

# INTERNATIONAL STANDARD

**IEC**  
**60216-4-1**

Fourth edition  
2006-01

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**Electrical insulating materials –  
Thermal endurance properties –**

**Part 4-1:  
Ageing ovens –  
Single-chamber ovens**

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## Electrical insulating materials – Thermal endurance properties –

### Part 4-1: Ageing ovens – Single-chamber ovens

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland  
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: [inmail@iec.ch](mailto:inmail@iec.ch) Web: [www.iec.ch](http://www.iec.ch)



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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL INSULATING MATERIALS –  
THERMAL ENDURANCE PROPERTIES –****Part 4-1: Ageing ovens –  
Single-chamber ovens**

## FOREWORD

- 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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International Standard IEC 60216-4-1 was prepared by subcommittee 15E: Methods of test, of IEC technical committee 15: Insulating materials, which has now been merged with IEC technical committee 98: Electrical insulation systems into IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems (provisional title).

This fourth edition of IEC 60216-4-1 cancels and replaces the third edition, published in 1990, and constitutes a technical revision.

The main changes with regard to the previous edition is that this edition adapts IEC 60216-4-1 to the technical content and the editorial form of IEC 60216-4-2 and IEC 60216-4-3. In addition, errors and omissions in the third edition have been corrected.

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

FDIS	Report on voting
112/16/FDIS	112/23/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.

IEC 60216, under the general title *Electrical insulating materials – Thermal endurance properties*, is composed of several parts:

- Part 1: Ageing procedures and evaluation of test results
- Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria<sup>1</sup>
- Part 3: Instructions for calculating thermal endurance characteristics
- Part 4-1: Ageing ovens – Single-chamber ovens
- Part 4-2: Ageing ovens – Precision ovens for use up to 300 °C
- Part 4-3: Ageing ovens – Multi-chamber ovens
- Part 5: Determination of relative thermal endurance index (RTE) of an insulating material
- Part 6: Determination of thermal endurance indices (TI and RTE) of an insulating material using the fixed time frame method

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site 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.

A bilingual version of this publication may be issued at a later date.

<sup>1</sup> For revisions and new parts, see the current catalogue of IEC publications for an up-to-date list.

# ELECTRICAL INSULATING MATERIALS – THERMAL ENDURANCE PROPERTIES –

## Part 4-1: Ageing ovens – Single-chamber ovens

### 1 Scope

This part of IEC 60216 covers minimum requirements for ventilated and electrically heated single-chamber ovens, with or without forced gas circulation, for thermal endurance evaluation of electrical insulation. It covers ovens designed to operate over all or part of the temperature range from 20 °C above ambient to 500 °C. It gives acceptance tests and in-service monitoring tests for these ageing ovens.

### 2 Normative references

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

ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*

IEC 60335 (all parts), *Household and similar electrical appliances – Safety*  
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### 3 Terms and definitions

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

#### 3.1

##### rate of ventilation

*N*

number of air changes per hour in the exposure chamber at room temperature

#### 3.2

##### exposure volume

that central part of the exposure chamber that meets the requirements for temperature fluctuation, temperature difference and temperature variation

#### 3.3

##### exposure temperature

*T*

temperature selected for ageing test specimens to obtain data for the determination of effects of temperature

NOTE See also “global exposure temperature”.

#### 3.4

##### temperature fluctuation

$\delta T_1$

maximum change in temperature at one point in the exposure volume over a period of time

**3.5  
temperature difference** $\delta T_2$ 

maximum difference of temperature between any two points in the exposure volume at any one time

**3.6  
temperature variation** $\delta T_v$ 

difference between the highest temperature and the lowest temperature measured in the exposure volume over a period of time

**3.7  
global average temperature**

average temperature, calculated from the results of determinations made over a period of at least 3 h using nine sensors spaced throughout the exposure volume of the chamber

**3.8  
global exposure temperature**

considered to be equal to the global average temperature if the sensors are mounted in the same space as that containing the specimens

NOTE The term 'global exposure temperature' is frequently abbreviated to 'exposure temperature'.

**3.9  
time constant** (of a standard specimen)

measure of time taken for the temperature of a standard specimen to approach the exposure volume temperature

**3.10  
temperature deviation** $\delta T_d$ 

calculated difference in the exposure temperature from the intended value due to the combination of the temperature difference, temperature fluctuation and the error in the measurement of temperature

NOTE Examples for calculation of temperature deviation are given in Annex B.

**3.11  
ventilation**

continuous passage of pre-heated gas through the exposure chamber

**3.12  
standard oven**

oven which meets the requirements of this standard

**3.13  
precision oven**

oven with an electrically heated and ventilated chamber and with the ability to maintain the exposure temperature in its exposure volume within the limits given in IEC 60216-4-2

NOTE The limits for temperature difference and temperature fluctuation in the exposure volume given in this standard are looser than those given in IEC 60216-4-2.

**3.14  
oven chamber**

interior volume of a single chamber oven providing the space for exposing test specimens or accommodating an iso-box (see 3.15)



### 3.15

#### iso box

metal box with a close fitting door, mounted in the oven chamber and used as an exposure chamber to reduce the temperature deviation present in the un-modified oven chamber (see IEC 60216-4-2)

## 4 Constructional requirements

### 4.1 General

The oven shall be soundly constructed of suitable materials designed for continuous operation over the whole of the allowable temperature range.

All electrical and other ancillary fittings shall be readily accessible for maintenance purposes.

NOTE This standard does not cover all safety aspects. Additional information may be found in the IEC 60335 series.

### 4.2 Mechanical requirements

The materials of construction of the oven chamber and the interior fittings shall be chosen as to not influence the properties of the specimens.

NOTE Aluminium alloys and stainless steel have been found suitable in many cases. Copper based alloys and any materials that may give off interfering volatiles over the temperature range of the oven, for example some silicone resins, must not be used.

The interior of the oven shall be constructed of suitable corrosion-resistant, non-absorbent material, so fabricated that any joints are leak-proof and not subject to corrosion. The interior surfaces shall be easy to clean.

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Attention shall be given to ensure that the door to the oven chamber is provided with an efficient seal and that any gasket materials used do not influence the properties of the specimens.

### 4.3 Ventilation

The oven chamber shall be provided with a supply of pre-heated ventilating gas, passing the chamber at one side and being exhausted through another. Wherever possible, the ventilating gas shall be directed in such a manner as to produce mixing of the ventilated gas throughout the chamber.

The rate of ventilation available shall be in accordance with 5.5

Consideration shall be given to ensure adequate purity of the incoming ventilating gas to minimize influence on the results.

If specified, inlet vents shall enable air and/or other gases to be supplied from controlled sources.

The construction shall be fitted with equipment to switch off the oven and preferably activate an alarm when the supply of ventilating gas fails.

NOTE It is recommended that the exhaust from the oven chamber be vented to outside atmosphere, but precautions should be taken to ensure that volatiles produced by ageing specimens do not damage health or the environment.

#### 4.4 Specimen mounting arrangements

Provision shall be made for supporting/suspending and positioning specimens within the exposure volume. The specimens shall neither touch each other nor touch the chamber walls. The specimens and supports shall not occupy more than 25 % of the cross-sectional area of the chamber in any one plane, nor occupy more than 10 % of the effective working volume of the chamber.

NOTE If there is an expectation in practice that any of these maxima could be exceeded, the supplier and purchaser should agree with the user on whether dummy loads should be used during the assessment of performance.

#### 4.5 Temperature control and indicator systems

The temperature in the exposure volume shall be controllable to the limits given in Clause 5.

The oven chamber shall be fitted with a minimum of two temperature sensors (numbered 1 and 2). Before installation, the sensors 1 and 2 shall be calibrated by reference to a suitable standard (sensor 3) to give a maximum measurement uncertainty within  $\pm 1,0$  K. The difference in reading between the two sensors as a function of temperature shall be recorded.

Sensor 3 shall have a maximum uncertainty of  $\pm 0,5$  K.

Temperature sensor 1 shall be mounted in a convenient manner, and used to indicate the chamber temperature.

NOTE 1 It is recommended that the temperature should be recorded during the whole test procedure. The readout also allows early identification of any malfunction in the system.

Temperature sensor 2 shall be mounted as closely as possible to where the test specimens will be located. Its placement shall be well defined and reproducible. It may be removed after the measurements.

An independent sensor may be used to control the temperature. The placing of that sensor shall be at the manufacturer's discretion. The control system shall have a drift rate of less than 2 K/year.

NOTE 2 The sensors may be of any type that meets the requirements (for example liquid-filled thermometer, resistance thermometer).

NOTE 3 Since the performance of thermocouples is less precise than filled thermometers and resistance systems, their use is not recommended for the measurement of temperature, although they may be found suitable for the measurement of temperature difference.

Where liquid-filled thermometers are used, care shall be taken to ensure that the immersion depth in use is the same as that used during calibration.

The oven shall be equipped with an excess temperature control device which shall be independent of the main temperature control system. It shall switch off the electrical heaters in the case where the actual temperature exceeds the intended temperature by a certain pre-set amount. The system shall also ensure that a warning light or other warning device is switched on if the excess temperature device operates, and that the heaters are not started automatically again when the oven temperature has dropped below the set temperature value, but require a manual start after the warning light has been manually switched off.

### 5 Performance requirements

#### 5.1 Temperature

It shall be possible to control the temperature of the exposure volume to within the limits of temperature variation over the full range claimed by the manufacturer.

## 5.2 Temperature difference and temperature fluctuation

The maximum allowable temperature differences and temperature fluctuations over a period of 3 h shall be as shown in Table 1.

**Table 1 – Maximum allowable temperature differences and temperature fluctuations**

Temperature range °C	Maximum allowable temperature difference and fluctuation K
≤80	2
>80 to ≤180	2,5
>180 to ≤300	3
>300 to ≤400	4
>400 to ≤500	5

## 5.3 Temperature variation

The maximum allowable temperature variation is given in Table 2.

**Table 2 – Maximum allowable temperature variation**  
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Temperature range °C	Temperature variation K
≤80	4
>80 to ≤180	5
>180 to ≤300	6
>300 to ≤400	8
>400 to ≤500	10

## 5.4 Maximum temperature deviation

Within the exposure volume, the relevant temperature deviation shall not exceed 1,25 times the maximum allowable temperature variation within the relevant temperature range.

## 5.5 Rate of ventilation

Rates in the range 5 to 20 changes per hour shall be made available through the exposure chamber.

## 5.6 Exposure volume

The exposure volume shall be sufficient to accommodate the test specimens according to 4.3. It shall not be less than 50 % of the volume of the oven chamber.

NOTE Experience has shown that an exposure volume of 35 l to 70 l (litres) is generally convenient.