potentiometer construction shall be taken into consideration during the test. Temperature shall be measured on the track with that current which flows under the test conditions required by the standard for the specific type of protection. If this results in a resistance value of less than 10 % of the track resistance value, the measurements shall be carried out at 10 % of the track resistance value.

For components having a total surface area of not more than 10 cm², their surface temperature may exceed that for the temperature class marked on the Group II electrical apparatus ~~or the corresponding maximum surface temperature for Group I electrical apparatus~~, if there is no risk of ignition from these components, with a safety margin of

- 50 K for T1, T2 and T3,
- 25 K for T4, T5 and T6 ~~and Group I.~~

This safety margin shall be ensured by experience of similar components or by tests of the electrical apparatus itself in representative explosive mixtures.

NOTE During the tests, the safety margin may be provided by increasing the ambient temperature.

6 Requirements for all electrical apparatus

6.1 General

Electrical apparatus and Ex components for use in explosive gas atmospheres shall

- a) comply with the requirements of this standard, together with one or more of the specific standards listed in Clause 1, and

NOTE 1 These specific standards may vary the requirements of this standard.

- b) ~~be constructed in accordance with the applicable safety requirements of the relevant industrial standards.~~ comply with the applicable requirements for similar apparatus for use in unclassified locations.

NOTE 2 ~~It is not a requirement of this standard that a certification body check compliance with this requirement. The manufacturer should indicate compliance by marking the apparatus or component in accordance with Clause 29 (and by stating the basis of compliance in the documentation, see Clause 28). Requirements for safety of electrical equipment in ordinary (unclassified) locations can be found in ANSI Standards, NEMA Standards, Federal Regulations, etc. Apparatus listed by a Nationally Recognized Testing Laboratory is considered to meet the applicable requirements found in these standards. A list of commonly applied standards is shown in informative Annex D.~~

NOTE 3 ~~If the electrical apparatus or Ex component is intended to withstand particularly adverse service conditions (for example, rough handling, humidity effects, ambient temperature variations, effects of chemical agents, corrosion), these should be specified to the manufacturer by the user. If certification is sought, it is not a requirement of this standard that the certification body confirm suitability for the adverse conditions. Special precautions should be taken when vibration effects on terminals, fuse holders, lampholders and current-carrying connections in general may impair safety, unless they comply with specific standards.~~

6.2 Mechanical strength of apparatus

The apparatus shall be subjected to the tests of 26.4. Guards relied upon to provide protection from impact shall be removable only by the use of a tool and shall remain in place for the required impact tests.

6.3 Opening times

Enclosures which can be opened more quickly than

- a) any incorporated capacitors, charged by a voltage of 200 V or more, to discharge to a value of residual energy of

- 0,2 mJ for electrical apparatus of ~~Group I or~~ Group IIA, or
 - 0,06 mJ for electrical apparatus of Group IIB, or
 - 0,02 mJ for electrical apparatus of Group IIC, including apparatus marked Group II only,
 - or double the above energy levels if the charging voltage is less than 200 V, or
- b) the surface temperature of enclosed hot components reduces to below the temperature class of the electrical apparatus

shall be marked with one of the following warning markings:

- an enclosure opening delay marking as specified in item a) of 29.8; or
- an enclosure opening marking as specified in item b) of 29.8.

6.4 Circulating currents

Where necessary, precautions shall be taken to guard against any effect due to the presence of circulating currents caused by stray magnetic fields, and the arcs or sparks that may occur as a result of interrupting such currents, or excessive temperatures caused by such currents.

NOTE Examples of precautions that can be taken include:

- the provision of equipotential bonding between parts of an enclosure or structure of apparatus; or
- the provision of an adequate quantity of fasteners.

Bonding conductors shall be such that they will only conduct through the designed connection points and not through any insulated joints. In order to ensure reliable current transfer without the risk of sparking under adverse operating conditions, such as vibration or corrosion, the bonds shall be protected against corrosion and loosening in accordance with 15.5. Particular care shall be taken with bare flexible conductors in close proximity to the bonded parts.

Bonding conductors are not required where insulation ensures that circulating currents cannot flow. However, provision shall be made for adequate earthing of isolated exposed conductive parts. The insulation of such parts shall be capable of withstanding a test of 100 V r.m.s for 1 min.

6.5 Gasket retention

Where the degree of protection provided by the enclosure depends on a gasketed joint which is intended to be opened for installation or maintenance purposes, gaskets shall be attached or secured to one of the mating faces to prevent loss, damage or incorrect assembly. The gasket material shall not itself adhere to the other joint face.

NOTE An adhesive may be used for attaching a gasket to one of the mating faces.

7 Non-metallic enclosures and non-metallic parts of enclosures

7.1 General

7.1.1 Applicability

The requirements given in this clause and in 26.7 shall apply to non-metallic enclosures and non-metallic parts of enclosures, on which the type of protection depends.

~~However, for sealing rings (see 3.5.3) on which the type of protection depends, the proof furnished according to A.3.3 shall be sufficient.~~

7.1.2 Specification of materials

The documents according to Clause 24 shall specify both the material and the manufacturing process of the enclosure or part of the enclosure.

7.1.3 Plastic materials

The specification for plastic materials shall include the following:

- a) the name of the manufacturer;
- b) the exact and complete reference of the material, including its colour, percentage of fillers and any other additives, if used;
- c) the possible surface treatments, such as varnishes, etc.;
- d) the temperature index (TI) corresponding to the 20 000 h point on the thermal endurance graph without loss of flexural strength exceeding 50%, determined in accordance with IEC 60216-1 and IEC 60216-2 and based on the flexing property in accordance with ISO 178. If the material does not break in this test before exposure to the heat, the index shall be based on the tensile strength in accordance with ISO 527-2 with test bars of Type 1A or 1B. As an alternative to the TI, the relative thermal index (RTI-mechanical impact) may be determined in accordance with UL 746B.

The data by which these characteristics are defined shall be supplied by the manufacturer.

NOTE It is not a requirement of this standard that conformity to the manufacturer's specification of the plastic material needs to be verified.

7.2 Thermal endurance

The endurance to heat and to cold of the enclosures, or parts of enclosures, of non-metallic materials shall be satisfactory (see 26.8 and 26.9).

Plastic materials shall have a TI corresponding to the 20 000 h point (see 7.1.3) of at least 20 K greater than the temperature of the hottest point of the enclosure or the part of the enclosure (see 26.5.1), having regard to the maximum ambient temperature in service (see 5.1.1). As an alternative to the TI, the relative thermal index (RTI-mechanical impact) may be determined in accordance with UL 746B.

7.3 Electrostatic charges on external non-metallic materials of enclosures

7.3.1 Applicability

The requirements of this subclause only apply to external non-metallic materials of electrical apparatus.

7.3.2 Avoidance of a build-up of electrostatic charge

Electrical apparatus shall be so designed that under normal conditions of use, maintenance and cleaning, danger of ignition due to electrostatic charges shall be avoided. This requirement shall be satisfied by one of the following:

- a) by suitable selection of the material so that the surface resistance of the enclosure, measured in accordance with 26.13, does not exceed $1 \text{ G}\Omega$ at $(23 \pm 2)^\circ\text{C}$ and $(50 \pm 5)\%$ relative humidity; or
- b) by limitation of the surface area of non-metallic parts of enclosures as shown in Table 4.

The surface area is defined as follows:

- for sheet materials, the area shall be the exposed (chargeable) area;
- for curved objects, the area shall be the projection of the object giving the maximum area;

- for individual non-metallic parts, the area shall be evaluated independently if they are separated by conductive earthed frames; or

NOTE 1 The values for surface area can be increased by a factor of four if the exposed area of non-metallic material is surrounded by conductive earthed frames.

Table 4 – Limitations of areas

Maximum surface area mm ²				
Group I apparatus	Group II apparatus			
	Zone (as defined in IEC 60079-10)	Group IIA	Group IIB	Group II or IIC
10 000	0	5 000	2 500	400
	1	10 000	10 000	2 000
	2	10 000	10 000	2 000

- c) by limitation of the transferred charge using the test method described in 26.14; or
- d) for hand-held apparatus only, the inability to store a dangerous charge as verified by measurement of capacitance when tested in accordance with the test method in 26.15; or
- e) for electrical apparatus intended for fixed installations, the precautions to avoid risk from electrostatic discharge may form part of the intended installation or be a feature of the process in which the apparatus is mounted. In this case, the apparatus shall be marked “X” in accordance with item i) of 29.2 and the documentation shall indicate all the necessary information to ensure the installation minimizes the risk from electrostatic discharge. Where practicable, the apparatus shall also be marked with the electrostatic charge warning given in item g) of 29.8.

NOTE 2 Care should be taken when selecting the use of a warning label for static risk control. In many industrial applications, especially coal mining, it is highly likely that warning labels may become illegible through the deposition of dusts. If this is the case it is possible that the act of cleaning the label may cause a static discharge.

NOTE 3 When selecting electrical insulating materials, attention should be paid to maintaining a minimum insulation resistance to avoid problems arising from touching exposed non-metallic parts that are in contact with live parts.

7.4 Threaded holes

Threaded holes for fasteners which secure covers intended to be opened in service for adjustment, inspection and other operational reasons, shall only be tapped into the non-metallic material when the thread form is compatible with the non-metallic material of the enclosure.

8 Enclosures containing light metals

8.1 Material composition

8.1.1 Group I

~~Materials used in the construction of enclosures of Group I electrical apparatus shall not contain, by mass, more than~~

- ~~15 % in total of aluminium, magnesium and titanium; and~~
- ~~6 % in total of magnesium and titanium.~~

~~The above requirement does not apply to Group I surveying instruments carried by persons.~~

8.1.2 Group II

Materials used in the construction of enclosures of Group II electrical apparatus for the different zones ~~(as defined in IEC 60079-10)~~ shall not contain, by mass, more than:

- for Zone 0
 - 10% in total of aluminium, magnesium, titanium and zirconium, or
 - 7.5% in total of magnesium, titanium and zirconium;
- for Zone 1
 - 7.5% magnesium;
- for Zone 2
 - no requirements except for fans, fanhoods, and ventilating screens which shall comply with the requirements for Zone 1.

Where the above compositions are exceeded, the apparatus shall be marked ~~with an "X"~~ in accordance with item i) of 29.2 and the special conditions for safe use shall contain sufficient information to enable the user to determine the suitability of the apparatus for the particular application, for example, to avoid an ignition hazard due to impact or friction.

NOTE Caution should be observed when copper or copper alloys are used for enclosures in atmospheres containing acetylene due to the potential formation of acetylides on the surface that can be ignited by friction or impact. The risk of ignition can be reduced by coating the copper or copper alloy with tin, nickel, or by other coatings, or by limiting the maximum copper content of the alloy to 30 percent.

8.2 Threaded holes

Threaded holes for fasteners which secure covers intended to be opened in service for adjustment, inspection and other operational reasons shall only be tapped into the material when the thread form is compatible with the material of the enclosure.

9 Fasteners

9.1 General

Parts necessary to achieve a specific type of protection or used to prevent access to uninsulated live parts shall be capable of being released or removed only with the aid of a tool.

Fastening screws for enclosures of materials containing light metals may be made of light metal or non-metallic material if the material of the fastener is compatible with that of the enclosure.

9.2 Special fasteners

~~When any of the standards for a specific type of protection requires a special fastener, this shall conform to the following.~~

- ~~— the thread shall be a metric thread of coarse pitch in accordance with ISO 262, with a tolerance class of 6g/6H in accordance with ISO 965-1 and ISO 965-3.~~
- ~~— the head of the screw or nut shall be in accordance with ISO 4014, ISO 4017, ISO 4032 or ISO 4762, and, in the case of hexagon socket set screws, ISO 4026, ISO 4027, ISO 4028 or ISO 4029.~~
- ~~— the holes in the electrical apparatus shall comply with the requirements of 9.3.~~

~~NOTE For Group I electrical apparatus, the heads of special fasteners liable to mechanical damage in normal service, which may invalidate the type of protection, should be protected, for example, by the use of shrouds or counter-bored holes.~~

9.3 Holes for special fasteners

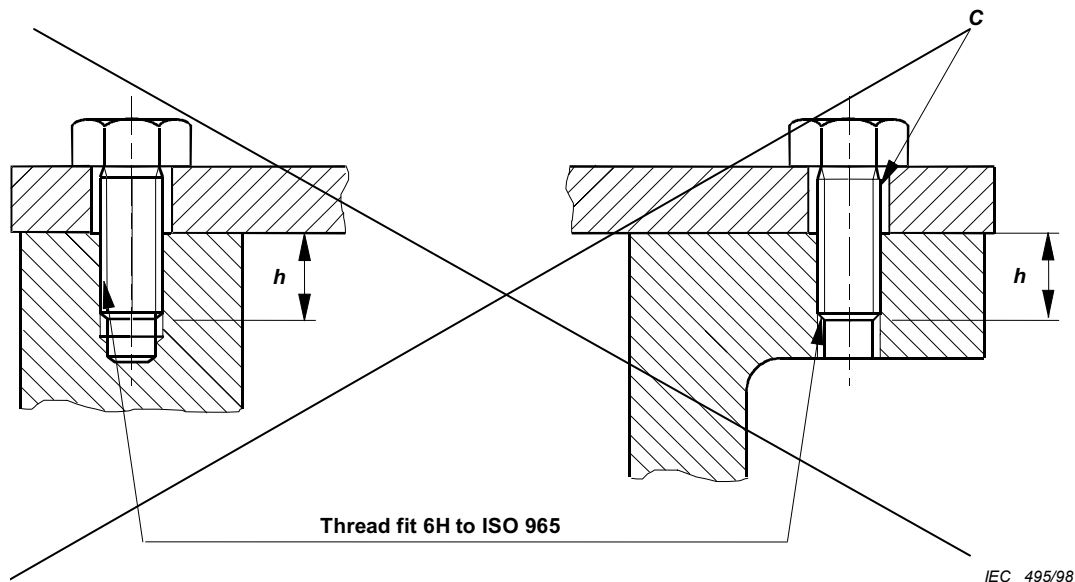
9.3.1 Thread engagement

Holes for special fasteners as specified in 9.2 shall be threaded for a distance to accept a thread engagement, h , at least equal to the major diameter of the thread of the fastener (see Figures 1 and 2).

9.3.2 Tolerance and clearance

The thread shall have a tolerance class of 6H in accordance with ISO 965-1 and ISO 965-3, and either

- the hole under the head of the associated fastener shall allow a clearance not greater than a medium tolerance class of H13 in accordance with ISO 286-2 (see Figure 1 and ISO 273); or
- the hole under the head (or nut) of an associated reduced shank fastener shall be threaded to enable the fastener to be retained. The dimensions of the threaded hole shall be such that the surrounding surface in contact with the head of such a fastener shall be at least equal to that of a fastener without a reduced shank in a clearance hole (see Figure 2).



Key

$h \geq$ major diameter of the thread of the fastener.

$c \leq$ maximum clearance permitted by tolerance of fit H13 of ISO 286-2.

Figure 1—Tolerances and clearance for threaded fasteners