SLOVENSKI STANDARD
SIST EN 60599:1999

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Nadomešča:
SIST HD 397 S1:1998

Električna oprema, impregnirana z mineralnim oljem, v delovanju – Vodilo za tolmačenje rezultatov analize raztopljenih in prostih plinov (IEC 60599:1999)

Mineral oil-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gases analysis

In Betrieb befindliche, mit Mineralöl imprägnierte elektrische Geräte - Leitfaden zur Interpretation der Analyse gelöster und freier Gase

Matériels électriques imprégnés d'huile minérale en service - Guide pour l'interprétation de l'analyse des gaz dissous et des gaz libres

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Mineral oil-impregnated electrical equipment in service Guide to the interpretation of dissolved and free gases analysis (IEC 60599:1999)

Matériels électriques imprégnés d'huile minérale en service - Guide pour l'interprétation de l'analyse des gaz dissous et des gaz libres (CEI 60599:1999)

Im Betrieb befindliche, mit Mineralöl imprägnierte elektrische Geräte Leitfaden zur Interpretation der Analyse gelöster und freier Gase (IEC 60599:1999)

This European Standard was approved by CENELEC on 1999-01-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of document 10/450/FDIS, future edition 2 of IEC 60599, prepared by IEC TC 10, Fluids for electrotechnical applications, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60599 on 1999-01-01.

This European Standard supersedes HD 397 S1:1979.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-01-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2002-01-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annexes A, B and C are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60599:1999 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE: When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050(191)	1990	International Electrotechnical Vocabulary (IEV) Chapter 191: Dependability and quality of service	-	-
IEC 60050(212)	1990	Chapter 212: Insulating solids, liquids and gases	-	-
IEC 60050(604)	1987	Chapter 604: Generation, transmission and distribution of electricity - Operation	-	-
IEC 60567	1992	Guide for the sampling of gases and of oil from oil-filled electrical equipment and for the analysis of free and dissolved gases	EN 60567	1992
IEC 61198	1993	Mineral insulating oils - Methods for the determination of 2-furfural and related compounds	EN 61198	1994

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Guide pour l'interprétation de l'analyse des gaz dissous et des gaz libres

Mineral oil-impregnated electrical equipment in service –

Guide to the interpretation of dissolved and free gases analysis

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MINERAL OIL-IMPREGNATED ELECTRICAL EQUIPMENT IN SERVICE – GUIDE TO THE INTERPRETATION OF DISSOLVED AND FREE GASES ANALYSIS

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60599 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications.

This second edition cancels and replaces the first edition published in 1978. This second edition constitutes a technical revision.

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

FDIS	Report on voting
10/450/FDIS	10/460/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.

Annexes A, B and C are for information only.

INTRODUCTION

Dissolved and free gas analysis (DGA) is one of the most widely used diagnostic tools for detecting and evaluating faults in electrical equipment. However, interpretation of DGA results is often complex and should always be done with care, involving experienced insulation maintenance personnel.

This guide gives information for facilitating this interpretation. The first edition, published in 1978, has served the industry well, but had its limitations, such as the absence of a diagnosis in some cases, the absence of concentration levels and the fact that it was based mainly on experience gained from power transformers. This second edition attempts to address some of these shortcomings. Interpretation schemes are based on observations made after inspection of a large number of faulty oil-filled equipment in service and concentrations levels deduced from analyses collected worldwide.

MINERAL OIL-IMPREGNATED ELECTRICAL EQUIPMENT IN SERVICE – GUIDE TO THE INTERPRETATION OF DISSOLVED AND FREE GASES ANALYSIS

1 Scope

This International Standard is a guide describing how the concentrations of dissolved gases or free gases may be interpreted to diagnose the condition of oil-filled electrical equipment in service and suggest future action.

This guide is applicable to electrical equipment filled with mineral insulating oil and insulated with cellulosic paper or pressboard-based solid insulation. Information about specific types of equipment such as transformers (power, instrument, industrial, railways, distribution), reactors, bushings, switchgear and oil-filled cables is given only as an indication in the application notes (see annex A).

The Guide may be applied only with caution to other liquid-solid insulating systems.

In any case, the indications obtained should be viewed only as guidance and any resulting action should be undertaken only with proper engineering judgment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(191):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

IEC 60050(212):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 212: Insulating solids, liquids and gases*

IEC 60050(604):1987, *International Electrotechnical Vocabulary (IEV) – Chapter 604: Generation, transmission and distribution of electricity – Operation*

IEC 60567:1992, *Guide for the sampling of gases and of oil from oil-filled electrical equipment and for the analysis of free and dissolved gases*

IEC 61198:1993, *Mineral insulating oils – Methods for the determination of 2-furfural and related compounds*

3 Definitions and abbreviations

3.1 Definitions

For the purpose of this International Standard, the following definitions, some of them based on IEC 60050(191), IEC 60050(212) and IEC 60050(604) apply:

3.1.1
fault
an unplanned occurrence or defect in an item which may result in one or more failures of the item itself or of other associated equipment [IEV 604-02-01]

NOTE – In electrical equipment, a fault may or may not result in damage to the insulation and failure of the equipment.

3.1.2
non-damage fault
a fault which does not involve repair or replacement action at the point of the fault
[IEV 604-02-09]

NOTE – Typical examples are self-extinguishing arcs in switching equipment or general overheating without paper carbonization.

3.1.3
damage fault
a fault which involves repair or replacement action at the point of the fault
[IEV 604-02-08, modified]

3.1.4
incident
an event related to an internal fault which temporarily or permanently disturbs the normal operation of an equipment [IEV 604-02-03, modified]

NOTE – Typical examples are gas alarms, equipment tripping or equipment leakage.

3.1.5
failure
the termination of the ability of an item to perform a required function [IEV 191-04-01]

NOTE – In the electrical equipment, failure will result from a damage fault or incident necessitating outage, repair or replacement of the equipment, such as internal breakdown, rupture of tank, fire or explosion.

3.1.6
electrical fault
a partial or disruptive discharge through the insulation

3.1.7
partial discharge
a discharge which only partially bridges the insulation between conductors. It may occur inside the insulation or adjacent to a conductor [IEV 212-01-34, modified]

NOTE 1 – Corona is a form of partial discharge that occurs in gazeous media around conductors which are remote from solid or liquid insulation. This term is not to be used as a general term for all forms of partial discharges.

NOTE 2 – X-wax is a solid material which is formed from mineral insulating oil as a result of electrical discharges and which consists of polymerized fragments of the molecules of the original liquid [IEV 212-07-24, modified]. Comparable products may be formed from other liquids under similar conditions.

NOTE 3 – Sparking of low energy, for example because of metals or floating potentials, is sometimes described as partial discharge but should rather be considered as a discharge of low energy.

3.1.8
discharge (disruptive)
the passage of an arc following the breakdown of the insulation [IEV 604-03-38, modified]

NOTE 1 – Discharges are often described as arcing, breakdown or short circuits. The more specific following terms are also used:

– sparkover (discharge through the oil);
– puncture (discharge through the solid insulation);
– flashover (discharge at the surface of the solid insulation);
– tracking (the progressive degradation of the surface of solid insulation by local discharges to form conducting or partially conducting paths);
– sparking discharges which, in the conventions of physics, are local dielectric breakdowns of high ionization density or small arcs.

NOTE 2 – Depending on the amount of energy contained in the discharge, it will be described as a discharge of low or high energy, based on the extent of damage observed on the equipment (see 5.2).

3.1.9
thermal fault
excessive temperature rise in the insulation

NOTE – Typical causes are
– insufficient cooling,
– excessive currents circulating in adjacent metal parts (as a result of bad contacts, eddy currents, stray losses or leakage flux),
– excessive currents circulating through the insulation (as a result of high dielectric losses), leading to a thermal runaway,
– overheating of internal winding or bushing connection lead.

3.1.10
typical values of gas concentrations
gas concentrations normally found in the equipment in service which have no symptoms of failure, and which are overpassed by only an arbitary percentage of higher gas contents, for example 10 % (see 8.2.1)

NOTE 1 – Typical values will differ in different types of equipment and in different networks, depending on operating practices (load levels, climate, etc.).

NOTE 2 – Typical values, in many countries and by many users, are quoted as "normal values", but this term has not been used here to avoid possible misinterpretations.

3.2 Abbreviations

3.2.1 Chemical names and symbols

Name	Symbol
Nitrogen	N_2
Oxygen	O_2
Hydrogen	H_2
Carbon monoxide	CO
Carbon dioxide	CO_2
Methane	CH_4
Ethane	C_2H_6
Ethylene	C_2H_4
Acetylene	C_2H_2

3.2.2 General abbreviations

DGA: Dissolved gas analysis
CIGRE: Conférence Internationale des Grands Réseaux Électriques
S: Analytical detection limit