

English Version

## Railway applications - Air conditioning for urban and suburban rolling stock - Part 2: Type tests

Applications ferroviaires - Conditionnement de l'air pour matériel roulant urbain et banlieue - Partie 2: Essais de type

Bahnwendungen - Luftbehandlung in Schienenfahrzeugen des innerstädtischen und regionalen Nahverkehrs - Teil 2: Typprüfungen

This European Standard was approved by CEN on 27 April 2006.

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# Contents

Page

Foreword.....	4
Introduction .....	5
1 Scope .....	6
2 Normative references .....	6
3 Terms and definitions .....	6
4 Test classification.....	6
5 Preliminary verifications .....	7
6 Comfort tests.....	7
6.1 Air movement.....	7
6.1.1 General remarks.....	7
6.1.2 Air flow rates .....	7
6.1.3 Pressure differentials (visualisation).....	7
6.2 Critical air speed .....	7
6.3 Measurement of air speeds .....	7
7 Climatic tests.....	8
7.1 General remarks.....	8
7.2 Preheating test.....	8
7.2.1 Test level TL1 .....	8
7.2.2 Test level TL2 .....	8
7.3 Pre-cooling test.....	8
7.3.1 Test level TL1 .....	8
7.3.2 Test level TL2 .....	8
7.4 Regulation tests .....	9
7.5 Tests with door open/closed .....	9
8 Tests at extreme exterior operating conditions .....	9
9 Complementary tests .....	9
9.1 Determination of the coefficient $k$ .....	9
9.1.1 Purpose of the test .....	9
9.1.2 Definition .....	9
9.1.3 Procedure .....	10
9.2 Thermography.....	10
9.3 Noise emission.....	10
9.4 Vibration generation.....	10
10 Methods of measurement – Measuring instruments .....	10
10.1 General remarks.....	10
10.2 Temperatures .....	11
10.2.1 Air temperature .....	11
10.2.2 Surface temperatures.....	11
10.3 Relative humidity .....	11
10.4 Air speed.....	11
10.5 Airflow rate .....	11
10.6 Simulated speed of the vehicle .....	11
10.7 Equivalent solar load.....	11
10.8 Energy consumption and power rating .....	11
11 Characteristics of the test equipment .....	11
11.1 General remarks.....	11

11.2	Occupation .....	12
11.3	Equivalent solar load .....	12
11.3.1	Solar load calculation .....	12
11.3.2	Window area .....	12
11.3.3	Wall area .....	13
11.3.4	Roof area .....	13
12	Distribution of measuring points .....	13
12.1	General .....	13
12.2	Distribution of sensors in the vehicle .....	14
12.2.1	Comfort envelope temperature measurement points .....	14
12.2.2	Surface temperature measurement points .....	14
12.2.3	Supply air outlet temperature measurement points .....	14
12.2.4	Comfort envelope air speed measurement points .....	14
12.2.5	Comfort envelope relative humidity measurement points .....	14
12.3	Climatic chamber sensor distribution .....	14
Annex A	(normative) Test programme for TL1 .....	15
Annex B	(normative) Test programme for TL2 .....	17
Annex C	(normative) Equivalent solar load .....	22
Annex D	(normative) Location of the measuring points used for the determination of the mean interior temperature (T <sub>im</sub> ), the determination of the range of extreme interior temperatures and the relative humidity in the comfort envelopes and local annexes .....	23
D.1	Vehicles without articulation .....	23
D.2	Vehicles with articulation .....	24
Annex E	(normative) Location of the measuring points used for the determination of surface temperatures .....	25
Annex F	(normative) Location of sensors .....	26

## Foreword

This document (EN 14750-2:2006) 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 December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

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 Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 coordinating the procurement procedures of entities operating in the water, energy, transport and postal services<sup>1)</sup>.

This series of European Standards includes the following parts:

- EN 14750-1, *Railway applications — Air conditioning for urban and suburban rolling stock — Part 1: Comfort parameters*;
- EN 14750-2, *Railway applications — Air conditioning for urban and suburban rolling stock — Part 2: Type tests*.

In the context of this series, there are two further series on air conditioning in rolling stock:

- 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*;
- EN 14813-1, *Railway applications — Air conditioning for driving cabs — Part 1: Comfort parameters*;
- EN 14813-2, *Railway applications — Air conditioning for driving cabs — Part 2: Type tests*.

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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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1) Official Journal No L 134 of 30.4.2004.

## Introduction

The object of this European Standard is to establish programmes and test methods to verify the air conditioning installations as described in EN 14750-1.

If necessary, the revised requirements due to the operating constraints of the vehicle will be detailed in the contractual specification. This European Standard applies if there is no particular clause in the contractual specification.

## 1 Scope

This European Standard is applicable to suburban and/or regional vehicles and also metro and tramway vehicles equipped with cooling and/or heating/ventilation systems. This European Standard excludes main line vehicles and driving cabs which are considered in separate European Standards.

This European Standard specifies the comfort parameter measurement methods for compartment or saloon (single level or double-decker).

The comfort parameters and their tolerances cited in this European Standard are defined in EN 14750-1.

## 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 14750-1:2006, *Railway applications — Air conditioning for urban and suburban rolling stock — Part 1: Comfort parameters*

EN ISO 3381, *Railway applications — Acoustics — Measurement of noise inside railbound vehicles (ISO 3381:2005)*

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

CIE 85, *Solar spectral irradiance*<sup>2)</sup>

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14750-1:2006 apply.

## 4 Test classification

Two levels of testing are detailed in this European Standard.

TL1 is a simplified level that gives principle information about the functionality of the system. It does not aim to verify the comfort parameters and performance of the system. It can be done in a workshop or at a yard.

TL2 is a full level test to verify the comfort parameters and the performance of the system. This test shall be performed in a climatic chamber or in appropriate environment.

The test classification shall be detailed in the contractual specification.

In the absence of any specified contractual detail, the full level of testing (TL2) shall apply. If not stated otherwise, the following requirements apply to both TL1 and TL2.

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

## 5 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, the water tightness of the vehicle and the thermal capacity of the air conditioning equipment. These verifications should be conducted before proceeding to the comfort test.

## 6 Comfort tests

### 6.1 Air movement

#### 6.1.1 General remarks

The tests shall be carried out under the following conditions:

- vehicle stationary and protected from bad weather;
- altitude < 1 000 m above sea level;
- exterior air speed between 0 km/h and 5 km/h;
- exterior temperature between + 15 °C and + 30 °C.

Where altitudes and exterior temperatures different to those stated above are used, corrections in relation to normal atmospheric conditions shall be made.

#### 6.1.2 Air flow rates

The flow rates of outside air (fresh air) shall be measured in accordance with 10.5.

#### 6.1.3 Pressure differentials (visualisation)

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

In particular, this visualisation shall be made for 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.

### 6.2 Critical air speed

Air velocities shall be measured at a height of 1,10 m above the floor at all seat positions and at 1,70 m above the floor at the positions as defined in Annex D. The purpose of these measurements is to find the location with the highest air velocity in the comfort envelope. When the distribution or air flows are different in heating, cooling or ventilation mode, the location with the highest air velocity shall be found in each mode. These critical high air velocity locations shall be used for the detailed measurement of the air velocities and air temperature for validating the acceptable air velocity requirements in the comfort envelope.

### 6.3 Measurement of air speeds

These tests shall be carried out during the climatic tests without the simulation of the thermal and volumetric effects of occupation (the heating elements, humidification, and ventilation equipment necessary or passenger dummies can affect the measurement inside the comfort envelope).

## **7 Climatic tests**

### **7.1 General remarks**

Annex A defines the test programme for test level TL1. The tests shall only be carried out on a stationary vehicle at an air speed as defined in Annex A.

Annex B defines the test programme for test level TL2 which enables the verification of comfort parameters defined in EN 14750-1. The order of the tests is not obligatory but shall be compatible with the physical conditions of the test and the means of measurement.

Throughout the tests, all the values at the measuring points defined in Clause 12 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 the doors, the toilet equipment, the power supply, the lighting etc. need to be tested, these tests shall not interfere in any way with the tests on the air conditioning systems.

### **7.2 Preheating test**

#### **7.2.1 Test level TL1**

The test conditions for preheating are defined in Annex A.

The vehicle shall be placed in the test area at least 8 h prior to testing, with the heating installation switched off.

Before the start of the preheating test, the interior air and surface temperatures shall be stabilised for at least 15 min within  $\pm 2$  K of the exterior air temperature.

#### **7.2.2 Test level TL2**

The test conditions for preheating are defined in Annex B.

Before the start of the preheating test, the interior air and surface temperatures shall be stabilised for at least 1 h within  $\pm 1$  K of the exterior air temperature.

### **7.3 Pre-cooling test**

#### **7.3.1 Test level TL1**

The test conditions for pre-cooling are defined in Annex A.

The vehicle shall be placed in the test area at least 8 h prior to testing, with the air conditioning installations switched off.

Before the start of the pre-cooling test, the interior air and surface temperatures shall be stabilised for at least 15 min within  $\pm 2$  K of the exterior air temperature. At this time, before starting the pre-cooling test, the artificial sunlight equipment or equivalent heating power shall be switched on for 2 h, corresponding to the values given in Annex E of EN 14750-1:2006 with all doors and windows closed.

#### **7.3.2 Test level TL2**

The test conditions for pre-cooling are defined in Annex B.



Before the start of the pre-cooling test, the interior air and surface temperatures shall be stabilised for at least 1 h within  $\pm 1$  K of the exterior air temperature. At this time, before starting the pre-cooling test, the artificial sunlight equipment or equivalent heating power shall be switched on for 2 h, corresponding to the values given in Annex E of EN 14750-1:2006 with all doors and windows closed.

## 7.4 Regulation tests

The test conditions are defined in Annex A and Annex B.

Starting from stabilised operation (see 3.35 of EN 14750-1:2006), after a changing of a parameter (interior or exterior), wait 60 min or three similar consecutive control cycles, then the results obtained shall be in accordance with the requirements defined in EN 14750-1.

## 7.5 Tests with door open/closed

The test conditions are defined in Annex A and Annex B.

Starting from stabilised operation (see 3.35 of EN 14750-1:2006), tests shall be performed according to 10.2 of EN 14750-1:2006.

## 8 Tests at extreme exterior operating conditions

The operation of the air conditioning equipment shall be checked at the extreme operating temperatures defined in 6.2 of EN 14750-1:2006.

At test level TL1, the tests could be carried out on the air conditioning equipment, prior to its installation onto the vehicle.

## 9 Complementary tests

### 9.1 Determination of the coefficient $k$

#### 9.1.1 Purpose of the test

The coefficient  $k$  characterises the thermal quality of a vehicle (efficiency of the insulation). The test shall be carried out only at TL2. The test conditions are defined in Annex B.

#### 9.1.2 Definition

The global coefficient  $k$  is defined by the following equation:

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

- 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 1,10 m, of all or part of the vehicle according to Annex D, and the mean exterior temperature ( $T_{em}$ ).

### **9.1.3 Procedure**

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

The air conditioning installation shall be isolated. The vehicle shall be without power (except for the batteries), the doors, and the windows shall be closed. Sealed gangways shall be normally only blocked by the vehicle door. Gangways without a vehicle door or unsealed 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 achieved by fans. The power consumption of the heating system and the fans shall be recorded separately.

All the measured data shall be recorded at least once per minute.

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

The output of the heating system and of the ventilation shall be maintained constant, the determination of the coefficient  $k$  shall be 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  $2 \text{ K}$ .

The coefficient  $k$  shall be calculated using the measurements taken during the last hour of stabilisation of temperatures.

## **9.2 Thermography**

Thermography should be used as a tool to investigate the thermal quality of the vehicle.

## **9.3 Noise emission**

The measurement of noise shall be carried out with the air conditioning installation functioning alone during any operating mode (excluding vehicle preparation) in accordance with EN ISO 3381.

## **9.4 Vibration generation**

The measurement of vibration shall be carried out on a stationary vehicle with the air conditioning installation functioning at a level which corresponds to the requirements of the contractual specification.

# **10 Methods of measurement – Measuring instruments**

## **10.1 General remarks**

Continuous recording should be carried out, taking as a base a minimum sampling rate of one measurement per minute for all the values recorded. All measuring devices shall be calibrated.

## **10.2 Temperatures**

### **10.2.1 Air temperature**

The measuring devices shall be Class S according to EN ISO 7726:2001, Table 2, and have a maximum drift of 0,25 K over the duration of recording.

### **10.2.2 Surface temperatures**

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

The class of measuring devices shall be identical to that specified in 10.2.1.

## **10.3 Relative humidity**

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

## **10.4 Air speed**

Continuous recording should be carried out, taking as a base a sampling rate 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 devices shall be Class C of EN ISO 7726:2001, Table 2.

## **10.5 Airflow rate**

The airflow shall be determined using a system of measurement which enables the recording of results with a minimum accuracy of 10 %; 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.

## **10.6 Simulated speed of the vehicle**

The speed of the air around the vehicle shall be determined by a calibrated system of measurement which enables the recording of results with a minimum accuracy of  $\pm 1$  m/s.

## **10.7 Equivalent solar load**

The measurement of the equivalent solar load shall be achieved by a calibrated system of measurement. This measurement shall be carried out in accordance with the procedure described in Annex C.

## **10.8 Energy consumption and power rating**

The measurements shall be carried out using the instruments having an accuracy of within 1 %.

# **11 Characteristics of the test equipment**

## **11.1 General remarks**

If the tests are performed in a climatic chamber, this chamber shall be approved by a certification organisation.

The allowable ranges of exterior temperature, exterior relative humidity and exterior air velocity stated in Annex A and Annex B shall be maintained throughout the tests.

## 11.2 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 14750-1:2006.

For the simulation of the sensible heat, equipment of low radiance whose surface temperature is less than + 40 °C shall be used.

The simulation of the latent heat shall be 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.

## 11.3 Equivalent solar load

If available, the equipment which simulates the equivalent solar load based on the index of terrestrial radiation (global solar load) of 1 120 W/m<sup>2</sup> in accordance with the CIE 85 should be composed of lamps whose characteristics comply with Table 1.

However, lamps which give an equivalent solar load can be used.

**Table 1 — Characteristics of solar radiation lamps**

Wavelength	Total radiation compared with terrestrial radiation given in CIE 85	Allowable variation
Nanometer	%	%
280 to 400	6,1	± 3
400 to 800	51,8	± 5
800 to 3 000	42,1	± 5

For TL1, if solar radiation lamps are not available, the equivalent solar load may be calculated by the following approximate method and simulated by evenly distributed floor-mounted heating elements within the vehicle interior. The maximum power of each heating element shall not exceed 500 W.

### 11.3.1 Solar load calculation

$$Q_S = Q_{S,F} + Q_{S,W} + Q_{S,D}$$

where

$Q_S$  is the total solar load, in W;

$Q_{S,F}$  is the solar load of the window area, in W;

$Q_{S,W}$  is the solar load of the side wall area, in W;

$Q_{S,D}$  is the solar load of the roof area, in W.

### 11.3.2 Window area

$$Q_{S,F} = A_F d_F q_{s,w} = A_F d_F E_n \cos 30$$

where

$A_F$  is the each side wall window area, in  $m^2$ ;

$d_F$  is the overall transmission factor of the windows 0,3 to 0,8;

$q_{s,w}$  is the heat load due to solar radiation on a vertical window, in  $W/m^2$ ;

$E_n$  is the equivalent solar load of the zone in accordance with Annex E of EN 14750-1:2006, in  $W/m^2$ .

### 11.3.3 Wall area

$$Q_{S,W} = \frac{k_w A_W}{\alpha_a} \varepsilon q_{s,w} = \frac{k_w A_W}{9} \varepsilon E_n \cos 30$$

where

$k_w$  is the  $k$ -value of the side wall, in  $W/m^2K$ ;

$A_W$  is the total surface of one side wall excluding window area, in  $m^2$ ;

$\alpha_a$  is the outside air heat transfer coefficient in stationary condition, in  $W/m^2K$ ;

$\varepsilon$  is the solar absorption factor 0,5 to 0,8 according to surface finishing;

$q_{s,w}$  is the heat load due to solar radiation on a vertical side wall, in  $W/m^2$ ;

$E_n$  is the equivalent solar load of the zone in accordance with Annex E of EN 14750-1:2006, in  $W/m^2$ .

### 11.3.4 Roof area

$$Q_{S,D} = \frac{k_d A_D}{\alpha_a} \varepsilon q_{s,d} = \frac{k_d A_D}{9} \varepsilon E_n \sin 30$$

where

$k_d$  is the  $k$ -value of the roof, in  $W/m^2K$ ;

$A_D$  is the total surface of the roof, in  $m^2$ ;

$\alpha_a$  is the outside air heat transfer coefficient in stationary condition, in  $W/m^2K$ ;

$\varepsilon$  is the solar absorption factor 0,5 to 0,8 according to surface finishing;

$q_{s,d}$  is the heat load due to solar radiation on the roof, in  $W/m^2$ ;

$E_n$  is the equivalent solar load of the zone in accordance with Annex E of EN 14750-1:2006, in  $W/m^2$ .

## 12 Distribution of measuring points

### 12.1 General

The measurement point positions are as indicated below. If for physical or environmental reasons it is not possible to measure in the point defined, the measurement point shall be detailed by the contractual specification.

## **12.2 Distribution of sensors in the vehicle**

### **12.2.1 Comfort envelope temperature measurement points**

These are defined in Annex D.

### **12.2.2 Surface temperature measurement points**

These are defined in Annex E.

### **12.2.3 Supply air outlet temperature measurement points**

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

### **12.2.4 Comfort envelope air speed measurement points**

These are defined in 6.2.

### **12.2.5 Comfort envelope relative humidity measurement points**

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

## **12.3 Climatic chamber sensor distribution**

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

## Annex A (normative)

### Test programme for TL1

**Table A.1 — Tests in heating mode for TL1**

Test	Description of test	Mean exterior temperature (Tem) °C	Relative humidity %	Air speed km/h	Simulation of occupation of the vehicle %	Equivalent solar load %	Position of the Tic control device	Remarks
TL 110	Preheating	< + 5	—	0 to 15	0	0	Normal	
TL 111	Regulation	< + 5	—	0 to 15	0	0	Normal	
TL 112	Regulation	< + 5	—	0 to 15	0	0	Extreme position	If a control device is a contractual requirement.
TL 113	Heating performance	< + 5	—	0 to 15	0	0	Manual control	Manual control means to bypass the regulation to test the performance.
TL 114	Door opening	< + 5	—	0 to 15	0	0	Normal	

Table A.2 — Tests in cooling mode for TL1

Test	Description of test	Mean exterior temperature (Tem) °C	Relative humidity %	Air speed km/h	Simulation of occupation of the vehicle %	Equivalent solar load %	Position of the Tic control device	Remarks
TL 120	Pre-cooling	> Tem	–	0 to 15	0	100	Normal	
TL 121	Regulation	> Tem	–	0 to 15	0	100	Normal	
TL 122	Regulation	> Tem	–	0 to 15	100	100	Normal	
TL 123	Cooling performance	> Tem	–	0 to 15	100	100	Manual control	Manual control means to bypass the regulation to test the performance.
TL 124	Door opening	> Tem	–	0 to 15	100	100	Normal	Sequence in accordance with 10.2 of EN 14750-1:2006.
Tem = + 25 °C for zone II and III and Tem = + 30 °C for zone I Equivalent solar load 100 %: 800 W/m <sup>2</sup> for zone I, 700 W/m <sup>2</sup> for zone II, 600 W/m <sup>2</sup> for zone III								



## Annex B (normative)

### Test programme for TL2

**Table B.1 — Tests in heating mode – Category A for TL2**

Test	Description of test	Mean exterior temperature (Tem) <sup>a</sup> °C	Relative humidity %	Air speed km/h	Simulation of occupation of the vehicle %	Equivalent solar load %	Position of the Tic control device <sup>b</sup>	Remarks
TL 210	Preheating	Tem	–	0 to 15	0	0	Normal	
TL 211	Regulation	Tem	–	0 to 15	0	0	Normal	
TL 212	Regulation	Tem	–	0 to 15	0	0	Extreme positions	If a control device is a contractual requirement.
TL 213	Heating performance	Tem	–	Maximum operational speed	0	0	Manual control	If maximum operational air speed possible. Manual control means to bypass the regulation to test the performance.
TL 214	Preheating	0	–	0 to 15	0	0	Normal	
TL 215	Regulation	0	–	0 to 15	0	0	Normal	
TL 216	Regulation	0	–	Maximum operational speed	0	0	Normal	If possible.
TL 217	Regulation	0	–	0 to 15	100	0	Normal	
TL 218	Door opening	0	–	0 to 15	0	0	Normal	Sequence in accordance with 10.2 of EN 14750-1:2006.

Table B.1 (concluded)

Test	Description of test	Mean exterior temperature (Tem) <sup>a</sup> °C	Relative humidity %	Air speed km/h	Simulation of occupation of the vehicle %	Equivalent solar load %	Position of the Tic control device <sup>b</sup>	Remarks
TL 219	Static k value	+ 5	–	0 to 15	0	0	Normal	
<sup>a</sup> Acceptable tolerance for Tem is $\pm 2$ K. <sup>b</sup> The normal position refers to the interior temperature setting (Tic). Tem = - 10 °C for zone I and Tem = - 20 °C for zone II and III								

Table B.2 — Tests in cooling mode – Category A for TL2

Test	Description of test	Mean exterior temperature (Tem) <sup>a</sup> °C	Relative humidity <sup>b</sup> %	Air speed km/h	Simulation of occupation of the vehicle %	Equivalent solar load %	Position of the Tic control device <sup>c</sup>	Remarks
TL 220	Pre-cooling	Tem 1	RH1	0 to 15	0	100	Normal	
TL 221	Regulation	Tem 1	RH1	0 to 15	0	100	Normal	
TL 222	Regulation	Tem 1	RH1	0 to 15	100	100	Normal	
TL 223	Cooling performance	Tem 1	RH1	0 to 15	100	100	Manual control	Manual control means to bypass the regulation to test the performance.
TL 224	Regulation	Tem 2	RH2	0 to 15	0	0	Normal	
TL 225	Regulation	Tem 2	RH2	0 to 15	0	100	Normal	
TL 226	Regulation	Tem 2	RH2	0 to 15	100	100	Normal	
TL 227	Door opening	Tem 2	RH2	0 to 15	100	100	Normal	Sequence in accordance with 10.2 of EN 14750-1:2006.
TL 228	Regulation	Tem 2	RH2	0 to 15	100	100	Extreme positions	If a control device is a contractual requirement.
<sup>a</sup> Acceptable tolerance for Tem is $\pm 2$ K. <sup>b</sup> Acceptable tolerance for relative humidity is $\pm 5$ %. <sup>c</sup> The normal position refers to the interior temperature setting (Tic).								

Zone (summer)	Tem 1	RH1	Equivalent solar load 100 %
I	+ 40 °C	40 %	800 W/m <sup>2</sup>
II	+ 35 °C	50 %	700 W/m <sup>2</sup>
III	+ 28 °C	45 %	600 W/m <sup>2</sup>

Zone (summer)	Tem 2	RH2	Equivalent solar load 100 %
I	+ 33 °C	40 %	800 W/m <sup>2</sup>
II	+ 28 °C	60 %	700 W/m <sup>2</sup>
III	+ 22 °C	45 %	600 W/m <sup>2</sup>

Table B.3 — Tests in heating mode – Category B for TL2

Test	Description of test	Mean exterior temperature (Tem) <sup>a</sup> °C	Relative humidity %	Air speed km/h	Simulation of occupation of the vehicle %	Equivalent solar load %	Position of the Tic control device <sup>b</sup>	Remarks
TL 212	Regulation	Tem	–	0 to 15	0	0	Extreme positions	If a control device is a contractual requirement.
TL 213	Heating performance	Tem	–	Maximum operational speed	0	0	Manual control	If maximum operational air speed possible. Manual control means to bypass the regulation to test the performance.
TL 214	Preheating	0	–	0 to 15	0	0	Normal	
TL 215	Regulation	0	–	0 to 15	0	0	Normal	
TL 216	Regulation	0	–	Maximum operational speed	0	0	Normal	If possible
TL 217	Regulation	0	–	0 to 15	100	0	Normal	
TL 218	Door opening	0	–	0 to 15	0	0	Normal	Sequence in accordance with 10.2 of EN 14750-1:2006
TL 219	Static k value	+ 5	–	0 to 15	0	0		
<sup>a</sup> Acceptable tolerance for Tem is $\pm 2$ K. <sup>b</sup> The normal position refers to the interior temperature setting (Tic). Tem = 0 °C for zones I and II and Tem = - 10 °C for zone III								

Table B.4 — Tests in cooling mode – Category B for TL2

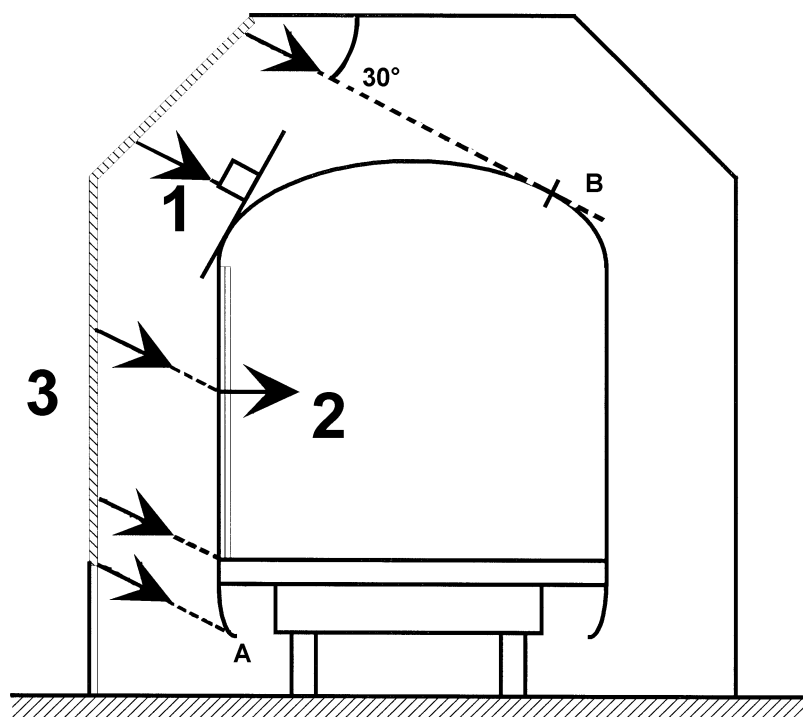
Test	Description of test	Mean exterior temperature (Tem) <sup>a</sup> °C	Relative humidity <sup>b</sup> %	Air speed km/h	Simulation of occupation of the vehicle %	Equivalent solar load %	Position of the Tic control device <sup>c</sup>	Remarks
TL 220	Precooling	Tem 1	RH1	0 to 15	0	100	Normal	
TL 221	Regulation	Tem 1	RH1	0 to 15	0	100	Normal	
TL 222	Regulation	Tem 1	RH1	0 to 15	100	100	Normal	
TL 223	Cooling performance	Tem 1	RH1	0 to 15	100	100	Manual control	Manual control means to bypass the regulation to test the performance.
TL 226	Regulation	Tem 2	RH2	0 to 15	100	100	Normal	
TL 227	Door opening	Tem 2	RH2	0 to 15	100	100	Normal	Sequence in accordance with 10.2 of EN 14750-1:2006.
TL 228	Regulation	Tem 2	RH2	0 to 15	100	100	Extreme positions	If a control device is a contractual requirement.
<sup>a</sup> Acceptable tolerance for Tem is $\pm 2$ K. <sup>b</sup> Acceptable tolerance for relative humidity is $\pm 5$ %. <sup>c</sup> The normal position refers to the interior temperature setting (Tic).								

Zone (summer)	Tem 1	RH1	Equivalent solar load 100 %
I	+ 40 °C	40 %	800 W/m <sup>2</sup>
II	+ 35 °C	50 %	700 W/m <sup>2</sup>
III	+ 28 °C	45 %	600 W/m <sup>2</sup>

Zone (summer)	Tem 2	RH2	Equivalent solar load 100 %
I	+ 33 °C	40 %	800 W/m <sup>2</sup>
II	+ 28 °C	60 %	700 W/m <sup>2</sup>
III	+ 22 °C	45 %	600 W/m <sup>2</sup>

## Annex C (normative)

### Equivalent solar load



#### Key

- 1  $E_n$  equivalent solar load on a surface perpendicular to the radiation
- 2  $E_v = E_n \cos 30^\circ = 0,866 E_n$  = equivalent solar load on the side wall surface of the vehicle  
 $E_n$  is defined in Annex E of EN 14750-1:2006
- 3 solar radiation lamps

**Figure C.1 — Simulation of solar exposure**

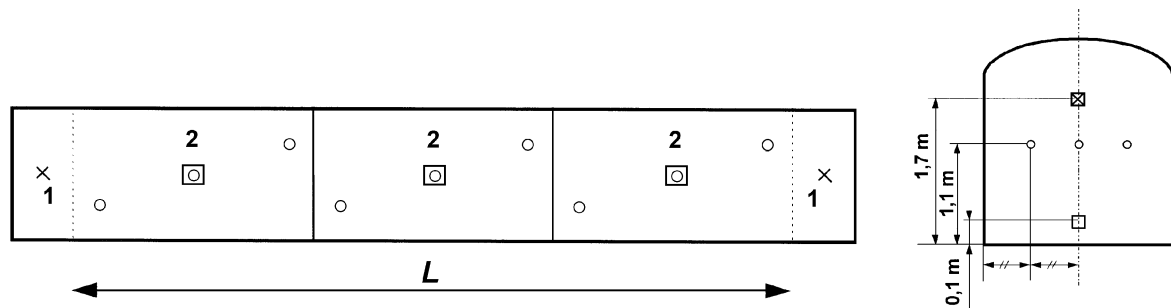
- Whatever type of vehicle, it is recommended that solar radiation is available between points A and B (compartments on the side of the lamps for compartmented vehicles);
- the bank of solar radiation lamps shall be at minimum, the same length as the vehicle on test.

## Annex D (normative)

### Location of the measuring points used for the determination of the mean interior temperature ( $T_{im}$ ), the determination of the range of extreme interior temperatures and the relative humidity in the comfort envelopes and local annexes

#### D.1 Vehicles without articulation

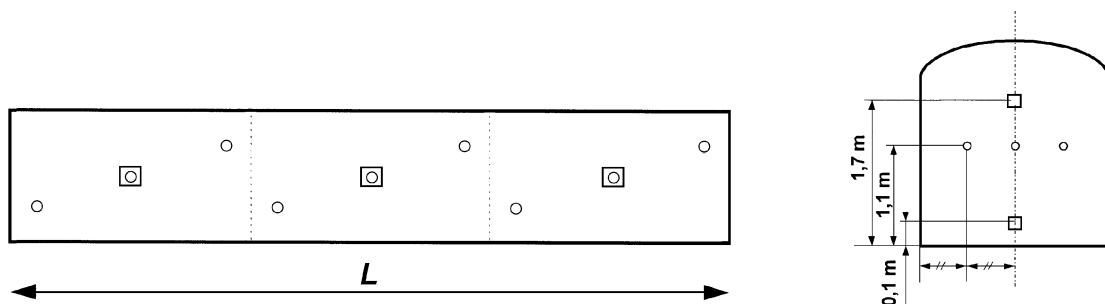
Two types of vehicles without articulation are illustrated in Figures D.1 and D.2.



#### Key

- 1 vestibule
- 2 sitting area
- $L$  length

Figure D.1 — Vehicles with vestibules



#### Key

- $L$  length

Figure D.2 — Vehicles without vestibules

A module shall be a part of a vehicle of length  $L$  located between two physically separated entrance areas or vestibules. When the entrance areas are not physically separated, the module shall correspond to the vehicle length.

Each vehicle module of length  $L$  shall be divided into two or three zones:

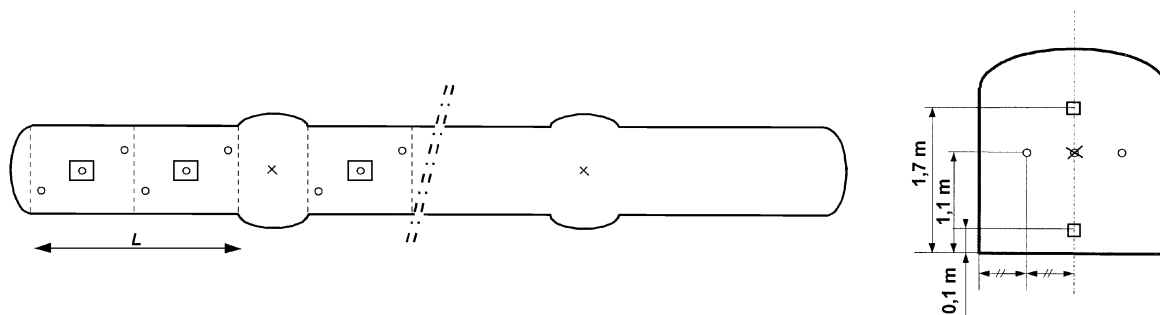
$L \leq 10$  m              two zones;

$L > 10$  m              three zones.

Relative humidity shall be measured in the geometric centre of each module at height of 1,10 m above floor.

Interior air temperatures shall be measured at all marked measuring points.

## D.2 Vehicles with articulation



### Key

$L$     length

**Figure D.3 — Vehicles with articulation**

A module shall be limited by two articulations or one articulation and the rest of the vehicle.

Each vehicle module of length  $L$  shall be divided into one or more zones:

$L > 10$  m              three zones;

$L > 5$  m and  $L \leq 10$  m    two zones;

$L \leq 5$  m              one zone

Relative humidity shall be measured in the geometric centre of each module at height of 1,10 m above floor.

Interior air temperatures shall be measured at all marked measuring points.

If the modules are identical, only one needs to be tested.



## Annex E (normative)

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

The measurements shall be taken in a cross section through the centre of a window close to the geometric centre of each zone.

#### Floors and ceilings

The temperature shall be measured as close as possible to the middle of the cross section. For the floor, an additional temperature shall be measured in the quarter of the cross section (see Figure E.1).

#### Glass

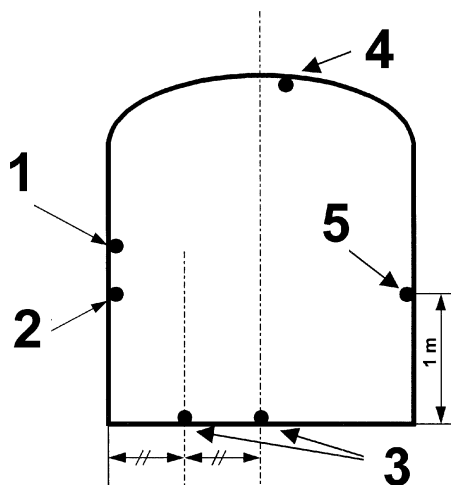
The temperature shall be measured at the geometric centre of the pane(s) making up the window.

#### Window frames

The temperature shall be measured at the middle of a vertical member of the window frame.

#### Side walls

The temperature shall be measured as close as possible to the defined cross section on the side wall at the height shown in Figure E.1.



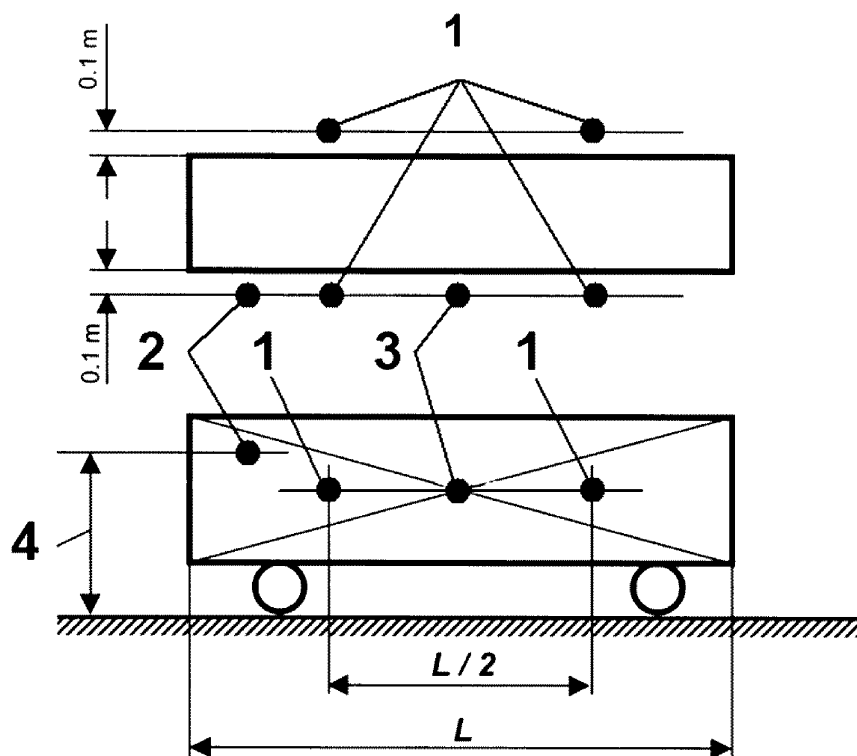
#### Key

- 1 glass
- 2 window frame
- 3 floor
- 4 ceiling
- 5 side wall

Figure E.1 — Surface measuring points of one cross section

## Annex F (normative)

### Location of sensors



#### Key

- 1 temperature sensors (four)
- 2 humidity sensor, one humidity sensor positioned 0,1 m from each vehicle fresh air inlet grill
- 3 air speed sensor (one)
- 4 fresh air grille height

**Figure F.1 — Location of sensors**

$T_{em}$  is the arithmetic mean value of the four temperature measurement points.

In climatic chambers fixed installed sensors can be used instead of these sensors if the same results can be ensured by validation.

