

TPVISION

Use of environmental classes and the corresponding tests philosophy in ETSI

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ETSI TR 100 035

- Technical Report (TR)
- **Environmental engineering Guidance and terminology**
- general introduction to a multi-part European Standard (EN), concerned with environmental conditions and environmental tests for telecommunications equipment
- background to the main concepts of environmental engineering

The complementary standard is divided into two main parts, each with a number of sub-parts:

- EN 300 019-1 series:
 - "Environmental conditions and environmental tests for telecommunications equipment; **Classification** of environmental conditions".
 - This part of the standard specifies different **standardized environmental classes** covering climatic and biological conditions, chemically and mechanically active substances and mechanical conditions during storage and transportation, and in use.
- EN 300 019-2 series:
 - "Environmental conditions and environmental tests for telecommunications equipment; **Specification** of environmental tests".
 - This part of the standard specifies the **test requirements** for the environmental classes.

ETSI EN 300 019-2-0

- ***The purpose of environmental testing is to demonstrate that an equipment under defined environmental conditions can survive without irreversible failures and perform according to requirements.***
- These tests are **not** reliability tests or lifetime tests.

9 sub parts:

- .. -0: "... Introduction";
- .. -1: "... Storage";
- .. -2: "... Transportation";
- .. -3: "... Stationary use at weatherprotected locations";
- .. -4: "... Stationary use at non-weatherprotected locations";
- .. -5: "... Ground vehicle installations";
- .. -6: "... Ship environments";
- .. -7: "... Portable and non-stationary use";
- .. -8: "... Stationary use at underground locations".

ETSI EN 300 019-1-0



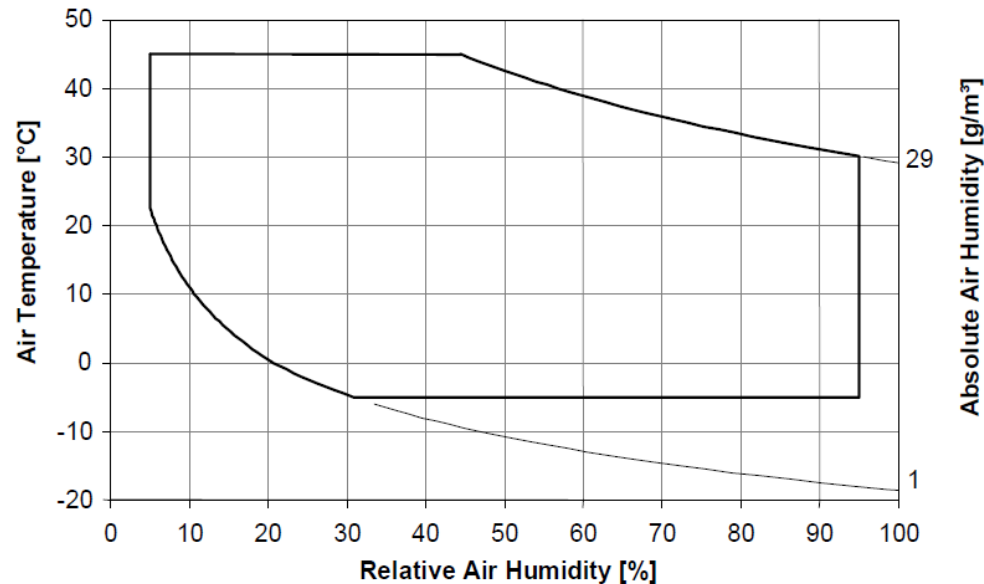
Environmental classes covered in Part 1

Not IN-USE		IN-USE					
Storage	Transportation	Stationary use			Mobile Use		Portable and non-stationary use
		Weather protected locations	Non-weather protected locations	Underground locations	Ground vehicle installations	Ship environment	
Part 1-1	Part 1-2	Part 1-3	Part 1-4	Part 1-8	Part 1-5	Part 1-6	Part 1-7
Class 1.1 Weather protected, partly temperature controlled storage locations	Class 2.1 Very carefull transportation	Class 3.1 Temperature controlled locations	Class 4.1 Non-weather protected locations	Class 8.1 Partly weather protected underground locations	Class 5.1 Protected installation	Class 6.1 Totally weather protected locations	Class 7.1 Temperature controlled locations
Class 1.2 Weather protected, not temperature controlled storage locations	Class 2.2 Carefull transportation	Class 3.2 Partly temperature controlled locations	Class 4.1E Non-weather protected locations - extended		Class 5.2 Partly protected installation	Class 6.2 Partly weather protected locations	Class 7.2 Partly temperature controlled locations
Class 1.3 Non- Weather protected storage locations	Class 2.3 Public transportation	Class 3.3 Temperature controlled locations	Class 4.2L Non-weather protected locations – extremely cold			Class 6.3 Non-weather protected locations	Class 7.3 Partly weather protected and non weather protected locations
Class 1.3E Non- Weather protected storage locations, extended		Class 3.4 Sites with heattrap	Class 4.2H Non-weather protected locations – extremely warm dry				Class 7.3E Partly weather protected and non weather protected locations - extended
		Class 3.5 Sheltered locations					
		Class 3.6 Telecommunications control room locations					

Class 1.1

Weather protected, partly temperature controlled

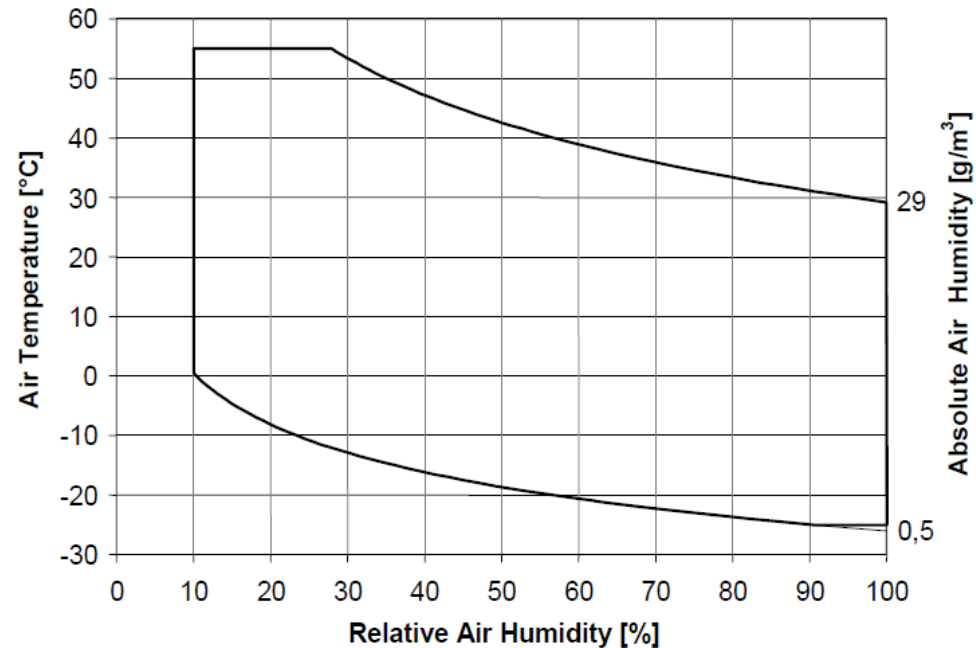
- This class shall apply to storage locations:
 - exposed to solar radiation and heat radiation also exposed to movements of the surrounding air due to draughts in buildings, e.g. through open windows. It is not subjected to precipitation and water from sources other than rain;
 - without particular risks by biological attacks. This includes protective measures, e.g. special package design, or storing at locations of such construction that mould growth, 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 dust or sand, but not situated in proximity to dust or sand sources;
 - with vibration of low significance and insignificant shock.
- The conditions of this class may occur in ordinary storage rooms for frost-resistant products.



Class 1.2

Weather protected, not temperature controlled

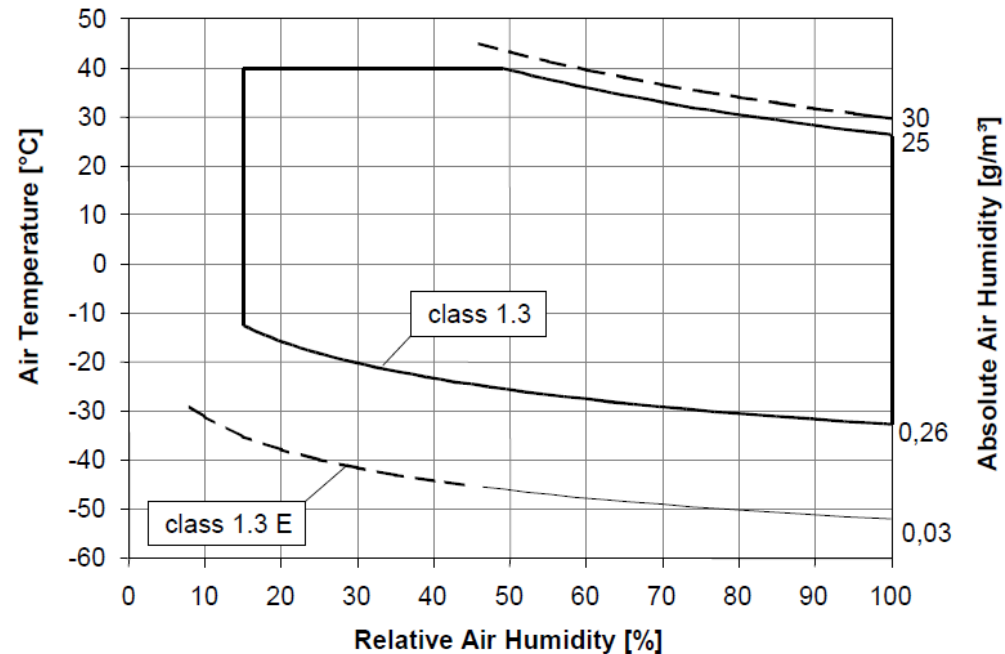
- This class shall apply to storage locations:
 - exposed to solar radiation and temporarily to heat radiation. They may also be exposed to movements of the surrounding air due to draughts, e.g. through doors, windows or other openings.
 - They may be subjected to condensed water, dripping water and to icing. They may also 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 areas with sources of sand or dust, including urban areas;
 - with vibration of low significance and insignificant shock.
- The conditions of this class may occur in:
 - unattended buildings;
 - some entrances of buildings;
 - some garages and shacks.



Class 1.3

Non-weather protected

- This class shall apply to storage locations:
 - directly exposed to an open-air climate including solar radiation, movement of the surrounding air, precipitation and water jets;
 - where mould growth, or attacks by animals but excluding 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 areas with sources of sand or dust, including urban areas;
 - with significant vibration and shock, e.g. transmitted from machines or passing vehicles in the vicinity, etc.



Class 1.1 – 1.3^E - Climatic

Environmental parameter		Unit	Class			
			1.1	1.2	1.3	1.3 ^E
a)	Low air temperature (see note 1)	°C	-5 (see note 8)	-25	-33 (see note 9)	-45 (see note 9)
b)	High air temperature (see note 1)	°C	45	55	40	45
c)	Low relative humidity (see note 1)	%	5	10	15	8
d)	High relative humidity (see note 1)	%	95	100	100	100
e)	Low absolute humidity (see note 1)	g/m ³	1	0,5	0,26	0,03
f)	High absolute humidity (see note 1)	g/m ³	29	29	25	30
g)	Rain intensity	mm/min	no	no	6	15
h)	Rate of change of temp. (see note 2)	°C/min	0,5	0,5	0,5	0,5
i)	Low air pressure (see note 3)	kPa	70	70	70	70
j)	High air pressure (see note 4)	kPa	106	106	106	106
k)	Solar radiation	W/m ²	700	1 120	1 120	1 120
l)	Heat radiation	W/m ²	(see note 7)	(see note 7)	negligible	Negligible
m)	Movement of the surrounding air	m/s	1,0	30	50	50
n)	Conditions of condensation	none	yes	yes	yes	Yes
o)	Conditions of precipitation (rain, snow, hail, etc.)	none	no	(see note 6) yes	yes	Yes
p)	Low rain temperature (see note 5)	°C	no	no	5	5
q)	Conditions from water from sources other than rain	none	no	dripping water	splashing water	splashing water
r)	Conditions of icing and frosting	none	yes (see note 8)	yes	yes	Yes

Class 1.1 – 1.3^E - Mechanical

		Class					
Environmental parameter		Unit	1.1 and 1.2		1.3 and 1.3E		Special (1M4)
a)	Stationary vibration, sinusoidal: displacement amplitude (see note 1)	mm	1,5		3,0		7,0
	acceleration amplitude (see note 1)	m/s ²		5		10	20
	frequency range (note 3)	Hz	2 to 9	9 to 200	2 to 9	9 to 200	2 to 9 9 to 200
	Stationary vibration Random Acceleration spectral density	ASD(m2/ S3)	0.02		0.04		
		(dB/oct)	+12	-12	+12	-12	
	Frequency range		5-10	10-50 50-100	5-10	10-50 50-100	
	Axes of vibration		3		3		
b)	Non-stationary vibration, including shock: (see note 2) shock response spectrum type I, peak acceleration (\hat{a})	m/s ²			100		
	Duration	ms			11		
	shock response spectrum type II peak acceleration (\hat{a})	m/s ²					250
	Duration	ms					6
	shock response spectrum type L peak acceleration (\hat{a})	m/s ²	40				
c)	duration	ms	22				
	Static load	kPa	5		5		5

Class 1.1 – Test specification

Environmental parameter			Environmental Class 1.1	Environmental test specification T1.1: Weatherprotected, partly temperature-controlled storage locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-5	-5	72 h	IEC 60068-2-1 [4]	Ab: Cold
	high	(°C)	+45	+45 or +55	72 h	IEC 60068-2-2 [5]	Bb: Dry heat
	change	(°C/min)	0,5	none			
Humidity	relative	low (%)	5	none			
		high (%)	95	93	96 h	IEC 60068-2-78 [11]	Cab: Damp heat steady state
	absolute	condensation	yes	none			
		low (g/m³)	1	none			
		high (g/m³)	29				

Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	velocity (mm/s) displacement (mm) acceleration (m/s²) frequency range (Hz) axes of vibration	1,5 5 2-9 9-200	5 2 5-62 62-200 3	3 x 5 sweep cycles	IEC 60068-2-6 [6]	Fc: Vibration (sinusoidal)
	random	ASD (m²/s³) (dB/oct) frequency range (Hz) axes of vibration		0,02 +12 -12 5-10 10-50 50-100 3	3 x 30 minutes	IEC 60068-2-64 [12]	Fh: Vibration, broad-band random (digital control)
Shocks	shocks	shock spectrum duration (ms) acceleration (m/s²) number of shocks directions of shocks	Type L 22 40	none			
Load	static load	(kPa)	5	none			

Class 1.2 – Test specification

Environmental parameter			Environmental Class 1.2	Environmental test specification T1.2: Weatherprotected, not temperature-controlled storage locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-25	-25	72 h	IEC 60068-2-1 [4]	Ab: Cold
	high	(°C)	+55	+55 or +70	72 h	IEC 60068-2-2 [5]	Bb: Dry heat
	change	(°C/min)	0,5	none			
Humidity	relative	low (%)	10	none			
		high (%)	100	93 +30	96 h	IEC 60068-2-78 [11]	Cab: Damp heat steady state
		condensation (%)	yes	90-100 +30	2 cycles	IEC 60068-2-30 [10]	Db: Damp heat cyclic Variant 1
	absolute	low (g/m³)	0,5	none			
		high (g/m³)	29				

Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	velocity (mm/s)	1,5	5		IEC 60068-2-6 [6]	Fc: Vibration (sinusoidal)
		displacement (mm)	5	2			
		acceleration (m/s²)	2-9	5-62	3 x 5 sweep cycles		
		frequency range (Hz)	9-200	62-200			
		axes of vibration		3			
	random	ASD (m²/s³)		0,02		IEC 60068-2-64 [12]	Fh: Vibration, broad-band random (digital control)
		(dB/oct)		+12 -12	3 x 30 minutes		
		frequency range (Hz)		5-10 10-50 50-100			
		axes of vibration		3			
Shocks	shocks	shock spectrum duration (ms)	Type L 22	none			
		acceleration (m/s²)	40				
		number of shocks					
		directions of shocks					
Load	static load	(kPa)	5	none			

Class 1.3 – Test specification

Environmental parameter			Environmental Class 1.3	Environmental test specification T1.3: Non-weatherprotected, storage locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-33	-33 or -45	72 h	IEC 60068-2-1 [4]	Ab: Cold
	high	(°C)	+40	+55 or +40	72 h	IEC 60068-2-2 [5]	Bb: Dry heat
	change	(°C) (°C/min)	0,5	-10/+40 0,5	2 cycles t1 = 3 h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	relative	low (%)	15	none			
		high (%)	100	93 +30	21 d	IEC 60068-2-78 [11]	Cab: Damp heat steady state
		condensation (%)	yes	90-100 +30	6 cycles	IEC 60068-2-30 [10]	Db: Damp heat cyclic Variant 1
	absolute	low (g/m³)	0,26	none			
		high (g/m³)	25				
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm) acceleration (m/s²) frequency range (Hz) axes of vibration	3,0 10 2-9 9-200	1,2 4 5-9 9-200 3	3 x 5 sweep cycles	IEC 60068-2-6 [6]	Fc: Vibration (sinusoidal)
	random	ASD (m²/s³) (dB/oct) frequency range (Hz) axes of vibration		0,04 +12 -12 5-10 10-50 50-100 3	3 x 30 minutes	IEC 60068-2-64 [12]	Fh: Vibration, broad-band random (digital control)
Shocks	shocks	shock spectrum duration (ms) acceleration (m/s²) number of shocks directions of shocks	Type I 11 100	half sine 11 50 6	3 in each direction	IEC 60068-2-27 [9]	Ea: Shock
Load	static load	(kPa)	5	none			

Class 1.3E – Test specification

Environmental parameter			Environmental Class 1.3E	Environmental test specification T1.3E: Non-weatherprotected, storage locations - extended			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-45	-45	72 h	IEC 60068-2-1 [4]	Ab: Cold
	high	(°C)	+45	+45 or +60	72 h	IEC 60068-2-2 [5]	Bb: Dry heat
	change	(°C) (°C/min)	0,5	-10/+40 0,5	2 cycles t ₁ = 3h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	relative	low (%)	8	none			
		high (%)	100	93 +30	21 d	IEC 60068-2-78 [11]	Cab: Damp heat steady state
		condensation (%)	yes	90-100 +40	6 cycles	IEC 60068-2-30 [10]	Db: Damp heat cyclic Variant 1
	absolute	low (g/m ³)	0,03	none			
		high (g/m ³)	30				

Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	3,0 10 2-9 9-200	1,2 4 5-9 9-200 3	3 x 5 sweep cycles	IEC 60068-2-6 [6]	Fc: Vibration (sinusoidal)
	random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration		0,04 +12 -12 5-10 10-50 50-100 3	3 x 30 minutes	IEC 60068-2-64 [12]	Fh: Vibration, broad-band random (digital control)
Shocks	shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type I 11 100	half sine 11 50 6	3 in each direction	IEC 60068-2-27 [9]	Ea: Shock
Load	static load	(kPa)	5	none			

Class 2.1

Very carefull transportation

- This class shall apply to transportation:
 - where the equipment may be moved between cold, non-weatherprotected and warm, weatherprotected conditions. It may for short periods be exposed to direct solar radiation, precipitation and splashing water. The equipment may be placed on a wet floor and inside an enclosure which is subjected to sunshine and rain etc. Non-weatherprotected exposure does not include exposure to sea waves. The equipment may be placed close to heating elements;
 - in areas and conditions where mould growth, attacks by animals, except termites, may occur;
 - which is non-weatherprotected (but including transport by sea where the equipment is protected against sea waves) in areas with normal industrial activities excluding those where large quantities of chemical pollutants are emitted;
 - which is non-weatherprotected, as well as weatherprotected and where sweeping of dusty floors is taken into account. Transportation in sand desert areas is not included;
 - in aircraft, lorries and air-cushioned trucks and trailers in areas with well-developed road systems. Only mechanical loading and unloading is included. No risk of dropping is taken into account. The mechanical conditions given apply to equipment placed on the floor of the compartment in which it is transported.

Class 2.2

Carefull transportation

- This class shall apply to transportation
 - where special care has been taken e.g. with respect to low temperature and handling.
 - Class 2.2 covers the conditions of class 2.1.
 - In addition class 2.2 includes transportation in all types of lorries and trailers in areas with well-developed road systems.
 - It also includes transportation by ship and by train with specially designed, shock-reducing buffers.
 - Manual loading and unloading of up to 20 kg is included.

Class 2.3

Public transportation

- This class shall apply to transportation
 - Where no special precautions have been taken.
 - The conditions covered include transportation in unventilated enclosures and in non-weatherprotected conditions with restrictions on the general open-air climates, excluding cold climates. Transportation by air covers equipment carried in heated, pressurised holds.
 - Class 2.3 covers the conditions of classes 2.1 and 2.2. In addition class 2.3 has a lower cold-temperature limit.
 - Continuous or repeated solar radiation, precipitation and splashing of water may occur.
 - Class 2.3 also includes all types of transport in areas without well-developed road systems.
 - Rough handling is included.

Class 2.1 – 2.3 - Climatic

	Environmental parameter	Class		
		Unit	2.1 and 2.2	2.3
a)	Low temperature air	°C	-25	-40
b)	High temperature, air, in unventilated enclosures (see note 1)	°C	+70	+70
c)	High temperature, air, in ventilated enclosures or outdoor air (see note 2)	°C	+40	+40
d)	Change of temperature: air/air (see note 3)	°C	-25/+30	-40/+30
e)	Change of temperature: air/ water (see note 3)	°C	+40/+5	+40/+5
f)	Relative humidity, not combined with rapid temperature changes	%	95	95
		°C	+ 40	+45
g)	Relative humidity, combined with rapid temperature changes air/air, at high relative humidity (see notes 3, 6)	%	95	95
		°C	-25/+30	-40/+30
h)	Absolute humidity, combined with rapid temperature changes: air/air, at high water content (see note 4)	g/m ³	60	60
		°C	+70/+15	+70/+15
i)	Low air pressure	kPa	70	70
j)	Change of air pressure	kPa/min	no	no
k)	Movement of the surrounding medium, air	m/s	20	20
l)	Precipitation, rain	mm/min	6 (see note 7)	6
m)	Radiation, solar	W/m ²	1 120	1 120
n)	Radiation, heat	W/m ²	600	600
o)	Water from sources other than rain (see note 5)	m/s	1 (see note 7)	1
p)	Wetness	none	conditions of wet surfaces	

Class 2.1 – 2.3 - Mechanical

	Environmental parameter	Unit	Class								
			2.1			2.2			2.3		
a)	Stationary vibration, sinusoidal. (note 5)										
	displacement amplitude (note 2)	mm	3,5			3,5			3,5		
	acceleration amplitude (note 2)	m/s ²		10	15		10	15		10	15
	frequency range (notes 3 and 4)	Hz	2 to 9	9 to 200	200 to 500	2 to 9	9 to 200	200 to 500	2 to 9	9 to 200	200 to 500
b)	Stationary vibration, random. (see note 5)										
	acceleration spectral density	m ² /s ³	1	0,3		1	0,3		1	0,3	
	frequency range (see note 3)	Hz	10 to 200	200 to 2 000		10 to 200	200 to 2 000		10 to 200	200 to 2 000	
c)	Non-stationary vibration, including shock (see note 6)										
	shock response spectrum type I, peak acceleration (ä) (note 6)	m/s ²									
	duration	ms		no			100 11			100 11	
	shock response spectrum type II, peak acceleration (ä) (note 6)	m/s ²									
	duration	ms		no			no			300 6	
d)	Free fall:			see note 8							
	mass < 20 kg	m		no			0,25			1,2	
	mass 20 kg to 100 kg	m		no			0,25			1,0	
	mass > 100 kg	m		no			0,1			0,25	
e)	Toppling										
	mass < 20 kg	none		no			Toppling around any of the edges				
	mass 20 kg to 100 kg	none		no			no		Toppling around any of the edges		
	mass > 100 kg	none		no			no		no		
f)	Rolling, pitching:										
	angle	degree		no			no		± 35 (see note 7)		
	period	s		no			no		8		
g)	Steady state acceleration	m/s ²		20			20			20	
h)	Static load	kPa		5			5			10	

Class 2.1 – Test specification

Environmental parameter			Environmental Class 2.1	Environmental test specification T 2.1: Very careful transportation			
Type	Parameter	Detail parameter	Characteristic Severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-25	-25	6 h	IEC 60068-2-1 [2]	Ab: Cold
	high	unventilated (°C)	+70	+70	6 h	IEC 60068-2-2 [5]	Bb: Dry heat
		ventilated or outdoors (°C)	+40	None			
	change	air/air (°C) (°C/min)	-25/+30	-25/+30 1,0	5 cycles t1 = 3h	IEC 60068-2-14 [6]	Nb: Change of temperature
		air/water (°C)	+40/+5	None			
Humidity	relative	slow temperature change (%) (°C)	95 +40	93 +30	4 d	IEC 60068-2-78 [7]	Cab: Damp heat steady state
		rapid temperature change (%) (°C)	95 -25/+30	90-100 +40	2 cycles	IEC 60068-2-30 [8]	Db: Damp heat cyclic Variant 1
		rapid temperature change (°C) (g/m³)	+70/+15 60	none			
	absolute						

Environmental parameter			Environmental Class 2.1	Environmental test specification T 2.1: Very careful transportation			
Type	Parameter	Detail parameter	Characteristic Severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm) acceleration (m/s²) frequency range (Hz) axes of vibration	3,5 10 15 2-9 9-200 200-500	none			
	random	ASD (m²/s³) (dB/oct) frequency range (Hz) axes of vibration	1 0,3 10-200 200-2 000	1,0 -3 5-20 20-200 3	3 x 30 minutes	IEC 60068-2-64 [9]	Fh: Vibration, broad-band random (digital control)

Class 2.2 – Test specification

Environmental parameter			Environmental Class 2.2	Environmental test specification T 2.2: Careful transportation			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-25	-25	72 h	IEC 60068-2-1 [2]	Ab: Cold
	high	unventilated (°C)	+70	+70	72 h	IEC 60068-2-2 [5]	Bb: Dry heat
		ventilated or outdoors (°C)	+40	none			
	change	air/air (°C) (°C/min)	-25/+30	-25/+30 1,0	5 cycles t1 = 3h	IEC 60068-2-14 [6]	Nb: Change of temperature
		air/water (°C)	+40/+5	none			
Humidity	relative	slow temperature change (%) (°C)	95 +40	93 +40	4 d	IEC 60068-2-78 [7]	Cab: Damp heat steady state
		rapid temperature change (%) (°C)	95 -25/+30	90-100 +40	2 cycles	IEC 60068-2-30 [8]	Db: Damp heat cyclic Variant 1
		rapid temperature change (°C) (g/m³)	+70/+15 60	none			
	absolute						
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm)	3,5	none			
		acceleration (m/s²)	10 15				
		frequency range (Hz)	2-9 9-200 200-500				
	random	axes of vibration					
		ASD (m²/s³) (dB/oct)	1,0 0,3	1,0 -3	3 x 30 minutes	IEC 60068-2-64 [9]	Fh: Vibration, broad-band random (digital control)
		frequency range (Hz)	10-200 200-2 000	5-20 20-200			
Shocks	shocks	axes of vibration					
		shock spectrum	Type I	half sine	100 in each direction	IEC 60068-2-27 [10]	Ea: shocks
		duration (ms)	11	6 11			
Fall	free fall	acceleration (m/s²)	100	100 50			
		mass (kg)		≤ 50 > 50			
		number of shocks					
	toppling around	direction of shocks		6			
		height (m)	0,25 0,25 0,1				
		mass (kg)	< 20 20 to 100 > 100	see table 7		IEC 60068-2-31 [11]	Ec: Procedure 1
	edges	attitude					
		mass (kg)	< 20 20 to 100 > 100	none			
		edges	any no no				

Class 2.3 – Test specification

Environmental parameter			Environmental Class 2.3	Environmental test specification T 2.3: Public transportation			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-40	-40	72 h	IEC 60068-2-1 [2]	Ab: Cold
	high	unventilated (°C)	+70	+70 (and +85)	72 h (6 h)	IEC 60068-2-2 [5]	Bb: Dry heat
		ventilated or outdoors (°C)	+40	none			
	change	air/air (°C)	-40/+30	-40/+30	5 cycles	IEC 60068-2-14 [6]	Nb: Change of temperature
		(°C/min)		1,0	t1 = 3 h		
Humidity	relative	slow temperature change (%)	95	93	4 d	IEC 60068-2-78 [7]	Cab: Damp heat steady state
		(°C)	+45	+40			
		rapid temperature change (%)	95	90-100	2 cycles	IEC 60068-2-30 [8]	Db: Damp heat cyclic Variant 1
	absolute	(°C)	-40/+30	+40			
		rapid temperature change (g/m³)	+70/+15	none			
Air	pressure	(kPa)	60				
		low	70	none			
	speed	Change	no				
Water	rain	(m/s)	20	none			
		intensity	6 mm/min	0,01 m³/min, 90 kPa	3 min/m² or 15 min	IEC 60068-2-18 [12]	Rb: Impacting water, Method 2
		low temperature (°C)	no				

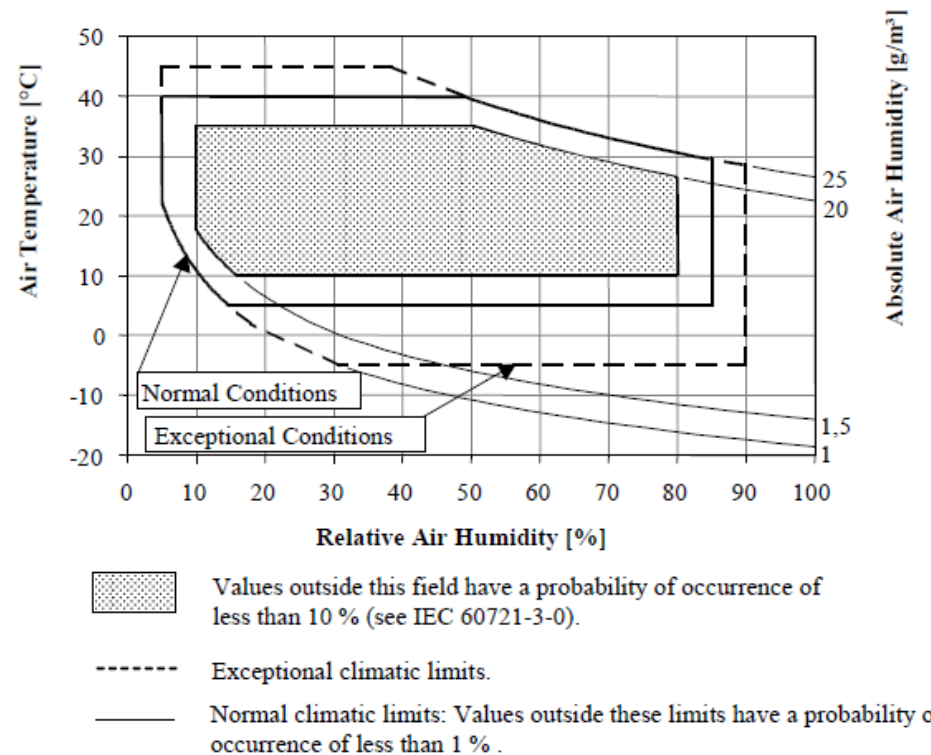
Class 2.3 – Test specification (cont...)

Environmental parameter			Environmental Class 2.3	Environmental test specification T 2.3: Public transportation			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm) acceleration (m/s^2) frequency range (Hz) axes of vibration	3,5 10 15 2-9 9-200 200-500	none			
	random	ASD (m^2/s^3) (dB/oct) frequency range (Hz) axes of vibration	1 0,3 10-200 200-2 000	1,0 -3 5-20 20-200 3	3 x 30 minutes	IEC 60068-2-64 [9]	Fh: Vibration, broad-band random (digital control)
Shocks	shocks	shock spectrum duration (ms) acceleration (m/s^2) mass (kg) number of shocks direction of shocks	Type I 11 6 100 300 Type II	half sine 6 11 180 100 $\leq 50 > 50$ 6	100 in each direction	IEC 60068-2-27 [10]	Ea: shocks
Fall	free fall	height (m) mass (kg) attitude	1,2 1,0 0,25 < 20 20 to 100 > 100	see table 7		IEC 60068-2-31 [11]	Ec: Procedure 1
	toppling around	mass (kg) edges	< 20 20 to 100 > 100 any any any	none			
Acceleration	steady state	(m/s^2)	20	none			
Load	static load	(kPa)	10	none			

Class 3.1

Temperature controlled locations

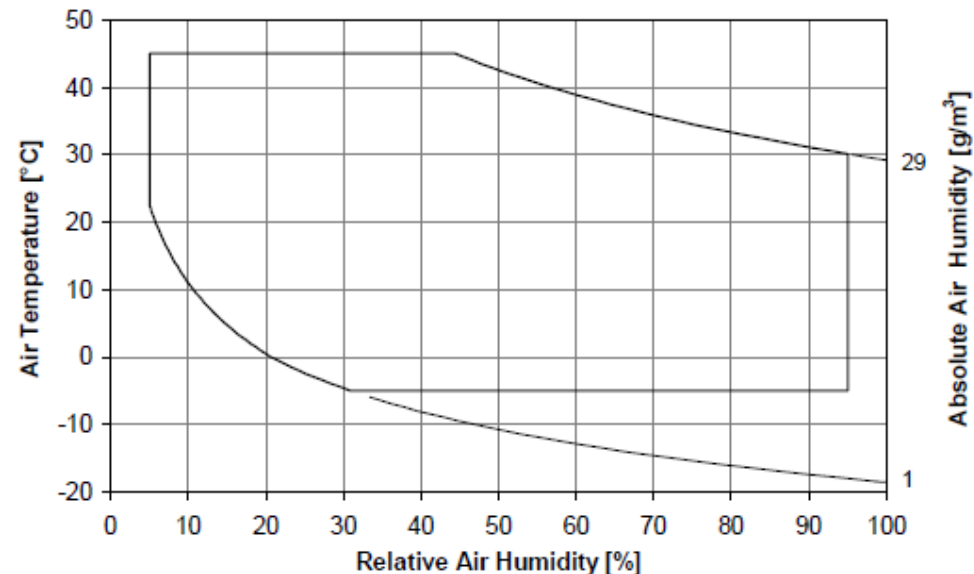
- This class shall apply to locations:
 - exposed to solar radiation and to heat radiation. It may also be exposed to movements of the surrounding air due to draughts in buildings. They are not subjected to condensed water, precipitation, water from sources other than rain or icing;
 - without particular 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;



Class 3.2

Partly temperature controlled locations

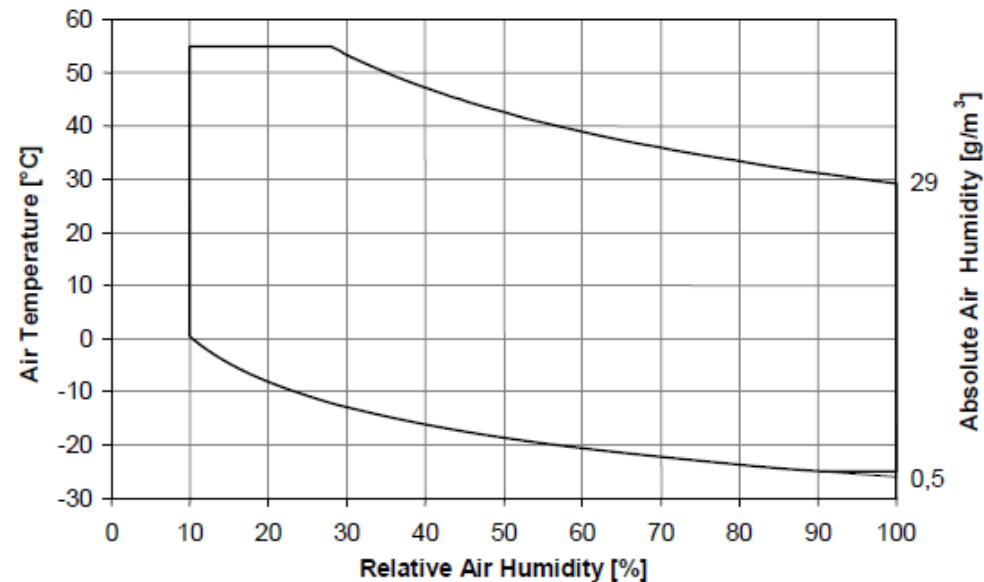
- This class shall apply to locations:
 - exposed to solar radiation and heat radiation. They may also be exposed to movements of the surrounding air due to draughts in buildings, e.g. through open windows. They may be subjected to condensed water. They are not subjected to precipitation;
 - where mould 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.



Class 3.3

Not temperature controlled locations

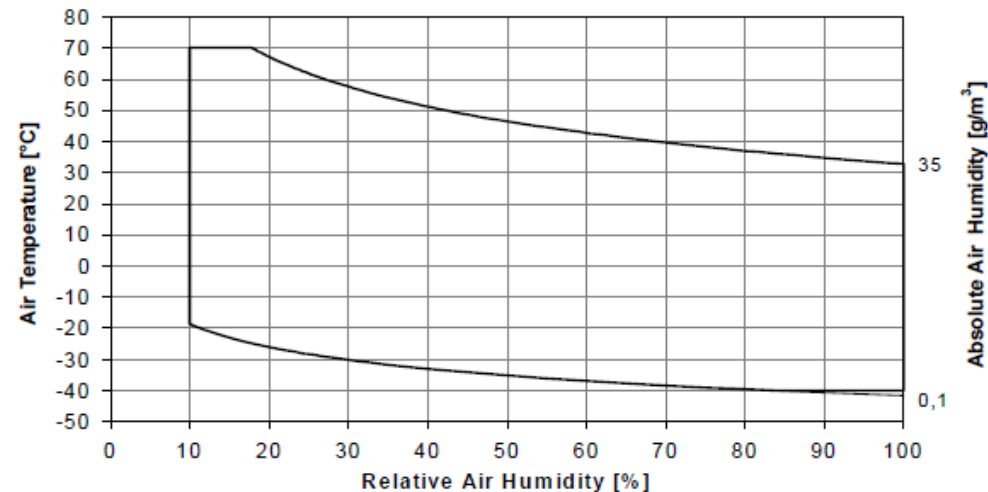
- This class shall apply to locations:
 - exposed to solar radiation and temporarily to heat radiation. It may also be exposed to movements of the surrounding air due to draughts e.g. through doors, windows or other openings. It may be subjected to condensed water, to water from sources other than rain 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.



Class 3.4

Sites with heattrap

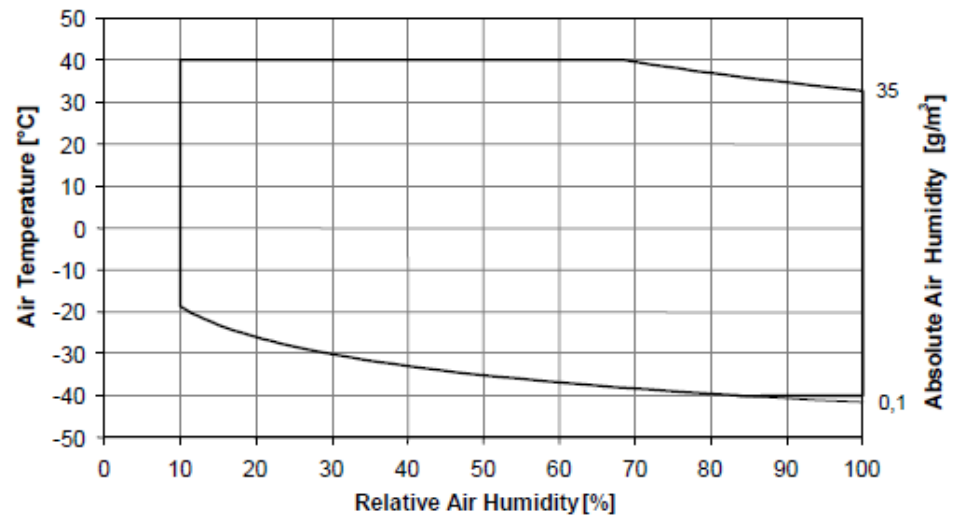
- This class shall apply to locations:
 - where installed equipment may also be exposed temporarily to solar radiation and temporarily to heat radiation. They may be exposed to movements of the surrounding air due to draughts e.g. through doors, windows or other openings. They may be subjected to condensed 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;
 - 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.
- The conditions of this class may be found in:
 - some sheds;
 - shacks;
 - lofts;
 - telephone booths;
 - some buildings.



Class 3.5

Sheltered locations

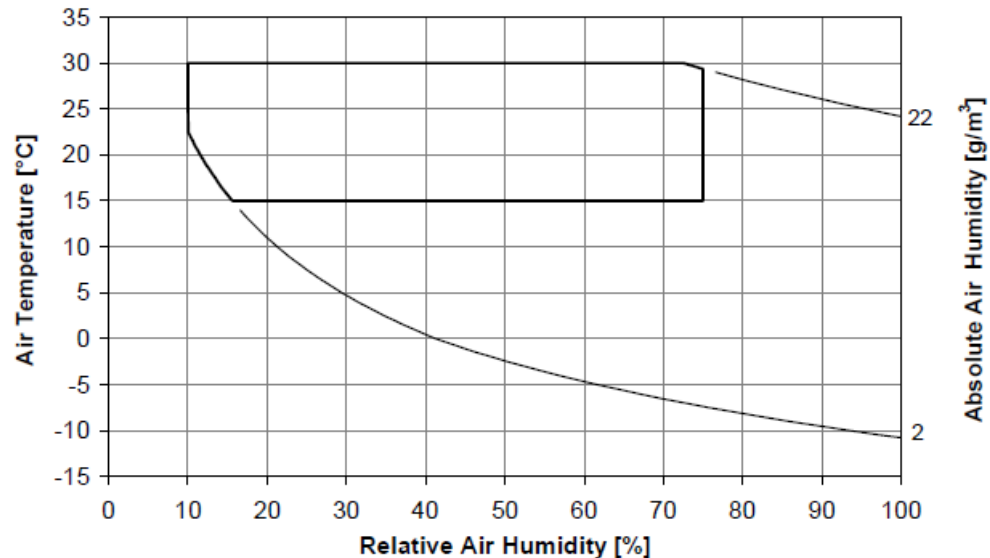
- This class shall apply to locations:
 - exposed to heat radiation from the roof or walls heated by the sun. They may be exposed to movement of the surrounding air through openings. They may be subjected to condensed water and to water from sources other than rain and to icing. They may be subjected 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;
 - 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.
- The conditions of this class may be found in:
 - some sheds;
 - open telephone booths;
 - under single roofs, e.g. carports.



Class 3.6

Telecommunications control room locations

- This class shall apply to a permanently temperature controlled enclosed location. Humidity is usually not controlled.
 - 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 shall apply 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.



Class 3.1 – 3.6 - Climatic

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	0,1	2
f)	High absolute humidity	g/m ³	25	29	29	35	35	35	22
g)	Rate of change of temperature (see note 1)	°C/min	0,5	0,5	0,5	1,0	1,0	1,0	0,5
h)	Low air pressure	kPa	70	70	70	70	70	70	70
i)	High air pressure (see note 2)	kPa	106	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	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	yes	no
n)	Conditions of wind - driven rain, snow, hail, etc.	none	no	no	Yes (see note 4)	yes	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	yes	no
	Climatogram, figure		1	2	3	4	5	6	

Class 3.1 – 3.6 - Mechanical

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			

Class 3.1 – Test specification

Environmental parameter			Environmental Class 3.1	Environmental test specification T3.1: In-use, Temperature-controlled locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	+5	+5	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+40	+40 or +50	16 h	IEC 60068-2-2 [6]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	+25/+40 0,5	half cycle $t_1 = 3$ h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	Relative	low (%)	5	none			
		high (%)	85	85	4 d	IEC 60068-2-78 [8]	Cab: Damp heat steady state
		condensation (°C)	no				
	Absolute	low (g/m ²)	1	none			
		high (g/m ²)	25				

Environmental parameter			Environmental Class 3.1	Environmental test specification T 3.1: In-use, Temperature-controlled locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	Sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	0,3 1,0 2-9 9-200	none			
Shocks	Shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks direction of shocks	Type L 22 40	half sine 11 30 6	3 in each direction	IEC 60068-2-27 [11]	Ea: Shock

Class 3.1^E – Test specification

Environmental parameter			Environmental Condition 3.1E	Environmental test specification T 3.1E: In-use, Temperature-controlled locations - Exceptional.			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-5	-5	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+45	+45 or +55	16 h	IEC 60068-2-2 [6]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	+25/+45 0,5	half cycle t ₁ = 3 h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	Relative	low (%)	5	none			
		high (%)	90	93	4 d	IEC 60068-2-78 [8]	Cab: Damp heat steady state
		condensation (°C)	no	+30			
	Absolute	low (g/m ³)	1	none			
		high (g/m ³)	25				

Class 3.2 – Test specification

Environmental parameter			Environmental Class 3.2	Environmental test specification T3.2: In-use, Partly temperature-controlled locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-5	-5	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+45	+45 or +55	16 h	IEC 60068-2-2 [6]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	+25/+55 or +25/+45 0,5	half cycle t ₁ = 3 h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	Relative	low (%)	5	none	4 d steady state	IEC 60068-2-78 [8]	Cab: Damp heat
		high (%)	95	93 +30			
		condensation (°C) (%)	yes	+30° 90-100	1 cycle	IEC 60068-2-30 [9]	Db: Damp heat cyclic Variant 1
	Absolute	low (g/m ³)	1	none			
		high (g/m ³)	29				
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	Sinusoidal	velocity (mm/s)	1,5	5	3 x 5 sweep cycles	IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
		displacement (mm)		2			
		acceleration (m/s ²)	5	5-62	3		
		frequency range (Hz)		9-200			
		axes of vibration	no	0,02	3 x 30 minutes	IEC 60068-2-64 [10]	Fh: Vibration, broad-band random (digital control)
		ASD (m ² /s ³)		+12			
	Random	frequency range (Hz)		5-10			
		axes of vibration		10-50			
			Type L	50-100			
				3			
Shocks	Shocks	shock spectrum	22 40	half sine	3 in each direction	IEC 60068-2-27 [11]	Ea: Shock
		duration (ms)		11			
		acceleration (m/s ²)		30			
		number of shocks		6			
		directions of shocks					

Class 3.3 – Test specification

Environmental parameter			Environmental Class 3.3	Environmental test specification T3.3: In-use, Not temperature-controlled locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-25	-25	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+55	+55 or +70	16 h	IEC 60068-2-2 [6]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	-5/+45 0,5	1 cycle t ₁ = 3 h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	Relative	low (%)	10	none			
		high (%) (°C)	100	93 +30	4 d	IEC 60068-2-78 [8]	Cab: Damp heat steady state
		condensation (%) (°C)	yes	90-100 +30	2 cycles	IEC 60068-2-30 [9]	Db: Damp heat cyclic Variant 1
	Absolute	low (g/m ³)	0,5	none			
		high (g/m ³)	29				

Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	Sinusoidal	velocity (mm/s)	1,5	5	3 x 5 sweep cycles	IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
		displacement (mm)		2			
		acceleration (m/s ²)	2-9	5-62			
		frequency range (Hz)		3			
	Random	axes of vibration	no	0,02	3 x 30 minutes	IEC 60068-2-64 [10]	Fh: Vibration, broad-band random (digital control)
		ASD (m ² /s ³) (dB/oct)		+12 5-10			
		frequency range (Hz)		10-50			
		axes of vibration		3			
Shocks	Shocks	shock spectrum	Type L	half sine	3 in each direction	IEC 60068-2-27 [11]	Ea: Shock
		duration (ms)		11			
		acceleration (m/s ²)	40	30			
		number of shocks		6			
		directions of shocks					

Class 3.4 – Test specification

Environmental parameter			Environmental Class 3.4	Environmental test specification T3.4: In-use, Sites with heat trap			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-40	-40	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+70	+70 or +85	16 h	IEC 60068-2-2 [6]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	-5/+45 0,5	2 cycles t ₁ = 3 h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	Relative	low (%)	10	none			
		high (%)	100	93 +35	4 d	IEC 60068-2-78 [8]	Cab: Damp heat steady state
		condensation (°C)	yes				
	Absolute	(%)		90-100 +30	2 cycles	IEC 60068-2-30 [9]	Db: Damp heat cyclic Variant 1
		(°C)					
		(g/m ³)	0,1	none			
		(g/m ³)	35				

Class 3.4 – Test specification (cont...)

Environmental parameter			Environmental Class 3.4	Environmental test specification T 3.4: Stationary use, Sites with heat-trap				
Type	Parameter	Detail parameter	Characteristic severity	Test severity		Duration	Reference	Method
Vibration IEC 60721-3-3 [4] Class 3M5	Sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	3,0 10 2-9 9-200	1,2 4 5-9 3 9-200	3 x 5 sweep cycles		IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
	Random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration	no	+12 5-10 0,04 -12 10-50 3 50-100	3 x 30 minutes		IEC 60068-2-64 [10]	Fh: Vibration, broad-band random (digital control)
Shocks IEC 60721-3-3 [4] Class 3M5	Shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type II 6 250	half sine 11 50 6	100 in each direction		IEC 60068-2-27 [11]	Ea: Shocks
Vibration IEC 60721-3-3 [4] Class 3M3	Sinusoidal	velocity (mm/s) displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	1,5 5 2-9 9-200	5 2 5-62 3 62-200	3 x 5 sweep cycles		IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
	Random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration	no	+12 5-10 0,02 -12 10-50 3 50-100	3 x 30 minutes		IEC 60068-2-64 [10]	Fh: Vibration, broad-band random (digital control)
Shocks IEC 60721-3-3 [4] Class 3M3	Shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type L 22 70	half sine 11 30 6	3 in each direction		IEC 60068-2-27 [11]	Ea: Shock

Class 3.5 – Test specification

Environmental parameter			Environmental Class 3.5	Environmental test specification T3.5: In-use, Sheltered locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-40	-40	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+40	+40	16 h	IEC 60068-2-2 [6]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	1,0	-40/+40 1,0	2 cycles t ₁ = 3 h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	Relative	low (%)	10	none	4 d	IEC 60068-2-78 [8]	Cab: Damp heat steady state
		high (%)	100	93 +35			
		condensation (%)	yes	90-100 +35	2 cycles	IEC 60068-2-30 [9]	Db: Damp heat cyclic Variant 1
	Absolute	(°C)					
		low (g/m ³)	0,1	none			
		high (g/m ³)	35				

Class 3.5 – Test specification (cont...)

Environmental parameter			Environmental Class 3.5	Environmental test specification T 3.5: In-use, Sheltered locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration IEC 60721-3-3 [4] Class 3M5	Sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	3,0 10 2-9 9-200	1,2 4 5-9 9-200 3	3 x 5 sweep cycles	IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
	Random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration	no	0,04 +12 -12 5-10 10-50 50-100 3	3 x 30 minutes	IEC 60068-2-64 [10]	Fh: Vibration, broad-band random (digital control)
Shocks IEC 60721-3-3 [4] Class 3M5	Shocks	shock spectrum (ms) duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type II 6 250	half sine 11 50 6	100 in each direction	IEC 60068-2-27 [11]	Ea: Shocks
Vibration IEC 60721-3-3 [4] Class 3M3	Sinusoidal	velocity (mm/s) displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	1,5 5 2-9 9-200	5 2 5-62 62-200 3	3 x 5 sweep cycles	IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
	Random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration	no	0,02 +12 -12 5-10 10-50 50-100 3	3 x 30 minutes	IEC 60068-2-64 [10]	Fh: Vibration, broad-band random (digital control)
Shocks IEC 60721-3-3 [4] Class 3M3	Shocks	shock spectrum (ms) duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type L 22 70	half sine 11 30 6	3 in each direction	IEC 60068-2-27 [11]	Ea: Shock

Class 3.6 – Test specification

Environmental parameter			Environmental Class 3.6	Environmental test specification T3.6: In-use, Temperature-controlled locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	+15	+15	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+30	+30 or +40	16 h	IEC 60068-2-2 [6]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	+25/+30 0,5	half cycle $t_1 = 3$ h	IEC 60068-2-14 [7]	Nb: Change of temperature
Humidity	Relative	low (%)	10	none			
		high (%)	75	85 +30	4 d	IEC 60068-2-78 [8]	Cab: Damp heat steady state
		condensation	no				
	Absolute	low (g/m ³)	2	none			
		high (g/m ³)	22				

Environmental parameter			Environmental Class 3.6	Environmental test specification T 3.6: In-use, Control room locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	Sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	0,3 1,0 2-9 9-200	none			
Shocks	Shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks direction of shocks	Type L 22 40	half sine 11 30 6	3 in each direction	IEC 60068-2-27 [11]	Ea: Shock

Class 4.1 en Class 4.1E

Non-weather protected locations

- Classes 4.1 & 4.1E applies to most of Europe.
 - ranges from mild warm dry to cold temperate.

Class 4.2L

Non-weather protected locations – extremely cold

- Class 4.2L covers extremely cold climatic conditions world-wide.
 - It ranges from warm temperate to extremely cold.

Class 4.2H

Non-weather protected locations – extremely warm dry

- Class 4.2H covers extremely warm dry climatic conditions world-wide.
 - It ranges from warm damp equable and extremely warm dry.

Class 4.1 – 4.2H - Climatic

Environmental parameter	Unit	Class			
		4.1	4.1E	4.2L	4.2H
a) Low air temperature (see note 1)	°C	-33	-45	-65	-20
b) High air temperature	°C	+40	+45	+35	+55
c) Low relative humidity	%	15	8	20	4
d) High relative humidity	%	100	100	100	100
e) Low absolute humidity	g/m ³	0,26	0,03	0,003	0,9
f) High absolute humidity	g/m ³	25	30	22	36
g) Rain intensity	mm/min	6	15	15	15
h) Rate of change of temperature (see note 2)	°C/min	0,5	0,5	0,5	0,5
i) Low air pressure (see note 3)	kPa	70	70	70	70
j) High air pressure	kPa	106	106	106	106
k) Solar radiation	W/m ²	1 120	1 120	1 120	1 120
l) Heat radiation	W/m ²	negligible	negligible	negligible	negligible
m) Movement of surrounding air	m/s	50	50	50	50
n) Condensation	none	yes	yes	yes	yes
o) Precipitation (rain, snow, hail, etc)	none	yes	yes	yes	yes
p) Low rain temperature (see note 4)	°C	+5	+5	+5	+5
q) Water from sources other than rain	none	splashing water	splashing water	splashing water	splashing water
r) Icing and frosting ice and frost formation	none	yes	yes	yes	yes

Class 4.1 – 4.2H - Mechanical

Environmental parameter	Unit	Class	
		4.1, 4.1E, 4.2L, 4.2H	
a) Stationary vibration, sinusoidal (see notes 1 and 3) displacement amplitude acceleration amplitude frequency range	mm m/s ² Hz	3,0 2-9	 10 9-200
b) Non-stationary vibration, including shock type II (see note 2) peak response acceleration duration	m/s ² ms	250 6	

Class 4.1 – Test specification

Environmental parameter			Environmental Class 4.1	Environmental test specification T 4.1: Stationary use, Non-weatherprotected locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-33	-33 or -45	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+40	+40 or +55	16 h	IEC 60068-2-2 [7]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	-10/+40 0,5	2 cycles $t_1 = 3$ h	IEC 60068-2-14 [8]	Nb: Change of temperature
Humidity	Relative	Low (%)	15	none			
		high (%)	100	93	10 d	IEC 60068-2-78 [16]	Cab: Damp heat steady state
		condensation (°C)	yes	+30			
	Absolute	(%)		90-100 +30	2 cycles	IEC 60068-2-30 [9]	Db: Damp heat, cyclic Variant 1
		(°C)					
Air	Pressure	Low (g/m ³)	0,26	none			
		high (g/m ³)	25				
	Speed	(kPa)	70	none			
Water	Rain	high (kPa)	106	none			
		(m/s)	50				
	Rain	Intensity	6 mm/min	0,01 m ³ /min 90 kPa	3 min/m ² or 15 min	IEC 60068-2-18 [15]	Rb: Impacting water Method 1
		low temperature (°C)	+5	none			
	Other sources		splashing water				
Water	Icing & frosting		yes	none			

Class 4.1E – Test specification

Environmental parameter			Environmental Class 4.1E	Environmental test specification T 4.1E: Stationary use Non-weatherprotected locations - extended			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-45	-45 or -55	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+45	+45 or +60	16 h	IEC 60068-2-2 [7]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	-10/+45 0,5	2 cycles t1 = 3 h	IEC 60068-2-14 [8]	Nb: Change of temperature
Humidity	Relative	low (%)	8	none	10 d	IEC 60068-2-78 [16]	Cab: Damp heat steady state
		high (%)	100	93 +30			
		condensation (%)	yes	90–100 +30	2 cycles	IEC 60068-2-30 [9]	Db: Damp heat cyclic Variant 1
	Absolute	(°C)					
		low (g/m ³)	0,03	none			
Air	Pressure	high (g/m ³)	30				
		low (kPa)	70	none			
	Speed	high (kPa)	106	none			
		(m/s)	50	none			
Water	Rain	intensity	15 mm/min	0,01 m ³ /min 90 kPa	6 min/m ² or 30 min	IEC 60068-2-18 [15]	Rb: Impacting water, method 1
		low temperature (°C)	+5	none			
	Other sources		splashing water				
	Icing & frosting		yes	none			

Class 4.2L – Test specification

Environmental parameter			Environmental Class 4.2L	Environmental test specification T 4.2L: Stationary use Non-weatherprotected locations – extremely cold			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-65	-65 or -75	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+35	+35 or +50	16 h	IEC 60068-2-2 [7]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	-10/+45 0,5	2 cycles t1 = 3 h	IEC 60068-2-14 [8]	Nb: Change of temperature
Humidity	Relative	low (%)	20	none			
		high (%)	100	93 +30	10 d	IEC 60068-2-78 [16]	Cab: Damp heat steady state
		condensation (%)	yes	90 – 100 +30	2 cycles	IEC 60068-2-30 [9]	Db: Damp heat cyclic Variant 1
	Absolute	low (g/m ³)	0,003	none			
		high (g/m ³)	22				
Air	Pressure	low (kPa)	70	none			
		high (kPa)	106	none			
	Speed	(m/s)	50	none			
Water	Rain	intensity	15 mm/min	0,01 m ³ /min 90 kPa	6 min/m ² or 30 min	IEC 60068-2-18 [15]	Rb: Impacting water, method 1
		low temperature (°C)	+5	none			
	Other sources		splashing water				
	Icing & frosting		yes	none			

Class 4.2H – Test specification

Environmental parameter			Environmental Class 4.2H	Environmental test specification T 4.2H: Stationary use Non-weatherprotected locations – extremely warm dry			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	Low	(°C)	-20	-20 or -30	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	High	(°C)	+55	+55 or +70	16 h	IEC 60068-2-2 [7]	Bb/Bd: Dry heat
	Change	(°C) (°C/min)	0,5	-10/+45 0,5	2 cycles t1 = 3 h	IEC 60068-2-14 [8]	Nb: Change of temperature
Humidity	Relative	low (%)	4	none			
		high (%)	100	93	10 d	IEC 60068-2-78 [16]	Cab: Damp heat steady state
		condensation (°C)	yes	+40			
	Absolute	(%)		90–100	2 cycles	IEC 60068-2-30 [9]	Db: Damp heat cyclic Variant 1
		(°C)		+30			
Air	Pressure	low (g/m ³)	0,9	none			
		high (g/m ³)	36				
	Speed	low (kPa)	70	none			
		high (kPa)	106	none			
Water	Rain	(m/s)	50	none			
		intensity	15 mm/min	0,01 m ³ /min 90 kPa	6 min/m ² or 30 min	IEC 60068-2-18 [15]	Rb: Impacting water, method 1
	Other sources	low temperature (°C)	+5	none			
			splashing water				
	Icing & frosting		yes	none			

Class 4.1 – 4.2H – Test specification

Environmental parameter			Environmental Class 4.X	Environmental test specification T 4.X: Stationary use, Non-weatherprotected locations				
Type	Parameter	Detail parameter	Characteristic severity	Test severity		Duration	Reference	Method
Vibration IEC 60721-3-4 [4] Class 4M5 [5]	Sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	3,0 10 2-9 9-200	1,2 4 5-9 9-200 3	3 x 5 sweep cycles		IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
	Random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration	no	+12 0,04 -12 5-10 10-50 50-100 3	3 x 30 minutes		IEC 60068-2-64 [10]	Fh: Vibration, broad-band (digital control)
Shocks IEC 60721-3-4 Class 4M5 [4]	Shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type II 6 250	half sine 11 50 6		100 in each direction	IEC 60068-2-27 [11]	Ea: Shock
Vibration IEC 60721-3-4 Class 4M3 [4]	Sinusoidal	velocity (mm/s) displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	1,5 5 2-9 9-200	5 2 5-62 62-200 3	3 x 5 sweep cycles		IEC 60068-2-6 [12]	Fc: Vibration (sinusoidal)
	Random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration	no	+12 0,02 -12 5-10 10-50 50-100 3	3 x 30 minutes		IEC 60068-2-64 [10]	Fh: Vibration, broad-band (digital control)
Shocks IEC 60721-3-4 Class 4M3 [4]	Shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type L 22 70	half sine 11 30 6		3 in each direction	IEC 60068-2-27 [11]	Ea: Shock

Class 8.1

Partly weather protected underground locations

- This class applies to locations:
 - where the installed equipment is normally protected from direct weather influences;
 - where the surrounding medium is normally air, but the equipment may be immersed in water during exceptional conditions;
 - 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 and dust;
 - with vibration and shock of low significance.
- The conditions of this class may be found in:
 - footway boxes;
 - manholes;
 - some tunnels;
 - etc.

Class 8.1 - Climatic

	Environmental parameter	Unit	Class 8.1
a)	Low air temperature	°C	-10
b)	High air temperature	°C	+40 (see note 1)
c)	Low relative humidity	%	5
d)	High relative humidity	%	100
e)	Low absolute humidity	g/m ³	0,5
f)	High absolute humidity	g/m ³	23
g)	Rate of change of temperature (see note 2)	°C/min	5 (see note 3)
h)	Low air pressure	kPa	70
i)	High air pressure (see note 4)	kPa	106
j)	Solar radiation	W/m ²	no
k)	Heat radiation	W/m ²	yes (see note 5)
l)	Movement of surrounding air	m/s	1
m)	Conditions of condensation	none	yes
n)	Conditions of wind-driven rain, snow, hail, etc.	none	no
o)	Conditions of water from sources other than rain	none	dripping water, condensed water soil water
p)	Conditions of icing	none	yes

Class 8.1 - Mechanical

			Class			
	Environmental parameter (see note 1)	Unit	8.1		Special (3M5)	
a)	Stationary vibration, sinusoidal:					
	displacement amplitude	mm	1,5		3,0	
	acceleration amplitude	m/s ²		5		10
	frequency range (see note 2)	Hz	2 to 9	9 to 200	2 to 9	9 to 200
b)	Non-stationary vibration including shock (see note)					
	shock response spectrum type L, peak acceleration \hat{a} duration	m/s ² ms	70 22			
	shock response spectrum type II, peak acceleration \hat{a} duration	m/s ² ms			250 6	

Class 8.1 – Test specification

Environmental parameter			Environmental Class 8.1	Environmental test specification T 8.1: In-use, partly weatherprotected locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-10	-10	16 h	IEC 60068-2-1	Ab/Ad: Cold
	high	(°C)	+40	+40	16 h	IEC 60068-2-2	Bb/Bd: Dry heat
	change	(°C/min) (°C)	5	-10/+40	2 cycles t1 = 3 h	IEC 60068-2-14	Na: Rapid change of temperature
Humidity	relative	low	(%) 5				
		high	(%) 100	93 +30	21 d	IEC 60068-2-56	Cb: Damp heat Steady state
		condensation	(%) (°C) yes	90-100 +40	2 cycles	IEC 60068-2-30	Db: Damp heat cyclic Variant 1
	absolute	low	(g/m³) 0,5				
		high	(g/m³) 23				
Air	pressure	low	(kPa) 70	none			
		high	(kPa) 106	none			
	speed	(m/s)	1	none			
	rain	intensity	no				
Water	other sources	low temperature	no				
		(m) (kPa)	dripping water condensed water immersion to soil water	2 19,6	1 h	IEC 60068-2-17	Qf: Immersion
	icing & frosting		yes				

Class 8.1 – Test specification (Cont...)

Environmental parameter			Environmental Class 8.1	Environmental test specification T 8.1: Stationary use, partly weatherprotected underground locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration IEC 60721-3-3 Class 3M5	sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	3,0 10 2-9 9-200	1,2 4 5-9 9-200 3	3 x 5 sweep cycles	IEC 60068-2-6	Fc: Vibration (sinusoidal)
	random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration		0,04 +12 -12 5-10 10-50 50-100 3	3 x 30 minutes	IEC 60068-2-64	Fh: Vibration, broad-band (digital control)
Shocks IEC 60721-3-3 Class 3M5	shocks	shock spectrum duration (ms) acceleration (m/s ²) number of bumps directions of bumps	Type II 6 250	half sine 11 50 6	100 in each direction	IEC 60068-2-29	Eb: Bump
Vibration IEC 60721-3-3 Class 3M3	sinusoidal	velocity (mm/s) displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	1,5 5 2-9 9-200	5 2 5-62 62-200 3	3 x 5 sweep cycles	IEC 60068-2-6	Fc: Vibration (sinusoidal)
	random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration		0,02 +12 -12 5-10 10-50 50-100 3	3 x 30 minutes	IEC 60068-2-64	Fh: Vibration, broad-band (digital control)
Shocks IEC 60721-3-3 Class 3M3	shocks	shock spectrum duration (ms) acceleration (m/s ²) number of shocks directions of shocks	Type L 22 70	half sine 11 30 6	3 in each direction	IEC 60068-2-27	Ea: Shock

Class 5.1

Protected installation

- This class applies to:
 - equipment subjected to heat from heating elements and solar radiation through windows. The vehicle may be moved between cold, non-weatherprotected and warm, weatherprotected conditions. The equipment may also be subjected to dripping water and conditions of wet mounting surfaces. Engine compartments may be subjected to the ingress of water and snow;
 - areas and conditions where mould growth and attacks by animals, except termites, may occur;
 - equipment internally mounted in partly open compartments and in engine compartments which may be subjected to the ingress of road salts;
 - locations with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;
 - compartments where contaminating fluids are not expected;
 - equipment not protected from sand and dust on vehicles not used in desert areas.

Class 5.2

Partly protected installation

- This class applies to:
 - equipment in compartments with wet surfaces and subjected to solar radiation. The equipment may also be subjected to direct solar radiation and rain;
 - areas and conditions where mould growth, attacks by animals but except termites, may occur;
 - equipment either externally mounted or internally mounted in partly-open compartments. The equipment may be subjected to the ingress of road salt or splashing water;
 - locations with normal levels of contaminants experienced in urban areas with industrial activities scattered over the whole area and/or with heavy traffic;
 - compartments where contaminating fluids are not expected;
 - equipment is not protected from sand and dust on vehicles not used in desert areas.

Class 5.1 – 5.2 - Climatic

Environmental parameter		Unit	Class	
			5.1	5.2
a)	Low temperature, air	°C	-25	-40
b)	High temperature, air, in ventilated compartments (except engine compartments) or outdoor (see note 1)	°C	+40	+40
c)	High temperature, air, in unventilated compartments, except engine compartments (see note 2)	°C	+70	+70
d)	High temperature, air, in engine compartments	°C	+70	+70
e)	Change of temperature, air/air (see note 3)	°C	-25/+30	-40/+30
f)	Gradual change of temperature, air/air, except in engine compartments	°C °C/minute	-25/+30 5	-40/+30 5
g)	Gradual change of temperature, air/air, in engine compartments	°C °C/minute	-25/+60 10	-40/+70 10
h)	Change of temperature, air/water, except in engine compartments (notes 3, 4)	°C	no	+40/+5
i)	Change of temperature, air/water, in engine compartments (notes 3, 4)	°C	+60/+5	+70/+5
j)	Change of temperature, air/snow, in engine compartments only	°C	+60/-5	+70/-5
k)	Relative humidity, not combined with rapid temperature changes except in engine compartments of vehicles powered by internal combustion engines	% °C	95 +40	95 +45
l)	Relative humidity, not combined with rapid temperature changes, in engine compartments of vehicles powered by internal combustion engines	% °C	no no	95 +70
m)	Relative humidity, combined with rapid temperature changes, air/air, at high relative humidities. Not in close proximity to refrigerated air conditioning systems	% °C	95 -25/+30	95 -40/+30
n)	Relative humidity combined with rapid temperature changes, air/air, at high relative humidities. In close proximity to refrigerated air conditioning systems	% °C	95 +10/+70	95 +10/+70
o)	Absolute humidity combined with rapid temperature changes, air/air, at high water content (see note 5)	g/m ³ of air	60 +70/+15	60 +70/+15
p)	Low relative humidity	% RH °C	10 30	10 30
q)	Low air pressure	kPa	70	70
r)	Movement of the surrounding air	m/s	20	20
s)	Precipitation, rain	mm/min	no	6
t)	Solar radiation	W/m ²	700	1 120
u)	Heat radiation, not in engine compartments	W/m ²	600	600
v)	Heat radiation, in engine compartments	W/m ²	600	1 200
w)	Water from sources other than rain (see note 6)	m/s	0,3	1
x)	Wetness	none	conditions of wet surfaces	

Class 5.1 – 5.2 - Mechanical

Environmental parameter		Unit	Class					
			5M2 (see note 1)			5M3 (see note 1)		
a)	Stationary vibration, sinusoidal:							
	displacement amplitude (see note 2)	mm	3,3			7,5		
	acceleration amplitude (see note 2)	m/s ²		10	15		20	40
	frequency range (see note 4)	Hz	2 to 9	9 to 200	200 to 500	2 to 8	8 to 200	200 to 500
b)	Stationary vibration, random:							
	acceleration spectral density	m ² /s ³	1		0,3	3		1
	frequency range	Hz	10 to 200		200 to 500	10 to 200		200 to 500
c)	Non-stationary vibration, including shock: (see note 3)							
	shock response spectrum type I peak acceleration (\hat{a})	m/s ²		100			300	
	duration	ms		11			11	
	shock response spectrum type II peak acceleration (\hat{a})	m/s ²		300			1 000	
	duration	ms		6			6	
d)	Impact from foreign bodies, stones	Joule		5			20	

Class 5.1 – Test specification

Environmental parameter			Environmental Class 5.1	Environmental test specification T5.1: Vehicle, protected installation			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-25	-25	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C)	+40 a), e)	+40 or +55	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
		(°C)	+70 b), c)	+70 or +85	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	rapid (°C)	-25/+30	none			
		gradual (°C/min)	-25/+30 5 not c)	-25/+30	5 cycles t ₁ = 3 h	IEC 60068-2-14 [2]	Na: Change of temperature
Temperature	change	(°C)	-25/+60 10 c)				
		air/water (°C)	no not c)				
		air/water (°C)	+60/+5 c)	none			
Humidity	relative	air/snow (°C)	+60/-5 c)				
		slow temperature change (%)	95 +40	93 +40	96 h	IEC 60068-2-56 [2]	Cb: Damp heat, steady state
		rapid temperature change (%)	95 -25/+30 not d)	90-100 +40	2 cycles	IEC 60068-2-30 [2]	Db: Damp heat, cyclic, Variant 2
		(°C)	95 +10/+70 d)	90-100 +55	2 cycles	IEC 60068-2-30 [2]	Db: Damp heat, cyclic, Variant 2
		low (%)	10 +30	none			
	absolute	rapid temperature change (g/m ³)	60 +70/+15	none			

Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm)	3,3	none			
		acceleration (m/s ²)	3 15				
	random	frequency range (Hz)	2-9 9-200 200-500				
Shocks	shocks	ASD (m ² /s ³)	1 0,3	1 -3		IEC 60068-2-64 [2]	Fh: Vibration, broad-band random (digital control)
		frequency range (Hz)	10-200 200-500	5-20 20-500 3	3 x 30 min		
		axes of vibration					
	bump	shock spectrum duration (ms)	Type I 11 Type II 6	half sine 6		IEC 60068-2-27 [2]	Ea: Shock
		acceleration (m/s ²)	100 300	300	3 in each direction		
		number of shocks directions shocks		6			
		acceleration (m/s ²)	no	100		IEC 60068-2-29 [2]	Eb: Bump
		duration (ms)		11			
		number of bumps directions of bumps		6	100 in each direction		

Class 5.2 – Test specification

Environmental parameter			Environmental Class 5.2	Environmental test specification T 5.2: Vehicle, partly protected installations				
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method	
Air temperature	low	(°C) -40	-40	-40	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold	
	high	(°C) +40	a), e)	+40 or +55	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat	
		(°C) +70	b), c)	+70 or +85	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat	
	change	rapid	(°C) -40/+30	-40/+30	5 cycles t ₁ = 3 h	IEC 60068-2-14 [2]	Na: Change of temperature	
		gradual	(°C) -40/+30					
			(°C/min) 5					not c)
(°C) -40/+70								
Temperature	change	(°C/min) 10	c)					
		air/water	(°C) -40/+5	not c)				
		air/water	(°C) +70/+5	c)				
Humidity	relative	air/ snow	(°C) +70/-5	c)				
		slow temperature change	(%) 95	93	96 h	IEC 60068-2-56 [2]	Cb: Damp heat, steady state	
		(%) +45	+40					
		rapid temperature change	(%) 95	90 - 100	2 cycles	IEC 60068-2-30 [2]	Db: Damp heat, cyclic, variant 2	
	absolute	(°C) -45/+30	+40					
		(%) 95	90 - 100	2 cycles	IEC 60068-2-30 [2]	Db: Damp heat, cyclic, variant 2		
Air	pressure	(%) +10/+70	+55					
		low	(%) 10					
		(°C) +30						
Water	speed	rapid temperature change	(g/m ³) 60					
		(°C) +70/+15						
		rain	(kPa) 70	none				
Water	intensity	(m/s) 20	none					
		mm/min 6	0,01 m ³ /min; 90 kPa	3 min/m ² or 15 min	IEC 60068-2-18 [2]	Rb: Impacting water Method 1.2		
		velocity	(m/s) 1					
Vibration	sinusoidal	wetness	wet surfaces					
		displacement	(mm) 3,3	none				
		acceleration	(m/s ²) 3					
Shocks	random	frequency range	(Hz) 2-9	9-200 200-500				
		ASD	(m ² /s ³) 1	0,3	1		IEC 60068-2-64 [2]	Fh: Vibration, broad-band random (digital control)
		frequency range	(dB/oct) 10-200	200-500	5-20 20-500	3 x 30 min		
Shocks	shocks	axes of vibration	(Hz) 3					
		shock spectrum	(ms) 11	Type I 6	half sine 6		IEC 60068-2-27 [2]	Ea: Shock
		duration	(m/s ²) 100	300	300	3 in each direction		
Shocks	bump	number of shocks		6				
		directions shocks						
		acceleration	(m/s ²) no		100		IEC 60068-2-29 [2]	Eb: Bump
Shocks	bump	duration	(ms) 11					
		number of bumps		6		100 in each direction		
		directions of bumps						

Class 6.1

Totally weather protected locations

- This class applies to:
 - equipment which is not exposed to heat radiation from adjacent equipment, heating elements or to solar radiation through glass or transparent materials;
 - installations on board vessels operating in areas without particular risk of attack by flora or fauna. It also covers other vessels where the installations are located in compartments of such construction that mould growth and attacks by animals are unlikely;
 - totally weatherprotected installations which are not subjected to salt mist, engine exhausts or emissions from nearby industrial sources;
 - installations protected from sand, dust and ingress of soot;
 - installations on board engine-powered vessels of all sizes.

Class 6.2

Partly weather protected locations

- This class applies to:
 - equipment which is subjected to direct solar radiation, to considerable heat dissipation from boilers, engines etc., to rain and water jets. The equipment may be connected to wet surfaces;
 - non-protected installations on board vessels operating in areas where mould growth and attacks by animals may occur;
 - non-weatherprotected installations on board vessels operating close to industrial areas with considerable air pollution emissions. Salt mist and exposure to engine exhausts are included;
 - all installations where sweeping of dusty decks may take place. It also covers locations subject to emissions from boiler exhausts (e.g. soot, acid, etc.). Non-weatherprotected installations on board vessels operating close to sand deserts are not covered;

Class 6.3

Non-weather protected locations

- This class applies to:
 - equipment which is subjected to direct solar radiation, to considerable heat dissipation from boilers, engines etc., to abnormal rain, heavy seas and water jets. The equipment may be connected to wet surfaces;
 - non-weatherprotected installations on board vessels operating in areas where mould growth and attacks by animals may occur;
 - non-weatherprotected installations on board vessels operating close to industrial areas with considerable air pollution emissions. Salt mist and exposure to engine exhausts are included;
 - all installations where sweeping of dusty decks may take place. It also covers locations subject to emissions from boiler exhausts (e.g. soot, acid, etc.). Non-weatherprotected installations on board vessels operating close to sand deserts are not covered;
 - class 6M3: installations on board engine-powered vessels of all sizes but excluding equipment connected directly to reciprocating types of machinery. Equipment connected directly to loading systems, container guides, cranes and installations in dredgers are included;
 - class 6M4: all installations on board engine-powered vessels of all sizes including equipment connected directly to reciprocating types of machinery (see note in clause 4.2).

Class 6.1 – 6.3 - Climatic

Environmental parameter		Unit	Class		
			6.1	6.2	6.3
a)	Low temperature	°C	+5	-25	-40 (see note 1)
b)	Low temperature, water	°C	Freezing-point of water (see note 2)		
c)	High temperature, air	°C	+40	+70	+70
d)	High temperature, surfaces (see note 3)	°C	no	+70	+70
e)	High temperature, water	°C	+30	+35	+35
f)	Gradual change of temperature, air, air	°C °C/minute	no	-25/+40 3	-25/+40 3
g)	Change of temperature, air/water	°C	no	+40/+5	+40/+5
h)	Humidity, not combined with rapid temperature changes	%	95	95	95
		°C	+30	+45	+45
i)	Humidity, combined with rapid temperature changes, air/air at high relative humidities	%	no	95	95
		°C		-25/+35	-25/+35
j)	Humidity combined with rapid temperature changes, air/air at high water content (see note 4)	g/m ³	no	60	60
		°C		+70/+15	+70/+15
k)	Low relative humidity	%	10	10	10
		°C	+30	+30	+30
l)	Movement of the surrounding medium, air	m/s	negligible	30	50
m)	Precipitation, rain	mm/min	no	6	15
n)	Solar radiation	W/m ²	negligible	1 120	1 120
o)	Heat radiation	W/m ²	negligible	1 200	1 200
p)	Water from sources other than rain	m/s	no	3	10
q)	Wetness	none	no	wet surfaces	

Class 6.1 – 6.3 - Mechanical

Environmental parameter		Unit	Class (see note 1)			
			6M3		6M4	
a)	Stationary vibration, sinusoidal (see notes 2 and 3)					
	displacement amplitude	mm	1,5		1,5	
	acceleration amplitude	m/s ²		20		50
	frequency range (see note 6)	Hz	2 to 18	18 to 200	2 to 28	28 to 200
b)	Non-stationary vibration, including shock: (see notes 3 and 4)					
	shock response spectrum type I					
	peak acceleration (\hat{a})	m/s ²	100		100	
	duration	ms	11		11	
	shock response spectrum type II					
	peak acceleration (\hat{a})	m/s ²	300		300	
	duration	ms	6		6	
	shock response spectrum type III					
	peak acceleration (\hat{a}) (see note 4)	m/s ²	500		500	
	duration	ms	2,3		2,3	
c)	Angular deviation, static condition: (see note 5)					
	rotation around X-axis (list), angle	degree	15		15	
	rotation around Y-axis (trim), angle	degree	10		10	
d)	Angular motion, dynamic condition: (see note 5)					
	rotation around X-axis (roll), angle	degree	22,5		22,5	
	frequency	Hz	0,14		0,14	
	rotation around Y-axis (pitch), angle	degree	10		10	
	frequency	Hz	0,2		0,2	
	rotation around Z-axis (yaw), angle	degree	4		4	
	frequency	Hz	0,05		0,05	
e)	Steady-state acceleration: (see note 5)					
	X-direction (surge)	m/s ²	5		5	
	Y-direction (sway)	m/s ²	6		6	
	Z-direction (heave)	m/s ²	10		10	

Class 6.1 – Test specification

Environmental parameter			Environmental Class 6.1	Environmental test specification T6.1: Ship, totally weatherprotected locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	+5	+5	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C)	+40	+40	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	air/water (°C)	no				
	surface	high (°C)	no				
Humidity	relative	low (%)	10	none			
		high; (°C)	95	93	96 h	IEC 60068-2-56 [2]	Cb: Damp heat steady state
		slow temperature change (°C)	+30	+30			
		high; (°C)	no				
	absolute	rapid temperature change (°C)					
		high; (g/m ³)	no				
		rapid temperature change (°C)					

Class 6.2 – Test specification

Environmental parameter			Environmental Class 6.2	Environmental test specification T6.2: Ship, partly weatherprotected locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-25	-25	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C)	+70	+70 or +85	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	gradual (°C) (°C/min)	-25/+40 3	-25/+40 3	5 cycles t ₁ = 3 h	IEC 60068-2-14 [2]	Nb: Change of temperature
	change	air/water (°C)	+40/+5	none			
	surface	high (°C)	+70	none			
Humidity	relative	low (%)	10	none			
		high; (°C)	95	93	96 h	IEC 60068-2-56 [2]	Cb: Damp heat steady state
		slow temperature change (°C)	+45	+40			
		high; (°C)	95	none			
	absolute	rapid temperature change (°C)	-25/+35				
Air	speed	high; (g/m ³)	60				
		rapid temperature change (°C)	+70/+15				
	temperature	(%)		90-100 +55	6 cycles	IEC 60068-2-30 [2]	Db: Damp heat cyclic, variant 2
		(°C)					
	speed	(m/s)	30	none			
Water	temperature	high (°C)	+35	none			
		low (°C)	freezing point	none			
	rain	intensity (mm/min)	6				
		volume (m ³ /min)		0,01 90	1 min/m ² or 5 min	IEC 60068-2-18 [2]	Rb: Impacting water method 1.2
	pressure	(kPa)					
Water	other sources	velocity (m/s)	3	none			
	wetness		wet surfaces	none			

Class 6.3 – Test specification

Environmental parameter			Environmental Class 6.3	Environmental test specification T6.3: Ship, non weatherprotected locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-40	-40	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C)	+70	+70 or +85	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	gradual (°C)	-25/+40	-25/+40	5 cycles $t_1 = 3$ h	IEC 60068-2-14 [2]	Nb: Change of temperature
		(°C/min)	3	3			
	surface	air/water (°C)	+40/+5	none			
Humidity	relative	high (°C)	+70	none			
		low (%)	10	none			
		high; slow temperature change (°C)	95	93	21 days	IEC 60068-2-56 [2]	Cb: Damp heat steady state
		high; rapid temperature change (°C)	+45	+40			
	absolute	high; (g/m ³)	95	none			
		rapid temperature change (°C)	-25/+35				
Air	speed	(m/s)	60				
	temperature	high (°C)	+70/+15	90-100 +55	6 cycles	IEC 60068-2-30 [2]	Db: Damp heat cyclic, variant 2
Water	rain	low (°C)	50	none			
		high (°C)	+35	none			
	other sources	intensity (mm/min)	freezing point	none			
		volume (m ³ /min)	15	0,01 90	1 min/m ² or 5 min	IEC 60068-2-18 [2]	Rb: Impacting water method 1.2
		pressure (kPa)					
	wetness	velocity (m/s)	10	none			
			wet surfaces	none			

Class 6.1 – 6.3 – Test specification

Environmental parameter			Environmental Class 6.1 to 6.3	Environmental test specification T 6.1 to 6.3: Ship locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	1,5 20 2-18 18-200	1,5 19,6 5-18 3 axes 18-200	3 x 10 sweep cycles	IEC 60068-2-6 [2]	Fc: vibration (sinusoidal)
	sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	1,5 20 2-18 18-200	1,0 7,0 5-13 3 axes 13-80	3 x 10 sweep cycles	IEC 60068-2-6 [2]	Fc: vibration (sinusoidal)
Shocks	shocks	shock spectrum type duration (ms) acceleration (m/s ²) mass (kg) shocks directions of shocks	I 11 II 6 III 2, 3 100 300 500	half sine 6 300 ≥ 100 6	3 shocks in each direction	IEC 60068-2-27 [2]	Ea: Shock
	bump	acceleration (m/s ²) mass (kg) duration (ms) bumps direction of bumps	no	250 < 100 6 6	100 bumps in each direction	IEC 60068-2-29 [2]	Ed: Bump

Environmental parameter			Environmental Class 6.2 to 6.3	Environmental test specification T 6.2 and 6.3: Ship locations Alternative test (IEC Class 6M4)			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Vibration	sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz) axes of vibration	1,5 50 2-28 28-200	1,5 49 5-28 3 axes 28-150	3 x 10 sweep cycles	IEC 60068-2-6 [2]	Fc: vibration (sinusoidal)
	random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) axes of vibration	no	19,2 -3 5-28 3 axes 28-150	3 x 30 min	IEC 60068-2-64 [2]	Fh: Vibration, broad-band (digital control)
Shocks	shocks	shock spectrum type duration (ms) acceleration (m/s ²) mass (kg) shocks directions of shocks	I 11 II 6 III 2, 3 100 300 500	half sine 6 300 ≥ 100 6	3 shocks in each direction	IEC 60068-2-27 [2]	Ea: Shock
	bump	acceleration (m/s ²) mass (kg) duration (ms) bumps direction of bumps		400 < 100 6 6	100 bumps in each direction	IEC 60068-2-29 [2]	Eb: Bump

Class 7.1

Temperature controlled locations

- The conditions of this class may be found in, and during transfer to, normal working or living areas, e.g.:
 - telecommunication centres;
 - workshops;
 - offices;
 - storage rooms for valuable and sensitive products;
 - shops;
 - rooms for general use (theatres, restaurants, etc.);
 - living rooms

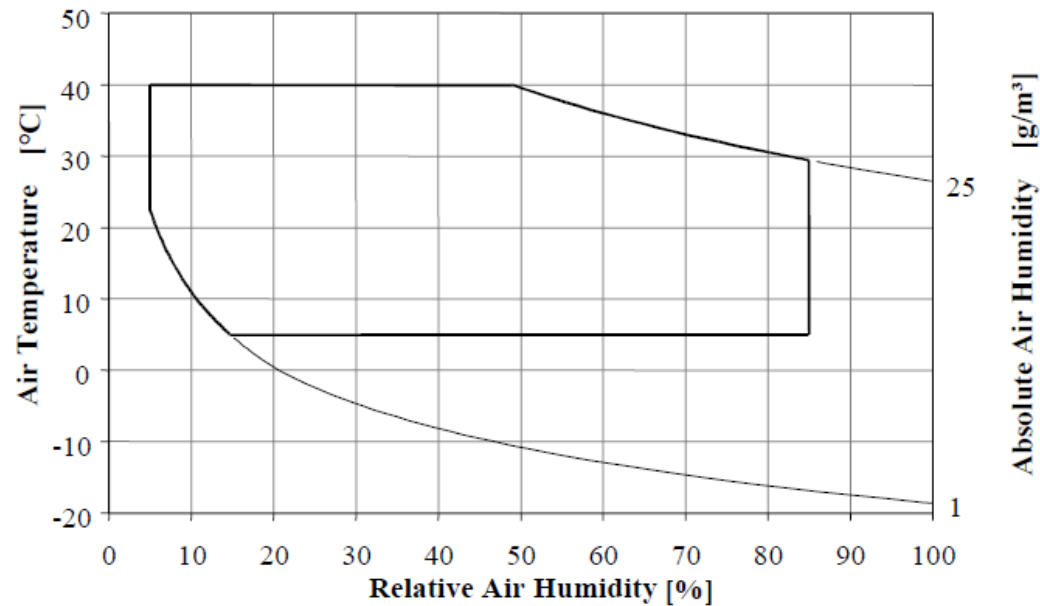


Figure 1: Climatogram for class 7.1: temperature controlled-locations

Class 7.2

Partly temperature controlled locations

- The conditions of this class may be found in, and during transfer to:
 - certain telecommunication buildings;
 - unattended equipment stations;
 - certain workshops;
 - buildings in factories and industrial process plants;
 - in garages;
 - entrances and staircases of buildings;
 - Cellars
 - Ordinary storage rooms for frost resistant products
 - Farm buildings etc.

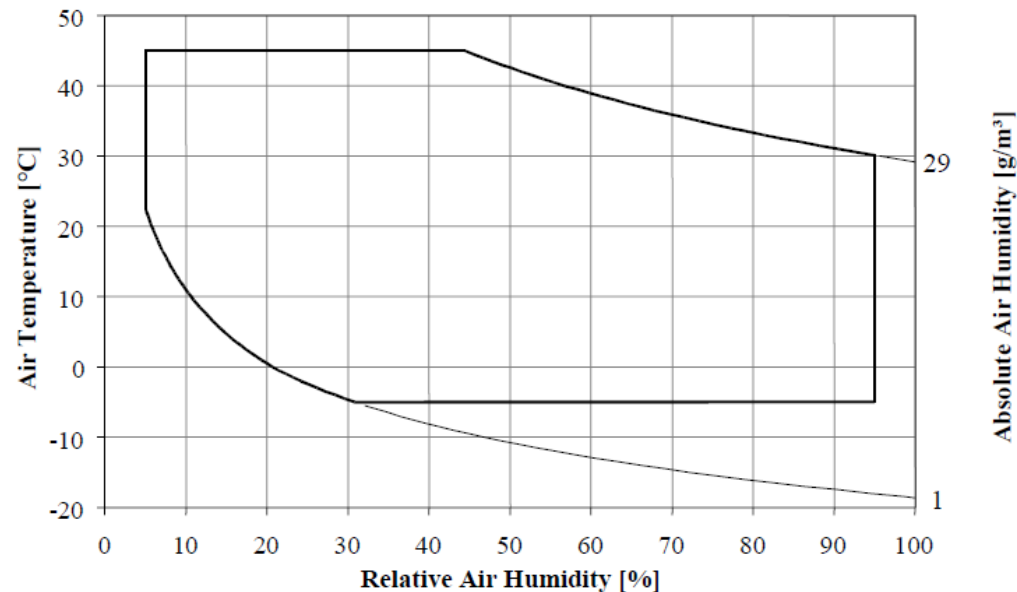


Figure 2: Climatogram for class 7.2: partly temperature controlled locations

Class 7.3

Partly weather protected and non weather protected locations

- This class applies to use at, and direct transfer between, locations:
 - exposed to direct solar radiation, heat radiation, movement of the surrounding air, condensed water, precipitation, water from sources other than rain and icing;
 - 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.

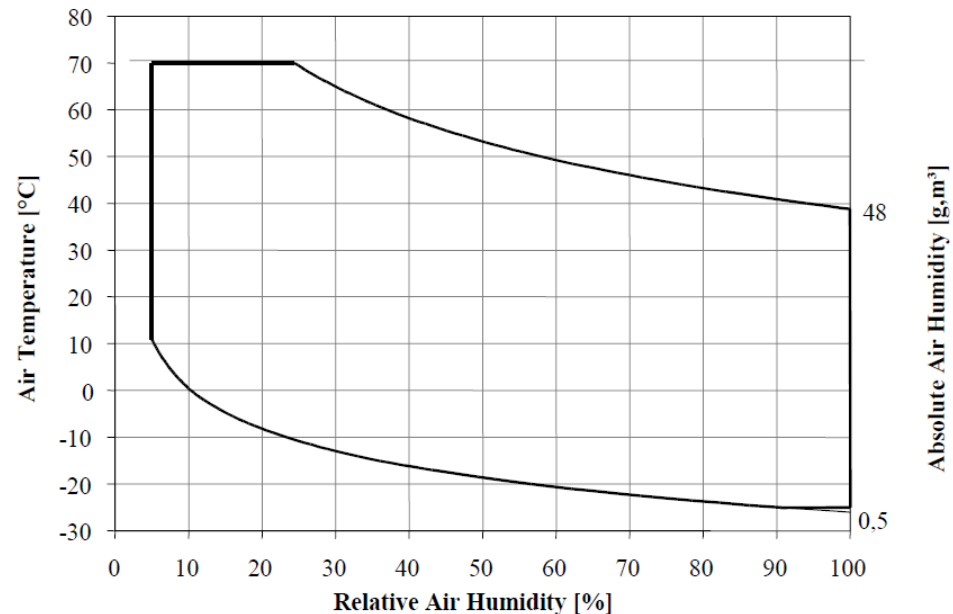
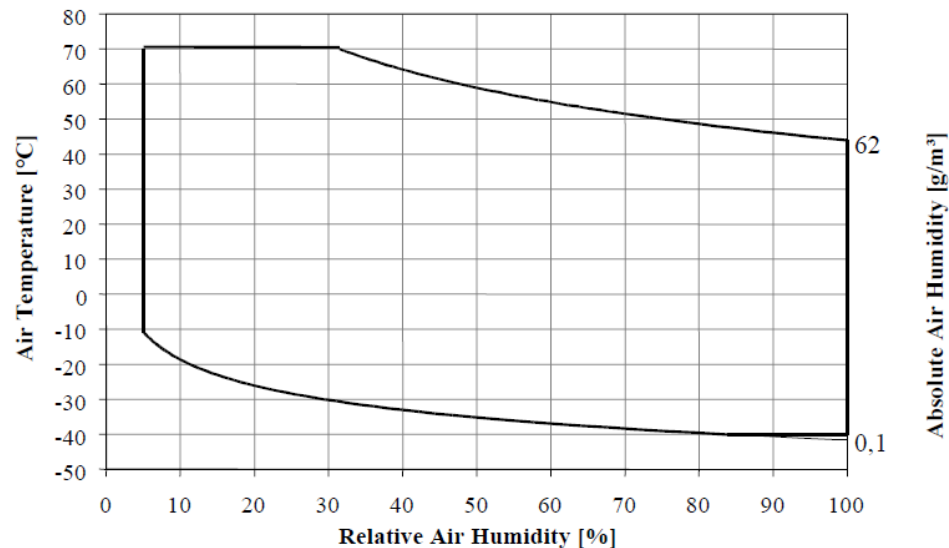


Figure 3: Climatogram for class 7.3: partly weatherprotected and non-weatherprotected location

Class 7.3E

Partly weather protected and non weather protected locations - extended

- This class applies to use at, and direct transfer between, locations:
 - exposed to direct solar radiation, heat radiation, movements of the surrounding air, condensed water, precipitation, water from sources other than rain and icing;
 - 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.



Class 7.1 – 7.3E - Climatic

Environmental parameter		Unit	Class			
			7.1	7.2	7.3	7.3E
a)	Low air temperature	°C	+5	-5	-25	-40
b)	High air temperature	°C	+40	+45	+70	+70
c)	Low relative humidity	%	5	5	5	5
d)	High relative humidity	%	85	95	100	100
e)	Low absolute humidity	g/m ³	1	1	0,5	0,5
f)	High absolute humidity	g/m ³	25	29	48	62
g)	Rapid change of temperature	no	+5/+25	-5/+25	-25/+30	-40/+30
h)	Low air pressure (see note 1)	kPa	70	70	70	70
i)	High air pressure (see note 2)	kPa	106	106	106	106
j)	Rate of change of air pressure	kPa/min	negligible	negligible	negligible	negligible
k)	Solar radiation	W/m ²	700	700	1 120	1 120
l)	Heat radiation	W/m ²	600	600	600	600
m)	Movement of surrounding air	m/s	5	5	30	30
n)	Condensation	no	yes	yes	yes	yes
o)	Precipitation (rain, snow, hail, etc.)	no	no	no	yes	yes
p)	Rain intensity	mm/min	no	no	6	6
q)	Low rain temperature (see note 3)	°C	no	no	5	5
r)	Water from sources other than rain	no	no	no	dripping water	
s)	Ice and frost formation	no	no	yes	yes	yes

Class 7.1 – 7.3E - Mechanical

Environmental parameter		Unit	Class					
			5M2 (see note 1)			5M3 (see note 1)		
a)	Stationary vibration, sinusoidal: (see note 1)							
	displacement amplitude	mm	3,5			7,5		
	acceleration amplitude	m/s ²		10	15		20	40
	frequency range (see note 2)	Hz	2 to 9	9 to 200	200 to 500	2 to 8	8 to 200	200 to 500
b)	Stationary vibration, random:							
	acceleration spectral density	m ² /s ³	1		0,3	3		1
	frequency range	Hz	10 to 200		200 to 2 000	10 to 200		200 to 2 000
c)	Non-stationary vibration, including shock: (see note 3)							
	shock response spectrum type I peak acceleration (ã)	m/s ²		100			300	
	duration	ms		11			11	
	shock response spectrum type II peak acceleration (ã)	m/s ²		300			1 000	
	duration	ms		6			6	
d)	Free fall							
	mass up to 1 kg	m		0,25			1,0	
	mass up to 10 kg	m		0,1			0,5	
	mass up to 50 kg	m		0,05			0,25	

Class 7.1 – Test specification

Environmental parameter			Environmental Class 7.1	Environmental test specification T7.1: Portable, Temperature - controlled location			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	+5	+5	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C)	+40	+40 or +50	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	(°C)	+5/+25	+5/+25	3 cycles $t_1 = 3$ h	IEC 60068-2-14 [2]	Na: Change of temperature
Humidity	relative	low (%)	5	none			
		high (%)	85	93	96 h	IEC 60068-2-56 [2]	Cb: Damp heat steady state
		(°C)	+30	+30			
	condensation	(%)	yes	90-100	2 cycles	IEC 60068-2-30 [2]	Db: Damp heat
		(°C)		+30			Cyclic, variant 2
	absolute	low (g/m ³)	1	none			
		high (g/m ³)	25	none			

Class 7.2 – Test specification

Environmental parameter			Environmental Class 7.2	Environmental test specification T7.2: Portable, Partly temperature- controlled locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-5	-5	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C)	+45	+45 or +55	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	(°C)	-5/+25	-5/+25	3 cycles t ₁ = 3 h	IEC 60068-2-14 [2]	Na: Change of temperature
Humidity	relative	low	(%) 5	none			
		high	(%) 95	93 +30	96 h	IEC 60068-2-56 [2]	Cb: Damp heat steady state
		condensation	(%) yes	90-100 +30	2 cycles	IEC 60068-2-30 [2]	Db: Damp heat Cyclic, variant 2
	absolute	low	(g/m ³) 1	none			
		high	(g/m ³) 29	none			

Class 7.3 – Test specification

Environmental parameter			Environmental Class 7.3	Environmental test specification T7.3 Portable, Partly weatherprotected and non-weatherprotected locations			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C)	-25	-25	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C)	+70	+70 or +85	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	(°C)	-25/+30	-25/+30	3 cycles $t_1 = 3$ h	IEC 60068-2-14 [2]	Na: Change of temperature
Humidity	relative	low (%)	5	none			
		high (%)	100	93 +40	96 h	IEC 60068-2-56 [2]	Cb: Damp heat steady state
		condensation (%)	yes	90-100 +40	2 cycles	IEC 60068-2-30 [2]	Db: Damp heat Cyclic, variant 2
	absolute	low (g/m ³)	0,5	none			
		high (g/m ³)	48	none			
Air	pressure	low (kPa)	70	none			
		high (kPa)	106	none			
	speed	(m/s)	30	none			
Water	rain	intensity (mm/min)	6				
		volume (m ³ /min)		0,01			
		pressure (kPa)		90	1 min/m ² or 5 min	IEC 60068-2-18 [2]	Rb: Impacting water method 1.2
		low temperature (°C)	+5	none			
	other sources		dripping water	none			
	icing & frosting		yes	none			

Class 7.3E – Test specification

Environmental parameter			Environmental Class 7.3E	Environmental test specification T7.3E Portable, Partly weatherprotected and non-weatherprotected locations - ext			
Type	Parameter	Detail parameter	Characteristic severity	Test severity	Duration	Reference	Method
Air temperature	low	(°C) -40	-40	-40	16 h	IEC 60068-2-1 [2]	Ab/Ad: Cold
	high	(°C) +70	+70	+70 or +85	16 h	IEC 60068-2-2 [2]	Bb/Bd: Dry heat
	change	(°C) -40/+30	-40/+30	-40/+30	3 cycles t ₁ = 3 h	IEC 60068-2-14 [2]	Na: Change of temperature
Humidity	relative	low (%) 5	5	none			
		high (%) 100	100	93	21 days	IEC 60068-2-56 [2]	Cb: Damp heat steady state
		condensation (°C) yes	yes	+40			
	absolute	low (g/m ³) 0,1	0,1	90-100	6 cycles	IEC 60068-2-30 [2]	Db: Damp heat
		high (g/m ³) 62	62	+40			Cyclic, variant 2
Air	pressure	low (kPa) 70	70	none			
		high (kPa) 106	106	none			
	speed	(m/s) 30	30	none			
Water	rain	intensity (mm/min) 6	6	0,01	1 min/m ² or 5 min	IEC 60068-2-18 [2]	Rb: Impacting water method 1.2
		volume (m ³ /min) pressure (kPa)		90			
		low temperature (°C) +5	+5	none			
	other sources		Dripping water	none			
	icing & frosting		yes	none			

Class 7.1 - 7.3E – Test specification

Environmental parameter			Environmental Class 7.1 to 7.3E			Environmental test specification T 7.1 to 7.3E: Portable. (IEC 721 class 7M2)				
Type	Parameter	Detail parameter	Characteristic severity			Test severity		Duration	Reference	Method
Vibration	sinusoidal	displacement (mm) acceleration (m/s ²) frequency range (Hz)	3,5	10	15	none				
	random	ASD (m ² /s ³) (dB/oct) frequency range (Hz) number of vibration axes	1,0		0,3	1	-3	3 × 30 minutes	IEC 60068-2-64 [2]	Fdb: Random vibration (wideband)
Shocks	shocks	shock spectrum pulse shape acceleration (m/s ²) duration (ms) number of shocks/direction number of shock directions	Type I	Type II		half sine 300 6 6		3	IEC 60068-2-27 [2]	Ea: Shock
	bump	acceleration (m/s ²) duration (ms) number of shocks/direction number of shocks directions	no			150 6 6		100	IEC 60068-2-29 [2]	Eb: Bump
Fall	free fall	height (m) mass (kg) number of falls/direction number of fall directions	0,25 ≤ 1	0,1 ≤ 10	0,05 ≤ 50	0,25 ≤ 1	0,1 ≤ 10	0,05 ≤ 50	IEC 60068-2-32 [2]	Ed: Free fall procedure 1
	drop and topple	height (m) number of drops/direction number of drop directions (bottom edges and corners)	no			0,1 4 edges+4 corners		1	IEC 60068-2-31 [2]	Ec: Drop and topple

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