BRITISH STANDARD

BS EN 60068-2-2:1993
IEC 68-2-2:1974
(including Supplement A:1976 and Amendment 1:1993)

Environmental testing —

Part 2: Tests —

Tests B: Dry heat

The European Standard EN 60068-2-2:1993 has the status of a British Standard
This Part should be read in conjunction with Part 1.1 General and guidance

UDC 621.3:620.193.94-976

Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

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Belgium
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Sweden
Switzerland
United Kingdom

This British Standard, having been prepared under the direction of the General Electrotechnical Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 August 1993

The following BSI references relate to the work on this standard:
Committee reference GEL/15
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Amendments issued since publication

Amd. No.	Date	Comments

Contents

National foreword

This British Standard has been prepared under the direction of the General Electrotechnical Standards Policy Committee and is the English language version of EN 60068-2-2:1993 *Basic environmental testing procedures, Part 2: Tests, Tests B: Dry heat* including Amendment A1:1993, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 68-2-2:1974 including Supplement A:1976 and Amendment 1:1993, published by the International Electrotechnical Commission (IEC). It supersedes BS 2011-2.1B:1977 which is withdrawn.

This edition constitutes a reprint of the 1977 edition of BS 2011-2.1B including Amendment 1:1980 and was published to bring the numbering system of the British Standard into line with the European Standard EN 60068-2-2.

The title of BS EN 60068 has been changed to *Environmental testing* to correspond with the change in title of IEC Publication 68. This change reflects the fact that IEC Publication 68 and BS EN 60068 are concerned with the whole subject of testing and avoids any possible confusion over whether it is the procedures or the testing that are basic. Amendments are not being issued to the other Parts of BS EN 60068, but their titles are being changed when these Parts are reviewed.

For the purposes of this British Standard, any references to IEC page numbers in the text should be ignored.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60068-2-2

March 1993

+ A1

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UDC 621.3:620.193.94-976

Supersedes HD 323.2.2 S1:1988

Descriptors: Electricity, components, equipment, climatic test, dry heat, sudden change of temperature, gradual change of temperature, loading conditions, procedures, components specifications writing, equipment specifications writing

English version

Basic environmental testing procedures — Part 2: Tests — Tests B: Dry heat (includes amendment A1:1993)

(IEC 68-2-2:1974 + IEC 68-2-2A:1976 + A1:1993)

Essais fondamentaux climatiques et de robustesse mécanique
Deuxième partie: Essais
Essais B: Chaleur sèche
(inclut l'amendement A1:1993)
(CEI 68-2-2:1974 + CEI 68-2-2A:1976 + A1:1993)

Umweltprüfungen
Teil 2: Prüfungen
Prüfgruppe B: Trockene Wärme
(enthält Änderung A1:1993)
(IEC 68-2-2:1974 + IEC 68-2-2A:1976 + A1:1993)

This European Standard was approved by CENELEC on 1992-09-15. 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 Harmonization Document HD 323.2.2 S1:1988 (IEC 68-2-2:1974 + IEC 68-2-2A:1976) was submitted to the CENELEC voting procedure for conversion into a European Standard.

The text of the International Standard was approved by CENELEC as EN 60068-2-2 on 15 September 1992.

This European Standard supersedes HD 323.2.2 S1:1988.

The following date was fixed:

— latest date of publication of an identical national standard (dop) 1994-01-01

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative.

Foreword of EN 60068-2-2:1993/A1: 1993

The text of document 50B(CO) 332, as prepared by sub-committee 50B: Climatic tests, of IEC technical committee 50: Environmental testing, was submitted to the IEC-CENELEC parallel vote in February 1992.

The reference document was approved by CENELEC as amendment A1 to EN 60068-2-2 on 9 December 1992.

The following dates were fixed:

— latest date of publication of an identical national standard (dop) 1994-01-01

— latest date of withdrawal of conflicting national standards (dow) 1994-01-01

Contents

Relationship of suffixes between tests A: Cold, and tests B: Dry heat

The relationship of suffixes between Tests A: Cold, and Tests B: Dry heat, is shown in the following table:

Suffix letter	Tests A: Cold			Tests B: Dry heat		
	Specimen type	Temperature change	Specimen temperature at commencement of test duration	Specimen type	Temperature change	Specimen temperature at commencement of test duration
a	non heat	sudden	stabilized[a]	non heat	sudden	stabilized[a]
b	non heat	gradual	stabilized[a]	non heat	gradual	stabilized[a]
c	—	—	—	heat	sudden	stabilized[a]
d	heat	gradual	stabilized[a]	heat	gradual	stabilized[a]

[a] The specimens will normally reach temperature stability before commencement of test duration. In exceptional cases, this will not be so, and additional information will be required in the relevant specification. See Clause **1** of the Introduction and IEC Publication 68-3-1. (Amendments to cover these cases are under consideration.)

Introduction

1 General

This publication deals with dry heat tests applicable both to heat-dissipating and non heat-dissipating specimens. For non heat-dissipating specimens, Tests Ba and Bb do not deviate essentially from earlier issues.

The object of the dry heat test is limited to the determination of the ability of components, equipment or other articles to be used or stored at high temperature.

These dry heat tests do not enable the ability of specimens to withstand or operate during temperature variations to be assessed. In this case, it would be necessary to use Test N: Change of temperature.

The dry heat tests are subdivided as follows:

Dry heat tests for non heat-dissipating specimens

— with sudden change of temperature, Ba;

— with gradual change of temperature, Bb.

Dry heat tests for heat-dissipating specimens

— with sudden change of temperature, Bc;

— with gradual change of temperature, Bd.

The procedures given in this publication are normally intended for specimens which achieve temperature stability during the performance of the test procedure.

The duration of the test commences at the time when temperature stability of the specimen has been reached.

For the exceptional cases when the specimen does not reach temperature stability during the performance of the test procedure, the duration of the test commences at the time when the test chamber reaches the test temperature.

The relevant specification shall define:

a) the rate of change of temperature in the test chamber;

b) the time at which the specimens are introduced into the test chamber;

c) the time at which the exposure commences;

d) the time at which the specimens are energized.

For these cases, the specification writer will find guidance on choosing the above four parameters in IEC Publication 68-3-1. (Amendments to cover these cases are under consideration.)

2 Application of tests for non heat-dissipating specimens versus tests for heat-dissipating specimens

A specimen is considered heat-dissipating only if the hottest point on its surface, measured in free air conditions (i.e. with no forced air circulation), is more than 5 deg C above the ambient temperature of the surrounding atmosphere after temperature stability has been reached (see IEC Publication 68-1, Sub-clause **4.6**).

It is obvious that when the relevant specification calls for a storage test or does not specify an applied load during the test, the Dry Heat Tests Ba and Bb will apply.

3 For non heat-dissipating specimens: Application of tests with sudden change of temperature versus tests with gradual change of temperature

In Test Ba with sudden change of temperature, the specimen is introduced into the test chamber, the latter being at the temperature specified for the test. It has been introduced as a convenient and time-saving method. Test Ba shall be used only when it is known that the effects of a sudden change of temperature are not detrimental to the test specimen.

In Test Bb with gradual change of temperature, the specimen is introduced into the test chamber, the latter being at the laboratory temperature. The temperature in the chamber is then increased gradually so as to cause no detrimental effects on the test specimen due to the temperature change.

4 Testing of heat-dissipating specimens with and without forced air circulation

The preferable method of testing heat-dissipating specimens is that which does not use forced air circulation. If this is impracticable, however, Tests Bc and Bd envisage also procedures for testing heat-dissipating specimens with forced air circulation.

Two methods for testing with air circulation are given (Method A, Method B). Method A applies to the cases where the chamber is large enough to comply with the requirements for testing without forced air circulation, but where the high temperature cannot be maintained without circulating the air in the chamber.

Method B applies to the cases where the chamber is too small to comply with the requirements for testing without forced air circulation.

5 Diagrammatic representations

To facilitate the choice of test method, a diagrammatic representation of the various procedures is given on page 15.

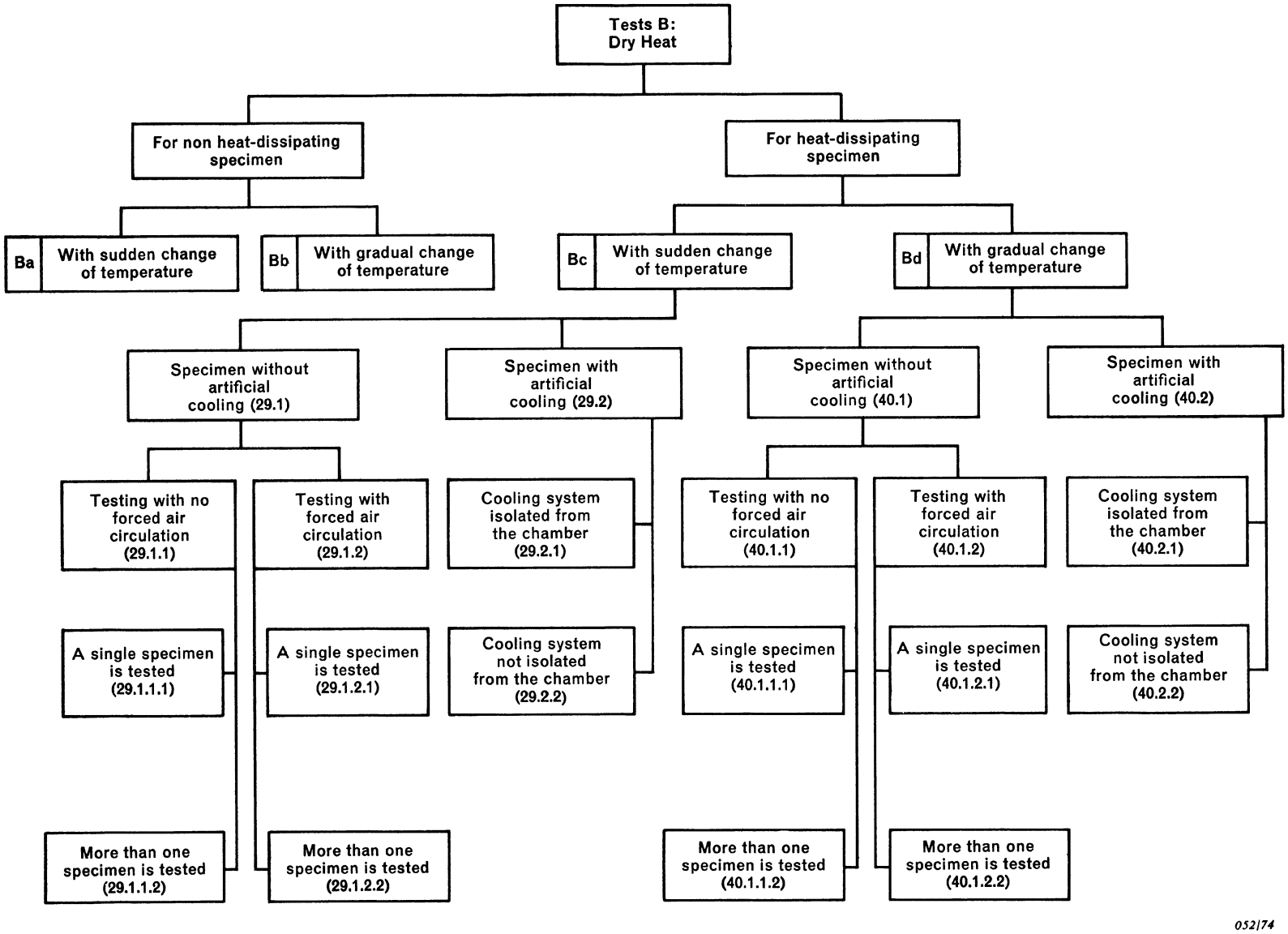
For the convenience of the user of this publication, a complete text without cross-references for each testing procedure is given.

Several clauses are therefore identical, especially in Tests Ba and Bb and in Tests Bc and Bd.

A block diagram showing which clauses are identical and which are different is given on page 16.

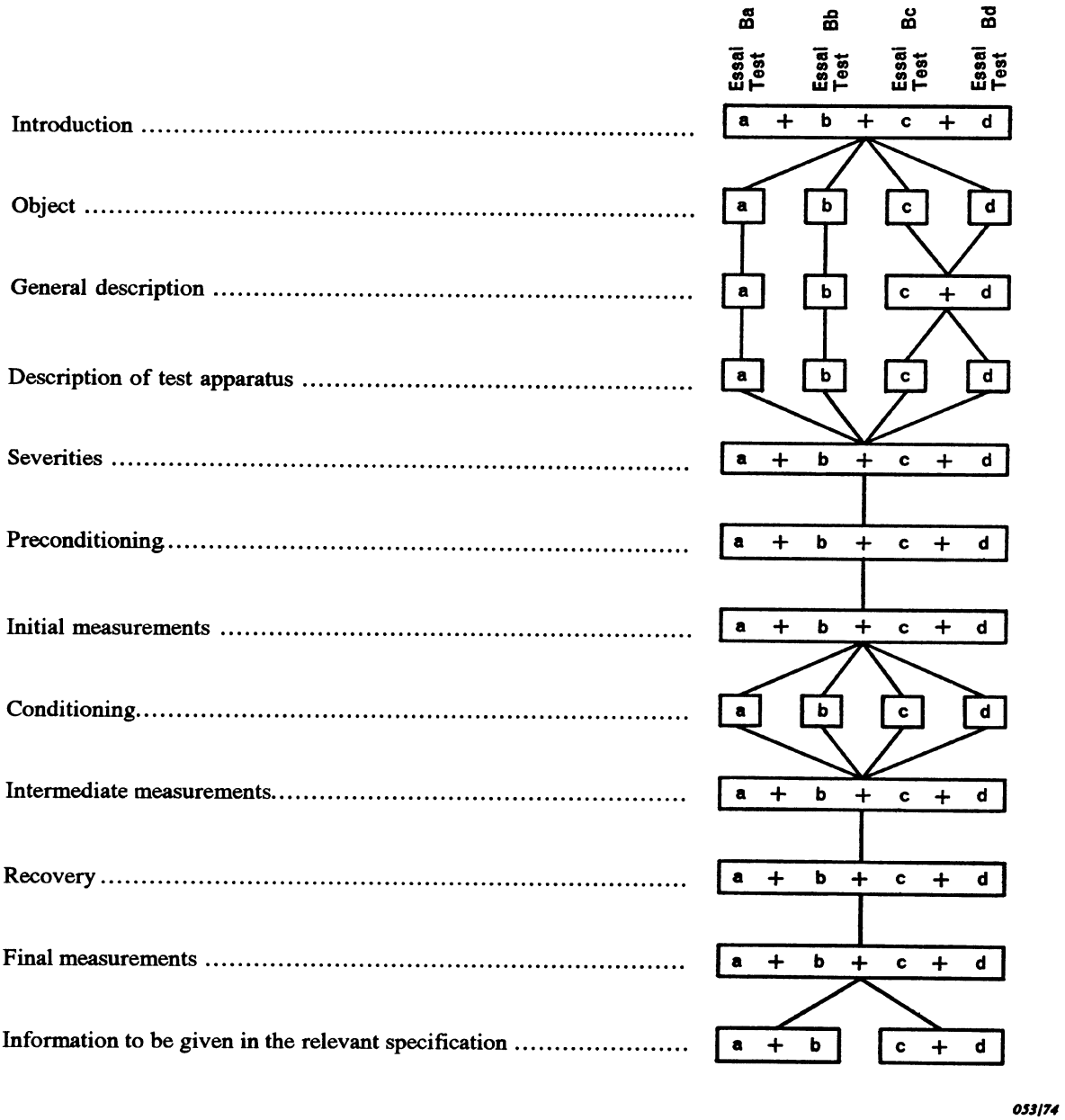
Block diagram of tests B: Dry heat

Diagrammatic representation of the various test procedures



Block diagram of tests B: Dry heat

Identical and different clauses of the Tests Ba, Bb, Bc and Bd are shown in this diagram



Section 1. Test Ba: Dry heat for non heat-dissipating specimen with sudden change of temperature

1 Object

To provide a standard test procedure to determine the suitability of non heat-dissipating components, equipment or other articles for use and/or storage under conditions of high temperature and for which the subjection to a sudden change of temperature has no detrimental effect.

This procedure is for specimens which are subjected to an elevated temperature for a time long enough for the specimen to achieve temperature stability.

In this procedure, the test duration is normally measured from the time when the specimen achieves temperature stability. For cases where this does not apply, see Introduction, Clause **1**.

2 General description

In this test, the specimen while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature appropriate to the degree of severity as specified in the relevant specification.

After temperature stability of the test specimen has been reached, the specimen is exposed to these conditions for the specified duration.

Specimens under test are normally in non-operating conditions.

Forced air circulation is normally used for this test.

3 Description of test apparatus

3.1 The chamber shall be capable of maintaining the specified temperature in the working space within the tolerances given in Sub-clause **4.1**. Forced air circulation may be used to maintain homogeneous conditions.

3.2 In order to limit radiation problems, the temperature of the walls of the chamber shall not differ by more than 3 % of the specified ambient temperature of the test, expressed in K. This requirement applies to all parts of the chamber walls and the specimens shall be unable to "see" any heating or cooling elements which do not comply with this requirement.

3.3 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 % relative humidity at 35 °C). When testing is performed at a temperature lower than 35 °C, the relative humidity shall not exceed 50 %.

4 Severities

The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected from those given in Sub-clauses **4.1** and **4.2**.

4.1 Temperature

+ 200 ± 2 °C
+ 175 ± 2 °C
+ 155 ± 2 °C
+ 125 ± 2 °C
+ 100 ± 2 °C
+ 85 ± 2 °C
+ 70 ± 2 °C
+ 55 ± 2 °C
+ 40 ± 2 °C
+ 30 ± 2 °C

NOTE 1 In the absence of other considerations, temperatures above 200 °C and up to 1 000 °C should be chosen from the following values:

250 °C 315 °C 400 °C 500 °C 630 °C 800 °C 1 000 °C.

The tolerance in each case should be ± 2 % of the above temperatures in °C.

NOTE 2 Where due to the size of the chamber it is not feasible to maintain these tolerances, the tolerance may be widened to ± 3 °C up to 100 °C and ± 5 °C up to 200 °C. When this is done, the tolerance used shall be specified in the test report.

4.2 Duration

2 h
16 h
72 h
96 h

Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of IEC publications which give particular recommendations for durations for such tests.

If the only intention of the testing procedure is to show whether the specimen will function at high temperature, the conditioning may be limited to a time such that the specimen under the test has reached temperature stability.

5 Preconditioning

The relevant specification may call for a preconditioning.

6 Initial measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

7 Conditioning

7.1 The chamber shall be at the temperature of the specified severity.

The specimen, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, "ready for use" state, in its normal position or as otherwise specified.

When the test specimen is intended for use with specific mounting devices, these should be used for testing.

The test (ambient) temperature shall be measured as in Sub-clause **4.4** of IEC Publication 68-1.

7.2 Time shall then be allowed for the chamber conditions to be re-established and for the specimen to reach temperature stability. (Temperature stability is defined in Sub-clause **4.6** of IEC Publication 68-1.)

7.3 For operational tests only:

The specimen shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification.

If required by the relevant specification, the specimen shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification, or be switched off.

NOTE A specimen, even under operating or loaded conditions shall be considered as non heat-dissipating as long as its surface temperature rise is not more than 5 deg C above the ambient temperature.

7.4 The specimen shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification.

The duration shall be measured from the time when temperature stability has been reached.

NOTE In the case of small specimens, it is not necessary to check by measurement that temperature stability has been reached. See IEC Publication 68-1, Sub-clause **4.6**, Note 2.

7.5 If required by the relevant specification, intermediate measurements shall be performed in accordance with Clause **8**.

7.6 At the end of this period, the specimen shall be subjected to the recovery procedure. In case the specimen remains in operating or loaded conditions during the test, it shall be switched off or unloaded before being subjected to the recovery procedure.

8 Intermediate measurements

The relevant specification may call for loading and/or measurements during or at the end of conditioning while the specimen is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be carried out. For these measurements, the specimen shall not be removed from the chamber.

NOTE Measurements preceded by recovery, which would require removal and reintroduction of the specimens into the chamber, are not permissible during the conditioning.
If it is desired to know the performance of the type of specimen before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

9 Recovery

9.1 The specimen shall then remain under standard atmospheric conditions for recovery for a period adequate for the attainment of temperature stability, with a minimum of 1 h. When several specimens are tested simultaneously and where the 1 h recovery period is adequate, the maximum period for recovery shall be 2 h and all measurements shall be completed at the end of this period.

9.2 If required by the relevant specification, the specimen shall be switched on or loaded and measured continuously during the recovery period.

9.3 If the standard conditions given above are not appropriate for the specimen to be tested, the relevant specification may call for other recovery conditions.

10 Final measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

11 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

a) preconditioning;

b) initial measurements;

c) state of specimen during conditioning;

d) severity, temperature and duration of exposure;

e) measurements and/or loading during conditioning;

f) recovery if non-standard;

g) final measurements;

h) any deviation in procedure as agreed upon between customer and supplier.

Section 2. Test Bb: Dry heat for non heat-dissipating specimen with gradual change of temperature

12 Object

To provide a standard test procedure to determine the suitability of non heat-dissipating components, equipment or other articles for use and/or storage under conditions of high temperature.

This procedure is for specimens which are subjected to an elevated temperature for a time long enough for the specimen to achieve temperature stability.

In this procedure, the test duration is normally measured from the time when the specimen achieves temperature stability. For cases where this does not apply, see Introduction, Clause **1**.

13 General description

In this test, the specimen while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature of the laboratory. The temperature is then adjusted to the temperature appropriate to the degree of severity as specified in the relevant specification.

After temperature stability of the test specimen has been reached, the specimen is exposed to these conditions for the specified duration.

Specimens under test are normally in non-operating conditions.

Forced air circulation is normally used for this test.

14 Description of test apparatus

14.1 The chamber shall be capable of maintaining the specified temperature in the working space within the tolerances given in Sub-clause **15.1**. Forced air circulation may be used to maintain homogeneous conditions.

14.2 In order to limit radiation problems, the temperature of the walls of the chamber after temperature stability has been reached shall not differ by more than 3 % of the specified ambient temperature of the test, expressed in K. This requirement applies to all parts of the chamber walls and the specimens shall be unable to "see" any heating or cooling elements which do not comply with this requirement.

14.3 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 % relative humidity at 35 °C). When testing is performed at a temperature lower than 35 °C, the relative humidity shall not exceed 50 %.

15 Severities

The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected from those given in Sub-clauses **15.1** and **15.2**.

15.1 Temperature

+ 200 ± 2 °C
+ 175 ± 2 °C
+ 155 ± 2 °C
+ 125 ± 2 °C
+ 100 ± 2 °C
+ 85 ± 2 °C
+ 70 ± 2 °C
+ 55 ± 2 °C
+ 40 ± 2 °C
+ 30 ± 2 °C

NOTE 1 In the absence of other considerations, temperatures above 200 °C and up to 1 000 °C should be chosen from the following values:

250 °C 315 °C 400 °C 500 °C 630 °C 800 °C 1 000 °C.

The tolerance in each case should be ± 2 % of the above temperatures in °C.

NOTE 2 Where due to the size of the chamber it is not feasible to maintain these tolerances, the tolerance may be widened to ± 3 °C up to 100 °C and ± 5 °C up to 200 °C. When this is done, the tolerance used shall be specified in the test report.

15.2 Duration

2 h
16 h
72 h
96 h

Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of IEC publications which give particular recommendations for durations for such tests.

If the only intention of the testing procedure is to show whether the specimen will function at high temperature, the conditioning may be limited to a time such that the specimen under the test has reached temperature stability.

16 Preconditioning

The relevant specification may call for a preconditioning.

17 Initial measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

18 Conditioning

18.1 The chamber shall be at the temperature of the laboratory.
The specimen, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, "ready for use" state, in its normal position or as otherwise specified.

When the test specimen is intended for use with specific mounting devices, these should be used for testing.

18.2 The temperature within the chamber shall then be adjusted to the temperature appropriate to the degree of severity and time shall be allowed for the specimen to reach temperature stability. (Temperature stability is defined in Sub-clause **4.6** of IEC Publication 68-1.)

The rate of change of temperature within the chamber shall not exceed 1 deg C per minute, averaged over a period of not more than 5 min.

The test (ambient) temperature shall be measured as in Sub-clause **4.4** of IEC Publication 68-1.

18.3 For operational tests only:

The specimen shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification.

If required by the relevant specification, the specimen shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification, or be switched off.

NOTE A specimen, even under operating or loaded conditions shall be considered as non heat-dissipating as long as its surface temperature rise is not more than 5 deg C above the ambient temperature.

18.4 The specimen shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification.

The duration shall be measured from the time when temperature stability has been reached.

NOTE In the case of small specimens, it is not necessary to check by measurement that temperature stability has been reached. See IEC Publication 68-1, Sub-clause **4.6**, Note 2.

18.5 If required by the relevant specification, intermediate measurements shall be performed in accordance with Clause **19**.

18.6 At the end of this period, the specimen shall remain in the chamber and the temperature shall be gradually lowered to a value lying within the limits of standard atmospheric conditions for testing. The rate of change of temperature within the chamber shall not exceed 1 degCper minute, averaged over a period of not more than 5 min.

In case the specimen remains in operating or loaded conditions during the test, it should be switched off or unloaded before the temperature is lowered.

At the end of this period, the specimen shall be subjected to the recovery procedure in the chamber or otherwise as appropriate.

19 Intermediate measurements

The relevant specification may call for loading and/or measurements during or at the end of conditioning while the specimen is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be carried out. For these measurements, the specimen shall not be removed from the chamber.

NOTE Measurements preceded by recovery, which would require removal and reintroduction of the specimens into the chamber, are not permissible during the conditioning.
If it is desired to know the performance of the type of specimen before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

20 Recovery

20.1 The specimen shall then remain under standard atmospheric conditions for recovery for a period adequate for the attainment of temperature stability, with a minimum of 1 h.

When several specimens are tested simultaneously and where the 1 h recovery period is adequate, the maximum period for recovery shall be 2 h and all measurements shall be completed at the end of this period.

20.2 If required by the relevant specification, the specimen shall be switched on or loaded and measured continuously during the recovery period.

20.3 If the standard conditions given above are not appropriate for the specimen to be tested, the relevant specification may call for other recovery conditions.

21 Final measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

22 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

a) preconditioning;

b) initial measurements;

c) state of specimen during conditioning;

d) severity, temperature and duration of exposure;

e) measurements and/or loading during conditioning;

f) recovery if non-standard;

g) final measurements;

h) any deviation in procedure as agreed upon between customer and supplier.

Section 3. Test Bc: Dry heat for heat-dissipating specimen with sudden change of temperature

23 Object

To provide a standard test procedure to determine the suitability of heat-dissipating components, equipment or other articles for use under conditions of high temperature and for which the subjection to a sudden change of temperature has no detrimental effect.

This procedure is for specimens which are subjected to an elevated temperature for a time long enough for the specimen to achieve temperature stability.

In this procedure, the test duration is normally measured from the time when the specimen achieves temperature stability. For cases where this does not apply, see Introduction, Clause **1**.

24 General description

In this test, the specimen while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature appropriate to the degree of severity as specified in the relevant specification.

After temperature stability of the test specimen has been reached, the specimen is exposed to these conditions for the specified duration.

The relevant specification shall define the functioning of the specimens under test.

Care shall be taken that any cooling devices of the specimens are in accordance with the prescription in the relevant specification.

The test conditions are designed to simulate the effects of subjecting the test specimens to “free air” conditions with defined thermal conduction characteristics of the mounting.

The specified test temperature is defined as the ambient temperature.

Testing with no forced air circulation is the preferred method. Forced air circulation may, however, be used when it is difficult or impossible to meet the conditions specified for testing without air circulation.

Appendix A to Appendix D form part of this specification.

25 Description of test apparatus

25.1 *Testing chamber*

25.1.1 The temperature in the chamber shall be checked by temperature sensing devices located so as to comply with the requirements of Sub-clause **4.4.2** of IEC Publication 68-1.

25.1.2 In the case of testing with no forced air circulation, the chamber shall be large enough compared with the size and amount of heat dissipation of the test specimen to allow a simulation of the effects of “free air” conditions.

The requirements on the size of chamber in which the effects of “free air” conditions are simulated are given in Appendix A as a function of size and heat dissipation per surface unit of the test specimen.

25.1.3 The walls of the chamber shall be near to thermal black and shall have an emissivity coefficient of not less than 0.7.

In order to limit radiation problems, the temperature of the walls of the chamber shall not differ by more than 3 % of the specified ambient temperature for the test, expressed in K.

This requirement applies to all parts of the chamber walls and the specimens shall be unable to “see” any heating or cooling elements which do not comply with this requirement.

25.1.4 In the case of testing in a chamber with forced air circulation, the velocity of the air should be as low as possible.

25.1.5 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 % relative humidity at 35 °C). When testing is performed at a temperature lower than 35 °C, the relative humidity shall not exceed 50 %.

25.1.6 Where a duty cycle is specified, precautions have to be taken if the test temperature is to be maintained at a steady figure.

In the case of components, a staggering of the on-periods will usually suffice, provided that at any one time the distribution of components on-load is reasonably uniform throughout the test chamber.

NOTE Where there is a duty cycle specified for specimens under test, then during the off-load periods the temperature of the chamber shall not fall below the specified test temperature (see Appendix D).

25.2 *Mounting*

25.2.1 The thermal conduction and other relevant characteristics of the mounting and connections of the test specimen shall be specified in the relevant specification. When the test specimen is intended for use with specific mounting devices, these shall be used for testing.

25.2.2 Where the specimen is designed for mounting on a heat sink with unspecified characteristics, the heat sink used for the purpose of test shall possess thermal capacity and thermal conduction adequate to maintain its temperature close to the test chamber temperature.

25.2.3 Where nothing is known about the mounting characteristics, the thermal conduction of the mounting shall be low, such that for all practical purposes the specimen is thermally isolated.

25.2.4 In the case of component type specimens, it may be necessary to use mounting racks, in which case the individual specification shall give all details necessary to define the thermal characteristics of the mounting and connections. In particular, where appropriate, the specification shall give the length of leads.

25.2.5 When more than one specimen is tested in the chamber, care shall be taken to ensure that a specimen is not unduly disturbed by the presence of surrounding specimens and mounting devices.

26 Severities

The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected from those given in Sub-clauses **26.1** and **26.2**.

26.1 Temperature

+ 200 ± 2 °C
+ 175 ± 2 °C
+ 155 ± 2 °C
+ 125 ± 2 °C
+ 100 ± 2 °C
+ 85 ± 2 °C
+ 70 ± 2 °C
+ 55 ± 2 °C
+ 40 ± 2 °C
+ 30 ± 2 °C

NOTE 1 In the absence of other considerations, temperatures above 200 °C and up to 1 000 °C should be chosen from the following values:

250 °C 315 °C 400 °C 500 °C 630 °C 800 °C 1 000 °C.

The tolerance in each case should be ± 2 % of the above temperatures in °C.

NOTE 2 Where due to the size of the chamber it is not feasible to maintain these tolerances; the tolerance may be widened to ± 3 °C up to 100 °C and ± 5 °C up to 200 °C. When this is done, the tolerance used shall be specified in the test report.

26.2 Duration

2 h
16 h
72 h
96 h

Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of IEC publications which give particular recommendations for durations for such tests.

If the only intention of the testing procedure is to show whether the specimen will function at high temperature, the conditioning may be limited to a time such that the specimen under the test has reached temperature stability.

27 Preconditioning

The relevant specification may call for a preconditioning.

28 Initial measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

29 Conditioning

29.1 Specimen without artificial cooling

29.1.1 *Testing with no forced air circulation*

29.1.1.1 *Test conditions applicable when a single specimen is tested*

a) The chamber shall be at the temperature of the specified severity.

b) The specimen, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, “ready for use” state, in its normal position or as otherwise specified.

c) Time shall then be allowed for the chamber conditions to be re-established and for the specimen to reach temperature stability.

d) The specimen shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification.

The specimen shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification.

e) The specimen shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification. The duration shall be measured from the time when temperature stability has been reached.

NOTE In the case of small specimens, it is not necessary to check by measurement that temperature stability has been reached. See IEC Publication 68-1, Sub-Clause **4.6**, Note 2.

f) If required by the relevant specification, intermediate measurements shall be performed in accordance with Clause **30**.

g) At the end of this period, the specimen shall be subjected to the recovery procedure. In case the specimen remains in operating or loaded conditions during the test, it shall be switched off or unloaded before being subjected to the recovery procedure.

29.1.1.2 *Test conditions applicable when more than one specimen is tested in the chamber*

When more than one specimen is tested in the same chamber, it is required that the surface temperatures measured at corresponding points on the test specimens shall not deviate from one specimen to another by more than 5 deg C or 5 % of the difference between the surface temperature and the air (ambient) temperature, whichever is the greater (see Note 2).

NOTE 1 A check that this requirement is met shall normally be made with the specimens mounted in the chamber in the manner used for testing.

If it is impracticable to make this check inside the chamber, the check may be made outside the chamber under normal laboratory conditions. The specimens shall be mounted in the manner used for testing (e.g. on a rack) and care shall be taken that the specimens are not subjected to extraneous disturbing influences.

NOTE 2 The requirement on acceptable deviation between surface temperatures at corresponding points on the test specimens is intended to limit the effects of stacking of specimens on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 %, whichever is the greater) shall not include the deviations caused by differences in heat dissipation between individual specimens. Such differences can be taken care of by checking on the same individual specimen in different positions in the chamber.

Testing shall proceed in accordance with Sub-clause **29.1.1.1**.

29.1.2 ***Testing with forced air circulation***

29.1.2.1 *Test conditions applicable when a single specimen is tested*

The following method, where forced air circulation is allowed, may be used when it is difficult to meet the conditions specified for testing without air circulation.

In any case the air velocity shall be low (if possible, not more than 0.5 m/s).

It is based on the assumption that the difference, ΔT_1, between the temperature of a hot point on the test specimen and the ambient temperature of the surrounding air in free air conditions is more or less independent of the ambient temperature of the surrounding air. This applies only if ΔT_1 is less than 25 deg C and where the ambient temperature variation ΔT_2, does not exceed 30 deg C.

These ranges can be extended to 80 deg C and 65 deg C respectively, if the corrections described in Appendix B are applied.

It shall be noted that the corrections cover convection errors as well as radiation errors.

For temperature differences, ΔT_1, greater than 80 deg C and/or changes in ambient temperature ΔT_2, greater than 65 deg C, the validity of this method has not been verified.

The specimen suitably mounted in the laboratory and protected from disturbing influences, such as sunlight and draughts, shall be subjected at room ambient temperature to the loading conditions specified for the elevated temperature at which the test is to be carried out. When temperature stability has been reached, the temperature of the hottest point or, in the case of larger or more complicated specimens, the temperature of a number of representative points shall be measured. The temperature rise, ΔT_1, which occurs at each point, shall be noted.

If ΔT_1 is less than 25 deg C, testing shall proceed in accordance with Sub-clause **29.1.1**.

If ΔT_1 is greater than 25 deg C, the corrected temperature T_s, based on the specified test temperature, shall be determined as described in Appendix B. The specimen shall be introduced into the chamber when the latter is at the temperature of the specified severity. The specimen shall then be switched on or electrically loaded as prescribed in the relevant specification and the temperature of the chamber shall be adjusted to a value at which the point measured on the surface of the specimen at room ambient temperature reaches the above-mentioned stabilized value T_s.

This temperature shall be maintained throughout the conditioning. Testing shall proceed in accordance with Sub-clauses **29.1.1.1** *d)* to **29.1.1.1** *g)*.

A diagrammatic representation is given in Appendix D.

29.1.2.2 *Test conditions applicable when more than one specimen is tested in the chamber*

When more than one specimen is tested in the same chamber, it is required that the surface temperatures measured at corresponding points on the test specimens shall not deviate from one specimen to another by more than 5 deg C or 5 % of the difference between the surface temperature and the air (ambient) temperature, whichever is the greater (see Note 2).

NOTE 1 A check that this requirement is met shall normally be made with the specimens mounted in the chamber in the manner used for testing, with the chamber heat switched off but the air circulation switched on.

NOTE 2 The requirement on acceptable deviation between surface temperatures at corresponding points on test specimens is intended to limit the effects of stacking of specimens on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 %, whichever is the greater) shall not include the deviations caused by differences in heat dissipation between individual specimens. Such differences can be taken care of by checking on the same individual specimen in different positions in the chamber.

a) One or a few of the specimens to be tested shall be selected and subjected to free air conditions with specified test ambient temperature. After temperature stability has been reached with the specimen(s) in loaded conditions, the temperature of representative points on the surface of the test specimen(s) shall be noted.

b) The total number of specimens shall then be introduced into the chamber. The chamber temperature shall be held at the temperature of the specified severity.

When specimens are mounted on a rack, interference with the air flow shall be as small as possible.

NOTE 3 If it is more convenient (e.g. when introducing individual racks of identical components at different times in the same chamber) the chamber may be held instead at the temperature defined in *d)* below.

c) Time shall then be allowed for the chamber conditions to be re-established and for the specimen to reach temperature stability.

d) The specimens shall be subjected to load and the chamber temperature adjusted so that, after temperature stability has been reached with the specimens in the loaded condition, the surface temperatures of the points measured under *a)* above are reproduced.

e) Testing shall proceed in accordance with Sub-clauses **29.1.1.1** *e)* to **29.1.1.1** *g)*.

29.2 Specimen with artificial cooling

The relevant specification shall define the characteristics of the coolant supplied to the specimen. When the coolant is air, care shall be taken that the air is not contaminated by oil and dry enough to avoid moisture problems.

29.2.1 *Cooling system "isolated" from the chamber*

Specimens of this type have cooling systems which are either self-contained or which obtain the coolant from an extraneous supply, with the coolant flow and return lines isolated from the chamber.

These specimens may be tested in accordance with Sub-clause **29.1.1**.

NOTE If cooling is so efficient that the surface temperature falls below ambient, it may be necessary to measure the ambient temperature of the surrounding air in a plane 0 cm to 5 cm above the specimen, half-way between the specimen and the wall of the chamber, rather than in a plane below the specimen.

29.2.2 *Cooling system "not isolated" from the chamber*

a) Specimens in which fresh cool air is brought from an extraneous source and then passes into the chamber after cooling of the specimen has taken place.

These may be tested in accordance with Sub-clause **29.1.1**.

b) Specimens in which the cooling air is drawn from the chamber and is returned to the chamber after fulfilling its cooling function.

These specimens may be tested in accordance with Sub-clause **29.1.1** with the exception that monitoring shall be made on the air entering the specimen. The temperature of this air shall lie within the specified limits.

30 Intermediate measurements

The relevant specification may call for loading and/or measurements during or at the end of conditioning while the specimen is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be carried out. For these measurements, the specimen shall not be removed from the chamber.

NOTE Measurements preceded by recovery, which would require removal and reintroduction of the specimens into the chamber, are not permissible during the conditioning.
If it is desired to know the performance of the type of specimen before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

31 Recovery

31.1 The specimen shall then remain under standard atmospheric conditions for recovery for a period adequate for the attainment of temperature stability, with a minimum of 1 h.

When several specimens are tested simultaneously and where the 1 h recovery period is adequate, the maximum period for recovery shall be 2 h and all measurements shall be completed at the end of this period.

31.2 If required by the relevant specification, the specimen shall be switched on or loaded and measured continuously during the recovery period.

31.3 If the standard conditions given above are not appropriate for the specimen to be tested, the relevant specification may call for other recovery conditions.

32 Final measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

33 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

a) preconditioning;

b) initial measurements;

c) details of mounting or supports;

d) state of specimen including cooling system during conditioning;

e) severity, temperature and duration of exposure;

f) measurements and/or loading during conditioning;

g) recovery if non-standard;

h) final measurements;

j) any deviation in procedure as agreed upon between customer and supplier.

Section 4. Test Bd: Dry heat for heat-dissipating specimen with gradual change of temperature

34 Object

To provide a standard test procedure to determine the suitability of heat-dissipating components, equipment or other articles for use under conditions of high temperature.

This procedure is for specimens which are subjected to an elevated temperature for a time long enough for the specimen to achieve temperature stability.

In this procedure, the test duration is normally measured from the time when the specimen achieves temperature stability. For cases where this does not apply, see Introduction, Clause **1**.

35 General description

In this test, the specimen while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature of the laboratory. The temperature is then adjusted to the temperature appropriate to the degree of severity as specified in the relevant specification.

After temperature stability of the test specimen has been reached, the specimen is exposed to these conditions for the specified duration.

The relevant specification shall define the functioning of the specimens under test.

Care shall be taken that any cooling devices of the specimens are in accordance with the prescription in the relevant specification.

The test conditions are designed to simulate the effects of subjecting the test specimens to “free air” conditions with defined thermal conduction characteristics of the mounting.

The specified test temperature is defined as the ambient temperature.

Testing with no forced air circulation is the preferred method. Forced air circulation may, however, be used when it is difficult or impossible to meet the conditions specified for testing without air circulation.

Appendix A to Appendix D form part of this specification.

36 Description of test apparatus

36.1 *Testing chamber*

36.1.1 The temperature in the chamber shall be checked by temperature sensing devices located so as to comply with the requirements of Sub-clause **4.4.2** IEC Publication 68-1.

36.1.2 In the case of testing with no forced air circulation, the chamber shall be large enough compared with the size and amount of heat dissipation of the test specimen to allow a simulation of the effects of “free air” conditions.

The requirements on the size of chamber in which the effects of “free air” conditions are simulated are given in Appendix A as a function of size and heat dissipation per surface unit of the test specimen.

36.1.3 The walls of the chamber shall be near to thermal black and shall have an emissivity coefficient of not less than 0.7.

In order to limit radiation problems, the temperature of the walls of the chamber after temperature stability has been reached shall not differ by more than 3 % of the specified ambient temperature for the test, expressed in K.

This requirement applies to all parts of the chamber walls and the specimens shall be unable to "see" any heating or cooling elements which do not comply with this requirement.

36.1.4 In the case of testing in a chamber with forced air circulation, the velocity of the air shall be as low as possible.

36.1.5 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 % relative humidity at 35 °C). When testing is performed at a temperature lower than 35 °C, the relative humidity shall not exceed 50 %.

36.1.6 Where a duty cycle is specified, precautions have to be taken if the test temperature is to be maintained at a steady figure.

In the case of components, a staggering of the on-periods will usually suffice, provided that at any one time the distribution of components on-load is reasonably uniform throughout the test chamber.

NOTE Where there is a duty cycle specified for specimens under test, then during the off-load periods the temperature of the chamber shall not fall below the specified test temperature (see Appendix D).

36.2 *Mounting*

36.2.1 The thermal conduction and other relevant characteristics of the mounting and connections of the test specimen shall be specified in the relevant specification. When the test specimen is intended for use with specific mounting devices, these shall be used for testing.

36.2.2 Where the specimen is designed for mounting on a heat sink with unspecified characteristics, the heat sink used for the purpose of test shall possess thermal capacity and thermal conduction adequate to maintain its temperature close to the test chamber temperature.

36.2.3 Where nothing is known about the mounting characteristics, the thermal conduction of the mounting shall be low, such that for all practical purposes the specimen is thermally isolated.

36.2.4 In the case of component type specimens, it may be necessary to use mounting racks, in which case the individual specification shall give all details necessary to define the thermal characteristics of the mounting and connections. In particular, where appropriate, the specification should give the length of leads.

36.2.5 When more than one specimen is tested in the chamber, care shall be taken to ensure that a specimen is not unduly disturbed by the presence of surrounding specimens and mounting devices.

37 Severities

The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected from those given in Sub-clauses **37.1** and **37.2**.

37.1 Temperature

+ 200 ± 2 °C
+ 175 ± 2 °C
+ 155 ± 2 °C
+ 125 ± 2 °C
+ 100 ± 2 °C
+ 85 ± 2 °C
+ 70 ± 2 °C
+ 55 ± 2 °C
+ 40 ± 2 °C
+ 30 ± 2 °C

NOTE 1 In the absence of other considerations, temperatures above 200 °C and up to 1 000 °C should be chosen from the following values:

250 °C 315 °C 400 °C 500 °C 630 °C 800 °C 1 000 °C.

The tolerance in each case should, be ± 2 % of the above temperatures in °C.

NOTE 2 Where due to the size of the chamber it is not feasible to maintain these tolerances, the tolerance may be widened to ± 3 °C up to 100 °C and ± 5 °C up to 200 °C. When this is done, the tolerance used shall be specified in the test report.

37.2 Duration

2 h
16 h
72 h
96 h

Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of IEC publications which give particular recommendations for durations for such tests.

If the only intention of the testing procedure is to show whether the specimen will function at high temperature, the conditioning may be limited to a time such that the specimen under the test has reached temperature stability.

38 Preconditioning

The relevant specification may call for preconditioning.

39 Initial measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

40 Conditioning

40.1 Specimen without artificial cooling

40.1.1 *Testing with no forced air circulation*

40.1.1.1 *Test conditions applicable when a single specimen is tested*

a) The chamber shall be at the temperature of the laboratory.

b) The specimen, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, "ready for use" state, in its normal position or as otherwise specified.

c) The temperature within the chamber shall then be adjusted to the temperature appropriate to the degree of severity and time shall be allowed for the specimen to reach temperature stability.

The rate of change of temperature within the chamber shall not exceed 1 deg C per minute, averaged over a period of not more than 5 min.

d) The specimen shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification.

The specimen shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification.

e) The specimen shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification.

The duration shall be measured from the time when temperature stability has been reached.

NOTE In the case of small specimens, it is not necessary to check by measurement that temperature stability has been reached. See IEC Publication 68-1, Sub-clause **4.6**, Note 2.

f) If required by the relevant specification, intermediate measurements shall be performed in accordance with Clause **41**.

g) At the end of this period, the specimen shall remain in the chamber and the temperature shall be gradually lowered to a value lying within the limits of standard atmospheric conditions for testing. The rate of change of the temperature within the chamber shall not exceed 1 deg C per minute, averaged over a period of not more than 5 min.

In case the specimen remains in operating or loaded conditions during the test, it shall be switched off or unloaded before the temperature is lowered.

h) At the end of this period the specimen shall be subjected to the recovery procedure in the chamber or otherwise as appropriate.

40.1.1.2 *Test conditions applicable when more than one specimen is tested in the chamber*

When more than one specimen is tested in the same chamber, it is required that the surface temperatures measured at corresponding points on the test specimens shall not deviate from one specimen to another by more than 5 deg C or 5 % of the difference between the surface temperature and the air (ambient) temperature, whichever is the greater (see Note 2).

NOTE 1 A check that this requirement is met shall normally be made with the specimens mounted in the chamber in the manner used for testing.

If it is impracticable to make this check inside the chamber, the check may be made outside the chamber under normal laboratory conditions. The specimens shall be mounted in the manner used for testing (e.g. on a rack) and care shall be taken that the specimens are not subjected to extraneous disturbing influences.

NOTE 2 The requirement on acceptable deviation between surface temperatures at corresponding points on the test specimens is intended to limit the effects of stacking of specimens on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 %, whichever is the greater) shall not include the deviations caused by differences in heat dissipation between individual specimens. Such differences can be taken care of by checking on the same individual specimen in different positions in the chamber.

Testing shall proceed in accordance with Sub-clause **40.1.1.1**.

40.1.2 *Testing with forced air circulation*

40.1.2.1 *Test conditions applicable when a single specimen is tested*

The following methods, where forced air circulation is allowed, may be used when it is not possible to meet the conditions specified for testing without air circulation.

In any case the air velocity shall be low (if possible, not more than 0.5 m/s).

Method A

This method is intended to be used when the chamber used for testing is large enough to meet the conditions specified in Appendix A, but maintenance of the ambient temperature in the chamber can only be obtained by circulation of air.

The specimen is placed or assembled inside the test chamber. With both the chamber air flow and heat switched off, the specimen shall be subjected to the loading conditions specified for the elevated temperature at which the test is to be carried out.

When temperature stability of the specimens has been reached, the temperatures of a number of representative points shall be measured using a suitable monitoring device. The temperature rise which occurs at each point shall then be noted.

The chamber air flow is switched on and, once temperature stability has been achieved, the temperature of the representative points shall again be measured. If the temperatures differ from those measured without air flow by more than 5 deg C or any other value stated by the relevant specification, the velocity of the air is too high and shall be reduced until the requirement of 5 deg C or other specified temperature difference is met. If this is not possible, Method B shall be used.

The chamber heating is now switched on for the commencement of testing. The monitoring of ambient temperature shall be carried out in accordance with the definition in Sub-clause **4.4.2** of IEC Publication 68-1.

Testing shall proceed in accordance with Sub-clause **40.1.1.1**.

A diagrammatic representation of Method A is given in Appendix C.

Method B

This method is intended to be used when the requirements in Appendix A cannot be met.

It is based on the assumption that the difference, ΔT_1, between the temperature of a hot point on the test specimen and the ambient temperature of the surrounding air in free air conditions is more or less independent of the ambient temperature of the surrounding air. This applies only if ΔT_1 is less than 25 deg C where the ambient temperature variation, ΔT_2, does not exceed 30 deg C.

These ranges can be extended to 80 deg C and 65 deg C respectively, if the corrections described in Appendix B are applied.

It shall be noted that the corrections cover convection errors as well as radiation errors.

For temperature differences, ΔT_1, greater than 80 deg C and/or changes in ambient temperature, ΔT_2, greater than 65 deg C, the validity of Method B has not been verified.

The specimen, suitably mounted in the laboratory and protected from disturbing influences, such as sunlight and draughts, shall be subjected at room ambient temperature to the loading conditions specified for the elevated temperature at which the test is to be carried out.

When temperature stability has been reached, the temperature of the hottest point or, in the case of larger or more complicated specimens, the temperature of a number of representative points shall be measured. The temperature rise, ΔT_1, which occurs at each point, shall be noted.

The specimen is introduced into the test chamber, subjected to the specified loading, and the chamber temperature is adjusted to a value at which the points measured at room ambient temperature reach a stabilized value which is the algebraic sum of the ambient temperature specified for the test and ΔT_1. If ΔT_1 is less than 25 deg C, testing shall proceed in accordance with Sub-clause **40.1.1.1**.

If ΔT_1 is greater than 25 deg C, the corrected temperature T_s, based on the specified test temperature, shall be determined as described in Appendix B. The specimen shall be introduced into the chamber while both specimen and chamber are at room temperature. Then the specimen shall be switched on or electrically loaded as prescribed in the relevant specification and the chamber temperature raised.

The rate of change of temperature shall not exceed 1 deg C per minute averaged over a period of not more than 5 min.

The final value of the chamber temperature shall be adjusted to a value at which the point measured on the surface of the specimen at room ambient temperature reaches the above-mentioned stabilized value T_s. This temperature shall be maintained throughout the conditioning. Testing shall proceed in accordance with Sub-clause **40.1.1.1** *d)* to **40.1.1.1** *h)*.

A diagrammatic representation of Method B is given in Appendix D.

40.1.2.2 *Test conditions applicable when more than one specimen is tested in the chamber*

When more than one specimen is tested in the same chamber, it is required that the surface temperatures measured at corresponding points on the test specimens shall not deviate from one specimen to another by more than 5 deg C or 5 % of the difference between the surface temperature and the air (ambient) temperature, whichever is the greater (see Note 2).

NOTE 1 A check that this requirement is met shall normally be made with the specimens mounted in the chamber in the manner used for testing, with the chamber heat switched off but the air circulation switched on.

NOTE 2 The requirement on acceptable deviation between surface temperature at corresponding points on test specimens is intended to limit the effects of stacking of specimens on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 %, whichever is the greater) shall not include the deviations caused by differences in heat dissipation between individual specimens. Such differences can be taken care of by checking on the same individual specimen in different positions in the chamber.

a) One or a few of the specimens to be tested shall be selected and subjected to free air conditions with the specified test ambient temperature. After temperature stability has been reached with the specimen(s) in loaded conditions, the temperature of representative points on the surface of the test specimen(s) shall be noted.

b) The total number of specimens shall then be introduced into the chamber. The air circulation and heat of the chamber shall be switched on and the temperature shall be adjusted so that, after temperature stability has been reached with the specimens in loaded conditions, the surface temperatures at the points measured under a) are reproduced.

When specimens are mounted on a rack, interference with the air flow shall be as small as possible.

Testing shall proceed in accordance with Sub-clause **40.1.1.1**.

40.2 Specimen with artificial cooling

The relevant specification shall define the characteristics of the coolant supplied to the specimen. When the coolant is air, care shall be taken that the air is not contaminated by oil and dry enough to avoid moisture problems.

40.2.1 *Cooling system "isolated" from the chamber*

Specimens of this type have cooling systems which are either self-contained or which obtain the coolant from an extraneous supply, with the coolant flow and return lines isolated from the chamber.

These specimens may be tested in accordance with Sub-clause **40.1.1**, with Method A of Sub-clause **40.1.2** as an alternative.

NOTE If cooling is so efficient that the surface temperature falls below ambient, it may be necessary to measure the ambient temperature of the surrounding air in a plane 0 cm to 5 cm above the specimen, half-way between the specimen and the wall of the chamber, rather than in a plane below the specimen.

40.2.2 *Cooling system "not isolated" from the chamber*

a) Specimens in which fresh cool air is brought from an extraneous source and then passes into the chamber after cooling of the specimen has taken place.

These may be tested in accordance with Sub-clause **40.1.1**, with Method A of Sub-clause **40.1.2** as an alternative.

b) Specimens in which the cooling air is drawn from the chamber and is returned to the chamber after fulfilling its cooling function.

These may be tested in accordance with Sub-clause **40.1.1**, with Method A of Sub-clause **40.1.2** as an alternative, with the exception that monitoring shall be made on the air entering the specimen. The temperature of this air shall lie within the specified limits.

41 Intermediate measurements

The relevant specification may call for loading and/or measurements during or at the end of conditioning while the specimen is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be carried out. For these measurements, the specimen shall not be removed from the chamber.

NOTE Measurements preceded by recovery, which would require removal and reintroduction of the specimens into the chamber, are not permissible during the conditioning.
If it is desired to know the performance of the type of specimen before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

42 Recovery

42.1 The specimen shall then remain under standard atmospheric conditions for recovery for a period adequate for the attainment of temperature stability, with a minimum of 1 h.

When several specimens are tested simultaneously and where the 1 h recovery period is adequate, the maximum period for recovery shall be 2 h and all measurements shall be completed at the end of this period.

42.2 If required by the relevant specification, the specimen shall be switched on or loaded and measured continuously during the recovery period.

42.3 If the standard conditions given above are not appropriate for the specimen to be tested, the relevant specification may call for other recovery conditions.

43 Final measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

44 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

a) preconditioning;

b) initial measurements;

c) details of mounting or supports;

d) state of specimen including cooling system during conditioning;

e) severity, temperature and duration of exposure;

f) measurements and/or loading during conditioning;

g) recovery if non-standard;

h) final measurements;

j) any deviation in procedure as agreed upon between customer and supplier.

Appendix A Volume of test specimen

The size of the chamber shall be such that the conditions stated below are satisfied:

i) *Volume of specimen equal to or less than 1 dm^3*

a) Power dissipation equal to or less than 50 W.

The minimum distance between any surface of the test specimen and the corresponding wall of the chamber shall be not less than 10 cm.

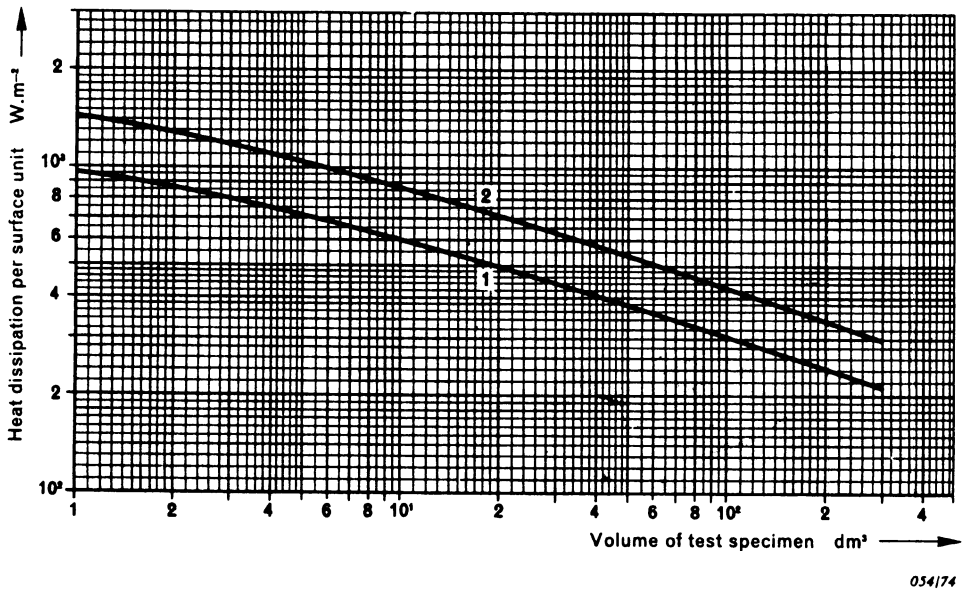
b) Power dissipation greater than 50 W and equal to or less than 100 W.

The minimum distance between any surface of the test specimen and the corresponding wall of the chamber shall be not less than 20 cm.

ii) *Volume of specimen greater than 1 dm^3*

The minimum distance between any surface of the test specimen and the corresponding wall of the chamber shall be 10 cm unless the relationship between the volume of the test specimen and the power dissipation per unit of surface area is such that the curves below indicate that a greater distance is required. The ratio between the volume of the chamber and the volume of the specimen shall be not less than 5 : 1. The specimen shall as far as practical be placed close to the centre of the test chamber so as to have as much space as possible between any part of the test specimen and the chamber walls. The monitoring of ambient temperature is carried out in accordance with the definitions in Clause **4** of IEC Publication 68-1.

NOTE 1 There shall be not less than 10 cm between any surface of the test specimen and the corresponding wall of the chamber.
NOTE 2 The volume of the specimen is defined as the volume of the smallest parallelepiped in which the specimen can be inscribed.
NOTE 3 The surface area of the specimen is defined as the total surface area of the smallest right-angled parallelepiped in which the specimen can be inscribed. If the heating of the specimen is asymmetric, the surface under consideration is only that of the side or sides most affected by the heat generation.

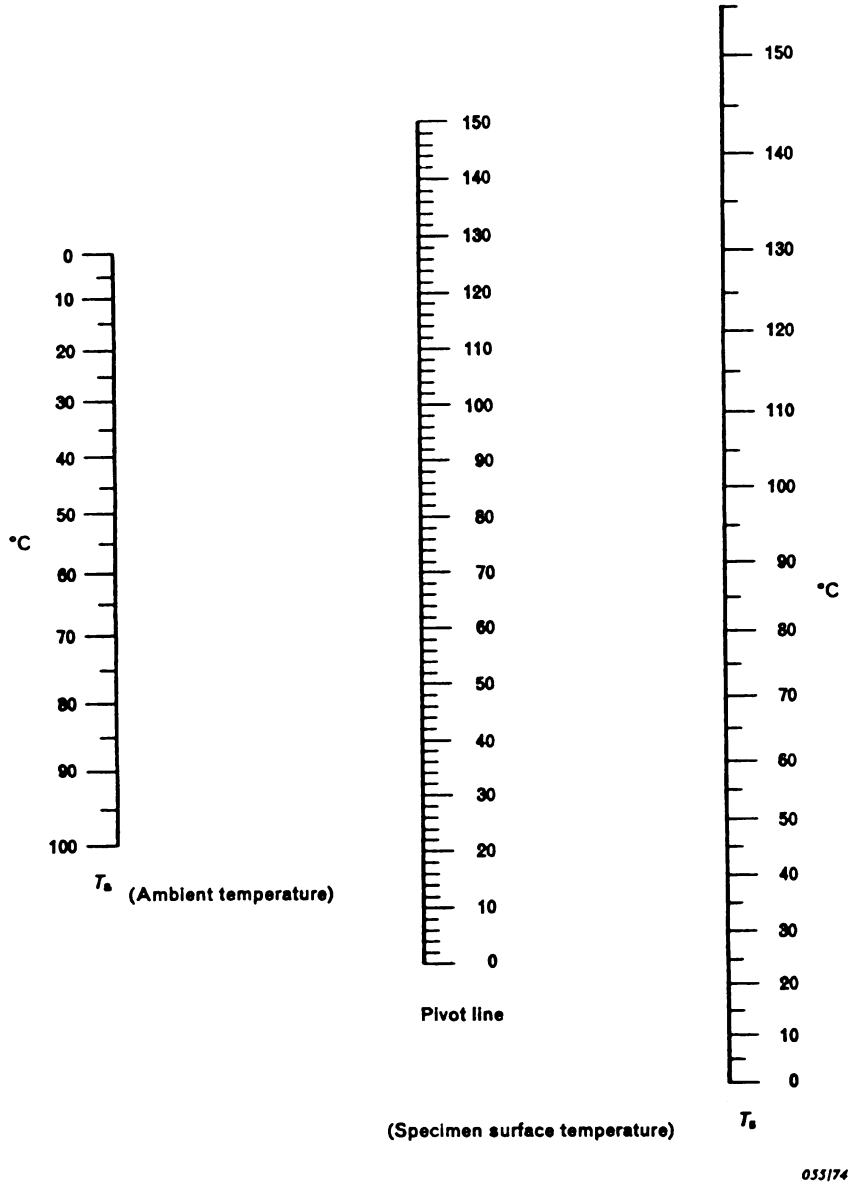


Curve 1 shows the maximum allowable heat dissipation per unit of surface area as a function of the volume of the test specimen when the distance between the surface of the specimen and the chamber is 10 cm.

Curve 2 shows the same relationship when the distance is 20 cm.

Figure 1

Appendix B Nomogram for correction for ambient temperature



Example:

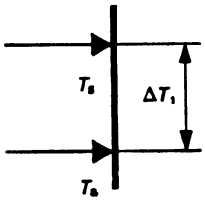
Question: An object dissipating a certain power in free air of 20 °C reaches a surface temperature of 70 °C.

What will be its surface temperature when dissipating the same power in free air at + 55 °C?

Answer: Draw a straight line from point + 20 °C on scale T_a to point + 70 °C on scale T_s; note its intersection with the pivot line.

Now draw a straight line from point + 55 °C on scale T_a through this intersection point on the pivot line and read the new intersection with scale T_s + 98 °C. This is the required surface temperature.

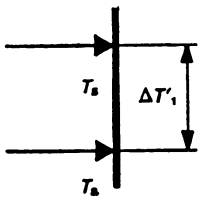
Appendix C Diagrammatic representation of test with forced air circulation for method A of test Bd



Specimen temperature

Ambient temperature with heat off

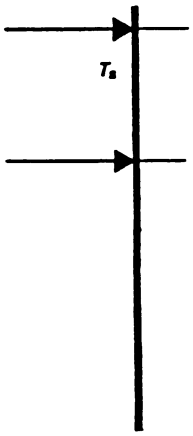
Stage 1 — Specimen loaded. Test in chamber conditions with chamber airflow off and heat off. Measurement of specimen temperature.



Specimen temperature

Ambient temperature with heat off

Stage 2 — Specimen loaded. Test in chamber conditions with chamber airflow on and heat off. $\Delta T_1 - \Delta T'_1$ shall be small.



Specimen temperature

Specified test temperature = test chamber temperature

Stage 3 — Specimen loaded. Test in chamber conditions with chamber airflow on and heat on. Monitoring on specified ambient test temperature.

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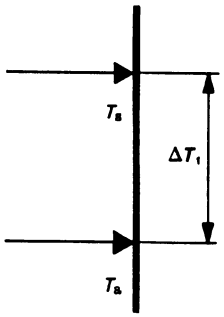
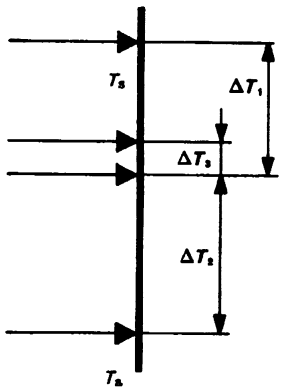
Appendix D Diagrammatic representation of test with forced air circulation for test Bc and for method B of test Bd



Stage 1 — Specimen loaded. Test in laboratory conditions with no forced air circulation. Measurement of specimen temperature.



Stage 2 — Specimen loaded. Test in chamber with forced air circulation. Monitoring on specimen temperature. (ΔT_3 shall be small. Measurement of the test chamber temperature is carried out in accordance with the definition in Clause **4** of Publication 68-1.)

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
68-1	—[a]	General	—	—
68-3-1	1974	Background information Section 1: Cold and dry heat tests	HD 323.3.1 S1[a]	1988

[a] IEC 68-1:1988 was harmonized as HD 323.1 S2:1988 HD 323.3.1 S1:1988 includes supplement IEC 68-3-1A:1978

National annex NA (informative)
Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the General Electrotechnical Standards Policy Committee (GEL/-) to Technical Committee GEL/15, upon which the following bodies were represented:

EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)
Electronic Components Industry Federation
Ministry of Defence
National Supervising Inspectorate
Society of Environmental Engineers
Society of Motor Manufacturers and Traders Limited

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

AEA Technology
Association of Manufacturers of Domestic Electrical Appliances
BEAMA Ltd.
Biodeterioration Society
Institute of Metals

National Annex NB (informative)

Cross-references

Publication referred to	Corresponding British Standard
	BS 2011 *Environmental testing*
IEC 68-1	Part 1.1:1989 *General and guidance*
IEC 68-3-1	Part 3A & B:1977 *Tests A (cold) and tests B (dry heat)*

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