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Railway applications - Air conditioning for main line rolling stock - Part 2 : Type tests

Applications ferroviaires - Conditionnement de l'air pour
matériel roulant grandes lignes - Partie 2 : Essais de type

Bahnwendungen - Luftbehandlung in
Schienenfahrzeugen des Fernverkehrs - Teil 2 :
Typprüfungen

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Foreword

This document EN 13129-2:2004 has been prepared by Technical Committee CEN/TC 256 "Railway Applications", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2005, and conflicting national standards shall be withdrawn at the latest by January 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of the following EU Directives:

- Council Directive 96/48/EEC of 23 July 1996 on the interoperability of the trans-European high-speed rail system¹⁾
- Council Directive 93/38/EEC of 14 June 1993 coordinating the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors²⁾

This entire document is applicable, so that no correspondence table is necessary.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

These series of European Standard "Railway application – Air conditioning" includes the following parts:

- EN 13129-1 Railway applications – Air conditioning for main line rolling stock – Part 1: Comfort parameters
- EN 13129-2 Railway applications – Air conditioning for main line rolling stock – Part 2: Type tests
- prEN 14750-1 Railway applications – Air conditioning for urban and suburban rolling stock – Part 1: Comfort parameters
- prEN 14750-2 Railway applications – Air conditioning for urban and suburban rolling stock – Part 2: Type tests
- prEN 14813-1 Railway applications – Air conditioning for driving cabs – Part 1: Comfort parameters
- prEN 14813-2 Railway applications – Air conditioning for driving cabs – Part 2: Type tests

¹⁾ Official Journal of the European Communities No L 235 of 17.9.96

²⁾ Official Journal of the European Communities No L 199 of 9.8.93

Introduction

The object of this document is to establish the programme and test methods to verify the air conditioning installations as described in EN 13129-1.

1 Scope

This document is applicable to main line railway vehicles that carry passengers, but excludes suburban, metro, tramway vehicles and driving cabs.

This document specifies the comfort parameter measurement methods for compartments or saloons (double-decker or not).

The comfort parameters and their tolerances referred to in this document are defined in EN 13129-1.

2 Normative references

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

EN 13129-1:2002, *Railway applications - Air conditioning for main line rolling stock – Part 1: Comfort parameters.*

EN ISO 7726:2001, *Ergonomics of the thermal environment - Instruments for measuring physical quantities (ISO 7726:1998).*

CIE 85, *Solar spectral irradiance*³⁾.

UIC 563:1990-01, *Fittings provided in coaches in the interests of hygiene and cleanliness.*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13129-1:2002 apply.

4 Preliminary verifications

It is advised that preliminary tests are carried out to verify the electrical and electronic assemblies, the functional logic of the control system, the air tightness of the air distribution system and the thermal capacity of the air conditioning equipment.

5 Air movement tests

5.1 Static air movement tests

5.1.1 Test conditions

The tests shall be carried out under the following conditions:

- vehicle stationary and protected from bad weather,
- altitude < 1 000 m above sea level,

3) To be purchased from: International Commission of Illumination, CIE Central Bureau, Kegelgasse 27, A-1030 Wien

- exterior air speed between 0 m/s and 4 m/s,
- exterior temperature between + 15 °C and + 30 °C.

5.1.2 Air flow rates

The flow rates below shall be measured in accordance with 9.4:

- outside air (or fresh air),
- exhaust air (if appropriate),
- recirculated air and/or conditioned air and/or mixed air.

5.1.3 Pressure differentials (Visualisation)

If appropriate, this can be shown up by the movement of smoke between the two relative areas.

In particular, this visualisation should be made for the catering service areas, the composite vehicles smoking/non-smoking, toilet/washrooms and the driving cab in order to verify that the air conditioning installation is well designed to avoid the propagation of odours.

5.2 Dynamic air movement tests

If appropriate, measurements of air speed and/or pressure shall be done during dynamic tests. These measurements shall be applied to the following air flows:

- fresh,
- exhaust,
- condenser.

These results shall be compared with measurements taken whilst using the same equipment on a stationary vehicle.

5.3 Comfort tests

5.3.1 Critical air speed

The purpose of these measurements is to find, as a minimum, the three seated positions which are the most unfavourable in the comfort envelope (see Annex G).

5.3.2 Measurement of air speeds

These measurements shall be carried out without the simulation of the thermal and volumetric effects of occupation (the heating elements, humidification equipment or dummies can affect the measurements inside the passenger space).

It is recommended, for information purpose only, to carry out further measurement:

- with a volumetric occupation of a compartment or a bay simulated with dummies,
- to continuously record the passenger space air speeds in accordance with 10.2 with the thermal output of occupation being simulated throughout the regulation tests.

6 Climatic tests

6.1 General remarks

Annex A defines a minimum schedule of tests which enables the verification of comfort parameters defined in EN 13129-1.

The order of the tests is not obligatory but shall be compatible with the physical characteristics of the climatic chamber and the means of measurement.

Throughout the tests, all the values at the measuring points defined in Clause 11 shall be recorded continuously, as well as the energy consumption and the power absorbed by the air conditioning installation itself, and the whole of the vehicle.

Should other equipment such as, for example, doors, toilet equipment, power supply, lighting, special equipment, etc, need to be tested, these tests should not interfere in any way with the tests on the air conditioning systems.

6.2 Preheating test

The test conditions for preheating are defined in Annex A.

Before the start of the pre-heating test, the interior temperatures of the air and the interior surfaces shall be the same as the exterior temperature and stabilised at ± 1 K for at least 1 h.

6.3 Precooling test

The test conditions for precooling are defined in Annex A.

Before the start of the precooling tests, the interior temperatures of the air and the interior surfaces shall be the same as the exterior temperature and stabilised at ± 1 K for at least 1 h. At this time, before starting the precooling test, the artificial sunlight equipment shall be switched on for 2 h, corresponding to the values given in Annex E of EN 13129-1:2002 with doors and windows closed.

6.4 Regulation tests

6.4.1 Procedure

Starting from stabilised operation (see 3.36 of EN 13129-1:2002),

- 1) one changes a parameter (interior or exterior)
- 2) after 90 minutes or three similar consecutive control cycles the results obtained shall be in accordance with the comfort conditions defined in EN 13129-1.

6.4.2 Tests in heating mode

6.4.2.1 The tests shall be carried out at the temperatures given in Table 1:

Table 1 — Mean exterior temperatures (Tem) for tests in heating mode

Zone I	Zone II	Zone III
Temperature	Temperature	Temperature
- 10 °C	- 20 °C	- 40 °C
0 °C	- 10 °C	- 10 °C
+ 10 °C	0 °C	0 °C
	+ 10 °C	+ 10 °C

6.4.2.2 The requirements specified in Clause 7 of EN 13129-1:2002 shall be verified by changing the position of the temperature setting device from the normal setting to the maximum and minimum position.

6.4.2.3 In order to be able to check the behaviour of the regulation system and see how the temperatures in the particular compartments vary, it is recommended to set 20 % to 30 % of the compartments at maximum and the remainder to minimum. The same check shall be made with 70 % to 80 % of the temperature setting devices at maximum position and the remainder at minimum.

6.4.2.4 To check the effect of occupation, total or partial, on the regulation system, tests with a simulated occupation shall be carried out in accordance with 10.2.

6.4.2.5 The tests carried out in the presence of wind are intended to check the behaviour of the air conditioning installation and the tightness of the vehicle body, as well as the behaviour of the air extraction outlets.

6.4.3 Tests in cooling mode

6.4.3.1 The tests shall be carried out at the external climatic conditions given in Table 2:

Table 2 — External climatic conditions for tests in cooling mode

Zone I			Zone II			Zone III		
Dry bulb temperature	Relative humidity	Equivalent solar radiation	Dry bulb temperature	Relative humidity	Equivalent solar radiation	Dry bulb temperature	Relative humidity	Equivalent solar radiation
°C	% RH	W/m ²	°C	% RH	W/m ²	°C	% RH	W/m ²
40	40	800	35	50	700	28	45	600
28	70	600	28	70	600	22	80	500
22	80	500	22	80	500			

6.4.3.2 The requirements specified in Clause 7 of EN 13129-1:2002 shall be verified by changing the position of the temperature setting device from the normal position to the maximum and minimum position.

6.4.3.3 In order to be able to check the behaviour of the regulation and see how the temperatures in the particular compartments vary, it is recommended to set 20 % to 30 % of the compartments at the maximum and the remainder at the minimum. The same check shall be made with 70 % to 80 % of the temperature setting devices at the maximum position and the remainder at minimum.

6.4.3.4 To check the effect of occupation, total or partial, on the regulation system, tests with a simulated occupation shall be carried out in accordance with 10.2.

6.4.3.5 The tests carried out in the presence of wind are intended to check the behaviour of the air conditioning installation and the tightness of the vehicle body, as well as the behaviour of the exhaust air outlets.

6.4.3.6 In order to verify the effect of the solar gain on the control system, the first test shall be carried out with a solar exposure of at least 4 h; the balance of tests will then follow the procedure of 6.4.1.

6.4.4 Tests with variable mean exterior temperature (Tem)

The regulation tests carried out with a mean exterior temperature (Tem) that decreases or increases by 3 K/h are intended to check the behaviour of the air conditioning installation and its control system during the change over from the cooling mode to the heating mode and vice versa; with and without supplementary disturbance caused by occupation and solar radiation of the vehicle.

The tests are also intended to record the start conditions of the modes of heating and/or ventilation and/or cooling. To carry this out, the corresponding mean exterior temperature (T_{em}) shall be stabilised for 30 min.

7 Tests at extreme exterior operating conditions

It will be necessary to check the operation of the air conditioning equipment at the extreme operating temperatures specified for the zones defined in 5.2 of EN 13129-1:2002.

8 Complementary tests

8.1 Verification of the anti-freeze protection

8.1.1 General remarks

Not specific to the air condition comfort test, but is complementary to it, the verification of anti-freeze protection shall be carried out if there is a functional connection between the air conditioning system and the water installation.

8.1.2 Aim of the tests

The object of the tests is to verify that the on board equipment does not suffer from damage caused by freezing in accordance with 1.4 of the document UIC 563:1990.

8.1.3 Test procedure

- The water tanks are filled at least five hours before the start of the tests with water at a temperature below 15 °C: for each type of tank, one tank is 1/4 full, the other tanks are filled to 3/4 full.
- The control functions of the installation are performed in according to the test operation instruction.

Before the start of the tests in line with the document UIC 563, there is a need to stabilise for 5 h, the mean exterior and interior temperatures of the areas reserved for passengers.

- Minimum duration of cooling of the vehicle: see UIC 563.
- The control functions of the installation are performed in accordance with the operation instruction.

The temperature of the tanks, exhaust valves, pipes and other items exposed to a risk of freezing shall be recorded. The test shall be discontinued if there is a risk of icing-up.

8.2 Determination of the coefficient k

8.2.1 Purpose of the test

The coefficient k characterises the thermal quality of a vehicle (efficiency of the insulation and influence of air infiltration).

8.2.2 Definition

The global coefficient k is defined by the following formula:

$$k = \frac{P}{A_e \times (T_{im} - T_{em})}$$

- The surface A_e is the developed exterior surface of the assembly including walls, ceiling, floor and ends of the structure for all or part of the vehicle under consideration. This shall include windows, doors and openings.

- P is the thermal power released inside the vehicle, necessary to maintain constantly the difference in absolute value between the mean interior temperature (T_{im}) measured at 1,1 m, of all or part of the vehicle according to Annex C, and the mean exterior temperature (T_{em}).

8.2.3 Procedure

The openings for fresh air and exhaust air are sealed, but not insulated.

The air conditioning installation is isolated. The vehicle is without power (except for the batteries), the doors and the windows are closed. Unsealed gangways are normally only blocked by the vehicle door. Gangways without a vehicle door or sealed gangways shall be blocked by a temporary panel whose thermal transmission coefficient is less than $0,5 \text{ W/m}^2\text{K}$.

It is necessary to provide a heating installation independent of that of the vehicle, controllable to a low output in the vehicle interior (and) distributed in the comfort envelope and/or annex areas. The uniformity of the temperatures inside the vehicle shall be guaranteed by fans. The power consumption of the system and the fans shall be recorded separately.

All the measured data shall be recorded at minimum every 1 min.

The value of the temperature difference $|T_{im}-T_{em}|$ shall be $(25 \pm 5) \text{ K}$. It is recommended that this test is carried out with $T_{em} = + 5 \text{ }^\circ\text{C} \pm 2 \text{ K}$.

The output of the heating system and of the ventilation is maintained constant, the determination of the coefficient k is possible after stabilisation of the temperatures:

- The values of T_{em} and $|T_{im}-T_{em}|$ shall be determined and averaged over a period of 30 min. The variation of these values, over a minimum period of 3 h shall be less than $0,1 \text{ K}$.
- The range of temperatures relating to different points of measurement (interior and exterior) shall be less than 2 K .

The coefficient k is calculated using the measurements taken during the last hour of stabilisation of temperatures.

8.3 Thermography

The thermographic test is recommended for evaluation of the thermal quality of the vehicle.

8.4 Noise and vibration

The measurement of noise and vibration shall be carried out on a stationary vehicle with the air conditioning installation functioning at a level which corresponds to the maximum performance conditions of the customer's specification.

9 Methods of measurement – Measuring instruments

9.1 General remarks

It is desirable to make a continuous recording, taking as a base rate of sampling of a minimum of one measurement per minute for all the values recorded.

9.2 Temperatures

9.2.1 Air temperature

The measuring devices shall be Class S according to EN ISO 7726:2001, Table 2, and having a maximum drift of $\pm 0,25 \text{ K}$ over the duration of recording.

9.2.2 Surface temperatures

In respect of the walls, and in order to measure the real temperature of the relevant surface, precautions should be taken to protect against external influences such as radiation, convection and transmission of heat.

The class of measuring devices should be identical to that in 9.2.1.

9.3 Relative humidity

The class of measuring devices shall be Class C according to EN ISO 7726:2001, Table 2.

9.4 Air speed

It is desirable to carry out a continuous recording, taking as a base rate of sampling of at least one measurement per second for a minimum period of 1 min. For the purpose of quantifying the variations in speed, the calculation of arithmetic averages, as well as that of the standard deviations for that period shall be carried out.

The measuring instruments used should be Class C of EN ISO 7726:2001, Table 2.

9.5 Airflow rate

The airflow should be determined using a calibrated system of measurement which enables the recording of results with a minimum accuracy of 5 % (it is not necessary to carry out a continuous recording of these measurements). At the same time the exterior temperature and the barometric pressure should be recorded.

9.6 Simulated speed of the vehicle

The speed of the air around the vehicle is determined by a calibrated system of measurement which enables the recording of results with a minimum accuracy of ± 1 m/s.

9.7 Equivalent solar energy

The measurement of the equivalent solar energy is achieved by a calibrated system of measurement. This measurement is carried out in accordance with the procedure described in Annex B.

9.8 Energy consumption and power rating

The measurements should be carried out using instruments having an accuracy of within 0,5 %.

10 Characteristics of the test equipment

10.1 General remarks

To meet the requirements of this document the tests shall be performed in an appropriate facility with suitable test equipment.

10.2 Occupation

The simulation of the occupation, total or partial, of the conditioned space shall be achieved in accordance with the curves of Annex D of EN 13129-1:2002.

For the simulation of the sensible heat, it is necessary to use heating equipment of low radiance whose surface temperature is less than + 40 °C.

The simulation of the latent heat is carried out by the production of water vapour. The sensible heat introduced by the equipment producing the vapour shall be incorporated in the total balance of sensible heat.

10.3 Temperature of the climatic chamber (Tem) and uniformity of the temperature of the wind tunnel

The temperature of the climatic chamber shall be satisfactory as to requirements of temperatures as follows:

- variation of temperature (Tem) during the tests in steady state conditions: $\leq 0,5$ K;
- with no thermal load the range of temperatures noted (plotted) at the points of measurement defined in Annex H shall be ≤ 2 K for all wind speeds;
- for stationary vehicle tests the wind speed shall be between 5 km/h and 15 km/h;
- for temperature distribution (difference between the point of measurement having the highest value and the point of measurement having the lowest value), it is necessary to incorporate the values measured for the determination of the temperature of the climatic chamber (Tem) in accordance with 11.2.

10.4 Relative humidity

Variation of the relative humidity during the test (steady state): $\leq 5\%$.

10.5 Simulation of speed (wind)

The appropriate elements of transition upstream and downstream (streamlining) are necessary to simulate the aerodynamic effects of the train or of the rake.

The wind speed measured shall be corrected to take into account the effects of the walls of the climatic chamber and to obtain heat exchange equivalent to that in service operation.

10.6 Equivalent solar energy

The equipment which simulates the equivalent solar energy based on the index of terrestrial radiation "global insulation" of $1\,120\text{ W/m}^2$ in accordance with the CIE 85 shall be composed of lamps whose characteristics conform with Table 3:

Table 3 — Characteristics of equipment

Wavelength (Nanometer)	Percentage of total radiation compared with terrestrial radiation given in CIE 85 (%)	Allowable variation (%)
280 – 400	6,1	± 3
400 – 800	51,8	± 5
800 – 3 000	42,1	± 5

11 Distribution of measuring points

11.1 Distribution of sensors in the vehicle

11.1.1 Comfort envelope temperature measurement points

These are defined in Annexes C, D, E.

11.1.2 Surface temperature measurement points

These are defined in Annex F.

11.1.3 Supply air outlet temperature measurement points

The temperature is measured at the hottest point (determined by the preliminary tests).

11.1.4 Comfort envelope air speed measurement points

These are defined in Annex G.

11.1.5 Comfort envelope relative humidity measurement points

The relative humidity is measured at the geometric centre of the compartments or zones defined in Annex D.

11.2 Climatic chamber sensor distribution

The measurement points of the mean exterior temperature T_{em} , the relative humidity and the air speed are defined in Annex H.

Annex A (normative)

Tests for verification of comfort parameters

Table A.1 — Tests in heating mode (Zone I – Winter)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
101	6.4.2	Regulation	+10	–	5 – 15	0	0	min.	
102	6.4.2	Regulation	+10	–	5 – 15	0	0	normal	
103	6.4.2	Regulation	+10	–	5 – 15	0	0	max.	
104	6.2	Preheating	+0	–	5 – 15	0	0	max.	Preheating time notice
105	6.4.2	Regulation	+0	–	5 – 15	0	0	max.	
106	6.4.2	Regulation	+0	–	5 – 15	0	0	normal	
107	6.4.2	Regulation	+0	–	≥ 120	0	0	normal	
108	6.4.2	Regulation	+0	–	≥ 120	100	0	normal	
109	6.4.2	Regulation	+0	–	5 – 15	at least 3 comp.	0	normal	 These tests only apply to compartment vehicles 
110	6.4.2	Regulation	+0	–	5 – 15	all except 3 comp.	0	normal	
111	6.4.2	Regulation	+0	–	5 – 15	0	0	20 % to 30 % of comp. max. remainder min.	
112	6.4.2	Regulation	+0	–	5 – 15	0	0	70 % to 80 % of comp. max. remainder min.	

Table A.1 (continued)

Test		Description of test	Mean exterior temperature (T _{em})	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
Extreme external temperature test									
113	7	Operational	-15	-	5 – 15	0	0	max.	Function test
114	6.4.2	Regulation	-10	-	5 – 15	0	0	max.	
115	6.4.2	Regulation	-10	-	5 – 15	0	0	normal	
116	6.4.2	Regulation	-10	-	≥ 120	0	0	normal	
117	8.1	Anti-freeze	-10	-	5 – 15	0	0		This test can be carried out at the same time as regulation test at - 10 °C
118	8.2	Static value of <i>k</i>	5 ± 2	-	5 – 15	0	0		

Table A.2 — Variable external temperature tests (Zone I – Summer)

Test		Description of test	Mean exterior temperature (T _{em})	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
N°	Clause		°C	%	km/h	%	%		
201	6.4.4	Regulation	0 ↗ +22	↗ 80	5 – 15	0	0	normal	T _{em} ↗ 3 K/h
202	6.4.3	Regulation	+22	80	5 – 15	0	0	normal	
203	6.4.3	Regulation	+22	80	5 – 15	100	0	normal	
204	6.4.3	Regulation	+22	80	5 – 15	100	0	max.	
205	6.4.3	Regulation	+22	80	5 – 15	100	0	min.	

Table A.2 (continued)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
N°	Clause		°C	%	km/h	%	%		
206	6.4.3	Regulation	+22	80	5 – 15	100	0	20 % to 30 % of devices: max. 70 % to 80 % of devices: min.	↑ These tests only apply to compartment vehicles ↓
207	6.4.3	Regulation	+22	80	5 – 15	100	0	70 % to 80 % of devices: max. 20 % to 30 % of devices: min.	
208	6.4.4	Regulation	+22 ↘ +5	80 ↘	5 – 15	100	0	normal	T _{em} ↘ 3 K/h
209	6.4.4	Regulation	+5		5 – 15	100	100	normal	
210	6.4.4	Regulation	+5 ↗ 28	↗ 70	5 – 15	100	100	normal	T _{em} ↗ 3 K/h
211	6.4.3	Regulation	28	70	5 – 15	0	100	normal	
212	6.4.3	Regulation	28	70	5 – 15	0	0	normal	

Table A.3 — Tests in cooling mode (Zone I – Summer)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
303-1	6.4.3	Regulation	28	70	5 – 15	100	100	min.	
304-1	6.4.3	Regulation	28	70	5 – 15	100	100	normal	
305-1	6.4.3	Regulation	28	70	≥ 120	100	100	normal	
306-1	6.4.3	Regulation	28	70	≥ 120	100	0	normal	
307-1	6.4.3	Regulation	28	70	≥ 120	0	0	normal	

Table A.3 (continued)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
308-1	6.4.3	Regulation	28	70	5 – 15	100	100	20 % to 30 % of devices: max. 70 % to 80 % of devices: min.	↑ These tests only apply to compartment vehicles ↓
309-1	6.4.3	Regulation	28	70	5 – 15	100	100	70 % to 80 % of devices: max. 20 % to 30 % of devices: min.	
310-1	6.4.3	Regulation	28	70	≥ 120	at least 3 comp.	100	normal	
311-1	6.4.3	Regulation	28	70	≥ 120	all except 3 comp.	100	normal	
Extreme external temperature test									
301	7	Operational	+45 or +50	35 or 30	5 – 15	0	0	min.	Function test
302	6.3	Precooling	40	40	5 – 15	0	100	min.	
303	6.4.3	Regulation	40	40	5 – 15	100	100	min.	
304	6.4.3	Regulation	40	40	5 – 15	100	100	normal	
305	6.4.3	Regulation	40	40	≥ 120	100	100	normal	
306	6.4.3	Regulation	40	40	≥ 120	100	0	normal	
307	6.4.3	Regulation	40	40	≥ 120	0	0	normal	

Table A.4 — Tests in heating mode (Zone II – Winter)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
101	6.4.2	Regulation	+10	–	5 – 15	0	0	min.	
102	6.4.2	Regulation	+10	–	5 – 15	0	0	normal	
103	6.4.2	Regulation	+10	–	5 – 15	0	0	max.	
104	6.2	Preheating	+0	–	5 – 15	0	0	max.	Preheating time notice
105	6.4.2	Regulation	+0	–	5 – 15	0	0	max.	
106	6.4.2	Regulation	+0	–	5 – 15	0	0	normal	
107	6.4.2	Regulation	+0	–	≥ 120	0	0	normal	
108	6.4.2	Regulation	+0	–	≥ 120	100	0	normal	
109	6.4.2	Regulation	+0	–	5 – 15	at least 3 comp.	0	normal	<p style="text-align: center;">↑</p> <p style="text-align: center;">These tests only</p> <p style="text-align: center;">apply to</p> <p style="text-align: center;">compartment vehicles</p> <p style="text-align: center;">↓</p>
110	6.4.2	Regulation	+0	–	5 – 15	all except 3 comp.	0	normal	
111	6.4.2	Regulation	+0	–	5 – 15	0	0	20 % to 30 % of devices: max.	
112	6.4.2	Regulation	+0	–	5 – 15	0	0	70 % to 80 % of devices: min. 70 % to 80 % of devices: max. 20 % to 30 % of devices: min.	
114-1	6.4.2	Regulation	–10	–	5 – 15	0	0	max.	
115-1	6.4.2	Regulation	–10	–	5 – 15	0	0	normal	
116-1	6.4.2	Regulation	–10	–	≥ 120	0	0	normal	

Table A.4 (continued)

Test		Description of test	Mean exterior temperature (T _{em})	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
Extreme external temperature test									
113	7	Operational	-25	-	5 – 15	0	0	max.	Function test
114	6.4.2	Regulation	-20	-	5 – 15	0	0	max.	
115	6.4.2	Regulation	-20	-	5 – 15	0	0	normal	
116	6.4.2	Regulation	-20	-	≥ 120	0	0	normal	
117	8.1	Anti-freeze	-10	-	5 – 15	0	0		This test can be carried out at the same time as regulation test at - 10°C
118	8.2	Static value of <i>k</i>	5 ± 2	-	5 – 15	0	0		

Table A.5 — Variable external temperature tests (Zone II – Summer)

Test		Description of test	Mean exterior temperature (T _{em})	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
201	6.4.4	Regulation	0 ↗ +22	↗ 80	5 – 15	0	0	normal	T _{em} ↗ 3 K/h
202	6.4.3	Regulation	+22	80	5 – 15	0	0	normal	
203	6.4.3	Regulation	+22	80	5 – 15	100	0	normal	
204	6.4.3	Regulation	+22	80	5 – 15	100	0	max.	
205	6.4.3	Regulation	+22	80	5 – 15	100	0	min.	

Table A.5 (continued)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
206	6.4.3	Regulation	+22	80	5 – 15	100	0	20 % to 30 % of devices: max. 70 % to 80 % of devices: min.	↑ These tests only apply to compartment vehicles ↓
207	6.4.3	Regulation	+22	80	5 – 15	100	0	70 % to 80 % of devices: max. 20 % to 30 % of devices: min.	
208	6.4.4	Regulation	+22 ↘ +5	80 ↘	5 – 15	100	0	normal	T _{em} ↘ 3 K/h
209	6.4.4	Regulation	+5		5 – 15	100	100	normal	
210	6.4.4	Regulation	+5 ↗ 28	↗ 70	5 – 15	100	100	normal	T _{em} ↗ 3 K/h
211	6.4.3	Regulation	28	70	5 – 15	0	100	normal	
212	6.4.3	Regulation	28	70	5 – 15	0	0	normal	

Table A.6 — Tests in cooling mode (Zone II – Summer)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
303-1	6.4.3	Regulation	28	70	5 – 15	100	100	min.	
304-1	6.4.3	Regulation	28	70	5 – 15	100	100	normal	
305-1	6.4.3	Regulation	28	70	≥ 120	100	100	normal	
306-1	6.4.3	Regulation	28	70	≥ 120	100	0	normal	
307-1	6.4.3	Regulation	28	70	≥ 120	0	0	normal	

Table A.6 (continued)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
308-1	6.4.3	Regulation	28	70	5 – 15	100	100	20 % to 30 % of devices: max. 70 % to 80 % of devices: min.	↑ These tests only apply to compartment vehicles ↓
309-1	6.4.3	Regulation	28	70	5 – 15	100	100	70 % to 80 % of devices: max. 20 % to 30 % of devices: min.	
310-1	6.4.3	Regulation	28	70	≥ 120	at least 3 comp.	100	normal	
311-1	6.4.3	Regulation	28	70	≥ 120	all except 3 comp.	100	normal	
Extreme external temperature test									
301	7	Operational	+40 or +45	40 or 35	5 – 15	0	0	min.	Function test
302	6.3	Precooling	35	50	5 – 15	0	100	min.	
303	6.4.3	Regulation	35	50	5 – 15	100	100	min.	
304	6.4.3	Regulation	35	50	5 – 15	100	100	normal	
305	6.4.3	Regulation	35	50	≥ 120	100	100	normal	
306	6.4.3	Regulation	35	50	≥ 120	100	0	normal	
307	6.4.3	Regulation	35	50	≥ 120	0	0	normal	

Table A.7 — Tests in heating mode (Zone III – Winter)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
101	6.4.2	Regulation	+10	–	5 – 15	0	0	min.	
102	6.4.2	Regulation	+10	–	5 – 15	0	0	normal	
103	6.4.2	Regulation	+10	–	5 – 15	0	0	max.	
104	6.2	Preheating	+0	–	5 – 15	0	0	max.	Preheating time notice
105	6.4.2	Regulation	+0	–	5 – 15	0	0	max.	
106	6.4.2	Regulation	+0	–	5 – 15	0	0	normal	
107	6.4.2	Regulation	+0	–	≥ 120	0	0	normal	
108	6.4.2	Regulation	+0	–	≥ 120	100	0	normal	
109	6.4.2	Regulation	+0	–	5 – 15	at least 3 comp.	0	normal	<p style="text-align: center;">↑</p> <p style="text-align: center;">These tests only</p> <p style="text-align: center;">apply to</p> <p style="text-align: center;">compartment vehicles</p> <p style="text-align: center;">↓</p>
110	6.4.2	Regulation	+0	–	5 – 15	all except 3 comp.	0	normal	
111	6.4.2	Regulation	+0	–	5 – 15	0	0	20 % to 30 % of devices: max.	
112	6.4.2	Regulation	+0	–	5 – 15	0	0	70 % to 80 % of devices: min. 70 % to 80 % of devices: max. 20 % to 30 % of devices: min.	
114-1	6.4.2	Regulation	–10	–	5 – 15	0	0	max.	
115-1	6.4.2	Regulation	–10	–	5 – 15	0	0	normal	
116-1	6.4.2	Regulation	–10	–	≥ 120	0	0	normal	
114-2	6.4.2	Regulation	–20	–	5 – 15	0	0	max.	
115-2	6.4.2	Regulation	–20	–	5 – 15	0	0	normal	
116-2	6.4.2	Regulation	–20	–	≥ 120	0	0	normal	

Table A.7 (continued)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
Extreme external temperature test									
113	7	Operational	-45	-	5 – 15	0	0	max.	Function test
114	6.4.2	Regulation	-40	-	5 – 15	0	0	max.	
115	6.4.2	Regulation	-40	-	5 – 15	0	0	normal	
116	6.4.2	Regulation	-40	-	≥ 120	0	0	normal	
117	8.1	Anti-freeze	-10	-	5 – 15	0	0		This test can be carried out at the same time as regulation test at - 10°C
118	8.2	Static value of <i>k</i>	5 ± 2	-	5 – 15	0	0		

Table A.8 — Variable external temperature tests (Zone III – Summer)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
201	6.4.4	Regulation	0 ↗ +22	↗ 80	5 – 15	0	0	normal	T _{em} ↗ 3 K/h
202	6.4.3	Regulation	+22	80	5 – 15	0	0	normal	
203	6.4.3	Regulation	+22	80	5 – 15	100	0	normal	
204	6.4.3	Regulation	+22	80	5 – 15	100	0	max.	
205	6.4.3	Regulation	+22	80	5 – 15	100	0	min.	

Table A.8 (continued)

Test		Description of test	Mean exterior temperature (T _{em})	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
206	6.4.3	Regulation	+22	80	5 – 15	100	0	20 % to 30 % of devices: max 70 % to 80 % of devices: min	↑ These tests only apply to compartment vehicles ↓
207	6.4.3	Regulation	+22	80	5 – 15	100	0	70 % to 80 % of devices: max 20 % to 30 % of devices: min	
208	6.4.4	Regulation	+22 ↘ +5	80 ↘	5 – 15	100	0	normal	T _{em} ↘ 3 K/h
209	6.4.4	Regulation	+5		5 – 15	100	100	normal	
210	6.4.4	Regulation	+5 ↗ 28	↘ 45	5 – 15	100	100	normal	T _{em} ↗ 3 K/h
211	6.4.3	Regulation	28	45	5 – 15	0	100	normal	
212	6.4.3	Regulation	28	45	5 – 15	0	0	normal	

Table A.9 — Tests in cooling mode (Zone III – Summer)

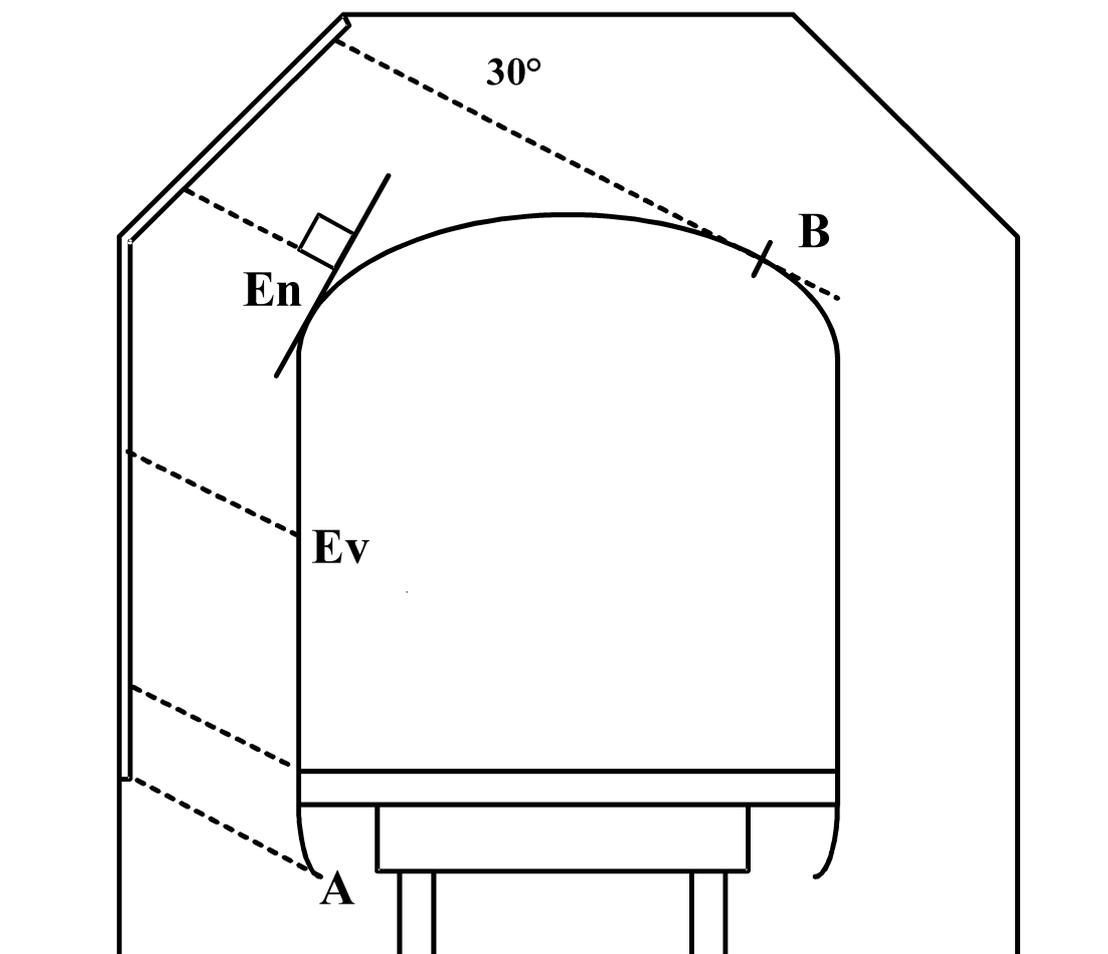
Test		Description of test	Mean exterior temperature (T _{em})	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
Extreme external temperature test									
301	7	Operational	+33 or +38	55 or 45	5 – 15	0	0	min.	Function test
302	6.3	Precooling	28	45	5 – 15	0	100	min.	
303	6.4.3	Regulation	28	45	5 – 15	100	100	min.	
304	6.4.3	Regulation	28	45	5 – 15	100	100	normal	
305	6.4.3	Regulation	28	45	≥ 120	100	100	normal	
306	6.4.3	Regulation	28	45	≥ 120	100	0	normal	
307	6.4.3	Regulation	28	45	≥ 120	0	0	normal	

Table A.9 (continued)

Test		Description of test	Mean exterior temperature (Tem)	Relative humidity	Air speed	Simulation of occupation of the vehicle	Equivalent solar energy	Position of the (Tic) control device	Remarks
n°	Clause		°C	%	km/h	%	%		
308	6.4.3	Regulation	28	45	5 – 15	100	100	20 % to 30 % of devices: max. 70 % to 80 % of devices: min.	↑ These tests only apply to compartment vehicles ↓
309	6.4.3	Regulation	28	45	5 – 15	100	70 % to 80 % of devices: max. 20 % to 30 % of devices: min.		
310	6.4.3	Regulation	28	45	≥ 120	at least 3 comp.	100	normal	
311	6.4.3	Regulation	28	45	≥ 120	all except 3 comp.	100	normal	

Annex B (normative)

Equivalent solar energy – (Simulation of solar exposure)



Key

E_n = Equivalent solar energy on a surface perpendicular to the radiation

$E_v = E_n \times \cos(30^\circ) = 0,866 \times E_n$ = Equivalent solar energy on the surface of the vehicle

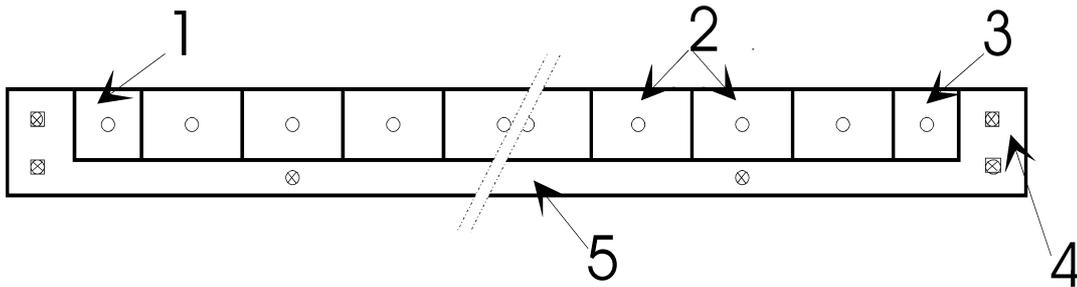
E_n is defined in Annex E of EN 13129-1:2002.

Figure B.1

- Whatever type of vehicle, it is recommended that solar radiation is available between points A and B (compartments on the side of the lamps for compartmented vehicles).
- The bank of solar radiation lamps shall be at minimum, the same length as the vehicle on test.
- The measurement of the equivalent solar energy shall be taken on the middle face of the vehicle side wall.

Annex C
(normative)

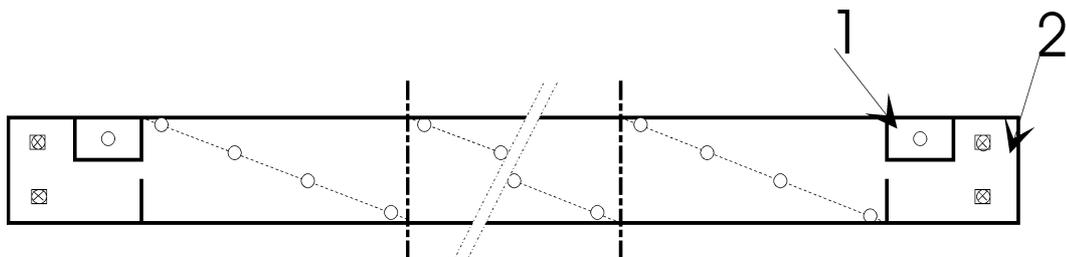
Location of the measuring points used for the determination of the mean interior temperature in the comfort envelope (T_{im}) and the measurement point location in the local annexes



Key

- | | | | |
|---|--------------|---|--|
| 1 | Local annex | 5 | Corridor |
| 2 | Compartments | □ | Measuring points 0,1 m above the floor |
| 3 | Local annex | ○ | Measuring points 1,1 m above the floor |
| 4 | Vestibule | × | Measuring points 1,7 m above the floor |

Figure C.1 — Compartmented vehicles



Key

- | | | | |
|---|--|---|--|
| 1 | Local annex | ○ | Measuring points 1,1 m above the floor |
| 2 | Vestibule | × | Measuring points 1,7 m above the floor |
| □ | Measuring points 0,1 m above the floor | | |

Figure C.2 — Open saloon vehicles

Compartment measuring points:

At the geometric centre of each compartment.

Open saloon measuring points:

On the diagonal shown in Figure C.2 (the carriage is divided into three equal parts).

Corridor measuring points (compartmented carriages):

On the longitudinal centre-line of the corridor, facing the centre of the second compartment and the one before last compartment.

Vestibule measuring points:

On the centre-line of the passenger (access) doors and at 0,5 m from them.

Local annex measuring points:

At the geometric centre of the space.

NOTE For vehicles not included in the above categories (sleeper or restaurant cars), one should determine, by analogy, representative measuring points.

Annex D
(normative)

Location of the measuring points used for the determination of the range of internal temperature extremes and relative humidity across the comfort envelope

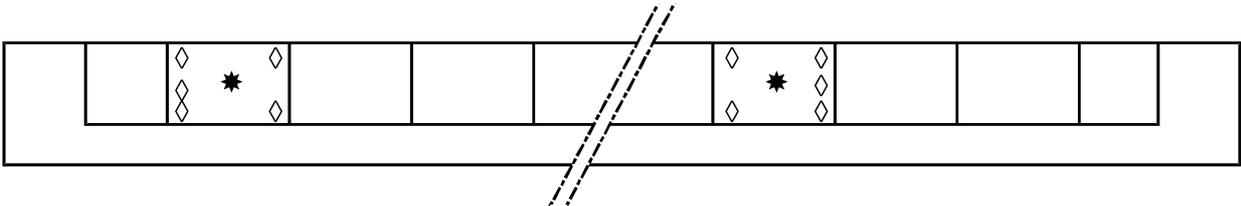
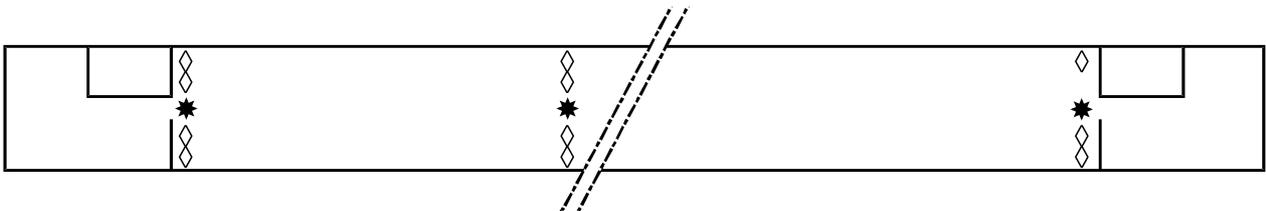


Figure D.1 — Compartmented vehicles



Key

- ◇ Measuring point as per Annex E
- * Geometric centre of the measurement zone

Figure D.2 — Open saloon vehicles

Location of the measuring points:

See Annex E.

Position of the measuring points in compartmented vehicles:

- At positions designated by a \diamond in a compartment adjacent to the vestibule.
- At positions designated by a \diamond in a compartment situated 2/3 down the length of the vehicle.
- At the position designated by a \ast at 1,7 m above the floor.

Position of the measuring points in open saloon vehicles:

- At positions designated by a \diamond in the row adjacent to the vestibule.
- At positions designated by a \diamond in a row situated in about the middle of the largest saloon.
- At the position designated by a \ast at 1,7 m above the floor.

NOTE For vehicles not included in the above categories (sleeper or restaurant cars), one should determine, by analogy, representative measuring points.

Annex E
(normative)

Location of the measuring points used for the determination of the variation of internal temperatures within the comfort envelope

Table E.1 — Measuring points

◇	Measuring points (See Annex D)
○	Head
□	Shoulders
▽	Knees
△	Feet

Dimensions in metres

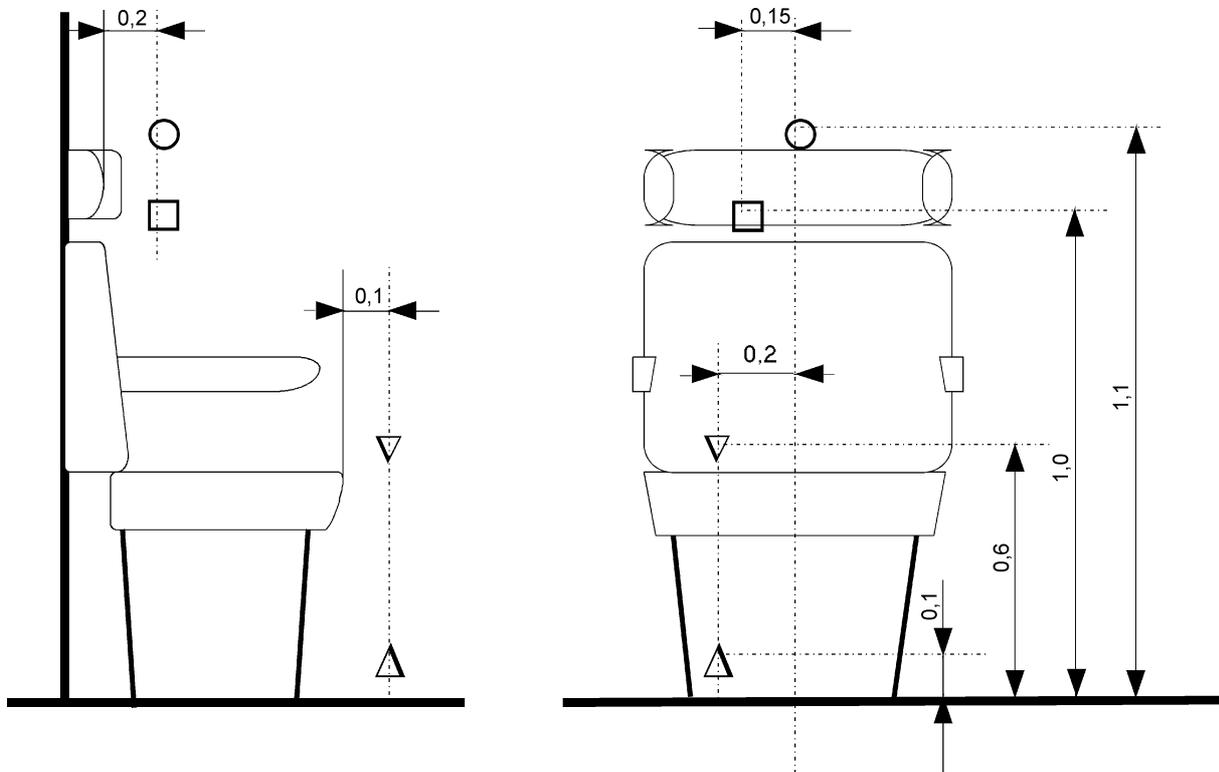


Figure E.1 — Seats

Dimensions in metres

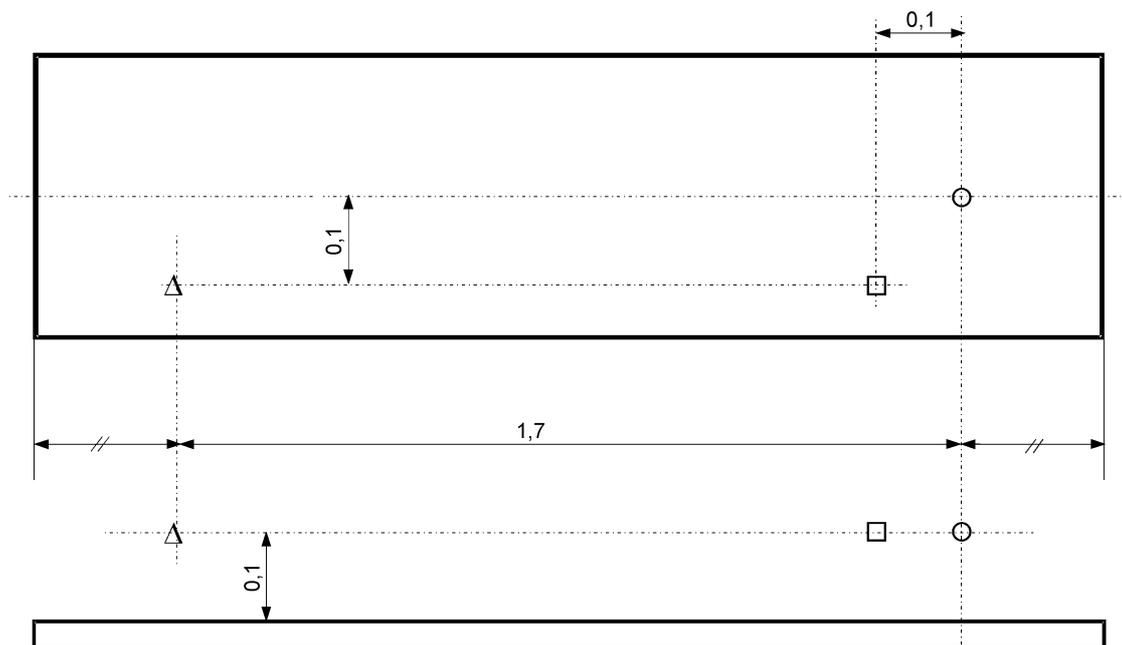


Figure E.2 — Sleeping berths

Annex F (normative)

Location of the measuring points used for the determination of surface temperatures

The measurements should be taken in the same compartments or zones as specified in Annex D.

Floors and ceilings:

The temperature is measured at the geometric positions of the zones as defined in Annex D.

Glass:

The temperature is measured at the geometric centre of the pane(s) making up the window.

Window frames:

The temperature is measured at the middle of each vertical member of the window frame.

Walls:

— walls laterally adjacent to a seat:

The temperature is measured at the same level as shoulders and knees as per Annex E.

— other walls (adjacent to a local annex):

The temperature is measured as close as possible to the geometric centre of the wall.

Annex G (normative)

Location of the measuring points used for the determination of air speeds in the comfort envelope

Choice of seating positions:

The worst seating positions are those where the air speed measured at 1,1 m from the floor is maximum.

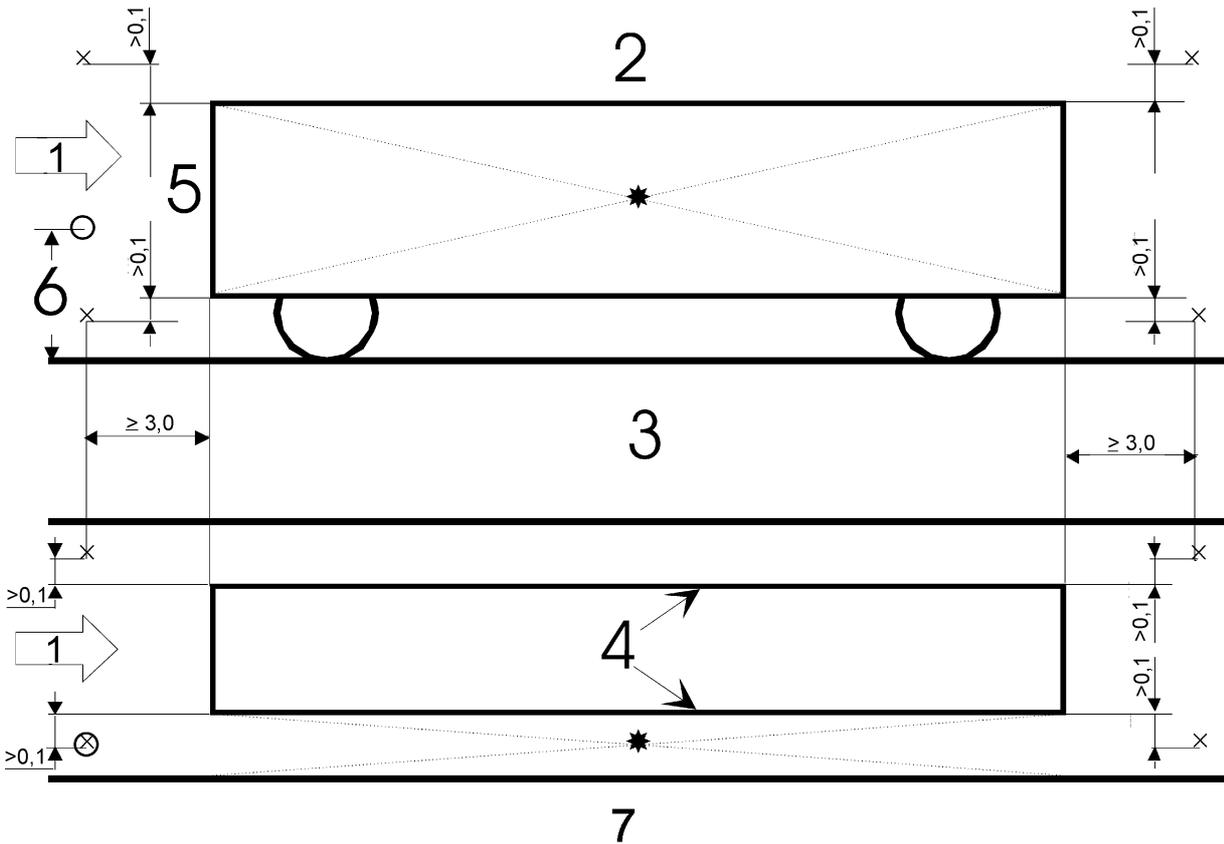
Measuring points:

The measuring points for each of the three positions are at the head (seated position), at the shoulders and at the feet according to the locations shown in Annex E.

Annex H
(normative)

Location of the sensors in the climatic chamber

Dimensions in metres



Key

- | | | | |
|---|------------------------|---|-------------------------|
| 1 | Wind | 6 | Fresh air grille height |
| 2 | Roof apex | 7 | Plan |
| 3 | Elevation | x | Temperature sensors (8) |
| 4 | Vehicle exterior faces | o | Humidity sensor (1) |
| 5 | End of vehicle | * | Air speed sensor (1) |

Figure H.1 — Measuring points

T_{em} is the arithmetic mean of the eight temperature measurement points.

