SLOVENSKI STANDARD
SIST EN 60567:1997

01-oktober-1997

Guide for sampling of gases and of oil from oil-filled electrical equipment and for the analysis of free dissolved gases (IEC 567:1992)

Guide for the sampling of gases and of oil from oil-filled electrical equipment and for the analysis of free and dissolved gases

Anleitung für die Probenahme von Gasen und von Öl aus ölgefüllten elektrischen Betriebsmitteln und für die Analyse freier und gelöster Gase

Guide d'échantillonnage de gaz et d'huile dans les matériels électriques immergés, pour l'analyse des gaz libres ou dissous

Ta slovenski standard je istoveten z: **EN 60567:1992**

ICS:

29.040.10 Izolacijska olja Insulating oils

SIST EN 60567:1997 **en**

EUROPEAN STANDARD

NORME EUROPEENNE

EUROPÄISCHE NORM

EN 60567

September 1992

UDC 621.315.615.2:665.767:620.113:543.27

Descriptors: Electrical equipment, gas, oil, sampling, sample, gas analysis, methode by extraction, gas chromatography

ENGLISH VERSION

Guide for the sampling of gases and of oil from oil-filled electrical equipment and for the analysis of free and dissolved gases (IEC 567:1992)

Guide d'échantillonnage de gaz et d'huile dans les matériels électriques immergés, pour l'analyse des gaz libres et dissous

(CEI 567:1992)

Anleitung für die Probenahme von Gasen und von Öl aus ölgefüllten elektrischen Betriebsmitteln und für die Analyse freier und gelöster Gase

(IEC 567:1992)

This European Standard was approved by CENELEC on 1992-06-16. 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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

FOREWORD

The text of document 10(CO)260, as prepared by IEC Technical Committee N° 10: Fluids for electrotechnical applications, was submitted to the IEC-CENELEC parallel vote in September 1991.

The reference document was approved by CENELEC as EN 60567 on 16 June 1992.

The following dates were fixed:

- latest date of publication of an identical national standard	(dop)	1993-07-01
- latest date of withdrawal of conflicting national standards	(dow)	1993-07-01

Annexes designated "normative" are part of the body of the standard. In this standard, annex ZA is normative.

ENDORSEMENT NOTICE

The text of the International Standard IEC 567:1992 was approved by CENELEC as a European Standard without any modification.

ANNEX ZA (normative)

OTHER INTERNATIONAL PUBLICATIONS QUOTED IN THIS STANDARD WITH THE REFERENCES OF THE RELEVANT EUROPEAN PUBLICATIONS

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

IEC Publication	Date	Title	EN/HD	Date
296	1982	Specification for unused mineral insulating oils for transformers and switchgear	-	-
599	1978	Interpretation of the analysis of gases in transformers and other oil-filled electrical equipment in service	HD 397 S1	1979

Other publication

ISO 5725:1986 - Precision of test methods - Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests

NORME INTERNATIONALE
INTERNATIONAL STANDARD

CEI
IEC
567

Deuxième édition
Second edition
1992-07

Guide d'échantillonnage de gaz et d'huile dans les matériels électriques immergés, pour l'analyse des gaz libres et dissous

Guide for the sampling of gases and of oil from oil-filled electrical equipment and for the analysis of free and dissolved gases

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE W

Pour prix, voir catalogue en vigueur
For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDE FOR THE SAMPLING OF GASES AND OF OIL FROM OIL-FILLED ELECTRICAL EQUIPMENT AND FOR THE ANALYSIS OF FREE AND DISSOLVED GASES

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This International Standard has been prepared by IEC Technical Committee No. 10: Fluids for electrotechnical applications.

This second edition replaces the first edition of IEC Publication 567, issued in 1977.

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

DIS	Report on Voting
10(CO)260	10(CO)271

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

INTRODUCTION

Gases may be formed in oil-filled electrical equipment due to natural ageing, but also, to a much greater extent, as a result of faults.

Operation with a fault may seriously damage the equipment and it is valuable to be able to detect the fault at an early stage of development.

Where a fault is not severe, the gases formed will normally dissolve in the oil, with a small proportion eventually diffusing from the liquid into any gas phase above it. Extracting dissolved gas from a sample of the oil and determining the amount and composition of this gas is a means of detecting such faults, and the type and severity of any fault may often be inferred from the composition of the gas and the rate at which it is formed.

In the case of a sufficiently severe fault, free gas will pass through the oil and collect in the gas-collecting (Buchholz) relay if fitted; if necessary this gas may be analysed to assist in determining the type of fault that has generated it. The composition of gases within the bubbles changes as they move through the oil towards the gas-collecting relay.

This can be put to good use, as information on the rate of gas production may often be inferred by comparing the composition of the free gases collected with the concentrations remaining dissolved in the liquid.

The interpretation of the gas analyses is the subject of IEC 599.

These techniques are valuable at all stages in the life of oil-filled equipment. During acceptance tests on transformers in the factory, comparison of gas-in-oil analyses before, during and after a heat run test can show if any hot-spots are present, and similarly analysis after dielectric testing can add to information regarding the presence of partial discharges or sparking. During operation in the field, the periodic removal of an oil sample and analysis of the gas content serve to monitor the condition of transformers and other oil-filled equipment.

The importance of these techniques has led to the preparation of this guide to the procedures to be used for the sampling, from oil-filled electrical equipment, of gases and oils containing gases, and for subsequent analysis.

NOTE - Methods described in this guide apply to mineral insulating oils, since experience to date has been almost entirely with such oils. The methods may also be applied to other insulating liquids, in some cases with modifications.

GUIDE FOR THE SAMPLING OF GASES AND OF OIL FROM OIL-FILLED ELECTRICAL EQUIPMENT AND FOR THE ANALYSIS OF FREE AND DISSOLVED GASES

1 Scope

This guide deals with the techniques for sampling free gases from gas-collecting relays and for sampling oil from oil-filled equipment such as power and instrument transformers, reactors, bushings, oil-filled cables and oil-filled tank-type capacitors. Three methods of sampling free gases and three methods of sampling oil are described; the choice between the methods often depends on the apparatus available and on the quantity of oil needed for analysis.

Before analysing the gases dissolved in oil, they must first be extracted from the oil. Two basic methods are described, one using extraction by vacuum and the other by stripping (displacing) the dissolved gases by bubbling the carrier gas through the oil sample. The gases are analysed quantitatively after extraction by gas chromatography; a method of analysis is described. Free gases from gas-collecting relays are analysed without preliminary treatment.

The preferred method for assuring the performance of the gas extraction and analysis equipment, considered together as a single system, is to degas samples of oil prepared in the laboratory and containing known concentrations of gases ("gas-in-oil standards"), and quantitatively analyse the gases extracted. Two methods of preparing gas-in-oil standards are described.

For daily calibration checks of the chromatograph, it is convenient to use a standard gas mixture containing a suitable known amount of each of the gas component to be analysed and diluted by nitrogen or by the carrier gas.

The techniques described take account, on the one hand, of the problems peculiar to analyses associated with acceptance testing in the factory, where gas contents of oil are generally very low and, on the other hand, of the problems imposed by monitoring equipment in the field, where transport of samples may be by unpressurised air freight and where considerable differences in ambient temperature may exist between the plant and the examining laboratory.

2 Normative references

The following standards 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 standards 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 standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 296: 1982, *Specification for unused mineral insulating oils for transformers and switchgear.*

IEC 599: 1978, *Interpretation of the analysis of gases in transformers and other oil-filled electrical equipment in service.*

ISO 5725: 1986, *Precision of test methods. Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests.*

3 Sampling of gases from gas-collecting (Buchholz) relays

3.1 *General remarks*

Gas samples from relays should be taken from the equipment with the minimum delay after gas accumulation has been signalled. Changes in composition caused by the selective reabsorption of components may occur if free gases are left in contact with oil.

Certain precautions are necessary when taking gas samples. The connection between the sampling device and the sampling vessel must avoid the ingress of air. Temporary connections should be as short as possible. Any rubber or plastic tubing used should have been proved to be impermeable to gases.

Gas samples should be properly labelled (see clause 5) and analysed without undue delay to minimize hydrogen loss (e.g. within a maximum period of one week).

Oxygen, if present in the gas, may react with any oil drawn out with the sample. Reaction is delayed by excluding light from the sample, for example by wrapping the vessel in aluminium foil or suitable opaque material.

Of the three methods described below, the syringe method is frequently preferred.

Sampling into a sampling tube by liquid displacement, using transformer oil as a sealing liquid, is simple but the different solubilities of the gas components may need to be taken into account if the gas quantity is such that some oil remains in the tube.

The vacuum method requires skill to avoid contaminating the sample by leakage of air into the system. It is particularly true where the gas to be sampled may be at less than atmospheric pressure (e.g. some sealed transformers).

3.2 *Sampling of free gases by syringe*

3.2.1 *Sampling equipment* (see figure 1)

1) Impermeable oil-resistant plastic or rubber tubing ③ provided with a connector to fit on to a suitable sampling connection of the gas-collecting relay.

2) Gas-tight syringes of suitable volume 1 (25 ml to 250 ml). Medical or veterinary quality glass syringes with ground-in plungers may be suitable; alternatively, syringes with oil-proof seals may be used. The syringe should be fitted with a cock enabling it to be sealed. It is often convenient to use the same syringes for both gas sampling and for oil sampling (see item 2 of 4.2.1). The gas tightness of a syringe may be tested by storing an oil sample containing a measurable quantity of hydrogen for at least two weeks and analysing aliquots for hydrogen at the beginning and end of the period. An acceptable syringe will permit losses of hydrogen of less than 2,5 % per week. General experience suggests that all-glass syringes leak less than those using plastic seals. Improvement of the gas tightness may be obtained by the use of a lubricant such as a light grease or transformer oil.

3) Transport containers which should be designed to hold the syringe firmly in place during transport but allow the syringe plunger freedom to move.

3.2.2 *Sampling procedure*

The apparatus is connected as shown in figure 1. The connections should be as short as possible and filled with oil at the start of sampling.

Sampling valve 5 is opened. If sampling from a gas-collecting relay on a transformer fitted with a conservator, a positive pressure will exist; the three-way cock 4 is carefully turned to position A and the oil in the connecting tubing 3 allowed to flow to waste 7. When gas reaches the three-way cock 4, the latter is turned to position B to connect the prelubricated syringe 1. Cock 2 is then opened and the syringe allowed to fill under the hydrostatic pressure, taking care that its plunger is not expelled. When a sufficient sample has been taken, cock 2 and sampling valve 5 are closed and the apparatus is disconnected.

The oil in the syringe is expelled by inverting the syringe and applying gentle pressure to the plunger.

Label carefully the sample (see clause 5).

3.3 *Sampling of free gases by displacement of oil*

This method is reliable only where the gas sample is at or above atmospheric pressure. The apparatus is shown in figure 2.

The sampling tube 28, typically of 100 ml capacity, is preferably of glass since the operator can then see how much oil remains in it during gas sampling. The sampling tube is filled with oil from the transformer on site. Before being used as described below, the connecting tube 3 should also be filled with oil.

The open end of the connecting tube ③ is fitted on to the gas sampling valve ⑤. The sampling valve and inlet cock of the sampling tube are opened. The sampling tube is inclined so that its closed end is the lowest point. The outlet cock on the sampling tube is then opened, allowing oil to run out to waste ⑦, drawing first any oil from the connection between relay and sampling valve, and the gas from the relay, into the sampling tube.

Sampling is complete when the gas collecting relay is completely filled with oil or when nearly all oil has gone from the sampling tube.

Both cocks ② on the sampling tube and the sampling valve ⑤ are closed and then the connections removed.

3.4 *Sampling of free gases by vacuum*

The apparatus is connected as shown in figure 3. With the equipment sampling valve ⑤ closed, cocks ①, ② and ⑩ open and the three-way cock ④ turned to position A, the vacuum pump ⑫ is allowed to evacuate the connecting tubing, the trap and the sampling vessel.

A satisfactory vacuum will be below 100 Pa. The system should be checked for leaks by closing the pump suction cock ⑩ and observing that no appreciable change in vacuum occurs. Over a time equal to that which will be taken for sampling, the pressure should not increase by more than 100 Pa. Similarly, the stopcock ① on the sampling tube should be vacuum tight to the same degree over several weeks.

If the connecting tubing between the equipment sampling valve ⑤ and the gas-collecting relay is filled with oil, the three-way cock ④ is turned to position (B). The equipment sampling valve ⑤ is carefully opened and oil allowed to flow into the trap ⑨. When the end of the oil stream is observed to reach the three-way cock ④, it is turned to position D to evacuate the oil from it. Thereafter the cock ④ is turned to position C. When sampling is complete, cock ① is closed first, then the equipment sampling valve ⑤ closed and the apparatus disconnected.

If the connecting tubing between the equipment and the sampling valve is empty of oil, the procedure for draining oil is omitted and the three-way cock ④ used in position C after evacuating and testing that the apparatus is leak tight.

4 Sampling of oil from oil-filled equipment

4.1 *General remarks*

Warning: When sampling oil precautions should be taken to deal with any sudden release of oil.

Of the three methods described below, the method of sampling by syringe is the most adequate method of oil sampling and is suitable irrespective of the mode of transport of samples.

Sampling into glass sampling tubes is also suitable provided they are fitted with sufficient lengths of rubber tubings acting as expansion devices.

Stainless steel sampling tubes fitted with valves are very robust and are not affected by large temperature changes and can be used without expansion devices.

Sampling in glass bottles is also adequate provided the bottles are fitted with a suitable cap which allows oil expansion. Sampling into bottles is simple, requires little skill, and is adequate for many purposes such as routine sampling on a large scale from equipment on site. The use of bottles (0,5 litre to 2,5 litre capacity) may be preferred where comparatively large samples of oil are required. When using the glass bottle sampling method, care should be taken to minimize air contact with the sample.

The methods described are suitable for large oil-volume equipment such as power transformers. With small oil-volume equipment, it is essential to ensure that the total volume of oil drawn off does not endanger the operation of the equipment.

The selection of points from which samples are drawn should be made with care. Normally, the sample should be taken from a point where it is representative of the bulk of the oil in the equipment. It will sometimes be necessary, however, to draw samples deliberately where they are not expected to be representative (for example in trying to locate the site of a fault).

Samples should be taken with the equipment in its normal condition. This will be important in assessing the rate of gas production.

Some of the dissolved oxygen present in the oil sample may be consumed by oxidation. The reaction can be delayed by exclusion of light (e.g. by wrapping a clear glass sampling vessel in an opaque material) but, in any case, the analysis should be carried out as soon as possible after sampling.

4.2 *Sampling of oil by syringe*

4.2.1 *Sampling equipment*

1) Impermeable oil-proof plastic or rubber tubing to connect the equipment to the syringe. This should be as short as possible. A three-way cock should be inserted in the tubing.

The connection between the tubing and the equipment will depend upon the equipment. If a sampling valve suitable for fitting to a tubing has not been provided, it may be necessary to use a drilled flange, or a bored oil-proof rubber bung on a drain or filling connection.

2) Graduated gas-tight syringes of size suitable for containing an adequate oil sample volume (20 ml to 250 ml) fitted with a cock or an obturator so that it may be sealed. See item 2) of 3.2.1 for checking the gas-tightness of the syringe.