

Classification of environmental conditions —

**Part 4-2: Guidance for the correlation
and transformation of environmental
condition classes of IEC 60721-3 to the
environmental tests of IEC 60068 —
Transportation**

ICS 19.040; 19.080

National foreword

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Classification des conditions d'environnement –

Partie 4-2:

**Guide pour la corrélation et la transformation
des classes de conditions d'environnement
de la CEI 60721-3 en essais d'environnement
de la CEI 60068 –
Transport**

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Transportation**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

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of environmental condition classes of IEC 60721-3
to the environmental tests of IEC 60068 –
Transportation**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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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IEC 60721-4-2, which is a technical report, has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
104/58/CDV	104/108/RVC

Full information on the voting for the approval of this technical report 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 3.

This document which is purely informative is not to be regarded as an International Standard.

The committee has decided that the contents of this publication will remain unchanged until 2002.
At this date, the publication will be

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- withdrawn;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

INTRODUCTION

It is essential to emphasize the guidance nature of this report since it is virtually impossible to specify mandatory requirements for worldwide use. However, for those cases which require different tests from those recommended in this report, the guidance given should establish principles and methodology to determine alternative tests.

Transformation guidance is provided where the parameters used to define conditions in IEC 60721-3-2 are different from those used to define the tests and/or the severities in IEC 60068-2.

The reasons for correlation are provided to enable specification writers to modify a test if their application warrants it. Where differences in values of parameters exist between IEC 60721-3-2 and IEC 60068-2, the nearest severities of the IEC 60068-2 test procedures are used. If it is necessary to deviate from an IEC 60068-2 severity, the reasons are detailed in the report and an alternative test is recommended in the tables.

CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

Part 4-2: Guidance for the correlation and transformation of environmental condition classes of IEC 60721-3 to the environmental tests of IEC 60068 – Transportation

1 Scope and object

This part of IEC 60721 is a technical report dealing with the correlation and transformation of the conditions given in IEC 60721-3-2 to the environmental tests defined in IEC 60068-2.

An environment may consist of a number of environmental conditions such as dynamic, climatic and biological and other effects due to chemically and mechanically active substances. In this report, only dynamic and climatic conditions have been considered.

The purpose of this technical report is to provide the specification writer with guidance together with a set of easy-to-use tables which correlate and transform these conditions.

2 Reference documents

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

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-5:1975, *Environmental testing – Part 2: Tests – Test Sa: Simulated solar radiation at ground level*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-7:1983, *Environmental testing – Part 2: Tests – Test Ga: Acceleration, steady state*

IEC 60068-2-13:1983, *Environmental testing – Part 2: Tests – Test M: Low air pressure*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

IEC 60068-2-18:1989, *Environmental testing – Part 2: Tests – Test R and guidance: Water*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60068-2-29:1987, *Environmental testing – Part 2: Tests – Test Eb and guidance: Bump*

IEC 60068-2-30:1980, *Environmental testing – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle)*

IEC 60068-2-31:1969, *Environmental testing – Part 2: Tests – Test Ec: Drop and topple, primarily for equipment type specimens*

IEC 60068-2-32:1975, *Environmental testing – Part 2: Tests – Test Ed: Free fall (Procedure 1)*

IEC 60068-2-56:1988, *Environmental testing – Part 2: Tests – Test Cb: Damp heat, steady state, primarily for equipment*

IEC 60068-2-64:1993, *Environmental testing – Part 2: Tests – Test Fh: Vibration, broadband, random (digital control) and guidance*

IEC 60721-2-3:1987, *Classification of environmental conditions – Part 2: Environmental conditions appearing in nature – Air pressure*

IEC 60721-3-0:1984, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Introduction*

IEC 60721-3-2:1997, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation*

IEC 60721-4-0, *Classification of environmental conditions – Part 4-0: Guidance for the correlation and transformation of the environmental condition classes of IEC 60721-3 to the environmental tests of IEC 60068 – Introduction¹⁾*

ISO 554:1976, *Standard atmospheres for conditioning and/or testing – Specifications*

ISO 2234:2000, *Packaging – Complete, filled transport packages and unit loads – Stacking tests using static load*

ISO 2533:1975, *Standard Atmosphere – Addendum 1 (1985), Addendum 2 (1997)*

ISO 4180-2:1980, *Complete, filled transport packages – General rules for the compilation of performance test schedules – Part 2: Quantitative data*

ISO 12048:1994, *Packaging – Complete, filled transport packages – Compression and stacking tests using a compression tester*

3 Overview

3.1 General remarks concerning IEC 60721

IEC 60721-3-2 establishes classes of groups of environmental parameters with their associated environmental conditions to which products may be exposed during transportation. Parameters in these classes are given individually, but the products may be exposed to them simultaneously. Some of the parameters are independent whilst others may be strongly correlated, for example; solar radiation and temperature.

¹⁾ To be published.

3.2 General remarks concerning IEC 60068

IEC 60068-2 establishes a series of environmental test procedures and appropriate test severities. Selection of test severities depends upon the failure consequences of the product. Two types of product may be placed at locations covered by the same environmental class. However, one type of product may be tested under significantly more severe conditions than the other because of its different failure consequences. This report only addresses normal failure consequences; for higher failure consequences, the test severity may need to be increased on the basis of specialist knowledge of the product.

3.3 Severities

IEC 60721-3-2 establishes classes of environmental conditions having a low probability of being exceeded, which cover the extreme short-term conditions to which products may be exposed. The suggested test severities given in the tables of this report take this into account. For further information, refer to IEC 60721-4-0, which serves as an introduction to the IEC 60721-4 series.

3.4 Recommended tests

In the following tables, two types of test are shown. The first details the equivalent IEC 60068-2 test using the nearest recommended severities. The second is the recommended test method and severities which are considered to be more suitable for testing most electrotechnical products.

3.5 Environmental tests for transportation classes

IEC 60721-3-2 classifies groups of environmental parameters and their severities to which products are subjected while being transported from one place to another, on ground, water, and in air, including loading and unloading, after being made ready for dispatch from the manufacturing factory. If the product is normally packaged for transportation, the environmental conditions apply to the packaged product.

If possible, the product should be tested in the state in which it is normally transported. For example, if the product is in a packaged state, then it should be tested in its packaging. If the product is transported both with and without its packaging, it may be necessary to perform tests for both configurations. For some tests and products, the test may be more severe for the packaged rather than the unpackaged product. For example, for products in a sealed package, the change of temperature test may produce condensation.

Environmental conditions created by co-located products within an enclosure are not included in this class.

3.6 Test durations

The durations recommended in tables 1 to 7 are selected on the basis that experience has shown them to be sufficient to demonstrate the effect of the condition on most products. However, the user may change these values if experience of a specific application warrants it. To assist the user, the notes associated with the tables in this report explain why the recommended duration was chosen.

3.7 Ambient

The term "ambient" which is used for some recommended tests refers to the standard atmospheric conditions described in 5.3.1 of IEC 60068-1, that is, between 15 °C and 35 °C and from 25 % to 75 % RH with a maximum absolute humidity of 22 g/m³ and at air pressure between 86 kPa and 106 kPa. Details of the standard atmospheric conditions are provided in ISO 2533 and its addenda, whilst a summary is provided in IEC 60721-2-3. A "reference condition" for testing is described in ISO 554.

4 Climatic conditions

Table 1 – Recommended tests for IEC 60721-3-2 – Class 2K2

(transportation in weatherprotected, conditions without heating, excluding cold, cold-temperate climates)

IEC 60721-3-2 – Climatic conditions		IEC 60068-2 – Climatic tests				
Environmental parameter ^a	Class 2K2	Nearest IEC 60068-2		Recommended test		Note No.
		Test method	Severity	Test method	Severity	
a) Low air temperature	–25 °C	As recommended test		60068-2-1: Ab	–25 °C, 16 h	1)
b) High air temperature, unventilated	+60 °C	As recommended test		60068-2-2: Bb	+55 °C, 16 h	2)
c) High temperature: air in ventilated enclosures or outdoor air	+40 °C	As recommended test		60068-2-2: Bb	+40 °C, 16 h	3)
d) Change of temperature: air/air	–25 °C/ +25 °C	As recommended test		60068-2-14: Na	–25 °C to ambient, five cycles <i>t</i> ₁ = 3 h, <i>t</i> ₂ < 3 min	4)
e) Change of temperature: air/water	No					
f) Relative humidity, not combined with rapid temperature changes	75 % +30 °C	As recommended test		60068-2-56: Cb	+30 °C, 85 % RH, 96 h	5)
g) Relative humidity, combined with rapid temperature changes: air/air at high relative humidity	No					
h) Absolute humidity, combined with rapid temperature changes: air/air at high water content	No					
i) Low air pressure	70 kPa	60068-2-13: M	70 kPa, 30 min	Test normally not required – See note 6)		6)
j) Change of air pressure	No					
k) Movement of surrounding air	No					
l) Precipitation (rain)	No					
m) Solar radiation	700 W/m ²	60068-2-5: Sa Procedure C	1 120 W/m ² , 72 h, 40 °C	Perform the dry-heat test and evaluate materials for photochemical reactions		7)
n) Radiation: heat	No					
o) Water from sources other than rain	No					
p) Wetness	No					
NOTE "No" in the class column means that no IEC 60721-3-2 condition is specified.						
^a No climatograms are shown for the transportation classes since they are not included in IEC 60721-3-2.						

Explanatory notes for table 1 – Class 2K2

- 1) The test temperature is equivalent to the environmental parameter of IEC 60721-3-2 for this class. Because there are rarely chemical or physical changes in material once low-temperature stabilization has been achieved, the recommended duration of 16 h is considered to be more than adequate and this may be reduced to 2 h for small products with low thermal mass. Test Aa is not recommended since test Na is used to evaluate the effects of temperature change (see row d) in the table).
- 2) The test temperature of +55 °C does not correspond to the environmental parameter of IEC 60721-3-2 as it is the nearest preferred value in IEC 60068-2. As 60 °C is also considered to be a high value for a ventilated condition as described for this class, this test temperature should be adequate for most applications. The selection of the duration of 16 h is considered to be adequate for most applications. Test Ba is not recommended since test Na is used to evaluate the effects of temperature change (see row d) in the table).
- 3) The test temperature is equivalent to the environmental parameter of IEC 60721-3-2 for this class. The selection of the duration of 16 h is the most acceptable of those recommended in IEC 60068-2 for the purpose of acceptance testing for most applications.
- 4) The change of temperature test is normally used to check design tolerancing, and the range is not important. However, in this class, condensation may occur, so a range is proposed which crosses the 0 °C boundary in order to allow condensation to occur. Ambient conditions, as described in 3.7, are proposed as the upper temperature to allow the single-chamber method to be used, thus making the test economical to perform. A rapid change of temperature test is used to simulate the conditions of opening enclosures and exposing the products to the outside air.
- 5) The test humidity is the nearest preferred test severity of test Cb of IEC 60068-2-56 (damp heat, steady state), although the relative humidity is higher than the value of the characteristic severity from IEC 60721-3-2. The duration of 96 h is considered to be sufficient to demonstrate that the product's design is adequately tolerated to survive this humidity.
- 6) For sealed products or for products containing or processing liquids, test M of IEC 60068-2-13 is recommended. For normal applications where the effect of air pressure is evaluated at the component level, no test is recommended.
- 7) The IEC 60068-2-5 procedure C test for simulating the effects of solar radiation at ground level is chosen since it produces continuous irradiation, thus allowing assessment of photo-degradation effects. Although the severity of this class is 700 W/m², the only Sa test condition contained in IEC 60068-2-5 is for a solar radiation value of 1 120 W/m².

It is recommended that no solar radiation test be performed since, in the transportation of the product, the main effect of solar radiation is a temperature rise in the location. This temperature rise is included in the value used for the dry-heat condition; therefore, no additional test is required. Photochemical reactions resulting from exposure to solar radiation are normally considered when choosing components, materials and finishes.

Table 2 – Recommended tests for IEC 60721-3-2 – Class 2K3*(transportation in non-weatherprotected, conditions, excluding cold and cold-temperate climates)*

IEC 60721-3-2 – Climatic conditions		IEC 60068-2 – Climatic tests				
Environmental parameter ^a	Class 2K3	Nearest IEC 60068-2		Recommended test		Note No.
		Test method	Severity	Test method	Severity	
a) Low air temperature	–25 °C	As test method		60068-2-1: Ab	–25 °C, 16 h	1)
b) High air temperature, air in unventilated enclosures	+70 °C	As test method		60068-2-2: Bb	+70 °C, 16 h	2)
c) High temperature: air in ventilated enclosures or outdoor air	+40 °C	As recommended test		60068-2-2: Bb	+40 °C, 16 h	2)
d) Change of temperature: air/air	–25 °C/ +30 °C	As recommended test		60068-2-14: Na	–25 °C to ambient, five cycles <i>t</i> ₁ = 3 h, <i>t</i> ₂ < 3 min	3), 6)
e) Change of temperature: air/water	+40 °C/ +5 °C	No IEC 60068-2 test		Test normally not required – See note 4)		4)
f) Relative humidity, not combined with rapid temperature changes	95 % +40 °C	As recommended test		60068-2-56: Cb	+40 °C, 93 % RH, 96 h minimum	5), 6)
g) Relative humidity, combined with rapid temperature changes: air/air at high relative humidity	95 % –25 °C/ +30 °C	No IEC 60068-2 test		Steady-state humidity test (test Cb) followed immediately by the rapid change of temperature test (test Na).		6)
h) Absolute humidity, combined with rapid temperature changes: air/air at high water content	60 g/m ³ +70 °C/ +15 °C	As recommended test		60068-2-30: Db Variant 2.	+55 °C, 90 - 100 % RH Two cycles	7)
i) Low air pressure	70 kPa	60068-2-13: M	70 kPa, 30 min	Test normally not required – See note 8)		8)
j) Change of air pressure	No					
k) Movement of surrounding air	20 m/s	No IEC 60068-2 test		Test normally not required – See note 9)		9)
l) Precipitation (rain)	6 mm/min	As recommended test		60068-2-18: Rb Method 2.2	Exposure: 1 min/m ² Duration: 5 min minimum	10)
m) Solar radiation	1 120 W/m ²	60068-2-5: Sa Procedure C	1 120 W/m ² , 72 h, 40 °C	Perform the dry-heat test and evaluate materials for photochemical reactions		11)
n) Radiation: heat	600 W/m ²	No IEC 60068-2 test		Test normally not required – See note 12)		12)
o) Water from sources other than rain	1 m/s	No IEC 60068-2 test		See note 13)		13)
p) Wetness – Conditions of wet surfaces		No IEC 60068-2 test		Test normally not required – See note 14)		14)
NOTE "No" in the class column means that no IEC 60721-3-2 condition is specified.						
^a No climatograms are shown for the transportation classes since they are not included in IEC 60721-3-2.						