

Railway applications — Air conditioning for urban and suburban rolling stock —

Part 1: Comfort parameters

The European Standard EN 14750-1:2006 has the status of a
British Standard

ICS 45.080.01

National foreword

This British Standard is the official English language version of EN 14750-1:2006.

The UK participation in its preparation was entrusted by Technical Committee RAE/1, Railway applications, to Subcommittee RAE/1/-/6, Air conditioning, heating and ventilation, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Railway applications - Air conditioning for urban and suburban rolling stock - Part 1: Comfort parameters

Applications ferroviaires - Conditionnement de l'air pour matériel roulant urbain et banlieue - Partie 1: Paramètres de bien-être

Bahnanwendungen - Luftbehandlung in Schienenfahrzeugen des innerstädtischen und regionalen Nahverkehrs - Teil 1: Behaglichkeitsparameter

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

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Foreword

This document (EN 14750-1:2006) 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of an identical text or by endorsement, at the latest by December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.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 services¹⁾.

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.

1) Official Journal No L 134 of 30.4.2004.

Introduction

The object of this European Standard is to establish common comfort parameters for the European railways. It also specifies the performance of the air-conditioning installations.

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 comfort parameters for compartment or saloon (single level or double-decker).

These comfort parameters apply in a similar way to the areas reserved for train staff, with the exception of the catering service areas.

The conditions under which the physical parameters mentioned in this European Standard shall be measured are defined in EN 14750-2.

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 779:2002, *Particulate air filters for general ventilation — Determination of the filtration performance*

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

EN 50126, *Railway applications — The specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

comfort

agreeable sensation perceived by a person concerning his climatic environment

3.2

air conditioning installations

equipment intended for ventilation and/or heating and/or cooling and/or filtration

3.3

forced air ventilation

air circulation generated by a mechanical action

3.4

natural ventilation

air circulation generated without mechanical action

3.5

preheating

process which enables the interior temperature to be raised without the presence of passengers

3.6**precooling**

process which enables the interior temperature to be lowered without the presence of passengers

3.7**heating**

process which enables the interior temperature to be raised or maintained

3.8**cooling**

process which enables the interior temperature to be lowered or maintained

3.9**dehumidification**

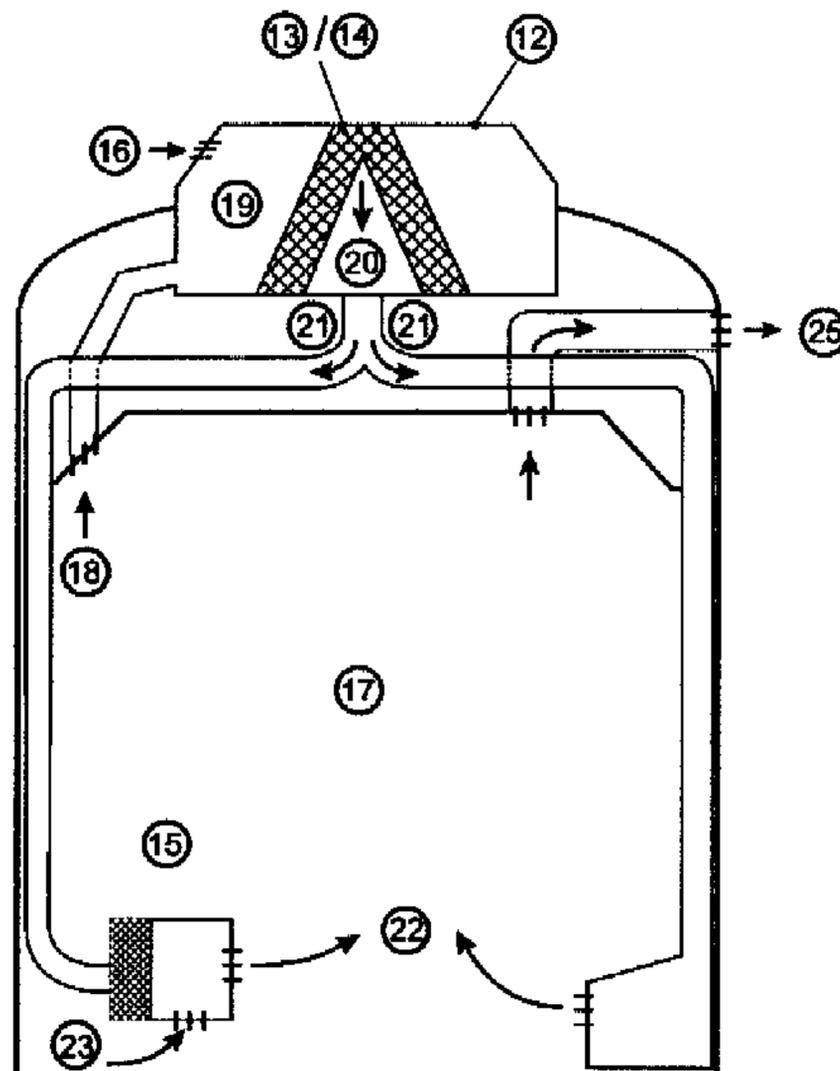
process which reduces the content of water in the interior air

3.10**air conditioning**

system which includes ventilation, heating, cooling and/or dehumidification

3.11**heating and ventilation**

system which includes ventilation and heating



NOTE 1 The representation is only given as an example and does not prejudice the design of the installation.

NOTE 2 Items 13 and 14 can be "and/or".

Figure 1 — Diagram explaining certain ventilation terms in railway environment

3.12

air handling unit

group of components designed to move, filter and/or mix, heat and/or cool the air (see Figure 1, No 12)

3.13

cooling unit

system that carries out the cooling function in a centralised and/or decentralised manner (see Figure 1, No 13)

3.14

principal heating unit

system that carries out the heating function in a centralised and/or decentralised manner with the use of heating elements associated or not with the forced air ventilation (see Figure 1, No 14)

3.15

auxiliary heating unit

de-centralised heating element(s) for adding heat locally (see Figure 1, No 15)

3.16

outside air or fresh air

air taken from outside (see Figure 1, No 16)

3.17

room air

air contained in a specified space (see Figure 1, No 17)

3.18

re-circulated air

air taken from the interior of a specified space and re-used (see Figure 1, No 18)

3.19

mixed air

combination of fresh air and re-circulated air (see Figure 1, No 19)

3.20

treated (or conditioned) air

air that may have been filtered and/or had energy exchanged as it passed through the air handling unit (see Figure 1, No 20)

3.21

primary air

quantity of treated air entering the ducts (see Figure 1, No 21)

3.22

supply air

treated air, that may be combined with some induced air, supplied to a specified space (see Figure 1, No 22)

3.23

induced air

room air that is taken and re-used locally (see Figure 1, No 23)

3.24

transfer air

air leaving a specified area (e.g. from a saloon to a vestibule, not shown in Figure 1)

3.25

exhaust air

air rejected outside the vehicle (see Figure 1, No 25)

3.26**interior temperature setting (T_{ic})**

theoretical temperature to be achieved by the room air

3.27**mean interior temperature (T_{im})**

arithmetic mean of the interior temperatures measured 1,10 m above the floor as specified in the procedure described in EN 14750-2

3.28**mean exterior temperature (T_{em})**

arithmetic mean of the exterior temperatures measured according to the procedure described in EN 14750-2

3.29**comfort envelope**

areas normally occupied by passengers. Areas of the vehicle which are intended only for passing through are excluded from the comfort envelope (e.g. gangways)

3.30**local annexes**

places where passengers stay temporarily

3.31**module**

longitudinal subdivision of a vehicle between any combination of cab wall, partition or articulation

NOTE

This definition is only for the purposes of determining the location of the sensors during testing.

3.32**heat transfer coefficient (k)**

ratio between the density of the heat flow rate per unit of surface area and the prevailing difference in temperature (T_{im}) and (T_{em}) across the relevant walls of the vehicles

NOTE 1 The coefficient k takes account of the efficiency of the insulation of the exterior walls and the effect of the infiltration of air caused by the non-airtightness of the vehicle in motion (doors, windows, various openings) and is applicable to all or part of the vehicle.

NOTE 2

This value is expressed in W/m^2K .

3.33**overall transmission factor of the windows**

ratio between the overall energy flow transmitted to the interior of the vehicle through the window and the incident solar flow

3.34**equivalent solar load**

total heat received by $1 m^2$ surface perpendicular to the radiation emitted by a luminous source (solar equivalent) and this, when inclined at an angle of 30° to the horizontal

3.35**stabilised operation**

operation obtained when (T_{im}) remains within the tolerance band defined in 9.1.1

3.36**stand by operation**

mode under which a predetermined interior temperature different from the interior temperature setting (T_{ic}) is maintained during non operational activity of the vehicle

4 Vehicle classification

The contractual specification shall detail the vehicle classification (category A or B, as applicable), the number of passengers (seated and/or standing) in normal occupation and any other assumptions relevant to calculating the thermal capacity of the air conditioning installation.

In the absence of a specified number of passengers in normal occupation one should consider for category A and B all seats occupied and 2 passengers/m² for the total standing area which shall be detailed by the contractual specification.

For guidance, a vehicle classification is proposed in Table 1. The relevant comfort parameters vary with the applicable category.

Table 1 — Vehicle classification

	Category A	Category B
Standing passengers	< 4 passengers/m ²	≥ 4 passengers/m ²
Average passenger journey time	> 20 min	≤ 20 min
Average time between two station stops	> 3 min	≤ 3 min

Suburban/regional vehicles shall be considered normally as category A and other vehicles shall be considered normally as category B.

For category A vehicles when the average passenger journey time is more than 1 h, it may be necessary to apply the main line vehicles standard (see EN 13129-1).

5 Comfort parameters

Outside the preconditioning periods, comfort is assessed:

- on the basis of environmental parameters such as:
 - air temperature;
 - air speed according to Annex B;
 - relative humidity according to Annex C;
 - temperature of the interior surfaces;
- as a function of thermal exchange between the environment and a seated person dressed normally according to Annex D, applicable for both seated and standing passengers;
- on the basis of the exterior climatic conditions which have an indirect effect.

6 Exterior conditions

6.1 Normal exterior operating conditions

The comfort parameters shall be satisfied between the limits of exterior conditions given in Annex E (see also Annex F), except where indicated otherwise in the contractual specifications (tunnel operation for example).

6.2 Extreme exterior operating conditions

The air conditioning installations shall be able to operate under extreme temperatures:

- 5 K below the minimum values and 5 K above the maximum values specified in Annex E;
- if they are placed under-frame, 10 K above the maximum values specified in Annex E.

The interior conditions as defined in Clause 9 are not contractual for these extreme conditions.

7 Performance of the heating and cooling installations

7.1 Heating

At the minimum exterior temperature for the climatic zone (Annex E), at the maximum vehicle operational speed, without solar load, without occupation and with the minimum fresh air supply (see Annex G), the mean interior temperature (T_{im}) in the comfort envelope shall for all the climatic zones be above + 15 °C for category A vehicles and + 10 °C for category B vehicles.

7.2 Preheating

The preheating conditions and performance (electrical power consumption and voltage, interior temperature increase and time etc.) shall be defined in the contractual specifications.

In the absence of any detail as above, the preheating time depends on the performance defined in 7.1 and other operational restrictions.

7.3 Cooling

At the exterior conditions of the climatic zone (Annex E), including solar load if applicable, with a stationary vehicle, for normal occupation (Clause 4) and minimum fresh air supply according to Annex G, the mean interior temperature (T_{im}) shall be less than or equal to the values in Table 2:

Table 2 — Maximum mean interior temperature at the design condition

Zone (summer)	Category A °C	Category B °C
I	+ 30	+ 32
II	+ 30	+ 33
III	+ 26	+ 29

The interior relative humidity shall be less than or equal to the relevant values as shown in Annex C.

7.4 Precooling

The precooling conditions and performance (electrical power consumption and voltage, interior temperature decrease and time etc.) shall be defined in the contractual specifications.

In the absence of any detail as above, the precooling time depends on the performance defined in 7.3 and other operational restrictions.

EN 14750-1:2006 (E)

7.5 Stand by operation

If stand by operation is required, it shall be detailed in the contractual specifications.

8 Control

8.1 General

Each vehicle shall be fitted with a regulation system which shall enable the comfort parameters defined in this European Standard to be achieved.

8.2 Interior temperature setting (Tic)

The contractual specification should define a regulation curve for the interior temperature setting (Tic) which is within the permitted area shown in Annex A. In the absence of such a definition, the recommended curves shown in Annex A shall be considered.

The regulation curve shall be followed within the limits of capacity defined in Clause 7. Outside these limits temperature deviation is allowed.

8.3 Interior temperature setting (Tic) for vehicles without cooling

These vehicles shall meet the conditions mentioned in 8.2 as long as the exterior conditions enable this normal interior temperature setting to be achieved.

9 Comfort condition requirements

9.1 Temperatures in the comfort envelope

9.1.1 Range of the mean interior temperature (Tim) with the respect to the interior temperature setting (Tic)

While the equipment functions under the nominal performance defined in Clause 7, this range shall not be greater than ± 2 K.

9.1.2 Range of the interior air temperatures measured 1,10 m from the floor

This range shall not be greater than 4 K for category A vehicles and 8 K for category B vehicles. The contractual specification shall detail any other range for category B vehicles.

9.1.3 Range of the interior air temperatures in a vertical section

This range shall not be greater than 4 K for category A vehicles and 8 K for category B vehicles. The contractual specification shall detail any other range for category B vehicles.

The interior temperature shall not be below + 3 °C.

9.2 Temperatures in the local annexes

9.2.1 Temperature in the vestibules

This subclause shall apply if the vestibules are separated from the comfort envelope by doors or stairways. If not, 9.1 shall apply.

The temperature in each vestibule shall be measured 1,70 m from the floor.

- In heating, this temperature shall be between + 3 °C and the mean interior temperature (T_{im}). In addition, the temperature shall always be above + 3 °C at 0,10 m above the vestibule floor;
- In cooling, this temperature shall be below the exterior temperature (T_{em}).

9.2.2 Temperature in the washrooms, WC's, other annex areas

The temperature at a point situated on the vertical geometric centre of the floor of these locations at a height of 1,10 m above the floor shall:

- in heating, not be less than 6 K below the mean interior temperature (T_{im}). In addition, for the washrooms and WC's, the value shall not be below + 3 °C;
- in cooling, not be more than 6 K above the mean interior temperature (T_{im}).

9.3 Relative humidity of air conditioned vehicles

Whatever the interior temperatures of comfort areas and within the limitations of the equipment performance defined in Clause 7 and Clause 8, the relative humidity shall be within the shaded area in Figure C.1 and Figure C.2.

9.4 Temperatures of the surfaces surrounding the comfort envelope of a stationary vehicle in heating mode

9.4.1 Walls and ceilings

In comparison with the mean interior temperature (T_{im}), the range of these interior surfaces shall not be greater than:

- 10 K for category A vehicles;
- 13 K for category B vehicles.

9.4.2 Windows and doors

The temperature of the interior surfaces of the window panes shall not be more than 15 K below the mean interior temperature (T_{im}).

9.4.3 Minimum surface temperatures

The surface temperatures of walls, ceiling, and floor with the exception of windows and doors shall not be below + 3 °C.

9.5 Temperature at the supply air outlets and surface temperature at active heating element grille

The temperature at any of the accessible supply air outlets or surface temperature at active heating element grille shall not be greater than + 65 °C except during the preheating periods. The air diffused onto seated passengers shall not be greater than + 45 °C.

In the cooling or ventilation mode, the supply air temperature should not be lower than + 12 °C except during the precooling periods.

9.6 Air speed

The air speed in the comfort envelope shall be equal to or less than the values defined by the curves in Annex B.

In a stabilised operation the time varying deviation of the air velocity at the air outlets shall be within a tolerance of $\pm 20\%$ of the average value.

9.7 Air quantities

9.7.1 Outside air or fresh air

The total volume of fresh air added by forced ventilation to the comfort envelope shall be in accordance with the values defined in Annex G.

9.7.2 Recirculated air

A recirculated air system shall ensure operation (even in a degraded condition) if the design of the vehicle allows the fresh air intakes to be temporarily blocked.

In the case of composite vehicles (smoking, non-smoking), the air conditioning system shall be designed to prevent the transfer of smoke from a smoking zone to a non-smoking zone.

9.7.3 Local annex ventilation

The vehicle air conditioning system shall be designed to prevent the transfer of odours from toilets and other local annexes into any other areas.

10 Complementary requirements

10.1 Heat transfer coefficient (*k*)

10.1.1 General

The coefficient *k* shall be measured on a stationary vehicle.

10.1.2 Coefficient *k* of the vehicle

The coefficient *k* of the vehicle shall be less than or at least equal to the values indicated in Table 3 as follows:

Table 3 — Coefficient *k* for the vehicle at standstill

Zone (winter)	Category A W/m ² K	Category B W/m ² K
I	2,5	3,5
II	2,2	3,0
III	2,0	2,5

10.1.3 Coefficient k for vestibules

This subclause applies if the vestibules are physically separated from the comfort envelope by a door. In that case the coefficient k should not be more than $1 \text{ W/m}^2\text{K}$ above the values defined in Table 3.

10.2 Door opening/closing cycles

During 10 operational cycles of opening and closing doors on one side of the vehicle, the installation shall be capable of attaining the values defined in Clause 7 and Clause 8 within the limits indicated in 9.1.1 before the next cycle commences. In the absence of detail in the contractual specification, the cycles defined in Table 4 are to be considered.

Table 4 — Door opening/closing cycles

	Category A	Category B
Duration doors closed	5 min	2 min
Duration doors open	30 s	20 s

10.3 Overall transmission factor of the windows

Vehicles used mainly for surface operation shall have an overall window transmission factor less than or at least equal to 70 %.

Vehicles used mainly for sub-surface operation but also used for some surface operation should use an appropriate overall window transmission factor to minimise the cooling capacity and improve passenger comfort.

10.4 Particle air filtration

Filter performance shall meet the requirements of EN 779:2002, applicable to railway air conditioning installations. In the absence of any detail in the contractual specification the filter grade G3 of the above standard is recommended.

10.5 Noise emission

For stationary vehicles, the overall sound pressure level generated in the comfort envelope by the air conditioning installation alone during any operating conditions (excluding vehicle preparation) shall not exceed the values in Table 5.

Table 5 — Overall sound pressure level

Category A	Category B
63 dB(A)	66 dB(A)

10.6 Vibration generation

The vibrations generated by the air conditioning installation alone shall be in accordance with the requirements of the contractual specification.

10.7 Safety devices

10.7.1 Heating

The heating equipment shall be fitted with a safety device to protect it from abnormal increases in air and equipment temperature. The heater shall be isolated in a reliable manner on activation of this safety device.

10.7.2 Cooling

The cooling equipment shall be fitted with a safety device to protect it against abnormal increases of pressure of the refrigerant fluid.

10.7.3 Emergency ventilation

If the flow of fresh air cannot be ensured by the air treatment unit, ventilation from the exterior shall be achieved by other means.

10.8 Sealing against water, snow and dust

All precautions should be taken to avoid the infiltration and retention of water from condensation, rain and washing plants, as well as snow.

10.9 Reliability, maintainability

10.9.1 Reliability

The calculation of MTBF (Mean Time Between Failures) shall be carried out in accordance with the requirements of EN 50126.

Additional requirements shall be as detailed in the contractual specification.

10.9.2 Maintainability

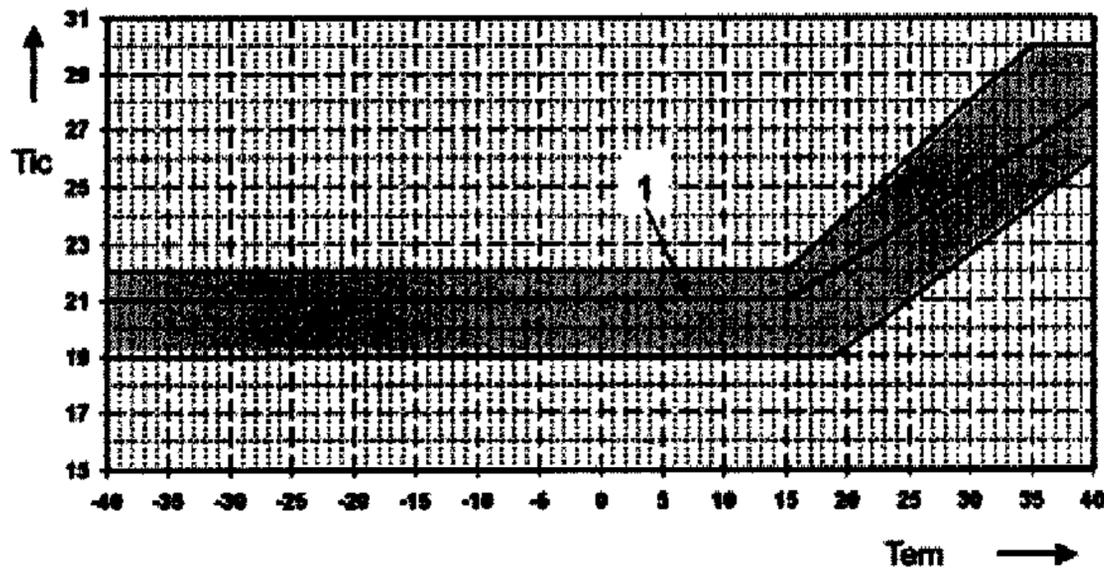
The design of the vehicles and the air conditioning installations shall take into account the maintenance plan of the end-user.

The periodic maintenance work shall be facilitated by easy access to and/or rapid dismantling of the items concerned.

The ease of dismantling of items shall take into account their reliability and maintenance period.

Annex A
(normative)

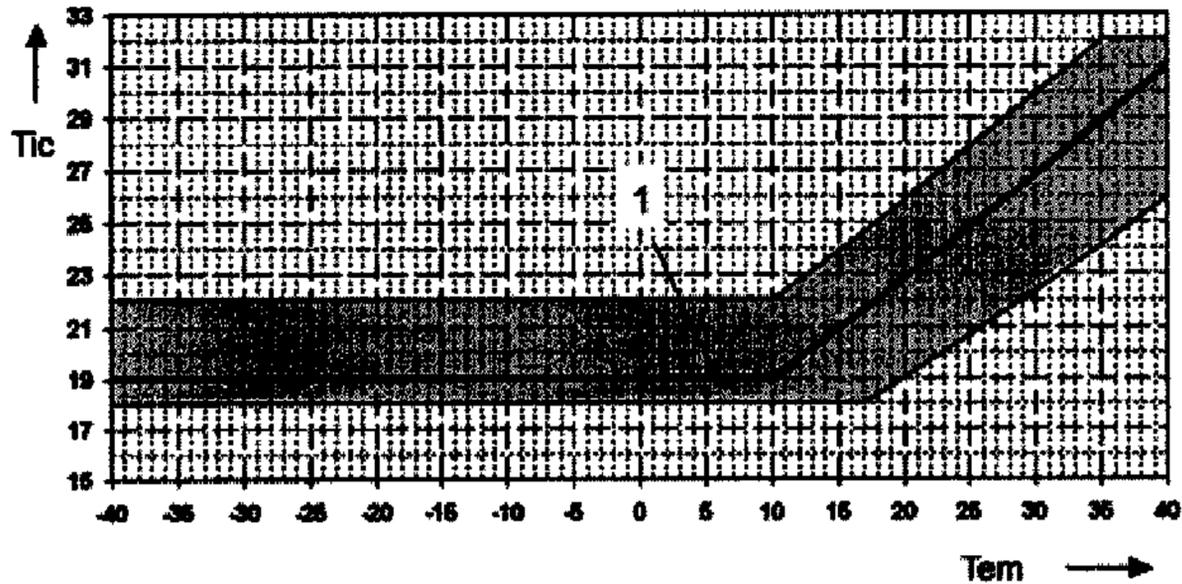
Regulation curves for the interior temperature setting



Key

- Tem mean exterior temperature, in °C
- Tic interior temperature setting, in °C
- 1 recommended curve for category A vehicles

Figure A.1 – Permitted area for the definition of the regulation curve of category A vehicles



Key

- Tem mean exterior temperature, in °C
- Tic interior temperature setting, in °C
- 1 recommended curve for category B vehicles

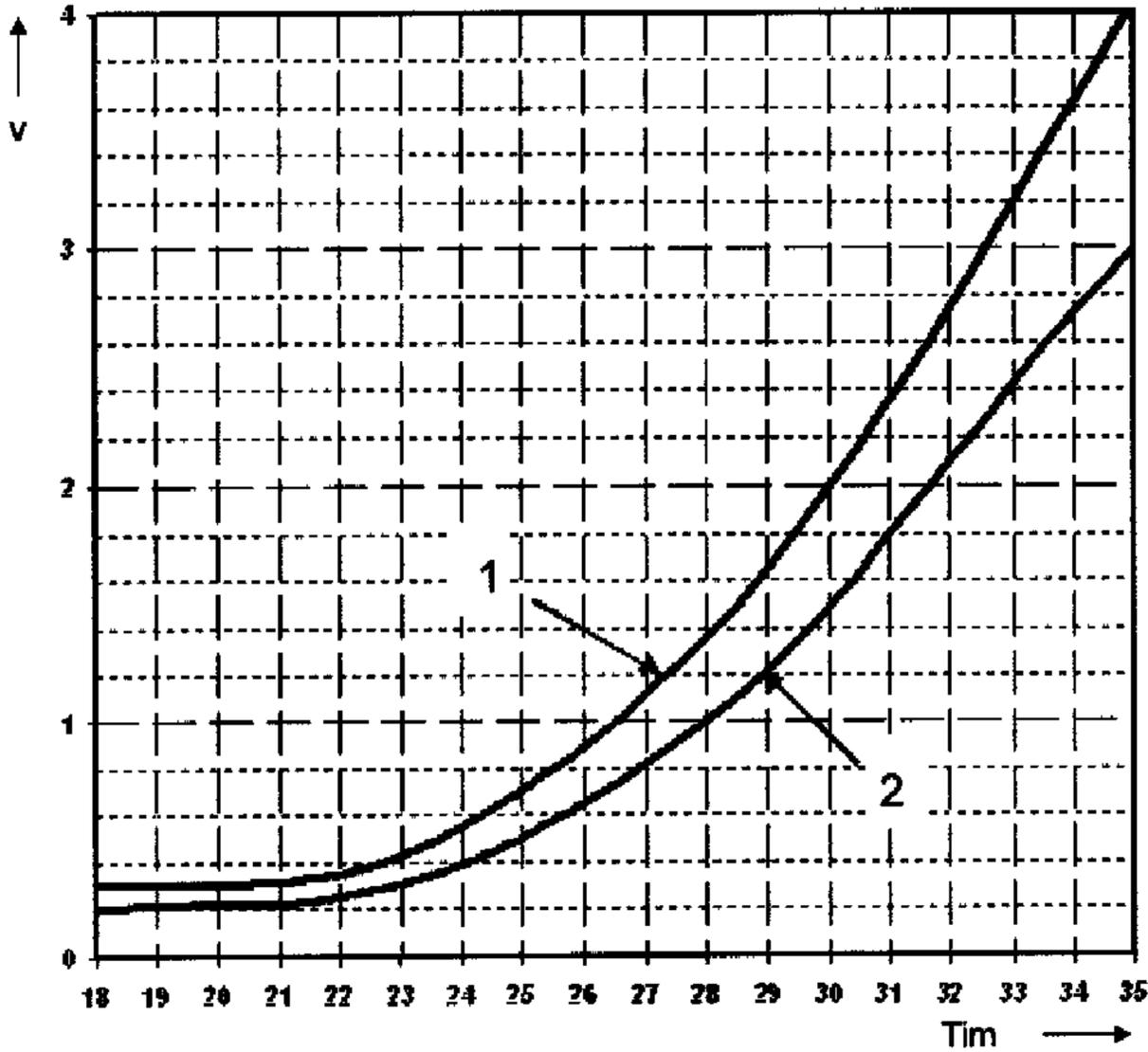
Figure A.2 – Permitted area for the definition of the regulation curve of category B vehicles

Annex B
(normative)

Acceptable air speed

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The temperatures indicated on the abscissa correspond to speed measurement points which shall be according to in EN 14750-2.



Key

- Tim mean interior temperature, in °C
- v air speed, in m/s
- 1 maximum air speed for heating ventilation and category B vehicles
- 2 maximum air speed for category A vehicles

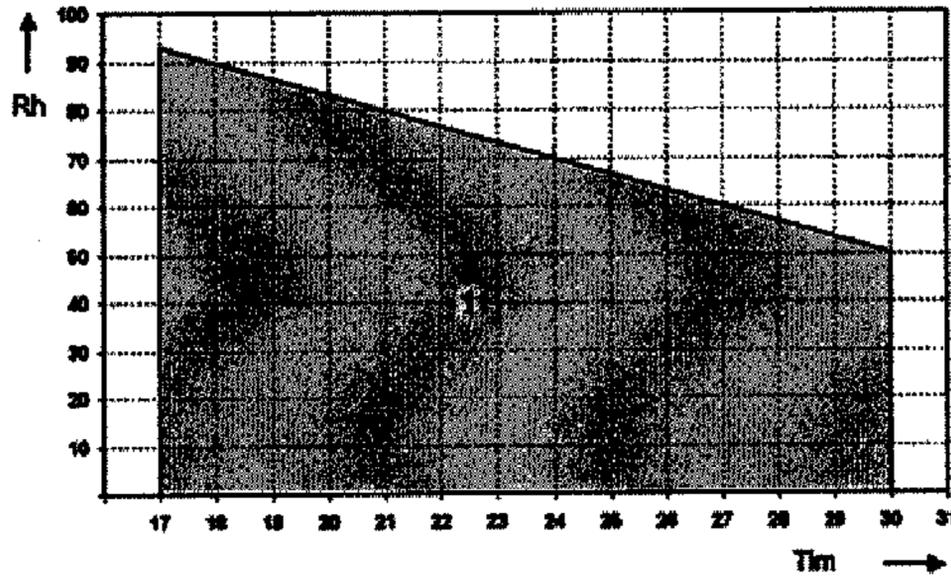
Figure B.1 — Acceptable air speed

Table B.1 — Acceptable air speed

Tim °C	Category A m/s	Category B m/s
+ 18	0,2	0,3
+ 22	0,25	0,35
+ 25	0,5	0,7
+ 28	1,0	1,4
+ 30	1,5	2,0
≥ + 35	3,0	4,0

Annex C (normative)

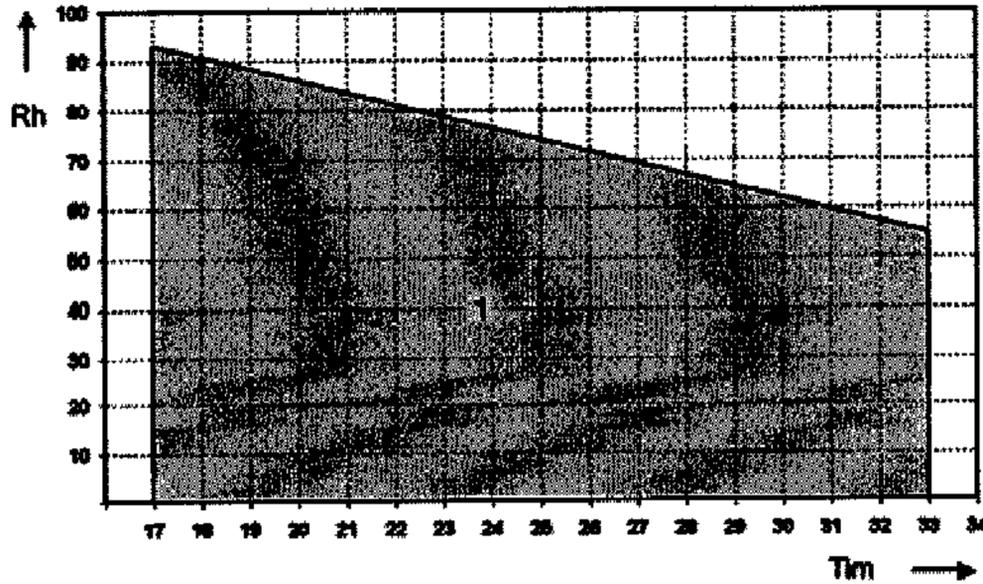
Relative humidity in the comfort envelope



Key

- Tim mean interior temperature, in °C
- Rh relative humidity, in %
- 1 acceptable relative humidity

Figure C.1 — Acceptable relative humidity for category A



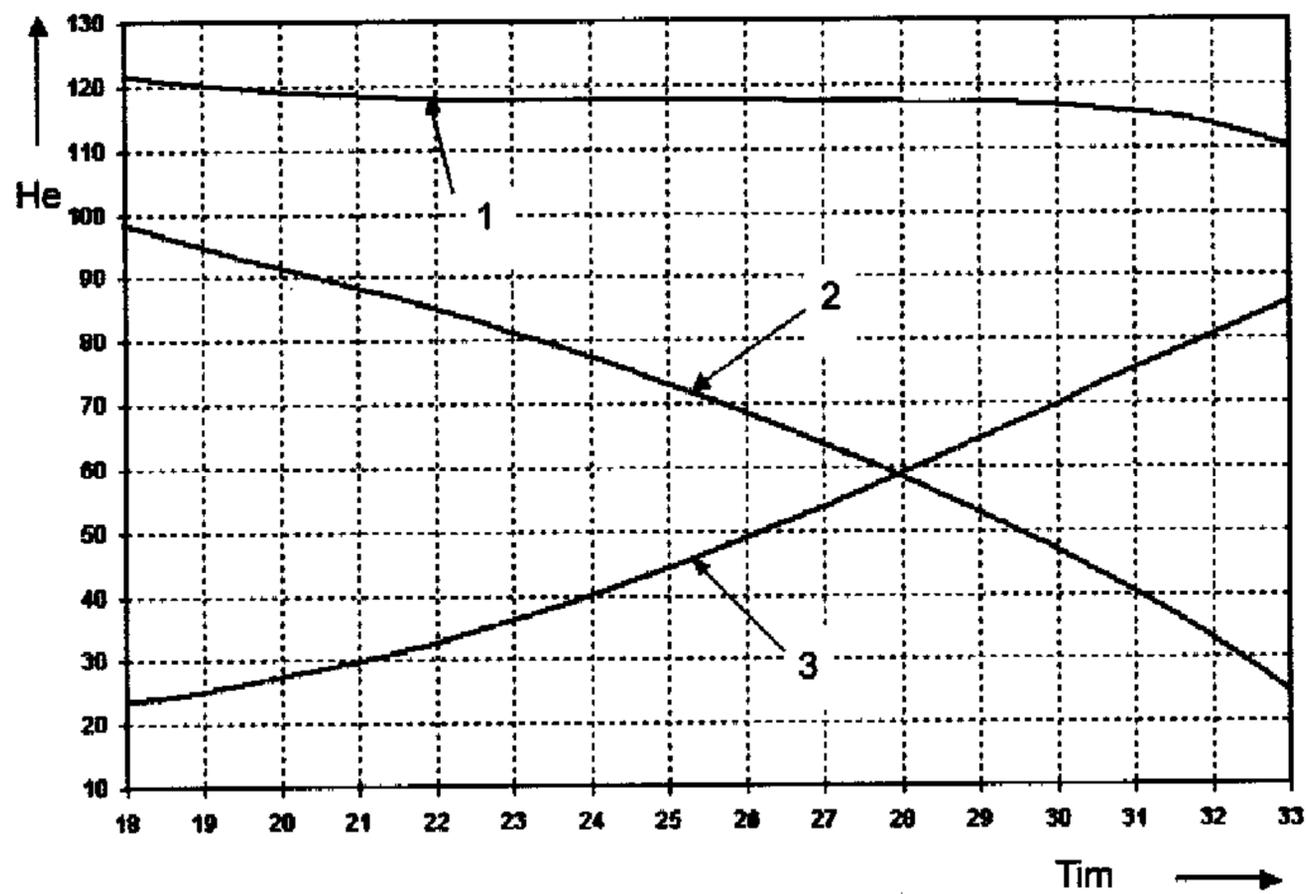
Key

- Tim mean interior temperature, in °C
- Rh relative humidity, in %
- 1 acceptable relative humidity

Figure C.2 — Acceptable relative humidity for category B

Annex D (normative)

Heat emitted by a seated person dressed normally



Key

- Tim mean interior temperature, in °C
 He heat emission, in W
 1 total heat
 2 sensible heat
 3 latent heat

Figure D.1 — Heat emitted by a seated person dressed normally

Annex E
(normative)

Definition of climatic zones

Table E.1 — Definition of climatic zones – Winter

Zone (winter)	Minimum exterior temperatures °C
I	- 10
II	- 20
III	- 40

Table E.2 — Definition of climatic zones – Summer

Zone (summer)	Maximum exterior temperatures °C	Relative humidity %	Equivalent solar load (E_n) W/m²
I	+ 40	40	800
II	+ 35	50	700
III	+ 28	45	600

Annex F (informative)

Grouping of countries in climatic zones

Country	Winter	Summer
Austria	Zone II	Zone II
Belgium	Zone II	Zone II
Bulgaria	Zone II	Zone II
Czech Republic	Zone II	Zone II
Croatia	Zone II	Zone II
Denmark	Zone II	Zone II
France	Zone II	Zone II
Finland	Zone III	Zone III
Greece	Zone I	Zone I
Germany	Zone II	Zone II
Hungary	Zone II	Zone II
Ireland	Zone I	Zone III
Italy	Zone II	Zone I
Luxemburg	Zone II	Zone II
Netherlands	Zone II	Zone II
Norway	Zone III	Zone III
Poland	Zone III	Zone II
Portugal	Zone I	Zone I
Romania	Zone II	Zone II
Serbia and Montenegro	Zone II	Zone II
Slovakia	Zone II	Zone II
Slovenia	Zone II	Zone II
Spain	Zone I	Zone I
Sweden	Zone III	Zone III
Switzerland	Zone II	Zone II
United Kingdom	Zone I	Zone III

Annex G (normative)

Fresh air flow rate

G.1 General

The air flows indicated in this annex are to be considered for the number of passengers defined in Clause 4.

If an additional fresh air flow rate is required for special national conditions, this should be detailed in the contractual specification.

G.2 Air conditioned vehicles

G.2.1 Category A

The normal fresh air flow rate shall be equal to or above $15 \text{ m}^3/\text{h}/\text{passenger}$. However, the fresh air flow rate can be reduced to a minimum of $10 \text{ m}^3/\text{h}/\text{passenger}$ to meet the heating and cooling performance as defined in Clause 7. The fresh air flow rate can be increased above the normal value whilst meeting the air speed requirements as defined in Annex B.

G.2.2 Category B

The normal fresh air flow rate shall be equal to or above $12 \text{ m}^3/\text{h}/\text{passenger}$. However, the fresh air flow rate can be reduced to a minimum of $8 \text{ m}^3/\text{h}/\text{passenger}$ to meet the heating and cooling performance as defined in Clause 7. The fresh air flow rate can be increased above the normal value whilst meeting the air speed requirements as defined in Annex B.

G.3 Heated/ventilated vehicles

The required air flows are the same as for the air conditioned vehicles.

However, for $T_{em} > 20 \text{ }^\circ\text{C}$ and $T_{im} > 24 \text{ }^\circ\text{C}$, the minimum fresh air flow shall be $30 \text{ m}^3/\text{h}/\text{passenger}$.

Bibliography

- [1] EN 13129-1, *Railway applications — Air conditioning for main line rolling stock — Part 1: Comfort parameters*

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