IEC 60068-1

Edition 7.0 2013-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 1: General and guidance

Essais d'environnement –
Partie 1: Généralités et lignes directrices

IEC 60068-1:2013

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 1: General and guidance

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 60068-1 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This seventh edition cancels and replaces the sixth edition, published in 1988, and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

– updated normative reference list;
– indication of normative and informative annexes;
– new informative Annex C, *Environmental test tailoring.*

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

FDIS	Report on voting
104/618/FDIS	104/627/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, published under the general title *Environmental testing*, can be found on the IEC website.

This standard should be used in conjunction with the relevant specification which will define the tests to be used, the required degree of severity for each of them, their order (if relevant), and the permissible performance limits.

The committee has decided that the contents of this publication will remain unchanged until the stability 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

The IEC 60068 series contains fundamental information on environmental testing procedures and severities of tests. In addition, this Part 1 contains information on atmospheric conditions for measurement and testing.

It is intended to be used in those cases where a relevant specification for a certain type of product (electrical, electromechanical or electronic equipment and devices, their subassemblies and constituent parts and components), hereinafter referred to as the "specimen", is to be prepared, so as to achieve uniformity and reproducibility in the environmental testing of this product.

NOTE 1 Although primarily intended for electrotechnical products, many of the environmental testing procedures in Part 2 of this series are equally applicable to other industrial products.

The expression "environmental conditioning" or "environmental testing" covers the natural and artificial environments to which specimens may be subjected and exposed to in practice so that an assessment can be made of their performance under conditions of storage, transportation, installation and use.

The requirements for the performance of specimens subjected to environmental conditioning are not covered by this standard. The relevant specification for the specimen under test defines the allowed performance limits during and after environmental testing.

When drafting a relevant specification or purchasing contract, only those tests should be specified that are necessary for the relevant specimen, taking into account the technical and economic aspects.

The IEC 60068 series consists of:

a) this first part, IEC 60068-1 – *General and guidance*, which deals with generalities;
b) the second part, IEC 60068-2 – *Tests* – which publishes particular tests separately for different applications;
c) the third part, IEC 60068-3 – *Supporting documentation and guidance*, which deals with background information on a family of tests.

The families of tests comprising Part 2 of the IEC 60068 series are designated by the following upper-case letters:

A: Cold
B: Dry heat
C: Damp heat (steady-state)
D: Damp heat (cyclic)
E: Impact (for example shock and rough handling shocks)
F: Vibration
G: Acceleration (steady state)
H: (Awaiting allocation)

NOTE 2 Originally allotted to storage tests.

J: Mould growth
K: Corrosive atmospheres (for example salt mist)
L: Dust and sand
M: Air pressure (high or low)
N: Change of temperature

P: (Awaiting allocation)

NOTE 3 Originally allotted to “flammability”.

Q: Sealing (including panel sealing, container sealing and protection against ingress and leakage of fluid)

R: Water (for example rain, dripping water)

S: Radiation (for example solar, but excluding electromagnetic)

T: Soldering (including resistance to heat from soldering)

U: Robustness of terminations (of components)

V: (Awaiting allocation)

NOTE 4 Originally allocated to “acoustic noise” but “vibration, acoustically induced” will now be Test Fg, one of the “vibration” family of tests.

W: (Awaiting allocation)

Y: (Awaiting allocation)

The letter X is used as a prefix together with a second lower-case letter providing for extension of the list of families of tests, e.g. Test Xa: Immersion in cleaning solvents. The letter Z is used to denote combined tests and composite tests as follows: Z is followed by a solidus (slash) and a group of lower-case letters relating to the combined or composite stresses, for example Test Z/am: Combined cold and low air pressure tests.

If appropriate, a test may be designated as “primarily intended for components” or “primarily intended for equipment”.

To provide for future expansion within a family of tests and to maintain consistency of presentation, each family of tests may be subdivided. The subdivisions are identified by the addition of a (lower-case) second letter, for example:

U: Robustness of terminations and integral mounting devices

Test Ua: Subdivided as Test Ua_1: Tensile; and Test Ua_2: Thrust

Test Ub: Bending

Test Uc: Torsion

Test Ud: Torque

This subdivision is made even though only one test is published and no further tests are immediately contemplated in the relevant family.

In order to avoid confusion with numbers, the letters i, I, o and O are not used.

ENVIRONMENTAL TESTING –

Part 1: General and guidance

1 Scope

The IEC 60068 series includes a series of methods for environmental testing along with their appropriate severities, and prescribes various atmospheric conditions for measurements and tests designed to assess the ability of specimens to perform under expected conditions of transportation, storage and all aspects of operational use.

Although primarily intended for electrotechnical products, this standard is not restricted to them and may be used in other fields where desired.

Other methods of environmental testing, specific to the individual types of specimen, may be included in the relevant specifications.

The framework of environmental test tailoring process is given in order to assist the production of test specifications with appropriate tests and test severities.

The IEC 60068 series provides a series of uniform and reproducible environmental, climatic, dynamic and combined tests, performed and measured under standard atmospheric conditions, for those preparing specifications and those engaged in the testing of products.

These test methods are based upon available international engineering experience and judgement and are primarily designed to provide information on the following properties of specimens:

a) the ability to operate within specified limits of temperature, pressure, humidity, mechanical stress or other environmental conditions and combinations of these conditions;

b) the ability to withstand conditions of transportation, storage and installation.

NOTE 1 The IEC 60721 series provides a system for classification of environmental conditions and gives relevant definitions.

The tests in this standard permit the comparison of the performance of sample products. To assess the quality or useful life of a given production lot, the test methods should be applied in accordance with a suitable sampling plan and may be supplemented by appropriate additional tests, if necessary.

NOTE 2 ISO defines “quality” as the degree to which a set of inherent characteristics fulfils requirements..

NOTE 3 "Useful life": under given conditions, the time interval beginning, at a given instant of time, and ending when the failure intensity becomes unacceptable or when the item is considered unrepairable as a result of a fault.

To provide tests appropriate to the different intensities of an environmental condition, some of the test procedures have a number of degrees of severity. These different degrees of severity are obtained by varying the time, temperature, air pressure or some other determining factor, separately or in combination.

As the tests and their degrees of severity should be based on real environmental conditions that a particular specimen might encounter, the framework and the necessary phases for the environmental test tailoring process are provided. The test tailoring process may be used to produce the required relevant test specification for the particular specimen.

2 Normative references

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

IEC 60068-2 (all parts), *Environmental testing – Tests*

3 Terms and definitions

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

NOTE Tests covered by this standard may, in themselves, consist of a series of operations in order to determine the effect of such a test, or series of tests, on a specimen.

3.1
test
complete series of operations implied by its title, normally comprising the following operations, if required:

a) pre-conditioning;
b) initial examination and measurements;
c) testing;
d) recovery;
e) final examination and measurements.

Note 1 to entry: Intermediate measurements may be required during conditioning and/or recovery.

Note 2 to entry: When the temperature and humidity for conditioning of a specimen for measurement are the same as those prescribed for pre-conditioning, the pre-conditioning and conditioning may be merged, and the pre-conditioning may be said to take the place of conditioning for measurement.

3.2
pre-conditioning
treatment of a specimen with the object of removing, or partly counteracting, the effects of its previous history

Note 1 to entry: Where pre-conditioning is called for, it is the first process in the test procedure.

Note 2 to entry: Pre-conditioning may be affected by subjecting the specimen to climatic, electrical, or any other conditions required by the relevant specification in order that the properties of the specimen may be stabilized before measurement and test.

3.3
testing
exposure of a specimen to environmental conditions in order to determine the effect of such conditions on the specimen

3.4
recovery
treatment of a specimen, after conditioning, in order that the properties of the specimen may be stabilized before measurement

3.5
specimen
product designated to be tested in accordance with the procedures of the IEC 60068 series

Note 1 to entry: The term “specimen” includes any auxiliary parts or systems that are integral functional features of the specimen, for example systems for cooling and heating.

3.6
heat-dissipating specimen
specimen with the hottest point on its surface, measured in free air conditions and under the air pressure as specified in 4.3, more than 5 K above the ambient temperature of the surrounding atmosphere after thermal stability has been reached

Note 1 to entry: Measurements required to prove that a specimen can be classified as either heat-dissipating or non-heat-dissipating can be made under standard atmospheric conditions for measurement and tests if care has been taken that no outside influence (for example draughts or sunlight) affects the measurements. In the case of large or complicated specimens, it may be necessary to make measurements at several points.

3.7
air conditions
conditions within an infinite space where the movement of the air is affected only by the heat-dissipating specimen itself

3.8
relevant specification
set of requirements to be satisfied by a specimen, indicating the method(s) necessary to determine whether the requirements given are satisfied

3.9
ambient temperature
temperature of the air (further defined in 3.9.1 and 3.9.2)

Note 1 to entry: In applying these definitions, guidance should be sought from IEC 60068-3-1.

3.9.1
non-heat-dissipating specimens
temperature of the air surrounding the specimen

3.9.2
heat-dissipating specimens
temperature of the air in free air conditions at such a distance from the specimen that the effect of the dissipation is negligible

Note 1 to entry: In practice, the ambient temperature is taken as the average of temperatures measured at a number of points in a horizontal plane situated between 0 mm and 50 mm below the specimen, at half the distance between the specimen and the wall of the chamber, or at 1 m distance from the specimen, whichever is less. Suitable precautions should be taken to avoid heat radiation affecting these measurements.

3.10
surface temperature
case temperature
temperature measured at one or more specified points on the surface of the specimen

3.11
thermal stability
state when the temperatures of all parts of the specimen are within 3 K, or as otherwise prescribed by the relevant specification, of their final temperature

Note 1 to entry: For non-heat-dissipating specimens, the final temperature will be the mean (in time) temperature of the chamber in which the specimen is placed. For heat-dissipating specimens, it is necessary to make repeated measurements to determine the interval of time for the temperature to change 3 K, or as otherwise prescribed by the relevant specification. Thermal stability has been reached when the ratio between two consecutive time intervals exceeds 1,7.

Note 2 to entry: Where the thermal time constant of the specimen is short compared with the duration of the exposure to a given temperature, no measurement is needed. Where the thermal time constant of the specimen is of the same order as the duration of the exposure, checks should be made to ascertain that

a) non-heat-dissipating specimens are within the required limit of the mean (in time) ambient temperature,

b) for heat-dissipating specimens the ratio between two consecutive time intervals exceeds 1,7 when repeated measurements are made to determine the interval of time required for the temperature to change by 3 K, or as otherwise prescribed by the relevant specification.

IEC 60068-3-1 gives background information on the testing of specimens with and without heat-dissipation.

Note 3 to entry: In practice, it may not be possible to make direct measurements of the internal temperature of the specimen. A check may then be made by measuring some other parameter which is temperature-dependent and for which the temperature dependence is known.

3.12
chamber
enclosure or space in some part of which the specified conditions can be achieved

3.13
working space
part of the chamber in which the specified conditions can be maintained within the specified tolerances

3.14
combined test
tests during which a specimen is subjected simultaneously to two or more environmental influences

Note 1 to entry: Tests with a simultaneous influence of a) temperature and humidity; b) temperature, humidity and a specific (including chemically active) medium; and c) temperature and solar radiation, are not related to combined tests.

Note 2 to entry: Combined tests, as a rule, are used to provide simultaneous climatic and mechanical influences.

Note 3 to entry: Measurements are usually taken at the start and at the end of the test.

3.15
composite test

test in which the specimen is exposed to two or more test environments in close succession

Note 1 to entry: The intervals of time between the exposures to different test environments are defined precisely since they may have a significant effect on the specimen.

Note 2 to entry: Pre-conditioning, recovery or stabilization periods are usually not included between each exposure.

Note 3 to entry: Measurements are usually taken prior to the start of the first exposure and at the conclusion of the last exposure.

3.16
sequence of tests
sequence in which the specimen is exposed successively to two or more test environments

Note 1 to entry: The durations of interval between the exposures to different test environments are such that they normally have no significant effect on the specimen.

Note 2 to entry: Pre-conditioning and recovery periods are usually performed between the different exposures.

Note 3 to entry: Measurements are usually taken before and after each exposure, the final measurement of one test being the initial measurement of the next.

3.17
reference atmosphere
atmosphere to which values measured under any other conditions are corrected by calculation

3.18
referee measurements
measurements repeated under closely controlled atmospheric conditions when the correction factors to adjust atmospheric-sensitive parameters to their standard reference atmosphere

values are unknown, and measurements under the recommended range of ambient atmospheric conditions are unsatisfactory

3.19
conditioning (of a specimen for measurement)
subjection of the specimen to an atmosphere of a specified relative humidity, or complete immersion in water or other liquid, at a specified temperature for a specified period of time

Note 1 to entry: According to circumstances, the space used for conditioning of a specimen for measurement may be a whole laboratory room in which the specified conditions are maintained within the prescribed tolerances, or a special chamber.

3.20
environmental test tailoring
process of producing testing procedures and test specifications on the basis of actual field conditions encountered by the particular specimen, derived from measurements, literature or other relevant sources and reduced and transformed so that it can be used for a test specification

Note 1 to entry: The environmental test tailoring process described in this standard is given in a general form in order to give a framework for consistent flow of information.

Note 2 to entry: There are various methods and practices for test tailoring and care should be taken to ensure the consistent tailoring process with compatible analysis methods and test procedures.

Note 3 to entry: In practice, it may not be possible to obtain reliable data, e.g. from literature, or to make measurements of the physical parameters of the specimen and its environment. Numerical simulation may be used to determine the environmental conditions and product responses needed to be used for the derivation of the test specifications. In particular, simulation may be valuable for the determination of product subassembly and constituent part and component level environmental conditions.

Note 4 to entry: For the specifications derived from the environmental test tailoring process, the tests and severities of this standard should be used. Other test procedures and test severities may be used only if reliable technical and/or proven economical benefits are found. In this case, the reasoning of the diversion from the standard tests should be included in the specification.

Note 5 to entry: With environmental test tailoring, it is not essential to reproduce the environmental conditions, only the critical failure mechanisms.

Note 6 to entry: If acceleration factors are used, they should always be chosen so as to avoid the introduction of mechanisms of failure which differ from those occurring in service, storage, or transportation.

Note 7 to entry: With environmental test tailoring, checks should be made to ascertain:

a) specimen life cycle profile;

b) critical failure mechanisms;

c) proper acceleration factors;

d) proper specimen modelling.

3.21
quality
ability of a product or a service to satisfy user's need

3.22
useful life
under given conditions, the time interval of the beginning, at a given instance of time, and ending when the failure intensity becomes unacceptable or when the item is considered unrepeatable as a result of a fault

4 Standard atmospheric conditions

4.1 Standard reference atmosphere

– temperature: 20 °C;

– air pressure: 101,3 kPa (1 013 mbar).

NOTE No requirement for relative humidity is given because correction by calculation is generally not possible.

If the parameters to be measured depend on temperature and/or pressure, and the law of dependence is known, the values shall be measured under the conditions specified in 4.3 and, if necessary, corrected by calculation to the standard reference atmosphere above.

4.2 Standard atmospheres for referee measurements and tests

If the parameters to be measured depend on temperature, pressure and humidity, and the law of dependence is unknown, the atmospheres to be specified shall be selected from Table 1.

Table 1 – Standard atmospheres for referee measurements and tests

Temperature °C			**Relative humidity** [a] %		**Air pressure** [a]	
Nominal value	**Close tolerance**	**Wide tolerance**	**Close range**	**Wide range**	kPa	mbar
20	±1	±2	63 to 67	60 to 70	86 to 106	(860 to 1 060)
23	±1	±2	48 to 52	45 to 55	86 to 106	(860 to 1 060)
25	±1	±2	48 to 52	45 to 55	86 to 106	(860 to 1 060)
27	±1	±2	63 to 67	60 to 70	86 to 106	(860 to 1 060)

NOTE 1 The above values include those published in this standard as well as those given in ISO 554 and ISO 3205.

NOTE 2 The value of 25 °C is included primarily because of its interest for the testing of semiconductor devices and integrated circuits (It does not appear in ISO 554 and ISO 3205).

NOTE 3 The close tolerances may be used for the referee measurements. The wider tolerances may be used only when allowed by the relevant specification.

NOTE 4 The relative humidity may be disregarded when it has no influence on the test results.

[a] Inclusive values.

4.3 Standard atmospheric conditions for measurements and tests

The standard range of atmospheric conditions for carrying out measurements and tests is shown in Table 2.

Table 2 – Standard atmospheres for measurements and tests

Temperature [a] °C	Relative humidity [a] %	Air pressure [a]
15 to 35	25 to 75	86 kPa to 106 kPa (860 mbar to 1 060 mbar)
[a] Inclusive values.		

Variations in temperature and humidity should be kept to a minimum during a series of measurements carried out as a part of one test on one specimen.

NOTE 1 For large specimens or in test chambers where it is difficult to maintain the temperature within the limits specified above, the range may be extended beyond these limits either down to 10 °C or up to 40 °C, when allowed by the relevant specification. Absolute humidity should not exceed 22 g/m^3.

Where the relevant specification recognizes that it is impracticable to carry out measurements in standard atmospheric conditions, a note stating the actual conditions shall be added to the test report.

NOTE 2 The relative humidity may be disregarded when it has no influence on the results of the test.

4.4 Recovery conditions

4.4.1 General

After the conditioning period and before making the final measurements, the specimens should be allowed to stabilize at the ambient temperature. Measurements shall be made after stabilization.

The "controlled recovery conditions" shall be applied if the electrical parameters to be measured are affected by absorbed humidity or by surface conditions of the specimens and if such parameters change rapidly, for example if the insulation resistance rises considerably within approximately 2 h after removal of the specimens from a humidity chamber.

If the electrical parameters of the specimens affected by absorbed humidity or surface conditions do not vary rapidly, recovery may be carried out in the conditions of standard atmospheric conditions for tests and measurements.

If recovery and measurements are performed in separate chambers, the combination of temperature and humidity conditions shall be such that condensation on the surface of the specimens does not occur when the specimen is transferred to the measurement chamber.

Most of the tests of IEC 60068-2 give the appropriate recovery conditions and duration. These conditions shall apply, unless otherwise prescribed by the relevant specification.

4.4.2 Controlled recovery conditions

NOTE 1 Controlled recovery conditions are also referred to as "standard recovery conditions".

The controlled recovery conditions are as follows:

– temperature: actual laboratory temperature ± 1 °C provided that it is within the limits specified in 4.3, between +15 °C and +35 °C;
– relative humidity: between 73 % and 77 %;
– air pressure: between 86 kPa and 106 kPa (860 mbar and 1 060 mbar);
– recovery period: to be stated in the relevant specification if different from that given in the appropriate method of test of IEC 60068-2.