

INTERNATIONAL STANDARD



**Classification of environmental conditions –
Part 3-2: Classification of groups of environmental parameters and their
severities – Transportation and handling**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and handling

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. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60721-3-2 has been prepared by IEC technical committee 104: Environmental conditions, classification, and methods of test.

This third edition cancels and replaces the second edition, published in 1997, and constitutes a technical revision.

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

- a) Clause 1: reworded and added handling.
- b) Clause 2: updated normative references.
- c) Clause 3: updated definitions.
- d) Clause 4: reworded and simplified.
- e) Clause 5: revised and updated. Several classes have been replaced by completely new classes based on the use of new information obtained from referenced Technical Reports.
- f) Table 1 through Table 5: updated.
- g) Table 6 deleted.
- h) Old annexes A to C removed except Clause A.3 that is incorporated in Clause 0.
- i) New Annex A.

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

FDIS	Report on voting
104/773/FDIS	104/783/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60721 series, published under the general title *Classification of environmental conditions*, 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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

The contents of the corrigenda 1 (2018-11), 2 (2022-06) and 3 (2024-05) have been included in this copy.

CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and handling

1 Scope and object

This part of IEC 60721 classifies the groups of environmental parameters and their severities to which a product is subjected while being transported ~~from one place to another after being made ready for dispatch from the manufacturing factory~~ and handled.

The most commonly used methods of transportation and handling have been taken into account, including the following:

- road transport: cars, ~~lorries~~, trucks, ~~animals~~, ~~conveyors~~;
- rail transport: trains, trams, ~~conveyors~~;
- water transport, inland and maritime: ships, ~~hovercraft~~, ~~conveyors~~;
- air transport: aircraft, ~~conveyors~~, jet, propeller, helicopter;
- ~~vertical transport~~ handling equipment: cranes, transport lifts, cableways, persons;
- conveyors;
- hand trollies.

The environmental conditions specified in this document are those ~~met by the product being transported~~ that the product can be exposed to while transported and handled. If the product is packaged, the environmental conditions apply to the package containing the product. ~~Only severe conditions, which may be harmful to products, are included.~~ If the product is unpackaged, the environmental conditions apply to the product.

Conditions for storage are given in IEC 60721-3-1.

~~The object of this standard is to classify groups of environmental parameters and their severities to which a product will be exposed when being transported on ground, water and in air, including loading and unloading.~~

~~A limited number of classes of environmental conditions are given, covering a broad field of application. The user of this standard should select the lowest classes necessary covering each of the conditions of the intended transportation. Some guidance for this is given in annex A.~~

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 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

~~IEC 721-1: 1990, Classification of environmental conditions — Part 1: Environmental parameters and their severities
Amendment 1 (1992)
Amendment 2 (1995)~~

~~IEC 721-2-1: 1982, Classification of environmental conditions — Part 2: Environmental conditions appearing in nature — Temperature and humidity
Amendment 1 (1987)~~

~~IEC 721-3-0: 1984, Classification of environmental conditions — Part 3: Classification of groups of environmental parameters and their severities — Introduction
Amendment 1 (1987)~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60721-1 and the following apply.

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>

3.1

weather-protected

~~The product, packed or unpacked, is contained within an enclosure which affords some protection from the environment, ranging from a temperature controlled container to a waterproof cover placed over the product. Ventilation ranges from controlled air flow to the raising of part of a waterproof cover to allow for natural air flow.~~
protected from the influences of meteorological conditions

3.2

non-weather-protected

~~The product, packed or unpacked, is not protected in any way from the environment.~~
not protected from the influences of meteorological conditions

4 General

~~Reference to IEC 721-3-0 is strongly recommended in order to avoid misuse of the classes defined in other sections of IEC 721-3.~~

~~The severities specified are those which will have a low probability of being exceeded. All specified values are maximum or limit values. These values may be reached, but do not occur permanently. Depending on the situation, there may be different frequencies of occurrence related to a certain period of time. Such frequencies of occurrence have not yet been included in this standard, but should be considered for any environmental parameter. They should additionally be specified, if applicable.~~

~~Information on the duration and frequency of occurrence is given, as clause 6, in amendment 1 to IEC 721-3-0.~~

~~Attention is drawn to the fact that combinations of the environmental parameters given may increase the effect on a product. This applies especially to the presence of high relative humidity in addition to biological conditions, or to conditions of chemically or mechanically active substances.~~

A product may be subjected to a range of environmental conditions during its lifetime. These conditions have been separated into classes described in IEC 60721-3-0. The classes given may be used for defining the maximum short-term environmental stresses on a product. However, they do not provide information regarding the long-term or total lifetime environmental stresses a product may experience. This means that no reliability or lifetime assessment is possible based on these classes alone. Refer to IEC 60721-2 (all parts) and applicable technical reports (IEC TR 62130, IEC TR 62131-2, IEC TR 62131-3, IEC TR 62131-4 and IEC TR 62131-5) for further information on actual environmental conditions.

A product may be simultaneously exposed to a number of environmental parameters. For example, solar radiation and temperature, temperature and humidity, as well as vibration and temperature change. Combinations of the environmental parameters given may increase the stress effect on a product. Therefore, combined conditions should be considered in the design and evaluation of a product.

Products should be designed to survive and operate in different environments. Basically, they will be affected by environmental influences in two ways:

- by the effects of short-term extreme environmental conditions which may directly cause malfunction or destroy the product;
- by the effect of long-term subjection to non-extreme environmental stresses which may slowly degrade the product and finally cause malfunction or destruction of the product.

Short-term extreme environmental conditions may occur at any time in a product's life. A product may be unaffected by an extreme condition when it is new but fail when it is subjected to the same condition after being used for a long period of time due to the effect of ageing. The order in which the environmental conditions are applied may affect the results of an evaluation.

It is important for the product specification, when referring to a certain class in IEC 60721-3 (all parts), to define whether the product is required to be capable of operating or only to survive without permanent damage when being exposed to the conditions described by the class.

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The environmental classes may be used as a basis for the selection of design and test severities with respect to the consequence of failure. Information contained in IEC 60721-3 (all parts) may be used as a means to help establish expected requirements for use, storage, transportation, etc., and in the development of relevant specifications. The selected severities used for testing should attempt to produce the effects of the actual environment.

EXAMPLE 1 A high temperature test on a heat dissipating product is designed to simulate the thermal effect of subjecting a product to conditions of high air temperature, solar radiation and other possible heat sources dependent on the application.

EXAMPLE 2 In a mechanical shock test, the product can be subjected to mechanical shocks of simple pulse shapes (e.g., half-sine), while the actual conditions cannot be described by such simple pulses.

It is recognized that extreme or special environmental conditions may exist which require consideration of severities that are not addressed by this document.

5 Classification of groups of environmental parameters and their severities

5.1 General

A ~~limited~~ number of classes for climatic conditions (K), special climatic conditions (Z), biological conditions (B), chemically active substances (C), mechanically active substances (S) and mechanical conditions (M) are specified.

~~See also clause 6.~~

~~The basis of these classes is explained in clause A.2 of annex A.~~

~~Climatic conditions in tropical areas as specified in classes 2K6 and 2K7 are explained in annex C.~~

~~The combination of the lowest classes 2K1/2B1/2C1/2S1/2M1 forms the conditions to which a product will be subjected when being transported under very restricted conditions. The combination of the highest classes 2K5/2B3/2C3/2S3/2M3 covers transportation under a very wide variety of conditions including very severe conditions.~~

~~A class with higher digit conditions normally includes all classes with lower digits.~~

~~For certain parameters it has not yet been possible to give quantitative values of severities.~~

~~A summary of the conditions covered by the classes is given in clause A.3 of annex A.~~

This classification allows for a number of possible combinations of environmental conditions which bear upon products wherever stored. It represents the real situation concerning world-wide conditions of storage due to local influences of open-air climate, etc. For certain environmental parameters, it has not yet been possible to specify quantitative severities.

For a given location or product, reference should be made to the total set of classes as defined in 5.2 through 5.6, for example:

~~2K2/2B1/2C2/2S2/2M3~~

2K13/2B3/2C2/2S6/2M5

5.2 K Climatic conditions

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NOTE The classes defined in previous versions of this document have been replaced with new classes as a result of recent efforts at collecting information regarding climatic conditions. Those results are contained in Technical Reports referenced in this document.

When selecting appropriate classes, attention should be paid to the fact that the climatic conditions in weather-protected locations may depend on the open-air (non-weather-protected) conditions, especially air temperature and solar radiation, and the type of transportation enclosure.

The following conditions are specified in Table 1.

- | | |
|------|--|
| 2K10 | applies to fully air conditioned enclosed transportation. Air temperature and humidity control is used continuously to maintain the required conditions. |
| 2K11 | applies to weather-protected transportation with limited temperature control and no humidity control. |
| 2K12 | applies to weather-protected transportation without temperature and humidity controls in unventilated enclosures in arid, temperate, tropical and cold climates. Polar climate is excluded. The product may be transported in heated, pressurized aircraft holds. |
| 2K13 | applies to non-weather-protected transportation in temperate, tropical, and cold climates. Arid and polar climates are excluded. |
| 2K14 | applies to transportation in non-weather-protected transportation worldwide (including arid and polar climates). This also includes transportation in unpressurized aircraft holds. The product may be subjected to sea waves when being transported on open decks of ships. |

Table 1 – Classification of climatic conditions

Environmental parameter	Unit	Class								
		2K1	2K2	2K3	2K4	2K5	2K5H	2K5L	2K6 ⁶⁾	2K7 ⁶⁾
a) Low air temperature	°C	+5	–25	–25	–40	–65	–25	–65	+5	–20
b) High air temperature, air in unventilated enclosures ¹⁾	°C	No	+60	+70	+70	+85	+85	+70	+70	+85
c) High air temperature, air in ventilated enclosures or outdoor air ²⁾	°C	+40	+40	+40	+40	+55	+55	+40	+40	+55
d) Change of temperature, air/air ³⁾	°C	No	–25/+25	–25/+30	–40/+30	–65/+30	–25/+30	–65/+30	+5/+30	–20/+30
e) Change of temperature, air/water ³⁾	°C	No	No	+40/+5	+40/+5	+55/+5	+55/+5	+40/+5	+40/+5	+55/+5
f) Relative humidity, not combined with rapid temperature changes	%	75	75	95	95	95	95	95	95	95
g) Relative humidity, combined with rapid temperature changes: air/air at high relative humidity ³⁾	°C	+30	+30	+40	+45	+50	+50	+45	+45	+50
	%	No	No	95	95	95	95	95	95	95
h) Absolute humidity, combined with rapid temperature changes: air/air at high water content ⁴⁾	g/m ³	No	No	60	60	80	80	60	60	80
	°C			+70/+15	+70/+15	+85/+15	+85/+15	+70/+15	+70/+15	+85/+15
i) Low air pressure	kPa	70	70	70	70	30	30	30	30	30
j) Change of air pressure	kPa/min	No	No	No	No	6	6	6	6	6
k) Movement of surrounding medium, air	m/s	No	No	20	20	30	30	30	30	30
l) Precipitation, rain	mm/min	No	No	6	6	15	15	6	15	15
m) Radiation, solar	W/m ²	700	700	1120	1120	1120	1120	1120	1120	1120
n) Radiation, heat	W/m ²	No	No	600	600	600	600	600	600	600
o) Water from sources other than rain ⁵⁾	m/s	No	No	1	1	3	3	3	3	3
p) Wetness	None	No	No	Conditions of wet surfaces						

1) The high temperature of the surface of a product may be influenced by both the surrounding air temperature given here and the solar radiation through a window or other opening.

2) The high temperature of the surface of a product is influenced by the surrounding air temperature given here and the solar radiation defined below.

3) A direct transfer of the product between the two temperatures given is presumed.

4) The product is assumed to be subjected to a rapid decrease of temperature only (no rapid increase). The figures of water content apply to temperatures down to the dew point; at lower temperatures the relative humidity is assumed to be approximately 100 %.

5) The figure indicates the velocity of water and not the height of water accumulated.

6) Further information on classes 2K6 (tropical damp) and 2K7 (tropical dry) is given in annex C.

Environmental parameter	Unit	Classification				
		Weather-protected			Non-weather-protected	
		2K10	2K11	2K12	2K13	2K14
a) Low air temperature	°C	+20 ⁶⁾	+5	–45	–45	–50
b) High air temperature	°C	+25 ⁶⁾	+40	+70	+45 ⁹⁾	+50 ⁹⁾
c) Low relative humidity ¹⁾	%	20	5	4	4	4
d) High relative humidity ¹⁾	%	75	85	100	100	100
e) Low absolute humidity ¹⁾	g/m ³	4	1	0,05	0,02	0,003
f) High absolute humidity ¹⁾	g/m ³	15	25	29	35	35
g) Rate of change of temperature ²⁾	°C/min	0,1	0,5	1,0	1,0	1,0
h) Low air pressure ³⁾	kPa	70	70	70	70	30
i) High air pressure ³⁾	kPa	106	106	106	106	106
j) Solar radiation	W/m ²	No	No	⁸⁾	1090	1090
k) Heat radiation	Not specified	None	None	None	None	None
l) Movement of surrounding air ⁴⁾	m/s	0,5	1,0	1,0	⁷⁾	⁷⁾
m) Condensation	Not specified	No	No	Yes	Yes	Yes
n) Precipitation (rain, snow, hail, etc.)	Not specified	No	No	No	Yes	Yes
o) Rain intensity	mm/min	None	None	None	3,3	3,3
p) Driving rain	m/s	None	None	None	⁷⁾	⁷⁾
q) Snow load	kg/m ²	None	None	None	100	100
r) Low rain temperature ⁵⁾	°C	None	None	None	+5	+5
s) Water from sources other than rain	Not specified	No	No	Dripping Water	¹⁰⁾	¹⁰⁾
t) Formation of ice and frost (including freeze-thaw)	Not specified	No	No	Yes	Yes	Yes
u) Temperature shock	Not specified	No	No	Yes	Yes	Yes

1) The low and high relative humidity levels are limited by the low and high absolute humidity, so that, for example, for environmental parameters a) and c), or b) and d), the severities given in Table 1 do not occur simultaneously.

2) Averaged over a period of time of 5 min.

3) The value of 70 kPa represents a limit for open-air conditions, normally at an altitude of 3 000 m. In some geographical areas, open-air conditions may occur at higher altitudes. Conditions in mines are not considered.

4) A cooling system based on non-assisted convection may be disturbed by adverse movement of surrounding air.

5) This rain temperature should be considered together with high air temperature b) and solar radiation j). The cooling effect of the rain has to be considered in connection with the surface temperature of the product.

6) These are air-conditioned locations with a tolerance of ±2 °C on stated temperature value.

7) If applicable, a special value should be selected based on expected transportation mode (e.g., lorry, open decks of ships).

8) Thermal effect of solar radiation is included in the temperature.

9) Thermal effect of solar radiation is not included in the temperature.

10) Sources of water other than rain are encompassed by driving rain.

5.3 B Biological conditions

No quantitative severity has been specified for the following conditions. The specified parameters of Table 2 are typical, but may not be complete.

- 2B1 applies to transportation in areas without risks from mould growth and attack by animals, or in compartments with environmental controls in place to prevent mould growth and attack by animals.
- 2B2 applies to transportation in areas where mould growth and attacks of animals, except termites, may occur.
- 2B3 applies to transportation in areas where attacks by termites may additionally occur.

Table 2 – Classification of biological conditions

Environmental parameter	Unit	Class		
		2B1	2B2	2B3
a) Flora	None	No	Presence of mould, fungus, etc.	
b) Fauna	None	No	Presence of rodents or other animals harmful to products: excluding termites including termites	

Biological parameter	Class		
	2B1	2B2	2B3
None	Negligible	Presence of mould, fungus, etc. Presence of rodents and other animals harmful to products excluding termites including termites	

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5.4 C Chemically active substances

The contamination of the natural atmosphere is mainly caused by chemical emissions from industrial activities, motor-driven vehicles, and heating systems. A further chemical influence is caused by aerosols of sea and road salts. Contamination may affect the product's function and materials. The parameters shown in Table 3 are estimates based on information available at the time of publication. It is recommended that reference be made to local or regional information specific to an area of interest when establishing requirements.

See Annex A for additional information.

- 2C1 applies to transportation and handling in rural and some urban areas with low industrial activity and moderate traffic, and areas where there is either no salt mist or there are protections in place to protect the product from salt mist. This also applies to handling indoors.
- 2C2 applies to transportation and handling in areas with normal levels of contaminants as experienced in urban areas with industrial activity scattered over the whole area, or with heavy traffic. This includes transportation in areas where salt mist is present including maritime transport of containers but not transport on open decks of ships.
- 2C3 applies to transportation and handling in areas that are in the immediate vicinity of industrial sources with chemical emissions, and transportation on open decks of ships.

Table 3 – Classification of chemically active substances

Environmental parameter	Unit	Class		
		2C1	2C2	2C3
a) Sea salts	None	No	Conditions of salt mist	Conditions of salt water
b) Sulphur dioxide	mg/m ³	0,1	1,0 (0,3)	10 (5,0)
	cm ³ /m ³	0,037	0,37 (0,11)	3,7 (1,85)
c) Hydrogen sulphide	mg/m ³	0,01	0,5 (0,1)	10 (3,0)
	cm ³ /m ³	0,0071	0,36 (0,071)	7,1 (2,1)
d) Nitrogen oxides- (expressed in the equivalent values of nitrogen dioxides)	mg/m ³	0,1	1,0 (0,5)	10 (3,0)
	cm ³ /m ³	0,052	0,52 (0,26)	5,2 (1,56)
e) Ozone	mg/m ³	0,01	0,1 (0,05)	0,3 (0,1)
	cm ³ /m ³	0,005	0,05 (0,025)	0,15 (0,05)
f) Hydrogen chloride	mg/m ³	0,1	0,5 (0,1)	5,0 (1,0)
	cm ³ /m ³	0,066	0,33 (0,066)	3,3 (0,66)
g) Hydrogen fluoride	mg/m ³	0,003	0,03 (0,01)	2,0 (0,1)
	cm ³ /m ³	0,0036	0,036 (0,012)	2,4 (0,12)
h) Ammonia	mg/m ³	0,3	3,0 (1,0)	35 (10)
	cm ³ /m ³	0,42	4,2 (1,4)	49 (14)

NOTES

- 1—The figures given are maximum values, occurring over a 30 min period per day.
- 2—The figures within brackets are the expected long-term mean values.
- 3—The values given in cm³/m³ have been calculated from the values given in mg/m³ and refer to 20 °C and 101,3 kPa.
- 4—The table uses rounded values.

<https://standards.iteh.ai/catalog/standards/iec/f8020806-6b7e-4c6d-ac22-beed28cc1db9/iec-60721-3-2-2018>

Environmental parameter	Unit ¹⁾	Class				
		2C1	2C2		2C3	
		Maximum value	Mean value	Maximum value ²⁾	Mean value	Maximum value ²⁾
a) Salt mist to include sea and road salts	None	No	Yes		Yes	
b) Saltwater	None	No	No		Yes	
c) Sulphur dioxide	mg/m ³	0,1	0,3	1,0	5,0	10
	cm ³ /m ³	0,037	0,11	0,37	1,85	3,7
d) Hydrogen sulphide	mg/m ³	0,01	0,1	0,5	3,0	10
	cm ³ /m ³	0,0071	0,071	0,36	2,1	7,1
e) Hydrogen chloride	mg/m ³	0,1	0,1	0,5	1,0	5,0
	cm ³ /m ³	0,066	0,066	0,33	0,66	3,3
f) Hydrogen fluoride	mg/m ³	0,003	0,01	0,03	0,1	2,0
	cm ³ /m ³	0,0036	0,012	0,036	0,12	2,4
g) Ammonia	mg/m ³	0,3	1,0	3,0	10	35
	cm ³ /m ³	0,42	1,4	4,2	14	49
h) Ozone	mg/m ³	0,01	0,05	0,1	0,1	0,3
	cm ³ /m ³	0,005	0,025	0,05	0,05	0,15