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BASIC SAFETY PUBLICATION
PUBLICATION FONDAMENTALE DE SÉCURITÉ

Environmental testing –
Part 2-14: Tests – Test N: Change of temperature

Essais d'environnement –
Partie 2-14: Essais – Essai N: Variation de température

IEC 60068-2-14:2009

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ENVIRONMENTAL TESTING –

Part 2-14: Tests – Test N: Change of temperature

FOREWORD

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International Standard IEC 60068-2-14 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This sixth edition cancels and replaces the fifth edition, published in 1984, and its amendment 1 (1986) and constitutes a technical revision.

The major changes with regard to the previous edition concern:

- merging of the previous version of IEC 60068-2-14 with IEC 60068-2-33: *Guidance on change of temperature tests*;
- updating of the figures, changes to some of the wording and editorial corrections made for clarification.

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

FDIS	Report on voting
104/481/FDIS	104/486/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.

It has the status of a basic safety publication in accordance with IEC Guide 104.

A list of all the parts in the IEC 60068 series, under the general title *Environmental testing*, can be found on the IEC website.

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,
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INTRODUCTION

A change of temperature test is intended to determine the effect on the specimen of a change of temperature or a succession of changes of temperature.

It is not intended to show effects which are due only to high or low temperatures. For these effects, the dry heat test or the cold test should be used.

The effect of such tests is determined by

– values of high and low conditioning temperature between which the change is to be effected,
– the conditioning times for which the test specimen is kept at these temperatures,
– the rate of change between these temperatures,
– the number of cycles of conditioning,
– the amount of heat transfer into or from the specimen.

Guidance on the choice of suitable test parameters for inclusion in the detail specification is given throughout this standard.

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ENVIRONMENTAL TESTING –

Part 2-14: Tests – Test N: Change of temperature

1 Scope

This part of IEC 60068 provides a test to determine the ability of components, equipment or other articles to withstand rapid changes of ambient temperature. The exposure times adequate to accomplish this will depend upon the nature of the specimen.

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.

IEC 60068 (all parts), *Environmental testing*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-17, *Environmental testing – Part 2-17: Tests – Test Q: Sealing*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

3 Field conditions of changing temperature

It is common in electronic equipment and components that changes of temperature occur. Parts inside equipment undergo slower changes of temperature than those on an external surface when the equipment is not switched on.

Rapid changes of temperature may be expected

– when equipment is transported from warm indoor environments into cold open air conditions or vice versa,
– when equipment is suddenly cooled by rainfall or immersion in cold water,
– in externally mounted airborne equipment,
– under certain conditions of transportation and storage.

Components will undergo stresses due to changing temperature when high temperature gradients build up in an equipment after being switched on, e.g. in the neighbourhood of high wattage resistors, radiation can cause rise of surface temperature in neighbouring components while other portions are still cool.

Artificially cooled components may be subjected to rapid temperature changes when the cooling system is switched on. Rapid changes of temperature in components may also be induced during manufacturing processes of equipment. Both the number and amplitude of temperature changes and the time interval between them are important.

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4 General

4.1 Design of change of temperature tests

Tests Na, Nb and Nc comprise alternate periods at a high and at a low temperature with well-defined transfers from one temperature to the other. The conditioning run from laboratory ambient to the first conditioning temperature, then to the second conditioning temperature, then back to laboratory ambient is considered one test cycle.

4.2 Test parameters

Test parameters comprise the following:

– laboratory ambient;
– high temperature;
– low temperature;
– duration of exposure;
– transfer time or rate of change;
– number of test cycles.

The high and low temperatures are understood to be ambient temperatures which will be reached by most specimens with a certain time-lag.

Only in exceptional cases may they be specified outside the normal storage or operating temperature range of the object under test.

The test is accelerated because the number of severe changes of temperature in a given period is greater than that which will occur under field conditions.

4.3 Purpose and choice of the tests

Change of temperature testing is recommended in the following cases:

– evaluation of electrical performance during a change of temperature, Test Nb;
– evaluation of mechanical performance during a change of temperature, Test Nb,
– evaluation of electrical performance after a specified number of rapid changes of temperature, Test Na or Test Nc;
– evaluation of the suitability of mechanical components, and of materials and combinations of materials to withstand rapid changes of temperature, Test Na or Test Nc;
– evaluation of the suitability of construction of components to withstand artificial stressing, Test Na or Test Nc.

The change of temperature tests specified in the IEC 60068 series is not intended to evaluate the difference in material constants or electrical performance when operating under temperature stability at the two extremes of temperature.

4.4 Choice of the duration of the exposure

The duration of the exposure should be based on the requirements stated in 7.2.3, 8.2.3 or 9.2.2, or as stated in the relevant specification, keeping in mind the following points:

a) The exposure begins as soon as the specimen is in the new environment.

b) Stabilization occurs when the temperature difference (ΔT) between the specimen and the test medium is within 3 K to 5 K, or as stated in the test specification. The stabilization period, (t_s), is from the start of exposure until the time when the temperature is within the

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specified difference. A representative point (or points) on the specimen may be used for this measurement.

c) The test duration, t_1, shall be longer than the specimen stabilization time, t_s. Figure 1 provides a graphical representation of the process. This may not be appropriate for heat generating specimens.

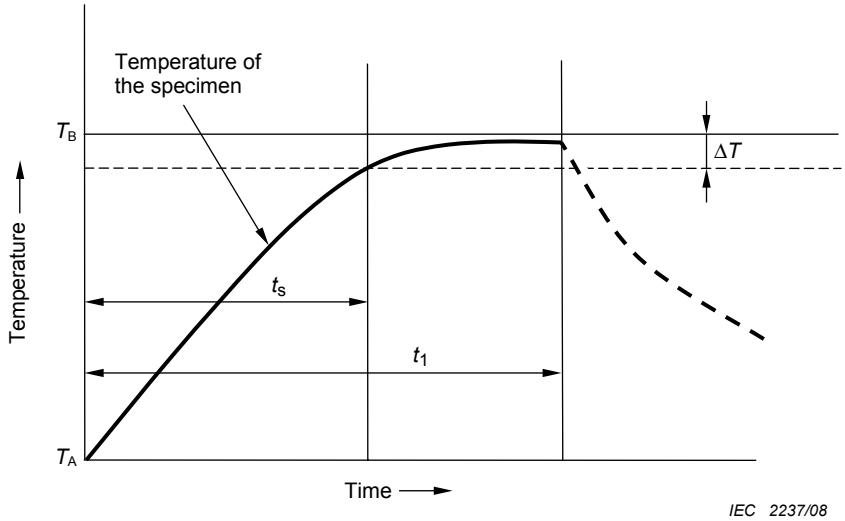

Figure 1 – Determination of test duration time (t_1)

4.5 Choice of the duration of the transfer time

If, in the case of the two-chamber method, because of the large size of the specimens the transfer time cannot be made in 3 min, the transfer time may be increased without an appreciable influence on the test results as follows:

$$t_2 \leq 0{,}05\ t_s$$

where

t_2 is the duration of the transfer time;

t_s is the stabilisation period of the specimen.

4.6 Applicability limits of change of temperature tests

Inside a specimen, the temperature change rate depends on the heat conduction of its materials, the spatial distribution of its heat capacity and its dimensions.

The change of temperature at a point on the surface of a specimen follows approximately an exponential law. Inside large specimens, such alternate exponential rises and decreases may lead to periodic and approximately sinusoidal changes of temperature with much lower amplitudes than the applied temperature swing.

The mechanism of heat transfer between the test specimen and the conditioning medium in the chamber or bath should be taken into account. Liquid in motion leads to very high rates of change of temperature on the surface of the specimens and still air to very low rates.

The two-bath method with water as a conditioning medium (Test Nc) should be restricted to specimens which are either sealed or are by their nature insensitive to water, since their performance and properties may deteriorate by immersion.

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In particular cases, such as with specimens sensitive to water, a test with liquid other than water may need to be specified. When designing such a test, the characteristics of heat transfer of the liquid, which may differ from those of water, shall be taken into account.

NOTE To assess the applicability of the two-bath method, evaluations from Test Q: Sealing (IEC 60068-2-17) may be helpful.

5 Guidance for the selection of the kind of test

The severity of the test will increase with the increase in the temperature difference, the increase in rate of temperature change, and the heat transfer to the specimen.

The application of Tests N is preferred as part of a sequence of tests. Some types of damage may not become apparent by the final measurements of a Test N, but may appear only during subsequent tests (e.g. Test Q: Sealing, Test F: Vibration or Test D: Accelerated damp heat).

The change of temperature Test Nc (Two-bath method) should not be used as an alternative to Test Q (Sealing).

When specifying a change of temperature test, the properties of the objects under test which are affected by conditions of changing temperature, and their possible failure mechanisms, should be kept in mind. The initial and the final measurements should be specified accordingly.

6 Initial and final measurements

Tests Na, Nb and Nc all use the same initial and final measurements.

6.1 Initial measurements

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

6.2 Final measurements

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

7 Test Na: Rapid change of temperature with prescribed time of transfer

7.1 General description of the test

This test determines the ability of components, equipment or other articles to withstand rapid changes of ambient temperature. The exposure times adequate to accomplish this will depend upon the nature of the specimen. The specimen shall be either in the unpacked, switched-off, ready for use state, or as otherwise specified in the relevant specification. The specimen is exposed to rapid changes of temperature in air, or in a suitable inert gas, by alternate exposure to low temperature and to high temperature.

7.2 Testing procedure

7.2.1 Testing chamber

Two separate chambers or one rapid temperature change rate chamber may be used. If two chambers are used, one for the low temperature and one for the high temperature, the location shall be such as to allow transfer of the specimen from one chamber to the other within the prescribed time. Either manual or automatic transfer methods may be used.

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The chambers shall be capable of maintaining the atmosphere at the appropriate temperature for the test in any region where the specimen is placed.

After insertion of the test specimens, the air temperature shall be within the specified tolerance after a time of not more than 10 % of the exposure time.

7.2.2 Mounting or supporting of the test specimen

Unless otherwise specified in the relevant specification, the thermal conduction of the mounting or supports shall be low, such that for practical purposes the specimen is thermally isolated. When testing several specimens simultaneously they shall be so placed that free circulation shall be provided between specimens, and between specimens and chamber surfaces.

7.2.3 Severities

The severity of the test is defined by the combination of the two temperatures, the transfer time, the exposure time of the specimen and the number of cycles.

The lower temperature, T_A, shall be specified in the relevant specification and should be chosen from the test temperatures of IEC 60068-2-1 and IEC 60068-2-2.

The higher temperature, T_B, shall be specified in the relevant specification and should be chosen from the test temperatures of IEC 60068-2-1 and IEC 60068-2-2.

The exposure time, t_1, of each of the two temperatures depends upon the heat capacity of the specimen. It may be 3 h, 2 h, 1 h, 30 min or 10 min, or as specified in the relevant specification. Where no exposure period is specified in the relevant specification, it is understood to be 3 h.

The preferred number of test cycles is five, unless otherwise specified in the relevant specification.

NOTE The 10 min exposure time applies to the testing of small specimens.

7.2.4 Conditioning

The specimen and the temperature in the test chamber shall be at the ambient temperature of the laboratory, +25 °C ± 5 K. If required by the relevant specification the specimen shall be brought into operating condition.

7.2.5 Test cycle

The test specimen shall be exposed to the cold temperature, T_A.

The temperature, T_A, shall be maintained for the specified period t_1. t_1 includes an initial time, not longer than 0,1 t_1 for temperature stabilization of the air temperature in the chamber (see 7.2.1).

NOTE 1 The exposure time is measured from the moment of insertion of the specimen into the chamber.

The specimen shall then be exposed to the hot temperature, T_B, in a period, t_2, which should not be more than 3 min.

t_2 shall include the time need for the removal from one chamber and the insertion into the second chamber as well as any dwell time at the ambient temperature of the laboratory.

NOTE 2 For specimens with a large mass, the transfer time from one chamber to another may be increased as specified in the relevant standard or specification.

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