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Edition 4.0 2015-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Explosive atmospheres –
Part 6: Equipment protection by liquid immersion "o"

Atmosphères explosives –
Partie 6: Protection du matériel par immersion dans le liquide "o"

IEC 60079-6:2015-02(en-fr)

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CONTENTS

FOREWORD....4
1 Scope....6
2 Normative references....6
3 Terms and definitions....7
4 Constructional requirements....8
4.1 General....8
4.2 Levels of protection and requirements of electrical equipment....8
4.2.1 Level of Protection....8
4.2.2 Requirements for Level of Protection “ob”....9
4.2.3 Requirements for Level of Protection “oc”....9
4.3 Switching device....9
4.4 Creepage and clearance....9
4.5 Liquid containment enclosures....10
4.5.1 General....10
4.5.2 Sealed enclosures....10
4.5.3 Unsealed enclosures....10
4.5.4 Outlet of breathing device or pressure relief device....10
4.5.5 Enclosures intended to be opened....10
4.5.6 Determination of the maximum/minimum criteria of the protective liquid....10
4.6 Immersion depth....11
4.7 Protective liquid level indication....11
4.7.1 General....11
4.7.2 Remote-indicating protective liquid level indicator....12
4.7.3 Safety devices for Level of Protection “ob”....12
4.8 Temperature limitations....12
4.8.1 General....12
4.8.2 Maximum Surface Temperature....12
4.8.3 Flashpoint of the protective liquid....12
4.9 Field wiring connections to liquid immersion equipment....12
4.10 Constructional elements of enclosures....12
4.10.1 Operating rods, shafts etc.....12
4.10.2 Devices for draining of liquid....13
5 Protective Liquid....13
5.1 Protective liquid specification....13
5.2 Detailed alternative specification....13
5.3 Group I equipment....13
5.4 Liquid contamination and gassing that may result from arcing....13
5.5 Total volume of the protective liquid....14
6 Verifications and tests....14
6.1 Type tests....14
6.1.1 Overpressure test on sealed enclosures....14
6.1.2 Reduced pressure test on sealed enclosures....14
6.1.3 Overpressure test on unsealed enclosures....14
6.1.4 Maximum temperature....14
6.1.5 Switching Tests....15
6.2 Routine tests....15

AVA Documents
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Full document details: IEC 60079-6 2015

6.2.1 Sealed enclosures 15
6.2.2 Unsealed enclosures 15
7 Marking 15
8 Instructions 16
Annex A (normative) Selection and erection requirements 17
Annex B (normative) Maintenance requirements 18
Annex C (normative) Repair and Overhaul requirements 19
Bibliography 20

Table 1 – Working voltage 9
Table 2 – Depth of immersion 11
Table B.1 – Inspection requirements 18

Documents
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EXPLOSIVE ATMOSPHERES –

Part 6: Equipment protection by liquid immersion "o"

FOREWORD

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International Standard IEC 60079-6 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

This fourth edition cancels and replaces the third edition, published in 2007. This edition constitutes a technical revision.

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

– Edition 4 represents a major technical revision of the requirements for oil immersion "o" and should be considered as introducing all new requirements. The normal "Table of Significant Changes" has not been included for this reason. In particular:
  - The requirements for oil immersion "o" have been redefined into liquid immersion , levels of protection "ob" and "oc" as recommended by the responses to 31/715/DC
  - The ability to protect sparking contacts has been added to both "ob" and "oc"
– Additional requirements have been introduced for the protective liquid.

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This part of IEC 60079 is to be used in conjunction with IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*.

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

FDIS	Report on voting
31/1157/FDIS	31/1172/RVD

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

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

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

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

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

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EXPLOSIVE ATMOSPHERES –

Part 6: Equipment protection by liquid immersion "o"

1 Scope

This part of IEC 60079 specifies the requirements for the design, construction, testing and marking of Ex Equipment and Ex Components with type of protection liquid immersion “o” intended for use in explosive gas atmospheres.

Ex Equipment and Ex Components of type of protection liquid immersion “o” are either:

- Level of Protection “ob” (EPL “Mb” or “Gb”)
- Level of Protection “oc” (EPL “Gc”)

For Level of Protection “ob”, this standard applies where the rated voltage does not exceed 11 kV r.m.s. a.c. or d.c.

For Level of Protection “oc”, this standard applies where the rated voltage does not exceed 15 kV r.m.s. a.c. or d.c.

NOTE Requirements for higher voltages are under consideration.

This standard supplements and modifies the general requirements of IEC 60079-0. 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60156, *Insulating liquids – Determination of the breakdown voltage at power frequency – Test method*

IEC 60247, *Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor (tan δ) and d.c. resistivity*

IEC 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

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

IEC 60814, *Insulating liquids – Oil impregnated paper and pressboard – Determination of water by automatic coulometric Karl Fischer titration*

IEC 60836, *Specifications for unused silicone insulating liquids for electrotechnical purposes*

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IEC 61099, *Insulating liquids – Specifications for unused synthetic organic esters for electrical purposes*

IEC 61125, *Unused hydrocarbon based insulating liquids – Test methods for evaluating the oxidation stability*

IEC 62021-1, *Insulating liquids – Determination of acidity – Part 1: Automatic potentiometric titration*

IEC 62535, *Insulating liquids – Test method for detection of potentially corrosive sulphur in used and unused insulating oil*

ISO 2592, *Determination of flash and fire points – Cleveland open cup method*

ISO 2719, *Determination of flash point – Pensky-Martens closed cup method*

ISO 3016, *Petroleum oils – Determination of pour point*

ISO 3104, *Petroleum products – Transparent and opaque liquids – Determination of kinematic viscosity and calculation of dynamic viscosity*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 and the following apply.

3.1
liquid immersion "o"
type of protection in which the electrical equipment or parts of the electrical equipment are immersed in a protective liquid in such a way that an explosive gas atmosphere which may be above the liquid or outside the enclosure cannot be ignited

3.2
protective liquid
liquid which prevents the explosive atmosphere from making direct contact with potential ignition sources

3.3
sealed equipment
equipment designed and constructed in such a manner as to prevent ingress of an external atmosphere during the expansion and contraction of the internally contained liquid during normal operation, for example, by means of an expansion vessel

3.4
non-sealed equipment
equipment designed and constructed in such a manner as to allow the ingress and egress of an external atmosphere during the expansion and contraction of the internally contained fluid during normal operation

3.5
maximum permissible protective liquid level
maximum level that the protective liquid can attain in normal service, taking into account the effects of expansion from the worst-case filling condition specified by the manufacturer to the condition of full load at maximum ambient temperature for which the equipment is designed

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3.6
minimum permissible protective liquid level
minimum level that the protective liquid can attain in normal service taking into account the effects of contraction from the worst-case filling condition to the condition of de-energization at minimum ambient temperature

3.7
disconnector
mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements

Note 1 to entry: A disconnector is capable of opening and closing a circuit when either negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

[SOURCE: IEC 60050-441:1984, 441-14-05]

3.8
switching device
device designed to make or break the current in one or more electric circuits

[SOURCE: IEC 60050-441:1984, 441-14-01]

3.9
safety device
device intended for use inside or outside explosive atmospheres but required for or contributing to the safe functioning of equipment and protective systems with respect to the risks of explosion

3.10
tap selector
device designed to carry, but not to make or break current, used in conjunction with a diverter switch to select tapping connections

[SOURCE: IEC 60050-421:1990, 421-11-02]

4 Constructional requirements

4.1 General

For Type of Protection “liquid immersion “o”, the Ex Equipment or parts of the Ex Equipment are immersed in a protective liquid in such a way that an explosive gas atmosphere, which may be above the liquid or outside the enclosure, cannot be ignited.

The Ex Equipment is constructed to ensure that the necessary amount of protective liquid is present. Dependent on the intended Equipment Protection Level, this is achieved by monitoring device(s), indicator(s) or a level control safety device with automatic switch off.

NOTE In accordance with the requirements for all electrical equipment given in IEC 60079-0, it is assumed that the relevant industrial requirements have been applied. The requirements of the IEC 60079 series of standards supplement those industrial requirements.

4.2 Levels of protection and requirements of electrical equipment

4.2.1 Level of Protection

Electrical equipment with liquid immersion “o” shall be either:

a) Level of Protection “ob” (EPL Gb or Mb); or

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b) Level of Protection “oc” (EPL Gc).

The requirements of this standard shall apply to all levels of protection unless otherwise stated.

4.2.2 Requirements for Level of Protection “ob”

Electrical circuits and components, when liquid immersed in accordance with this standard, are considered to be not ignition capable in normal operation and during expected malfunctions, and shall be assigned a Level of Protection “ob” (EPL Gb or Mb).

A liquid level indication according to 4.7 is required.

Switching devices protected by liquid immersion level of protection “ob” shall comply with the following additional requirements:

a) When a sealed enclosure is employed, the enclosure shall comply with the overpressure test in 6.1.1 using four times the prescribed pressure.
b) Electrical equipment containing switching devices operated in the protective liquid, rated at 2 kVA per contact or less, are permitted without further test. Where the switching device is rated above 2 kVA per contact, neither pressure increases nor excessive decomposition products shall invalidate the type of protection as demonstrated by tests in accordance with 6.1.5.
c) The equipment shall be suitable for a prospective short circuit current of 32 kA unless marked with a lower value.

Disconnectors and manual tap selectors, above 1 000 V, shall be lockable and provided with a warning according to 7 i). In addition, information on their use shall be included in the instructions.

4.2.3 Requirements for Level of Protection “oc”

Electrical circuits and components, when liquid immersed in accordance with this standard, are considered to be not ignition capable in normal operation or in the case of regular expected occurrences, and shall be assigned a Level of Protection “oc” (EPL Gc).

Ex Equipment containing switching devices operated in the protective liquid, rated at 10 kVA per contact or less, are permitted without further test. For switching devices rated above 10 kVA per contact, neither pressure increases nor excessive decomposition products shall invalidate the type of protection as demonstrated by tests in accordance with 6.1.5.

4.3 Switching device

Switching devices are only permitted for a.c. circuits where the working voltage of the switch does not exceed the values given in Table 1. Switching devices for d.c. circuits are not permitted.

Table 1 – Working voltage

Level of Protection	“ob”	“oc”
Working voltage of switching device	1 000 V r.m.s. a.c.	6,6 kV r.m.s. a.c.

4.4 Creepage and clearance

Electrical circuits and components intended to be immersed in the protective liquid shall meet the relevant industrial requirements for creepage and clearance distances in air before being immersed in the protective liquid. If the relevant industrial standard gives options for pollution degree, pollution degree 2 shall be assumed.

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4.5 Liquid containment enclosures

4.5.1 General

The chemical resistance against the protective liquid shall be documented by the manufacturer.

NOTE It is not a requirement of this standard that conformity to the chemical resistance against the protective liquid be verified.

The enclosures shall be subjected to the type tests as specified in Clause 6 for sealed and unsealed enclosures respectively.

Connection bushings provided for termination of the electrical conductors shall be considered as part of the enclosure and subject to the requirements of this clause.

4.5.2 Sealed enclosures

Covers of sealed enclosures may be continuously welded to the enclosure, or sealed by means of a gasket, in which case, the cover shall be provided with special fasteners according to IEC 60079-0.

Equipment with a sealed enclosure shall be provided with a pressure-relief device. This device shall be permanently set by the manufacturer of the liquid-filled equipment to operate at a pressure of at least 10 kPa. Enclosures permanently sealed at the time of manufacture shall not be capable of being opened without leaving visible evidence that the enclosure has been opened. The enclosure shall be marked in accordance with 7 c).

NOTE Suitable techniques that can provide visible evidence of being opened are, for example, welding, soldering, cemented joints, rivets, cementing of screws, or lead-seal safety-wiring of screws.

4.5.3 Unsealed enclosures

An enclosure, which is not sealed, shall be constructed so that gas or vapour that may evolve from the protective liquid in normal service can escape through a breathing device which includes a suitable drying agent. The manufacturer shall specify the maintenance requirements for the drying agent.

4.5.4 Outlet of breathing device or pressure relief device

The outlet of the breathing device for unsealed equipment and the outlet of the pressure relief device for sealed equipment shall face down and have a degree of protection of at least IP66 as given in IEC 60529.

4.5.5 Enclosures intended to be opened

Enclosure that are designed to be opened shall incorporate sealing methods that are capable of being renewed without damage to the enclosure when the equipment is repaired, refilled and resealed. The enclosure shall be marked in accordance with 7 d).

4.5.6 Determination of the maximum/minimum criteria of the protective liquid

The following criteria shall be specified:

a) the maximum and minimum level of the protective liquid;

b) the maximum working angle, from the horizontal, of the equipment;

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4.6 Immersion depth

Live parts of the electrical equipment shall be immersed to a depth according to Table 2 within the protective liquid, at the minimum possible liquid level no matter the orientation of the internal equipment.

Table 2 – Depth of immersion

Voltage (See [a]) $U_{r.m.s.}$ a.c. or d.c. V	Distance	
	No switching device	With a switching device *(a.c. only)*
≤ 50 V	3 mm	10 mm
≤ 250 V	5 mm	15 mm
≤ 1 000 V	10 mm	20 mm
≤ 6 000 V	25 mm	50 mm
≤ 10 000 V	25 mm	–
≤ 13 640 V	50 mm	–

[a] When determining the required values for depth of immersion, the working voltage may be higher than the voltage in the table by a factor of 1,1 (see Note).

NOTE The factor of 1,1 recognizes that at many places in a circuit, the working voltage equals the rated voltage and that there are a number of rated voltages in common use that can be accommodated by the 1,1 factor.

4.7 Protective liquid level indication

4.7.1 General

Protective liquid level indicating device(s) complying with the following requirements shall be provided so that the liquid level of each separate liquid-filled compartment can be easily checked in service.

The maximum and the minimum protective liquid levels permissible in normal service shall be marked in accordance with 7 e), taking into account the effects of expansion and contraction resulting from operational temperature changes over the full ambient temperature range specified by the manufacturer.

The protective liquid level indicating device shall be marked in accordance with 7 f) to indicate the levels to which the electrical equipment shall be filled under the filling temperature conditions specified by the manufacturer. Alternatively, an adjacent label shall be provided which fully specifies the filling conditions.

The location of the protective liquid level indicating device shall be such that the minimum possible indicated level of the protective liquid cannot be beneath the level necessary to comply with 4.6, taking into account the effects of expansion and contraction resulting from operational temperature changes over the full ambient temperature range specified by the manufacturer.

The manufacturer shall prepare documentation to show that transparent parts will retain their mechanical and optical properties when in contact with the protective liquid.

For non-sealed equipment, a dipstick may be used provided that, in normal operation, the dipstick is secured in its measurement position and that the requirements of 4.5.1 with regard to ingress protection are maintained. An adjacent warning marking shall be provided in accordance with 7 g).

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4.7.2 Remote-indicating protective liquid level indicator

If a remote-indicating protective liquid level indicator is provided, the switching element shall be lower than the sensing element by at least the dimension shown in Table 2, or it shall be protected by one of the types of protection suitable for the application. If the manufacturer does not provide the remote-indicating liquid level indicator, the certificate number shall include the "X" suffix in accordance with IEC 60079-0 and the Specific Condition of Use shall specify all necessary information required by the user to ensure conformity with the requirements of this standard.

4.7.3 Safety devices for Level of Protection “ob”

For Level of Protection “ob” with switching devices, a protective liquid level safety device shall monitor the level of the protective liquid and provide for automatic disconnection of power upon reduction of oil below the permitted minimum. The switching element of the safety device shall be lower than the sensing element of the safety device by at least the dimension shown in Table 2, or shall be protected by one of the types of protection suitable for the application If the manufacturer does not provide the safety devices, the certificate number shall include the "X" suffix in accordance with IEC 60079-0 and the Specific Condition of Use shall specify all necessary information required by the user to ensure conformity with the requirements of this standard.

NOTE Safety devices for these applications normally have a fault tolerance of 0 and a safety integrity level SIL 1. Requirements for such safety devices are currently given in EN 50495. A project has been initiated to consider the development of an IEC standard based on EN 50495 which would provide requirements for these safety devices.

4.8 Temperature limitations

4.8.1 General

The maximum permissible temperature for equipment or parts of equipment shall be equal to the lower of the two temperatures determined by 4.8.2 or 4.8.3

4.8.2 Maximum Surface Temperature

The temperature at the free surface of the protective liquid or at any point on the surface of the electrical equipment to which an explosive gas atmosphere has access shall not exceed the limit for the assigned temperature class or assigned maximum surface temperature. In no case shall the limit exceed 200 °C.

4.8.3 Flashpoint of the protective liquid

The stated minimum flash-point (closed cup) for the protective liquid used shall be at least 25 K greater than the temperature at the free surface of the protective liquid and the temperature of the internal components immersed in the liquid.

4.9 Field wiring connections to liquid immersion equipment

Liquid immersion is not an accepted type of protection for field wiring connections. Bushings shall be used for connections through the wall of the equipment. Direct entry is not permitted.

The field wiring connections shall be protected with a type of protection suitable for the application.

4.10 Constructional elements of enclosures

4.10.1 Operating rods, shafts etc.

If the enclosure contains operating rods, shafts etc. it shall comply with the tests of 6.1.1 and 6.1.2 if a sealed enclosure and 6.1.3 if an unsealed enclosure. The tests shall be carried out

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