UL 60079-6

STANDARD FOR SAFETY

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

UL Standard for Safety for Explosive Atmospheres – Part 6: Equipment Protection by Liquid Immersion "o", UL 60079-6

Fourth Edition, Dated April 29, 2016

Summary of Topics

This revision of ANSI/UL 60079-6 dated August 14, 2020 is being issued to update the title page to reflect the reaffirmation of its ANSI approval. No changes in requirements have been made.

This standard is an adoption of IEC 60079-6, Explosive Atmospheres – Part 6: Equipment Protection by Liquid Immersion "o" (fourth edition issued by IEC February 2015) with US National Differences.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated June 5, 2020.

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UL 60079-6

Standard for Explosive Atmospheres – Part 6: Equipment Protection by Liquid Immersion "o"

First Edition – December, 2002
Second Edition – March, 2007
Third Edition – July, 2009

Fourth Edition

April 29, 2016

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through August 14, 2020.

The most recent designation of ANSI/UL 60079-6 as a Reaffirmed American National Standard (ANS) occurred on July 31, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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Preface (UL)

This UL Standard is based on IEC Publication 60079-6: fourth edition Explosive atmospheres – Part 6: Equipment protection by liquid immersion "o". IEC publication 60079-6 is copyrighted by the IEC.

Note – 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.

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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.

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 from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

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, figure, or annex. 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, figure, or annex 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, figure, or annex of the base IEC text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

EXPLOSIVE ATMOSPHERES – Part 6: Equipment protection by liquid immersion "o"

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 Publication(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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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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 some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

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.

EXPLOSIVE ATMOSPHERES – Part 6: Equipment protection by liquid immersion "o"

1 Scope

1DV.1 DE *Modification of Clause 1, first paragraph to replace with the following:*

1DV.1.1 This standard ~~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.

1DV.2 DR *Modification of Clause 1, fifth paragraph to replace with the following:*

1DV.2.1 This standard supplements and modifies the general requirements of UL 60079-0 ~~IEC 60079-0~~. Where a requirement of this standard conflicts with a requirement of UL 60079-0 ~~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.

2DV DR *Modification of Clause 2 references to replace with the following:*

~~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***

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***

UL 60079-0, ***Explosive Atmospheres Part 0: Equipment – General Requirements***

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

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.

4.1DV.1 DR *Modification of Clause 4.1 NOTE to replace with the following:*

NOTE In accordance with the requirements for all electrical equipment given in UL 60079-0 ~~IEC 60079-0~~, it is assumed that the relevant industrial requirements have been applied. The requirements of the UL 60079-0 and its sub-parts ~~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

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.

4.2.2DV.1 DR *Modification of Clause 4.2.2, third paragraph to add the following NOTE after item c):*

NOTE The National Electrical Code®, (NEC®), ANSI/NFPA 70, may limit the use of increased safety terminations to 10 kA available short circuit current.

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.

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.

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;

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).

4.7.2 Remote-indicating protective liquid level indicator

4.7.2DV DR *Modification of Clause 4.7.2 to replace with the following:*

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 equipment shall be marked ~~certificate number shall include the "X" suffix~~ in accordance with UL 60079-0 ~~IEC 60079-0~~ to indicate that there are Specific Conditions of Use 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”

4.7.3DV DR *Modification of Clause 4.7.3 to replace with the following:*

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 equipment shall be marked ~~certificate number shall include the "X" suffix~~ in accordance with UL 60079-0 ~~IEC 60079-0~~ to indicate that there are Specific Conditions of Use 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 with such elements in place. Operating rods or shafts used in a sealed enclosure shall be subject to a conditioning of 500 operations prior to the tests of 6.1.1 and 6.1.2

4.10.2 Devices for draining of liquid

Devices for draining the liquid shall be secured against inadvertent removal.

5 Protective Liquid

5.1 Protective liquid specification

The protective liquid shall be a mineral oil conforming to IEC 60296, a silicone liquid conforming to IEC 60836, a synthetic organic ester liquid (Type T1) conforming to IEC 61099, or shall be a liquid conforming to the requirements of 5.2.

NOTE The future use of natural ester liquids per IEC 62770 is under consideration.

5.2 Detailed alternative specification

The specification for the alternative protective liquid shall include the following:

a) the protective liquid shall have a fire point of not less than 300 °C determined by the test method indicated in ISO 2592;

b) the protective liquid flash-point (closed cup) determined in accordance with ISO 2719 shall be not less than 25 K above the free surface temperature of the protective liquid (See 4.8.3);

c) the protective liquid shall have a kinematic viscosity of not more than 100 cSt at 25 °C determined in accordance with ISO 3104;

d) the protective liquid shall have an electrical breakdown strength of not less than 30 kV determined in accordance with IEC 60156;

e) the protective liquid shall have a volume resistivity at 25 °C of not less than 1×10^{12} Ω × m determined in accordance with IEC 60247;

f) the pour point, determined in accordance with ISO 3016, shall be no higher than the lower of -30 °C or 10 K less than the minimum ambient temperature of the equipment;

g) the acidity (neutralization value) shall be not more than 0,03 mg KOH/g determined in accordance with IEC 62021-1;

h) the protective liquid shall have no adverse effect on the properties of materials with which it is in contact;

i) the oxidation stability shall not exceed 0,15 % sludge according to IEC 61125;

j) the sulphur content shall be confirmed as non-corrosive according to IEC 62535; and

k) the water content shall not exceed 35 ppm according to IEC 60814.

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

5.3 Group I equipment

For Group I equipment, mineral oils are not acceptable.

5.4 Liquid contamination and gassing that may result from arcing

Where switching devices are incorporated in the electrical equipment and may give rise to contamination of the protective liquid, suitable maintenance instructions shall be prepared. As a minimum these will include instructions for the cleaning/filtering/replacement of the protective liquid following a given number of normal switching operations and following interruption of fault currents.

5.5 Total volume of the protective liquid

The documentation prepared in accordance with IEC 60079-0 shall specify the total volume of the protective liquid, including the maximum and minimum volumes to maintain the levels required as given in 4.6.

6 Verifications and tests

6.1 Type tests

6.1.1 Overpressure test on sealed enclosures

For Level of Protection “ob” with a switching device switching more than 2 kVA per contact, a pressure equal to 4 times the pressure relief device setting, and for all other enclosures, a pressure equal to 1,5 times the pressure relief device setting shall be applied internally. In no case shall the test pressure be less than 150 kPa. The period of application of the pressure shall be at least 60 s. The pressure relief device entry shall be sealed for the duration of the test.

The test shall be considered satisfactory if, at the end of the test, the enclosure has suffered neither damage nor permanent distortion which adversely affects its ability to comply with 4.6.

NOTE A non-compressible hydraulic media is normally used for these tests. If a compressible media such as air or inert gas is used, failure of the enclosure can result in personal injury or property damage.

6.1.2 Reduced pressure test on sealed enclosures

The internal pressure of the enclosure without protective liquid shall be reduced by an amount equivalent to not less than the pressure that would result from a change in the protective liquid level from the maximum permissible level to the minimum permissible level when appropriately corrected for any ambient temperature variations specified in the documentation.

At the end of 24 h, any increase in pressure shall not exceed 5 %.

6.1.3 Overpressure test on unsealed enclosures

A pressure equal to 150 kPa, with the breather sealed, shall be applied internally. The period of application shall be at least 60 s.

The test shall be considered satisfactory if, at the end of the test, the enclosure has suffered neither damage nor permanent distortion that adversely affects its ability to comply with 4.5.3 and 4.5.5.

NOTE A non-compressible hydraulic media is normally used for these tests. If a compressible media such as air or inert gas is used, failure of the enclosure can result in personal injury or property damage.

6.1.4 Maximum temperature

A sample of “o” equipment shall be subjected to a type test to ensure that the temperature limits specified in 4.8 are not exceeded.

For “o” equipment without an external load, the test shall be carried out in accordance with the temperature measurements of IEC 60079-0.

For “o” equipment with an external load, the test shall be carried out for Level of Protection “ob” by adjusting the current to 110 % of the rated current and for Level of Protection “oc” at 100 % of the rated current in normal operation and at the maximum rated duty cycle.

NOTE Equipment with characteristics such as non-linear external loads, input power control or difficult to define failure modes introduces challenges into the determination of maximum temperatures under malfunction conditions.

6.1.5 Switching Tests

The electrical switching tests given in the relevant IEC industrial standards shall be carried out with the equipment in its design configuration. The protective liquid shall be at minimum level. At the conclusion of the tests:

a) there shall be no release of the protective liquid nor shall the required creepage and clearance distances be compromised; and

b) the protective liquid shall have an electrical breakdown strength of not less than 30 kV determined in accordance with IEC 60156.

6.2 Routine tests

6.2.1 Sealed enclosures

Each sealed enclosure shall be subjected to both the following tests in sequence:

a) the overpressure test described in 6.1.1. This routine test may be omitted for other than welded enclosures, if during type testing, the equipment complies with the acceptance criteria in 6.1.1 using four times the pressure relief device setting;

NOTE A non-compressible hydraulic media is normally used for these tests. If a compressible media such as air or inert gas is used, failure of the enclosure can result in personal injury or property damage.

b) the test described in 6.1.2 or an equivalent accelerated test using a lower pressure. In the latter case, the calculations shall be documented to demonstrate that his test will achieve the same threshold value of leakage as in the 24 h test.

6.2.2 Unsealed enclosures

Each unsealed enclosure shall be subjected to the test specified in 6.1.3. This routine test may be omitted for other than welded enclosures, if during type testing; the equipment complies with the acceptance criteria in 6.1.3 using 600 kPa.

NOTE A non-compressible hydraulic media is normally used for these tests. If a compressible media such as air or inert gas is used, failure of the enclosure can result in personal injury or property damage.

7 Marking

Ex Equipment or Ex Components of liquid immersion “o” shall be marked in accordance with IEC 60079-0, with the following additional marking:

a) the protective liquid to be used;

b) the pressure relief device setting (where appropriate);

c) “This enclosure has been permanently sealed and cannot be repaired” (where appropriate);

d) “This enclosure is factory sealed – Consult manufacturer’s instructions for repair” (where appropriate);

e) minimum and maximum level of protective fluid;