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European Standard (Telecommunications series)

**Environmental Engineering (EE);
Environmental conditions and environmental tests
for telecommunications equipment;
Part 1-3: Classification of environmental conditions;
Stationary use at weatherprotected locations**



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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document is part 1, sub-part 3 of a multi-part deliverable covering the environmental conditions for telecommunications equipment, as identified below:

Part 1: "Classification of environmental conditions"; (see note 1)

Sub-part 0: "Introduction";

Sub-part 1: "Storage";

Sub-part 2: "Transportation";

Sub-part 3: "Stationary use at weatherprotected locations";

Sub-part 4: "Stationary use at non-weatherprotected locations";

Sub-part 5: "Ground vehicle installations";

Sub-part 6: "Ship environments";

Sub-part 7: "Portable and non-stationary use";

Sub-part 8: "Stationary use at underground locations";

Part 2: "Specification of environmental tests" (see note 2).

NOTE 1: Specifies different standardized environmental classes covering climatic and biological conditions, chemically and mechanically active substances and mechanical conditions during storage, transportation and in use. Sub-part 1-0 forms a general overview of part 1.

NOTE 2: Specifies the recommended test severities and test methods for the different environmental classes.

National transposition dates	
Date of adoption of this EN:	6 November 2009
Date of latest announcement of this EN (doa):	28 February 2010
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 August 2010
Date of withdrawal of any conflicting National Standard (dow):	31 August 2010

1 Scope

The present document defines classes of environmental conditions and their severities to which telecommunication equipment may be exposed. The severities specified are those which will have a low probability of being exceeded; generally less than 1 %.

The present document applies to equipment mounted for stationary use including periods of erection work, down time, maintenance and repair at weatherprotected locations defined in clause 5.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
 - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
 - for informative references.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

- | | |
|-----|---|
| [1] | IEC 60721-3-3: "Classification of environmental conditions - Part 3-3: Classification of groups of environmental parameters and their severities - Stationary use at weatherprotected locations". |
| [2] | IEC 60068-2-27: "Environmental testing. Part 2-27: Tests. Test Ea and guidance: Shock". |
| [3] | IEC 60721-2-6: "Classification of environmental conditions. Part 2: Environmental conditions appearing in nature. Earthquake vibration and shock". |
| [4] | IEC 60068-3-3: "Environmental testing - Part 3: Guidance. Seismic test methods for equipment". |
| [5] | ETSI EN 300 019-2-3: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-3: Specification of environmental tests; Stationary use at weatherprotected locations". |

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

- | | |
|-------|---|
| [i.1] | IEC 60721-3-0: "Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Introduction". |
|-------|---|

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

absolute humidity: mass of water vapour in grams which is associated with one cubic metre of dry air in an air/water vapour mixture

air conditioning system: system that fully and automatically controls the climatic parameters air temperature and humidity by heating, cooling, humidifying and dehumidifying

climate-controlling system: system that controls or influences climate, acting at least on one climatic parameter in one direction

cooling system: system that controls or influences climate by decreasing the air temperature only

NOTE: This can decrease the absolute humidity.

data centre: includes all buildings, facilities, offices and rooms which contain enterprise servers, server communication equipment, cooling equipment and power equipment, and provide some form of data service (see note)

NOTE: E.g. large scale mission critical facilities all the way down to small server rooms located in office buildings.

forced ventilation system: system that controls or influences climate by introducing outdoor air into the room or expelling air out of the room

heating system: system that controls or influences climate by increasing the air temperature only

NOTE: This can decrease the relative humidity.

relative humidity: ratio of the partial pressure of the water vapour in moist air at a given temperature, to the partial pressure of the water vapour in saturated air at the same temperature

stationary use: equipment which is mounted firmly on a structure, or on mounting devices, or permanently placed at a certain site

NOTE: It is not intended for portable use, but short periods of handling during erection works and for which down time, maintenance and repair at the location are included.

weatherprotected location: location at which the equipment is protected from direct weather influences

EXAMPLE 1: Totally weatherprotected location (enclosed location):
direct weather influences are totally excluded.

EXAMPLE 2: Partly weatherprotected location (sheltered location):
direct weather influences are not completely excluded.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

RS	Response Spectrum
ZPA	Zero Period Acceleration

4 Environmental classes

The classes shown in parentheses, e.g. (3C1), may be selected for special applications.

4.1 Class 3.1: Temperature-controlled locations

Class 3.1 is a combination of classes 3K3/3Z2/3Z4/3B1/3C2(3C1)/3S2/3M1 in IEC 60721-3-3 [1].

The climatogram is shown in figure 1.

Seismic environment: **zone 4** as defined in IEC 60721-2-6 [3]. Option zone 4 (modified Mercalli scale ≥ 9): if earthquake conditions are specified by the customer, the conditions stated in clause 5.6 apply.

This class applies to a permanently temperature controlled enclosed location. Humidity is usually not controlled. The climatogram is shown in figure 1.

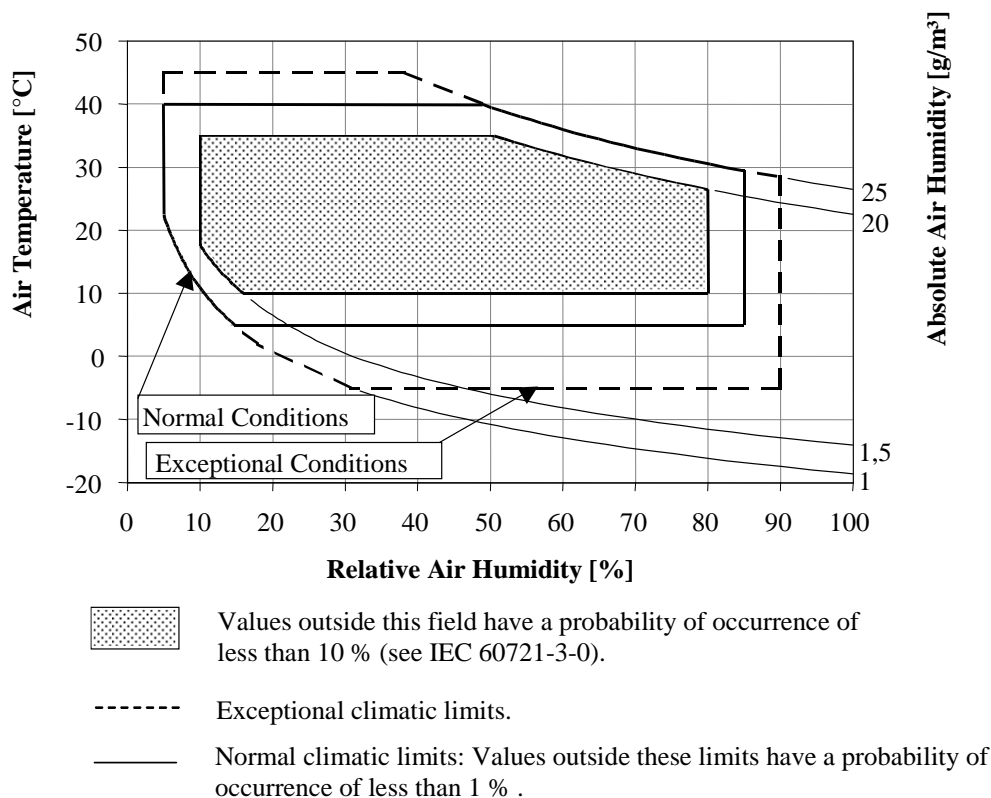
Heating, cooling, forced ventilation and humidification are used as necessary to maintain the required conditions - especially where there is a significant difference between the room environment and the external ambient. The climate-controlling systems could be periodically switched on or off but extremely high or low temperatures are prevented.

This class applies to locations:

- where installed equipment may be exposed to solar radiation and to heat radiation. It may also be exposed to movements of the surrounding air due to draughts in buildings. They are not subjected to condensed water, precipitation, water from sources other than rain or icing;
- without particular risks of biological attacks. This includes protective measures, e.g. special product design, or installations at locations of such construction that mould growth and attacks by animals, etc. are not probable;
- with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;
- without special precautions to minimize the presence of sand or dust, but which are not situated in proximity to sources of sand or dust;
- with insignificant vibration and shock.

The conditions of this class may be found in:

- normal living or working areas, e.g. living rooms, rooms for general use (theatres, restaurants);
- offices;
- shops;
- workshops for electronic assemblies and other electrotechnical products;
- telecommunication centres;
- storage rooms for valuable and sensitive products;
- data centres;
- computer halls.



NOTE: Exceptional conditions may occur following the failure of the temperature controlling system. This is described as 3.1E in the tables but it should be noted that there is no separate class 3.1E.

Figure 1: Climatogram for Class 3.1: Temperature-controlled locations

4.2 Class 3.2: Partly temperature-controlled locations

This class is a combination of classes 3K5/3Z2/3Z4/3B2/3C2(3C1)/3S3/3M2 in IEC 60721-3-3 [1].

Seismic environment: **zone 4** as defined in IEC 60721-2-6 [3]. Option zone 4 (modified Mercalli scale ≥ 9): if earthquake conditions are specified by the customer, the conditions stated in clause 5.6 apply.

This class applies to an enclosed location having neither temperature nor humidity control. The climatogram is shown in figure 2.

Heating may be used to raise low temperatures especially where there is a significant difference between the conditions of this class and the open-air climate. Building construction is designed to avoid extremely high temperatures.

This class applies to locations:

- where installed equipment may be exposed to solar radiation and heat radiation. They may also be exposed to movements of the surrounding air due to draughts in buildings, e.g. through open windows. They may be subjected to condensed water. They are not subjected to precipitation;
- where mould growth or attacks by animals, except termites, may occur;
- with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;
- in close proximity to sources of sand or dust;
- with vibration of low significance, e.g. for products fastened to light supporting structures subjected to negligible vibrations.

The conditions of this class may be found in:

- entrances and staircases of buildings;
- garages;
- cellars;
- certain workshops;
- buildings in factories and industrial process plants;
- unattended equipment stations;
- certain telecommunication buildings;
- ordinary storage rooms for frost resistant products and farm buildings, etc.

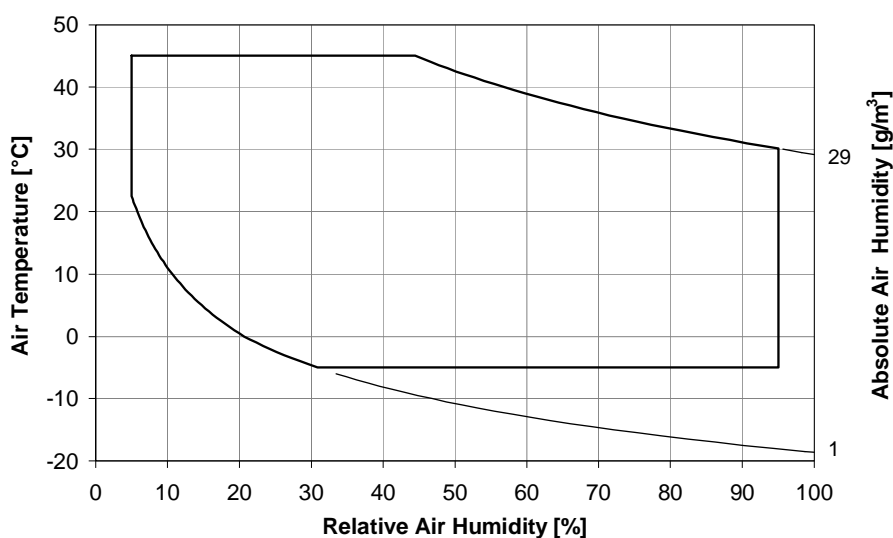


Figure 2: Climatogram for class 3.2: Partly temperature-controlled locations

4.3 Class 3.3: Not temperature-controlled locations

This class is a combination of classes 3K6/3Z2/3Z4/3Z7/3B2/3C2(3C1)/3S3/3M2 in IEC 60721-3-3 [1].

Seismic environment: **zone 4** as defined in IEC 60721-2-6 [3], Option zone 4 (modified Mercalli scale ≥ 9): if earthquake conditions are specified by the customer, the conditions stated in clause 5.6 apply.

This class applies to a weatherprotected location having neither temperature nor humidity control. The location may have openings directly to the open air, i.e. may be only partially-weather protected. The climatogram is shown in figure 3.

The climatic conditions of this class may be affected to a varying extent by the conditions of the open-air climate and the construction of the building.

This class applies to locations:

- where installed equipment may be exposed to solar radiation and temporarily to heat radiation. It may also be exposed to movements of the surrounding air due to draughts e.g. through doors, windows or other openings. It may be subjected to condensed water, to water from sources other than rain and to icing. It may temporarily be subjected to limited wind-driven precipitation, including snow;
- where mould growth, or attacks by animals, except termites, may occur;
- with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;
- in close proximity to sources of sand or dust;
- with vibration of low significance, e.g. for products fastened to light supporting structures subjected to negligible vibrations.

The conditions of this class may be found in:

- some entrances to buildings;
- some garages;
- some shacks;
- unattended buildings, etc.

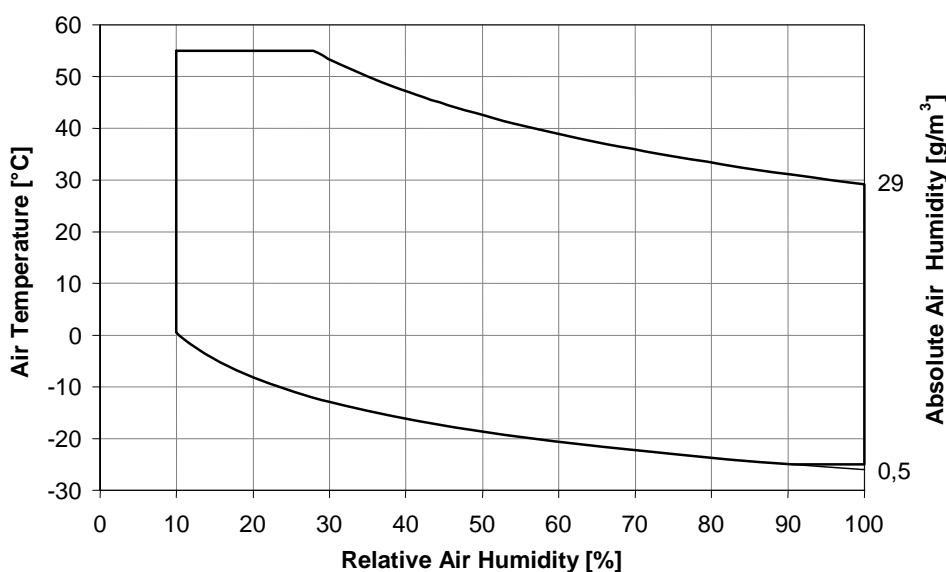


Figure 3: Climatogram for class 3.3: Not temperature controlled locations

4.4 Class 3.4: Sites with heat-trap

This class is a combination of classes 3K7/3Z2/3ZA/3Z7/3Z8/3B2/3C2(3C3)/3S3/3M5(3M3) in IEC 60721-3-3 [1].

Seismic environment: **zone 4** as defined in IEC 60721-2-6 [3]. Option zone 4 (modified Mercalli scale ≥ 9): if earthquake conditions are specified by the customer, the conditions stated in clause 5.6 apply.

This class applies to a weather protected location having neither temperature nor humidity control. The location may have openings directly to the open air, i.e. may be only partially weather protected. The effect of direct solar radiation and heat trap conditions exist. The climatogram is shown in figure 4.

This class applies to locations:

- where installed equipment may also be exposed temporarily to solar radiation and temporarily to heat radiation. They may be exposed to movements of the surrounding air due to draughts e.g. through doors, windows or other openings. They may be subjected to condensed water and to water from sources other than rain and to icing. They may be subjected to limited wind-driven precipitation including snow;
- where mould growth, or attacks by animals, except termites, may occur;
- with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;

NOTE 1: At locations in the immediate neighbourhood of industrial sources with chemical emissions either special precautions can be taken or the special chemical class can be chosen.

- in close proximity to sources of sand or dust;
- where transmitted vibrations are experienced from machines or passing vehicles. Higher shock levels may be experienced e.g. from adjacent machines.

NOTE 2: These requirements do not cover intentional damage by vandals.

The conditions of this class may be found in:

- some sheds;
- shacks;
- lofts;
- telephone booths;
- some buildings.

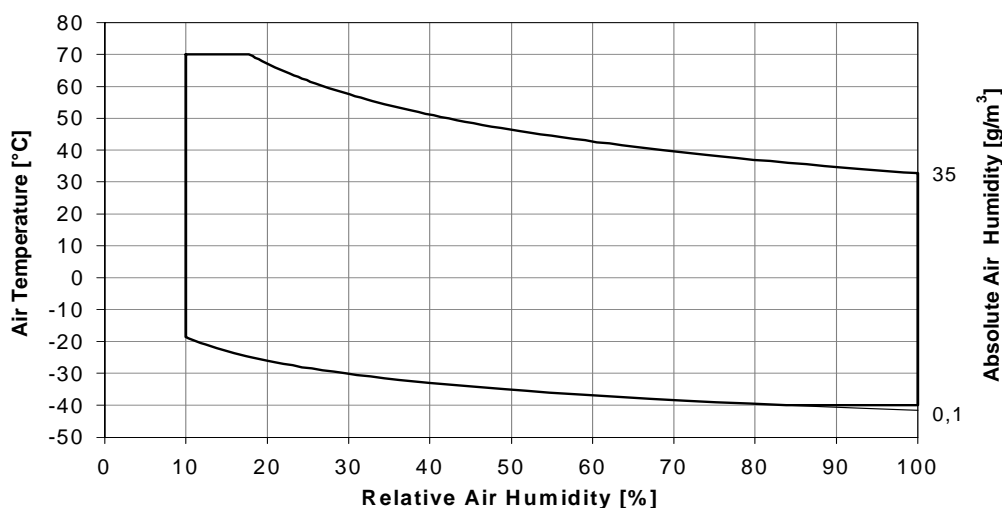


Figure 4: Climatogram for class 3.4: Sites with heat-trap

4.5 Class 3.5: Sheltered locations

This class is a combination of IEC classes 3K7 low/3Z2/3Z6/3Z7/3Z8/3B2/3C2(3C3)/3S3/3M5(3M3) in IEC 60721-3-3 [1].

Seismic environment: **zone 4** as defined in IEC 60721-2-6 [3]. Option zone 4 (modified Mercalli scale ≥ 9): if earthquake conditions are specified by the customer, the conditions stated in clause 5.6 apply.

This class applies to a shelter where direct solar radiation and heat-trap conditions do not exist. The climatogram is shown in figure 5.

This class applies to locations:

- where installed equipment may be exposed to heat radiation from the roof or walls heated by the sun. They may be exposed to movement of the surrounding air through openings. They may be subjected to condensed water and to water from sources other than rain and to icing. They may be subjected to limited wind-driven precipitation including snow;
- where mould growth, or attacks by animals, except termites, may occur;
- with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;

NOTE 1: At locations in the immediate neighbourhood of industrial sources with chemical emissions either special precautions can be taken or the special chemical class can be chosen.

- in close proximity to sources of sand or dust;
- where transmitted vibrations are experienced from machines or passing vehicles. Higher shock levels may be experienced, e.g. from adjacent machines.

NOTE 2: For equipment intended for public use more severe mechanical conditions are expected. Special requirements should be used for such equipment. These requirements do not cover intentional damage by vandals.

The conditions of this class may be found in:

- some sheds;
- open telephone booths;
- under single roofs, e.g. carports.

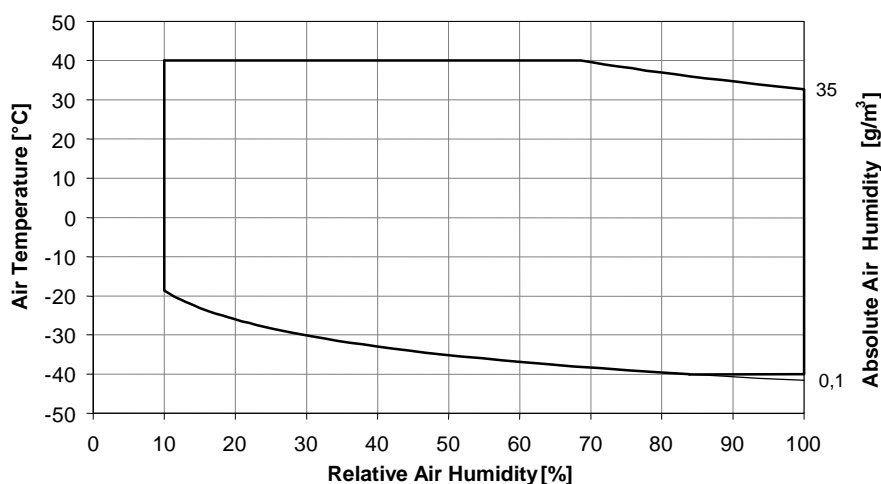


Figure 5: Climatogram for class 3.5: Sheltered locations

4.6 Class 3.6: Telecommunication control room locations

This class is a combination of classes 3K2/3Z2/3Z4/3B1/3C2(3C1)/3S2/3M1 in IEC 60721-3-3 [1].

Seismic environment: **zone 4** as defined in IEC 60721-2-6 [3]. Option zone 4 (modified Mercalli scale ≥ 9): if earthquake conditions are specified by the customer, the conditions stated in clause 5.6 apply.

This class applies to a permanently temperature controlled enclosed location. Humidity is usually not controlled. The climatogram is shown in figure 6.

Heating, cooling, forced ventilation and humidification are used as necessary to maintain the required conditions - especially where there is a significant difference between the room environment and the external ambient. The climate-controlling systems could be periodically switched on or off but high or low temperatures are prevented.

This class applies to locations:

- where installed equipment may be exposed to solar radiation and to heat radiation. It may also be exposed to movements of the surrounding air due to draughts in buildings. They are not subjected to condensed water, precipitation, water from sources other than rain;
- without particular risks of biological attacks. This includes protective measures, e.g. special product design, or installations at locations of such construction that mould growth and attacks by animals, etc. are not probable;
- with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;
- without special precautions to minimize the presence of sand or dust, but which are not situated in proximity to sources of sand or dust;
- with insignificant vibration and shock.

The conditions of this class may be found in:

- dedicated control rooms within telecommunication centres intended to be used for small specialized peripheral equipment such as workstations, test equipment, storage media and printers.

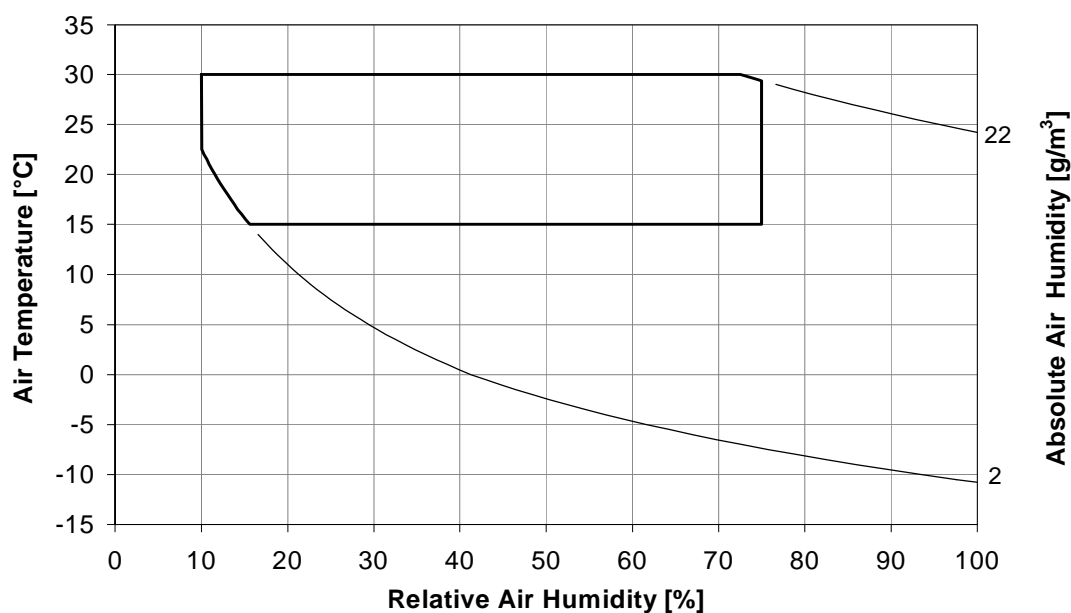


Figure 6: Climatogram for Class 3.6: Telecommunication control rooms

5 Environmental conditions

5.1 Climatic conditions

Table 1: Climate parameters for environmental classes 3.1 to 3.6

Environmental parameter	Unit	Class							
		3.1		3.2	3.3	3.4	3.5	3.6	
		Normal	Exceptional (E)						
a)	Low air temperature	°C	+5	-5	-5	-25	-40	-40	+15
b)	High air temperature	°C	+40	+45	+45	+55	+70	+40 (see note 5)	+30
c)	Low relative humidity	% RH	5	5	5	10	10	10	10
d)	High relative humidity	% RH	85	90	95	100	100	100	75
e)	Low absolute humidity	g/m ³	1		1	0,5	0,1	0,1	2
f)	High absolute humidity	g/m ³	25		29	29	35	35	22
g)	Rate of change of temperature (see note 1)	°C/min	0,5		0,5	0,5	1,0	1,0	0,5
h)	Low air pressure	kPa	70		70	70	70	70	70
i)	High air pressure (see note 2)	kPa	106		106	106	106	106	106
j)	Solar radiation	W/m ²	700		700	1 120	1 120	-	700
k)	Heat radiation	W/m ²	600		600	600 (see note 4)	600 (see note 4)	600 (see note 6)	600
l)	Movement of the surrounding air (see note 3)	m/s	5		5	5	5	30	5
m)	Conditions of condensation	none	no		yes	yes	yes	yes	no
n)	Conditions of wind - driven rain, snow, hail, etc.	none	no		no	Yes (see note 4)	yes	yes	no
o)	Conditions of water from sources other than rain	none	no		no	dripping	dripping spraying	dripping spraying	no
p)	Conditions of icing	none	no		yes	yes	yes	yes	no
	Climatogram, figure		1		2	3	4	5	6

NOTE 1: Averaged over a period of 5 minutes.

NOTE 2: Conditions in mines are not considered.

NOTE 3: A cooling system based on non-assisted convection may be disturbed by adverse movement of the surrounding air.

NOTE 4: Temporarily.

NOTE 5: Direct solar radiation and heat-trap conditions do not exist.

NOTE 6: Secondary effect of solar radiation.

5.2 Biological conditions

Table 2: Biological conditions for environmental classes 3.1 to 3.6

Environmental parameters		Unit	Class	
			3.1 and 3.6	3.2 to 3.5 (see note)
a)	Flora	none	-	presence of mould, fungus, etc
b)	Fauna	none	-	presence of rodents and other animals harmful to products but excluding termites
NOTE: At non-heated locations (class 3.3) only mould growth may be encountered.				

5.3 Chemically active substances

Table 3a: Chemically active substances for environmental classes 3.1 to 3.3 and 3.6

Environmental parameter		Unit (see note 2)	Class (see note 1)		
			3.1, 3.2, 3.3 and 3.6		special (3C1)
			Mean (see note 4)	Max (see note 5)	Max (see note 5)
a)	Salt mist	none	sea salts, road salts, excl. class 3.1 and 3.6 (see note 6)		
b)	Sulphur dioxide (SO ₂)	mg/m ³ cm ³ /m ³	0,3 0,11	1,0 0,37	1,0 0,37
c)	Hydrogen sulphide (H ₂ S)	mg/m ³ cm ³ /m ³	0,1 0,071	0,5 0,36	0,01 0,0071
d)	Chlorine (Cl)	mg/m ³ cm ³ /m ³	0,1 0,034	0,3 0,1	0,1 0,034
e)	Hydrochloric acid (HCl)	mg/m ³ cm ³ /m ³	0,1 0,066	0,5 0,33	0,1 0,066
f)	Hydrofluoric acid (HF)	mg/m ³ cm ³ /m ³	0,01 0,012	0,03 0,036	0,03 0,036
g)	Ammonia (NH ₃)	mg/m ³ cm ³ /m ³	1,0 1,4	3,0 4,2	0,3 0,42
h)	Ozone (O ₃)	mg/m ³ cm ³ /m ³	0,05 0,025	0,1 0,05	0,01 0,005
i)	Nitrogen oxides (NO _x) (see note 7)	mg/m ³ cm ³ /m ³	0,5 0,26	1,0 0,52	0,1 0,052
See table 3b for notes.					

Table 3b: Chemically active substances for environmental classes 3.4 and 3.5

Environmental parameter	Unit (see note 2)	Class (see note 1)				
		3.4 and 3.5		special (3C3) (see note 3)		
		Mean (see note 4)	Max (see note 5)	Mean (see note 4)	Max (see note 5)	
a)	Salt mist	none	sea salts, road salts			
b)	Sulphur dioxide (SO ₂)	mg/m ³ cm ³ /m ³	0,3 0,11	1,0 0,37	5,0 1,85	10 3,7
c)	Hydrogen sulphide (H ₂ S)	mg/m ³ cm ³ /m ³	0,1 0,071	0,5 0,36	3,0 2,1	10 7,1
d)	Chlorine (Cl)	mg/m ³ cm ³ /m ³	0,1 0,034	0,3 0,1	0,3 0,1	1,0 0,34
e)	Hydrochloric acid (HCl)	mg/m ³ cm ³ /m ³	0,1 0,066	0,5 0,33	1,0 0,66	5,0 3,3
f)	Hydrofluoric acid (HF)	mg/m ³ cm ³ /m ³	0,01 0,012	0,03 0,036	0,1 0,12	2,0 2,4
g)	Ammonia (NH ₃)	mg/m ³ cm ³ /m ³	1,0 1,4	3,0 4,2	10 14	35 49
h)	Ozone (O ₃)	mg/m ³ cm ³ /m ³	0,05 0,025	0,1 0,05	0,1 0,05	0,3 0,15
i)	Nitrogen oxides (NO _x) (see note 7)	mg/m ³ cm ³ /m ³	0,5 0,26	1,0 0,52	3,0 1,56	9,0 4,68

NOTE 1: Because of the low probability of simultaneous occurrence of these gases at the levels of IEC class 3C2, the values of 3C1 are considered more appropriate to describe the long term environmental conditions.

NOTE 2: The values given in cm³/m³ have been calculated from the values given in mg/m³ and refer to 20 °C. The table uses rounded values.

NOTE 3: It is not mandatory to consider the special class 3C3 as a requirement for the combined effect of all parameters stated. If applicable, values of single parameters may be selected from this special class. In such instances the values given for the classes 3.4 and 3.5 are valid for all parameters not especially named.

NOTE 4: Mean values are the average values (long-term values) to be expected.

NOTE 5: Maximum values are limit or peak values occurring over a period of not more than 30 minutes per day.

NOTE 6: Salt mist may be present at sheltered locations of coastal areas and offshore sites.

NOTE 7: Expressed as the equivalent values of nitrogen dioxide.

5.4 Mechanically active substances

Table 4: Mechanically active substances for environmental classes 3.1 to 3.6

Environmental parameters	Unit	Class	
		3.1 and 3.6	3.2. to 3.5 (see note)
a) Sand	mg/m ³	30	300
b) Dust (suspension)	mg/m ³	0,2	0,4
c) Dust (sedimentation)	mg/(m ² h)	1,5	15

NOTE: In locations where appropriate air filtering methods are used, e.g. in unheated telecommunication centres then the mechanically active substances of class 3.1 apply.

5.5 Mechanical conditions

Table 5: Mechanical conditions for the environmental classes 3.1 to 3.6

Environmental parameter		Unit	Class							
			3.1 and 3.6		3.2 and 3.3		3.4 and 3.5 (see note 1)		special 3M3 (see note 1)	
a)	Stationary vibration, sinusoidal (see notes 2 and 4)									
	displacement amplitude	mm	0,3		1,5		3,0		1,5	
	acceleration amplitude	m/s ²		1		5		10		5
	frequency range	Hz	2 to 9	9 to 200	2 to 9	9 to 200	2 to 9	9 to 200	2 to 9	9 to 200
b)	Non-stationary vibration, including shock (see note 3)									
	shock response spectrum type L, peak acceleration (\hat{a})	m/s ²		40		40				70
	duration	ms		22		22				22
	shock response spectrum type II, peak acceleration (\hat{a})	m/s ²					250			
	duration	ms					6			
NOTE 1: When the consequences of mechanical failure are minor, or the probability of high mechanical stresses is rare, the mechanical levels of IEC class 3M3 may be chosen.										
NOTE 2: Units are peak displacement amplitude (mm), peak acceleration amplitude (m/s ²) and frequency range (Hz).										
NOTE 3: For definition of Modal Shock Response Spectra (First Order Maximax Shock Response Spectra) see IEC 60721-3-3 [1], and Maximax see IEC 60068-2-27 [2].										
NOTE 4: Random vibration is often a more realistic vibration characteristic compared with sinusoidal. Test severities for random vibration are given in EN 300 019-2-3 [5] and these represent all types of vibration found in practice. Random vibration is therefore recommended to be used as an environmental parameter unless significant sinusoidal vibration is known to be present in a particular application. IEC 60721-3-3 [1] presently has no data for random vibration levels experienced in practice.										

5.6 Earthquake conditions

The dynamic environment which an equipment experiences during an earthquake depends on several parameters including the intensity of the ground motion, the structural characteristics of the building, the elevation of the equipment in the building and the characteristics of the structures used to support and house the equipment itself.

The most common method for specifying seismic conditions taking into account all these parameters is through the definition of a Response Spectrum (RS).

A RS is the graphical representation of the maximum response (i.e. acceleration) of an array of single degree-of-freedom oscillators as a function of oscillator frequency, in response to an applied transient base motion.

In other words the RS may be used to describe the motion that equipment is expected to experience at its mounting during a postulated seismic event.

To define an RS it is necessary to define the base motion and the characteristics of the array of the single degree-of-freedom oscillators, including their damping ratio.

The high frequency asymptotic value of the acceleration of the response spectrum is normally called *Zero Period Acceleration* (ZPA) and represents the largest peak value of acceleration of the base motion.

In the absence of a detailed knowledge of the possible seismic motion, the ZPA value can be obtained by the following formula (see IEC 60068-3-3 [4]):

$$\text{ZPA} = a_f = a_g \times K \times D \times G$$

where:

- a_f floor acceleration;
- a_g ground acceleration that depends on the intensity of the earthquake;
- K *superelevation factor* that takes into account the amplification of the ground acceleration resulting from the vibrational behaviour of buildings and structures;
- D *direction factor* that takes into consideration possible intensity differences of the seismic motion between the horizontal and vertical axes;
- G *geometric factor*; normally specified among testing parameters when single axis excitation is used for testing to take into account the interaction, due to installation location, along the different axes of the equipment of simultaneous multi-directional input vibrations.

The parameter severities that shall be used for classes 3.1 to 3.6 are shown in table 6.

The severities have been chosen from those stated in IEC 60068-3-3 [4].

Table 6: Earthquake parameters for classes 3.1 to 3.6

Parameter	Description	Severity
Earthquake intensity	strong to very strong earthquakes (Richter scale magnitude > 7, Modified Mercalli intensity scale > IX)	$A_g = 5 \text{ m/s}^2$
Superelevation factor	installations on stiff structures connected rigidly to buildings	$K = 2$
Direction factor	no intensity differences among axes	$D_{xyz} = 1$
Geometric factor	single-axis excitation with interaction with the other axes	$G = 1,5$

The corresponding Response Spectrum, assuming a damping ratio of the single degree-of-freedom oscillators $\zeta = 2\%$, is described in figure 7 and table 7.

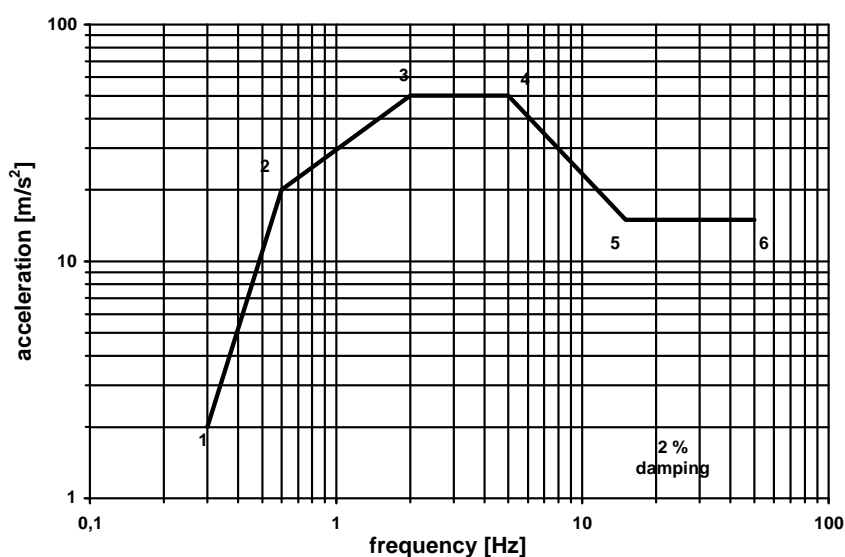


Figure 7: Earthquake Response Spectrum

Table 7: Acceleration co-ordinates for the Response Spectrum

Co-ordinate point	Frequency (Hz)	Values for upper floor acceleration (m/s ²)
1	0,3	2
2	0,6	20
3	2,0	50
4	5,0	50
5	15,0	15
6	50,0	15

Annex A (informative): Bibliography

- IEC 60721-3-0: "Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Introduction".
- ETSI ETR 035: "Equipment Engineering (EE); Environmental engineering Guidance and terminology".

History

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