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REDLINE VERSION

INTERNATIONAL STANDARD

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Environmental testing –
Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 2-38: Tests –
Test Z/AD: Composite temperature/humidity cyclic test

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60068-2-38:2009. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60068-2-38 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test. It is an International Standard.

This third edition cancels and replaces the second edition, published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the figures have been updated;

b) changes to the wording has been made for clarification purposes.

The text of this International Standard is based on the following documents:

Draft	Report on voting
104/891/FDIS	104/896/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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ENVIRONMENTAL TESTING –

Part 2-38: Tests –
Test Z/AD: Composite temperature/humidity cyclic test

1 Scope

This part of IEC 60068 ~~provides~~ specifies a composite test procedure, primarily intended for component type specimens, to determine, in an accelerated manner, the resistance of specimens to the deteriorative effects of high temperature/humidity and cold conditions.

This test standard does not apply to specimens that are energized during the complete test. Specimens can be energized during the constant phases of the tests. Measurements on energized specimens are typically carried out during constant phases of the test unless specified otherwise.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-1, *Environmental testing – Part 1: General and guidance*

~~IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*~~

~~IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*~~

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

IEC 60068-2-67, *Environmental testing – Part 2-67: Tests – Test Cy: Damp heat, steady state, accelerated test primarily intended for components*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO online browsing platform: available at http://www.iso.org/obp

4 General

4.1 Description of the test

Test Z/AD is a cyclic temperature/humidity test which is designed to reveal defects in test specimens caused by "breathing" as distinct from the absorption of moisture.

This process can be initiated by the forming of condensation on the specimen's surface. As the temperature on parts or the whole of the specimen's surface might be lower than the corresponding dew point at the humidity value, water can accumulate in small cracks or gaps on the specimen's surface.

Once the air temperature is reduced, the air in internal voids of specimen is contracted which results in a drop of pressure and drawing-in either wet air or condensed water through cracks or other leaks inside the specimen. The wet air will condense on inner walls of a void and may gradually fill it. During the temperature rising phase, the air in the void is expanded, this time with a lower dew point than during drawing-in, and partially escape out. This cycle is repeated, and water can be accumulated inside the specimen and may gradually fill its voids.

This so-called "breathing" effect is caused by changing the temperature inside the specimen in an atmosphere with high humidity. During the excursion to sub-zero temperature phase of the test, the water trapped in cracks and other voids freezes and due to the expansion of ice volume the cracks extend, and new cracks can form.

This test differs from other cyclic damp heat tests in that it derives its increased severity from:

a) a greater number of temperature variations or "~~pumping~~ breathing" actions in a given time;

b) a greater cyclic temperature range;

c) a higher cyclic rate of change of temperature;

d) the inclusion of a number of excursions to sub-zero temperatures.

The accelerated breathing and the effect of the freezing of trapped water in cracks and fissures are the essential features of this composite test.

It is emphasized, however, that the freezing effect will occur only if the fissure dimensions are large enough to allow the penetration of a coherent mass of water as is normally the case in fissures between seals and metal assemblies, or between seals and wire terminations.

The degree of condensation will depend mainly upon the thermal time constant of the surface of the test specimens and may be negligible for very small specimens but copious for large specimens.

Similarly, the breathing effect will be more apparent on specimens which contain relatively large air-filled or gas-filled voids, but again, the severity of the test will depend to some extent on the thermal characteristics of the specimens.

The condensation effect and the temperature distribution could be disturbed by functional checks, therefore the checks should be carried out during the constant phases of the temperature profiles (Figure 2 and Figure 3, areas B and F).

To simply the programming of the test sequences, the set points are given in Annex A.

4.2 Application of the test

For the reasons given above, it is recommended that this test procedure be limited to component type specimens when the construction of the specimens suggests a "breathing" type of damp heat test combined with icing and where the thermal characteristics are compatible with the rates of change of temperature, etc., of test Z/AD.

For solid type specimens, for example plastic encapsulated, where there may be small hairline cracks or porous material, the absorption or diffusion mechanisms will predominate and a steady damp heat such as test C of IEC 60068-2-78 is preferred for investigating these effects.

For larger specimens such as equipment or when it is essential for components to ensure thermal stability during the various phases of the cycle, test Db of IEC 60068-2-30 should be employed, although due to the reduced number of cycles in a given period, the degree of acceleration may not be as fast. In this case, test Db should normally form part of a sequence such as that defined in IEC 60068-1.

As in other damp heat tests, a polarizing voltage or electrical loading may be applied to the specimens. In the case of electrical loading, the loading should be such that the temperature rise of the specimens does not unduly affect the chamber conditions.

From the above, test Z/AD should not be considered to be interchangeable with, or an alternative to, either steady-state or other cyclic damp heat tests, but the choice of test procedure should be made with due regard for the physical and thermal characteristics of the test specimens and the types of failure mechanisms which are significant for each particular case.

5 Description of test chamber

5.1 General

The exposure to moisture, followed by cold, can either be performed in one chamber or in two separate chambers.

NOTE All temperatures and humidity values measured refer to a supply air measurement of the test chamber.

5.2 Chamber for exposure to moisture

The chamber for the exposure to moisture shall be so constructed that:

a) the temperature can be varied between 25 °C ± 2 K and 65 °C ± 2 K in a period of between 1,5 h and 2,5 h for both rising and falling temperatures;

b) the relative humidity can be maintained at $\left(93^{+3}_{-3}\right)$ % during the periods of constant or rising temperature and between 80 % ~~RH~~ and 96 % ~~RH~~ during the falling temperature periods;

c) the conditions prevailing at any point in the working space are uniform and are as similar as possible to those prevailing in the immediate vicinity of suitably located temperature- and humidity-sensing devices;

   The air in the chamber shall therefore be continuously stirred at a rate necessary to maintain the specified conditions of temperature and humidity.

d) the specimens under test shall not be subjected to radiant heat from the chamber conditioning processes;

e) ~~water used for the maintenance of chamber humidity shall have a resistivity of not less than 500 Ωm~~ the water used for the chamber humidity system shall comply with the limits given in IEC 60068-2-67;

f) condensed water shall be continuously drained from the chamber and not used again unless it has been re-purified.

Precautions shall be taken to ensure that no condensed water from the walls and roof of the test chamber can fall on the specimens.

5.3 Chamber for exposure to cold

The chamber for exposure to cold shall be so constructed that

a) the temperature can be maintained at –10 °C ± 2 K,

b) the conditions prevailing at any point in the working space are uniform and are as similar as possible to those prevailing in the immediate vicinity of suitably located temperature-sensing devices.

The air in the chamber shall therefore be continuously moving.

Care ~~shall~~ should be taken that the thermal capacity of the specimen under test does not appreciably influence conditions within the chamber.

The humidity chamber may be used for exposure to cold, in which case it shall meet the requirements of 4.1 and, in addition, shall be so constructed that

1) the temperature can be lowered from 25 °C ± 2 K to −10 °C ± 2 K in a period of not more than 30 min,

2) the specimen can be held at a temperature of −10 °C ± 2 K for a period of 3 h,

3) the temperature can be raised from −10 °C ± 2 K to 25 °C ± 2 K in a period of not more than 90 min.

6 Severities

The number of 24 h cycles shall be 10, unless otherwise specified. If other than 10, the relevant specification shall define the number.

7 Testing procedure

7.1 Preconditioning ~~(see Figure 1)~~

Unless otherwise specified, the specimens in the unpacked, switched-off, ready-for-use state shall be subjected to the conditions for "assisted drying" specified in IEC 60068-1 (55 °C ± 2 K with a relative humidity not exceeding 20 %) for a period of 24 h prior to the first cycle of the damp heat test.

The specimens shall then be allowed to attain thermal stability at standard atmospheric conditions for testing or, as otherwise specified, before the initial measurements are made.

Figure 1 gives an overview about the preconditioning phase. During the stabilizing period no specific rate of cooling is specified, however it shall not exceed 1 K/min.

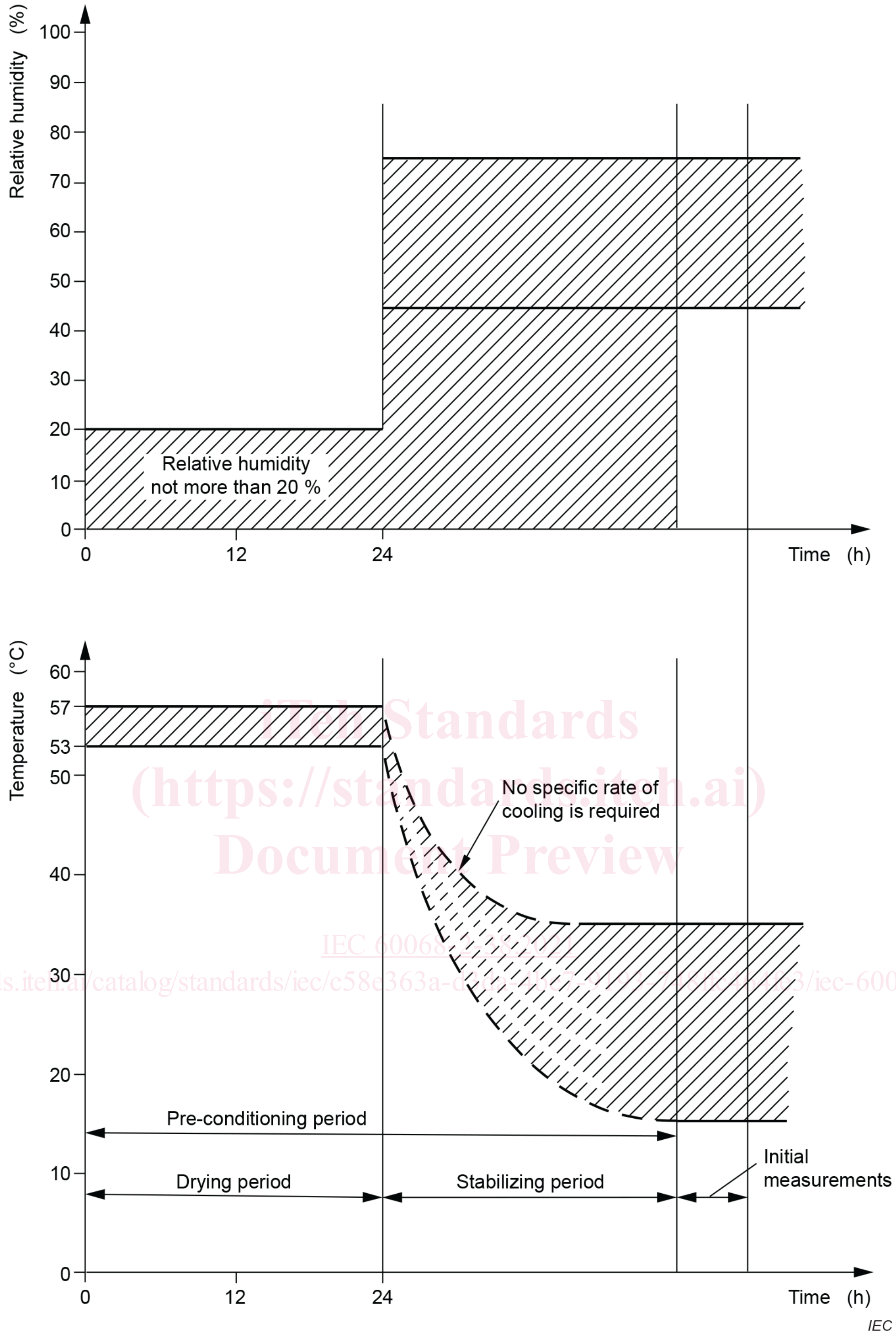

Figure 1 – Preconditioning

7.2 Initial measurements

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

7.3 Conditioning

The total temperature tolerance of ±2 K given in this document is intended to take account of absolute errors in the measurement, slow changes of temperature and temperature variations of the working space.

NOTE This tolerance is valid for an empty test space during stabilized temperature/humidity conditions of the test. In some conditions, where the specimen has a negligible impact on the chamber control, the tolerances can still be valid for the chamber with specimen(s).

However, in order to maintain the relative humidity within the required tolerances, it is necessary to keep the temperature difference between any two points in the working space at any moment within narrower limits. The required humidity conditions will not be achieved if such temperature differences exceed 1 K. It may also be necessary to keep short-term fluctuations within ~~±0,5 K~~ these limits to maintain the required humidity.

The specimens shall be introduced into the humidity chamber, in the unpacked, switched-off, ready-for-use state, and mounted in the normal orientation, if this is known, or as otherwise specified and shall be subjected to 10 temperature/humidity cycles, each of 24 h duration.

During any five of the first nine of the above cycles after exposure to the humidity subcycle (~~points a) to f)~~ areas A to H in Figure 2), the specimens shall be subjected to cold. The position of the cold subcycles should be defined in the relevant specification.

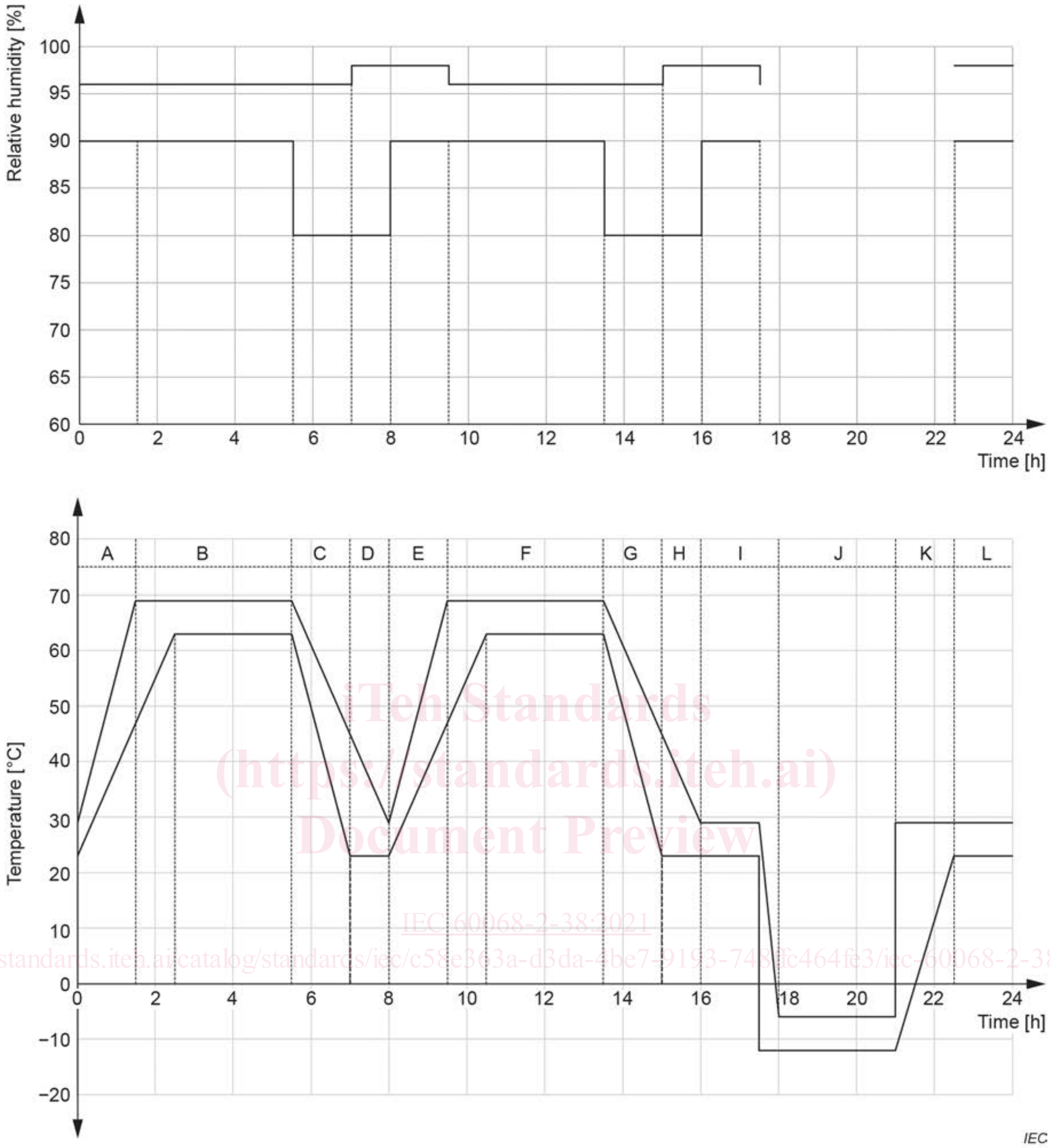

Figure 2 – Exposure to humidity followed by exposure to cold

This exposure may be performed either in the same chamber or in separate chambers. If separate chambers are used for the high-temperature/high-humidity and low-temperature subcycles of the test, the specimens should not be subjected to thermal shock conditions unless it is known that they are insensitive to this degree of thermal shock.

If a batch of specimens is subjected to thermal shock using the two chamber method and significant failures occur, a further batch shall be retested with gradual change of temperatures and shall be considered to have passed the test successfully if no significant failures occur under these conditions.

The remaining four of the first nine cycles shall be run without exposure to cold (see 7.4.3 and Figure 3). The humidity cycles ~~prescribed~~ specified are the same in all cases.