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Environmental testing –

Part 2-1: Tests – Test A: Cold

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 2-1: Tests – Test A: Cold

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60068-2-1 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This sixth edition cancels and replaces the fifth edition issued in 1990. It includes the revised text of the fifth edition, amendment 1 issued in 1993 and amendment 2 issued in 1994.

This sixth edition deals with cold tests applicable both to non heat-dissipating and heat-dissipating specimens. For non heat-dissipating specimens, Tests Ab and Ad do not deviate essentially from earlier issues. Test Ae has been added primary for testing equipment that requires being operational throughout the test including the conditioning periods.

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

FDIS	Report on voting
104/407/FDIS	104/410/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.

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- withdrawn,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

INTRODUCTION

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	Air velocity	Specimen type	Temperature change	Air velocity
a	Withdrawn			Withdrawn		
b	Non heat	Gradual	High preferred	Non heat	Gradual	High preferred
c	Withdrawn			Withdrawn		
d	Heat dissipating	Gradual	Low preferred	Heat	Gradual	Low preferred
e	Heat dissipating, powered throughout	Gradual	Low preferred	Heat, powered throughout	Gradual	Low preferred

ENVIRONMENTAL TESTING –

Part 2-1: Tests – Test A: Cold

1 Scope and object

This part of IEC 60068 deals with cold tests applicable to both non heat-dissipating and heat-dissipating specimens. For non heat-dissipating specimens, Tests Ab and Ad do not deviate essentially from earlier issues. Test Ae has been added primarily for testing equipment that requires being operational throughout the test, including the conditioning periods.

The object of the cold test is limited to the determination of the ability of components, equipment or other articles to be used, transported or stored at low temperature.

Cold tests cover by this standard do not enable the ability of specimens to withstand or operate during the temperature variations to be assessed. In this case, it would be necessary to use IEC 60068-2-14.

The cold tests are subdivided as follows:

– *Cold tests for non heat-dissipating specimens*

  - with gradual change of temperature, Ab;

– *Cold test for heat-dissipating specimens*

  - with gradual change of temperature, Ad,
  - with gradual change of temperature, specimen powered throughout, Ae.

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

Temperature chamber(s) are constructed and verified in accordance with specifications IEC 60068-3-5 and IEC 60068-3-7.

Further guidance for dry heat and cold tests can be found in IEC 60068-3-1 and general guidance in IEC 60068-1.

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 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-14, *Basic environmental test procedures – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-3-1, *Environmental testing – Part 3: Background information – Section one: Cold and dry heat tests*

IEC 60068-3-5, *Environmental testing – Part 3-5: Supporting documentation and guidance – Confirmation of the performance of temperature chambers*

IEC 60068-3-7, *Environmental testing – Part 3-7: Supporting documentation and guidance – Measurements in temperature chambers for tests A and B (with load)*

IEC 60068-5-2, *Environmental testing – Part 5-2: Guide to drafting of test methods – Terms and definitions*

IEC 60721 (all parts), *Classification of environmental conditions*

3 Terms and definitions

For the purposes of this document, the definitions given in IEC 60068-5-2, as well as the following definitions, apply.

3.1
low air velocity in the working space
velocity of conditioning airflow within a working space which is sufficient to maintain conditions but low enough so that the temperature at any point on the test specimen is not reduced by more than 5 K by the influence of the circulation of the air (if possible, not more than 0,5 m/s)

3.2
high air velocity in the working space
velocity of conditioning airflow within a working space, which in order to maintain conditions, also reduces the temperature at any point on the test specimen by more than 5 K by the influence of the circulation of the air

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

4.1 General

A specimen is considered to be heat-dissipating only if the hottest point on its surface, measured in free air conditions (i.e. with low air velocity circulation), is more than 5 K above the ambient temperature of the surrounding atmosphere after temperature stability has been reached (see 4.8 of IEC 60068-1). When the relevant specification calls for a storage or transportation test, or does not specify an applied load during the test, the Cold Test Ab will apply.

4.2 Ascertaining high or low air velocity in the test chamber

Under standard atmospheric conditions for measurements and test (see IEC 60068-1) with an air velocity <0,2 m/s achieved without induced air movement, the specimen shall be switched on or electrically loaded as specified for the low temperature at which the test is to be carried out.

When temperature stability of the specimen has been reached, the temperature of a number of representative points around or on the specimen shall be measured using a suitable monitoring device. The temperature rise that occurs at each point shall then be noted.

The chamber 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 K (or a value stated by the relevant specification) this value shall be noted in the test report and the test chamber is considered to have high velocity circulation. The specimen is then switched off and any loading conditions removed.

4.3 Non heat-dissipating specimens

In Test Ab 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 reduced gradually so as to cause no detrimental effects on the test specimen due to the temperature change. High air velocity is recommended as this will reduce the time required for temperature stabilization.

4.4 Testing of heat-dissipating specimens

Tests Ad and Ae describe procedures for testing heat-dissipating specimens with low air velocity circulation. This is to allow localized hot spots to develop within the specimen similar to those that would appear in installed applications.

4.5 Temperature monitoring

The air temperature in the chamber shall be measured by temperature sensors located at such a distance from the specimen that the effect of the dissipation is negligible. Suitable precautions shall be taken to avoid heat radiation affecting these measurements. For more information see IEC 60068-3-5.

4.6 Packaging

For storage and transportation tests, equipment may be tested with its packaging in place. However, as these tests are steady-state tests, the equipment will eventually stabilize at chamber temperature. Packaging shall be removed unless the relevant specification requires it to remain in place, or heating elements are incorporated in the package.

4.7 Diagrammatic representations

To facilitate the choice of test method, a diagrammatic representation of the various procedures is given in Figure 1.

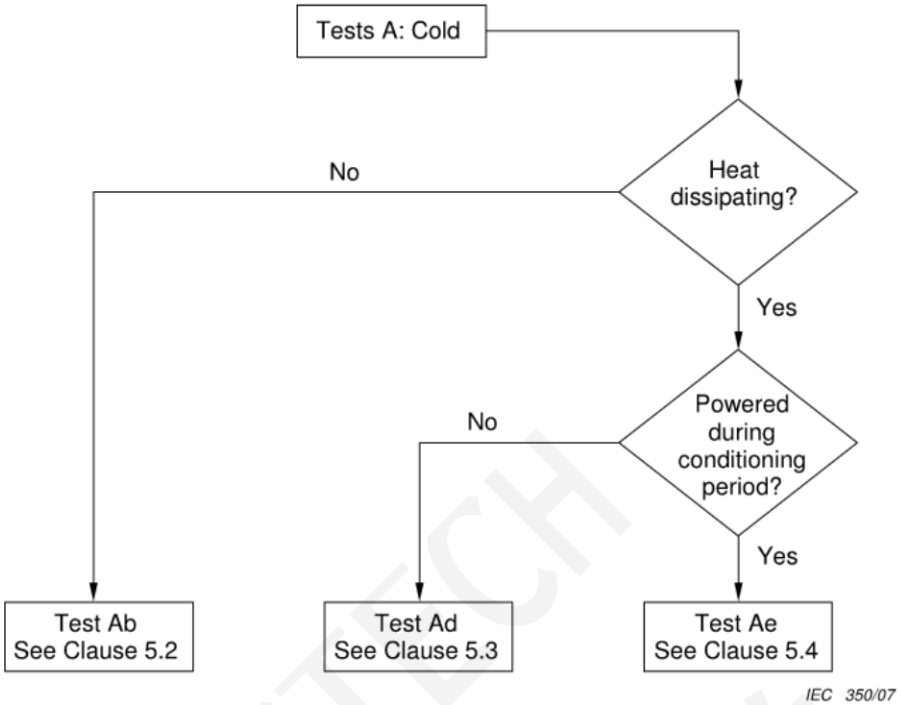

Figure 1 – Block diagram tests A: Cold

5 Test description

5.1 General

Tests Ab, Ad, and Ae are similar. Differences are noted in 5.2.2, 5.3.2 and 5.4.2. All other portions of the test are the same, starting with Clause 6. The rate of change of temperature within the chamber shall not exceed 1 K per minute, averaged over a period of not more than 5 min. The relevant specification shall define the functioning of the specimen under test.

Care shall be taken to see that any cooling devices of the specimen are in accordance with the requirement in the relevant specification.

5.2 Test Ab: Cold for non heat-dissipating specimens with gradual change of temperature

5.2.1 Object

This procedure is intended for non heat-dissipating specimens which are subjected to a lower temperature for a time long enough for the specimen to achieve temperature stability.

5.2.2 General description

The specimen is introduced into the chamber which is 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. For specimens that are required to be operational (even though they do not meet the requirements of being heat dissipating), power shall then be applied to the specimen and a functional test is performed as necessary. A further period of stabilization may be necessary and the specimen shall then be exposed to the low temperature conditions for a duration as specified in the relevant specification.

Specimens under test are normally in non-operating conditions.

High air velocity circulation is normally used for this test.

5.3 Test Ad: Cold for heat-dissipating specimens with gradual change of temperature that are powered after initial temperature stabilization

5.3.1 Object

This procedure is for heat-dissipating specimens which are subjected to a low temperature for a time long enough for the specimen to achieve temperature stability.

5.3.2 General description

The specimen is introduced into the chamber which is at the temperature of the laboratory. If necessary, a test is performed to determine if the chamber fulfils the requirements of low air velocity. 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 powered on and stabilized again and then exposed to these conditions for the specified duration. The specimen shall remain in the operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification.

Low air velocity circulation is normally used for this test.

5.4 Test Ae: Cold for heat-dissipating specimens with gradual change of temperature that are required to be powered throughout the test

5.4.1 Object

This procedure is intended for heat dissipating specimens which are subjected to a low temperature for a time long enough for the specimen to achieve temperature stability and which are required to be powered throughout the test period.

5.4.2 General description

The specimen is introduced into the chamber which is at the temperature of the laboratory. If necessary, a test is performed to determine if the chamber fulfils the requirements of low air velocity chamber. Power is then applied to the specimen and a functional test is performed, as necessary. 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.

Low air velocity circulation is normally used for this test.

5.4.3 Energizing the specimen

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

6 Test procedure

6.1 Confirmation of performance

IEC 60068-3-5 provides guidance for the confirmation of performance of temperature test chambers. IEC 60068-3-1 provides general guidance for the performance of Tests A and B.

The chamber shall be large enough compared with the size and amount of heat-dissipation of the test sample.

6.2 Working space

The dimensions of the test sample shall be such that it is entirely within the working space of the test chamber.

The temperature of incident air delivered to the test specimen shall be within ± 2 K of test severity temperature during the steady-state condition. The air temperature in the working space shall be measured in accordance with 4.5.

Where, due to the size of the chamber, it is not feasible to maintain these tolerances, the tolerance may be widened to ±3 K down to –25 °C and ±5 K down to –65 °C. When this is done, the tolerance used shall be specified in the test report.

6.3 Thermal radiation

The ability of the specimen to transfer heat by thermal radiation shall be minimized. This will normally result in the screening of any heating or cooling elements from the specimen and ensuring that parts of the chamber surfaces are not significantly different in temperature from that of the conditioning air.

6.4 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.

6.5 Mounting

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

6.6 Severities

The severities, as indicated by temperature and duration of exposure, shall be prescribed by the relevant specification. They shall be:

a) chosen from the values given in 6.6.1and 6.6.2; or

b) derived from the known environment if this gives significantly different values; or

c) derived from other known sources of relevant data (for example IEC 60721).

6.6.1 Temperature

– 65 °C	– 40 °C	– 20 °C	+ 5 °C
– 55 °C	– 33 °C	– 10 °C	
– 50 °C	– 25 °C	– 5 °C	

6.6.2 Duration

2 h	72 h
16 h	96 h

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

6.7 Preconditioning

The relevant specification may call for preconditioning.

6.8 Initial measurements

The initial state of the specimen shall be known. This may be achieved by visual inspection, and/or functional tests as required by the relevant specification.

6.9 Conditioning

The specimen shall be exposed to the low temperature conditions for the duration, as detailed in the relevant specification.

For the exceptional cases when the specimen does not achieve temperature stability, the duration of the test starts at the time that the specimen is energized. Such cases are typically caused by specimens having long duty cycles.

6.10 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(s) after which they shall be carried out. For these measurements, the specimen shall not be removed from the chamber.

NOTE 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 should be performed separately for each lot.

6.11 Final temperature ramp

If the specimen remains in operating or loaded condition during the test, it shall be switched off or unloaded before the temperature is raised with the exception of Test Ae in which the specimen shall remain operational throughout the recovery period.

At the end of the specified duration, the specimen shall remain in the chamber and the temperature shall be gradually raised 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 K per minute, averaged over a period of not more than 5 min.

6.12 Recovery

The specimen shall be subjected to the recovery procedure in the chamber or otherwise, as deemed suitable. Appropriate steps may be taken to remove droplets of water, as required, without damaging the specimen.

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.

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

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

6.13 Final measurements

The specimen shall be visually inspected and such performance checks made as are required by the relevant specification.

7 Information to be given in the relevant specification

When Test A: Cold is included in the relevant specification, the following details shall be given, as far as they are applicable:

a) type of test;

b) preconditioning;

c) initial measurements;

d) details of mounting or supports;

e) state of specimen including cooling system during conditioning;

f) severity, temperature and duration of exposure;
g) rate of change of temperature;
h) measurements and/or loading during conditioning;
i) recovery if non-standard;
j) final measurements;
k) any deviation in procedure as agreed upon between customer and supplier;
l) temperature difference if low air velocity was not established (see 4.2).

8 Information to be given in the test report

As a minimum the test report shall show the following information:

a)	Customer	(name and address)
b)	Test laboratory	(name and address and details of accreditation - if any)
c)	Test dates	
d)	Type of test	(Ab, Ad, Ae)
e)	Purpose of test	(development, qualification etc.)
f)	Test standard, edition	(IEC 60068-2-1, edition *)
g)	Relevant laboratory test procedure	(code and issue)
h)	Test specimen description	(drawing, photo, quantity build status etc.).
i)	Test chamber identity	(manufacturer, model number, unique id, etc.)
j)	Performance of test apparatus	(set point temperature control, air flow etc.)
k)	Air velocity and direction	(air velocity and direction of incident air to the specimen)
l)	Uncertainties of measuring system	
m)	Calibration data	(last and next due date)
n)	Initial, intermediate and final measurements	
o)	Required severities	(from relevant specification)
p)	Test Severities	(measuring points, data etc.)
q)	Performance of test specimens	(results of functional tests etc.)
r)	Observations during testing and actions taken	
s)	Summary of test	
t)	Distribution	

NOTE A test log should be written for the testing which can be attached to the report.

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