UIC CODE 553

6th edition, February 2004

Translation

OR

Heating, ventilation and air-conditioning in coaches

Ventilation, chauffage et climatisation des voitures
Lüftung, Heizung und Klimatisierung der Reisezugwagen

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volumes :

V - Rolling Stock

VI - Traction

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With effect from 1 January 2000
All members of the International Union of Railways

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1st edition, January 1947	First edition
3rd edition, January 1971	3 amendments
4th edition, January 1979	2 amendments
5th edition, January 1990	3 amendments
6th edition, February 2004	Adapted to EN 13129-1 Retyped in FrameMaker

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

"Climate control installations" include ventilation, heating and cooling equipment as well as, in some instances, devices to humidify/dehumidify the air. This term is also used in cases where no cooling, humidifying or dehumidifying equipment is provided.

This leaflet distinguishes between areas for use by passengers and ancillary areas.

Areas for passenger use may be either compartments or open saloons.

Ancillary areas include side corridors, entrance vestibules, sanitary facilities, catering facilities, baby changing rooms, staff rooms, telephone boxes, etc.

Different comfort standards apply for passenger accommodation and the various ancillary areas.

Key terms and definitions in respect of air treatment in railway vehicles are listed in Appendix A or the Glossary.

1 - Scope

1.1 - This leaflet lays down the conditions governing the climate control equipment fitted in seating, dining, couchette and sleeping cars (henceforth called coaches) authorised for unrestricted use in international traffic, irrespective of their design.

UIC Leaflet 553-1 sets out the tests and measurement procedures required or recommended for type testing climate control equipment.

1.2 - The provisions of this leaflet and *UIC Leaflet 553-1* shall also apply to climate control equipment fitted in:

- high speed vehicles as defined in *UIC Leaflet 660*,

- all passenger vehicles used in cross-border traffic.

1.3 - In addition to complying with the provisions of this leaflet, the design of climate control equipment on coaches shall take account of the k-value (heat transfer coefficient) and window transmission factor τ, described in *UIC Leaflet 567*.

2 - Equipment of coaches

2.1 - Coaches shall be fitted with climate control equipment that can run on electrical power from the train cable defined in *UIC Leaflet 552*.

2.2 - The permissible wattage drawn by coaches, including on-board climate control installations, is set out in *UIC Leaflet 550*.

2.3 - Coaches shall be fitted with heating and ventilation equipment capable of guaranteeing the comfort standards laid down in Appendix B - page 14 for passenger accommodation and ancillary areas at the outdoor temperatures stipulated for the climate zones listed in Appendix C - page 18.

Coaches authorised for speeds of >160 km/h shall also be fitted with a cooling system.

3 - Performance of heating and cooling equipment

3.1 - Depending on the conditions governing the use of a coach, the performance of its heating and cooling equipment shall be compatible with the three climate zones defined in Appendix C - page 18.

3.2 - Passenger areas shall be supplied with the volumes of fresh air per seat or berth stipulated in Appendix H - page 23 depending on the outside temperature but irrespective of speed.

3.3 - Heating equipment

3.3.1 - Pre-heating

At an outside temperature of 0°C and with the coach at a standstill, a minimum ambient temperature of +18°C shall be attained within a period of not more than 70 minutes in all areas reserved for the use of passengers, irrespective of the setting of the different temperature regulators.

3.3.2 - Normal operation

At maximum permissible speed, the minimum outside temperature for the selected climate zone from Appendix C and the specified rate of fresh air intake, a mean ambient temperature of 22°C shall be maintained in all passenger areas (Lighting = 0, Occupation level = 0, Solar heating equivalent = 0).

3.4 - Cooling equipment

3.4.1 - Pre-cooling

Under the outdoor conditions described in point 3.1 and with the individual temperature regulators at the lowest setting, an ambient temperature of no more than 2 K above the theoretical mean ambient temperature shall be attained within a period of 100 minutes in all passenger areas in coaches at a standstill.

3.4.2 - Normal operation

With the coach at a standstill (maximum air velocity, for example, in a climate chamber of 10 km/h) and at the maximum outdoor temperature and solar heating values for the selected climate zone listed in Appendix C as well as the specified rate of fresh air intake, the ambient temperature limits set out in Appendix E - page 20 shall be complied with in all unlit passenger areas filled to capacity (see Appendix D - page 19 for heat emitted by individuals), with the temperature regulator set to "medium".

3.5 - Extreme conditions

3.5.1 - Minimum and maximum outdoor temperatures

The equipment must remain operational under the following extreme temperatures:

- 5 K below the minimum values (10 K for Poland, Romania, Slovakia, the Czech Republic and Hungary) and 5 K above the maximum values laid down in point 3.1,

- 15 K above the maximum values stipulated in point 3.1, where equipment is fitted under the vehicle underframe.

At the above-listed extreme temperatures, compliance with the comfort standards stipulated in Appendix B - page 14 is no longer required.

3.5.2 - Fresh air supply

If damage to a piece of equipment in the coach means that the volumes of fresh air stipulated in Appendix H - page 23 cannot be provided, a back-up ventilation system with reduced air supply shall be available. Emergency ventilation systems powered by the coach battery shall be capable of operating for 30 minutes.

4 - Centralised operating, control, safety and monitoring devices

4.1 - It shall be possible to switch the climate control equipment in a coach on or off by means of a switch located on the control panel defined in *UIC Leaflet 550-1*. This switch shall also be used to shut down the climate control equipment, including the air supply fan, in an emergency.

4.2 - The climate control equipment shall be designed to switch on automatically as soon as the train cable is live, the coach power supply system is activated and the switch described in point 4.1 is on.

Similarly, it shall stop automatically when the power supply is cut off. In addition, the loads connected to the battery shall also switch off in line with the conditions set out in *UIC Leaflet 550* and thus ensure that the battery cannot be flattened.

Passengers should not be subject to any unpleasant warm or cold air movements when equipment starts up again after short power outages.

4.3 - All electrical heater units shall be fitted with a safety device to prevent any unacceptable degree of overheating. Functioning of this safety device shall be completely independent of the control regulator and power supply source and ensure failsafe cut-off of the current supply to the heater unit.

4.4 - The cooling equipment shall be fitted with safety devices to prevent an unacceptable increase in refrigerant pressure.

4.5 - The design of the control panel, the arrangement of the fuses and the markings and inscriptions on the components are governed by the provisions of *UIC Leaflet 550 and 550-1*.

4.6 - Centralised operation of climate control equipment throughout the entire train (heat chain).

Pending.

5 - Regulation of climate control equipment

O **5.1 -** Each coach shall be equipped with a regulation system enabling the general comfort requirements outlined in Appendix B - page 14 to be observed.

O **5.2 -** It shall be possible for the temperature inside each passenger compartment or saloon to be modified by means of a regulator as described in point 6 - page 8 providing a minimum adjustment range of ±2 K (±3 K for couchette and sleeping cars) above and below the temperatures specified in Appendix B. The temperature in passenger accommodation shall vary by no more than 1 K when the regulator is switched between two consecutive settings.

Adjusting the regulator shall bring about a change in ambient temperature of at least 1 K in under 15 minutes.

O **5.3 -** Adjusting the regulator in one compartment shall not alter the ambient temperature in other compartments by more than ±0,3 K.

R **5.4 -** Open saloon coaches may be considered as a single unit from the point of view of temperature regulation.

O **5.5 -** At the start of each coach run, the regulator should be set back to the theoretical mean ambient temperature.

O **5.6 -** A maximum temperature variation of ±1 K is briefly allowed in passenger compartments and saloons during transition from pre-heating or pre-cooling to normal operation.

O **5.7 -** To cater for possible malfunctioning of the climate control equipment, including the controls, it should be designed to continue operating at a lower level of efficiency and/or reduced comfort parameters if need be.

6 - Regulator for varying the temperature in the passenger accommodation

6.1 - Marking of regulators

Temperature regulators shall be identified using the pictogram defined in *UIC Leaflet 413*.

6.2 - Compartment regulators

The temperature regulator shall be accessible to passengers in compartments. It shall be positioned either below the window or above the door.

6.3 - Regulators in open saloon coaches

The temperature regulator for open saloons shall be located on the train crew control panel defined in *UIC Leaflet 550-1* and operated by train crew members only.

7 - Additional requirements

7.1 - Air filters

The purification capacity of air filters shall comply with the requirements of filter class G4 pursuant to European Standard *EN 779* as applied to climate control equipment on board railway vehicles.

7.2 - Noise emissions

When the coach is stationary, the noise level generated solely by the climate control equipment and power supply system required to operate it shall not exceed the following values in the passenger accommodation:

Climate zone Summer	1st class day coach Sleeping car Couchette Restaurant car dB (A)	All other coaches dB (A)
I	55	60
II	55	57
III	55	57

7.3 - Vibrations

Vibrations generated solely by the climate control equipment and power supply system required to operate it shall comply with the requirements laid down in *prENV 12 299* and the stipulations of point 7.2 of this leaflet.

7.4 - Protection against water, snow and dust

All necessary measures shall be taken prevent condensation, rain, wash water and snow from penetrating into and accumulating in the coach. These elements shall not cause the climate control equipment to malfunction.

7.5 - Air ducts

Ducts used to transfer heated and cooled air shall be insulated.

All air ducts and nozzles fitted in coaches should be arranged in such a way as to enable deposits and dust to be removed during routine maintenance without the need for dismantling.

8 - Operating instructions, explanatory note and diagrams

8.1 - These instructions and their layout shall comply with the requirements set out in *UIC Leaflet 550*.

8.2 - The following documentation at least shall be available in the coach switch box to enable any faults in the climate control system to be identified and rectified:

- diagram showing the arrangement of the main components,
- basic circuit diagram,
- brief explanatory note with information on how to repair defects. (No explanatory note is required if the coach is fitted with a diagnostics system in compliance with *UIC Leaflet 557* and Man Machine Interface MMI Form 3).

9 - Compliance with comfort requirements

9.1 - Compliance with the specified ratings and comfort requirements shall be verified during a type test in a climate chamber. Care shall be taken to ensure that the temperatures generated by the climate control equipment are fully stabilised in all rooms when these checks are made.

9.2 - Tests to demonstrate compliance with the comfort requirements shall be carried out in accordance with the provisions of *UIC Leaflet 553-1*.

10 - Pressure protection

Pending.

Appendix A - Overview to explain railway-specific terms

The diagram selected only serves as an example and does not have any influence on the design of the equipment.

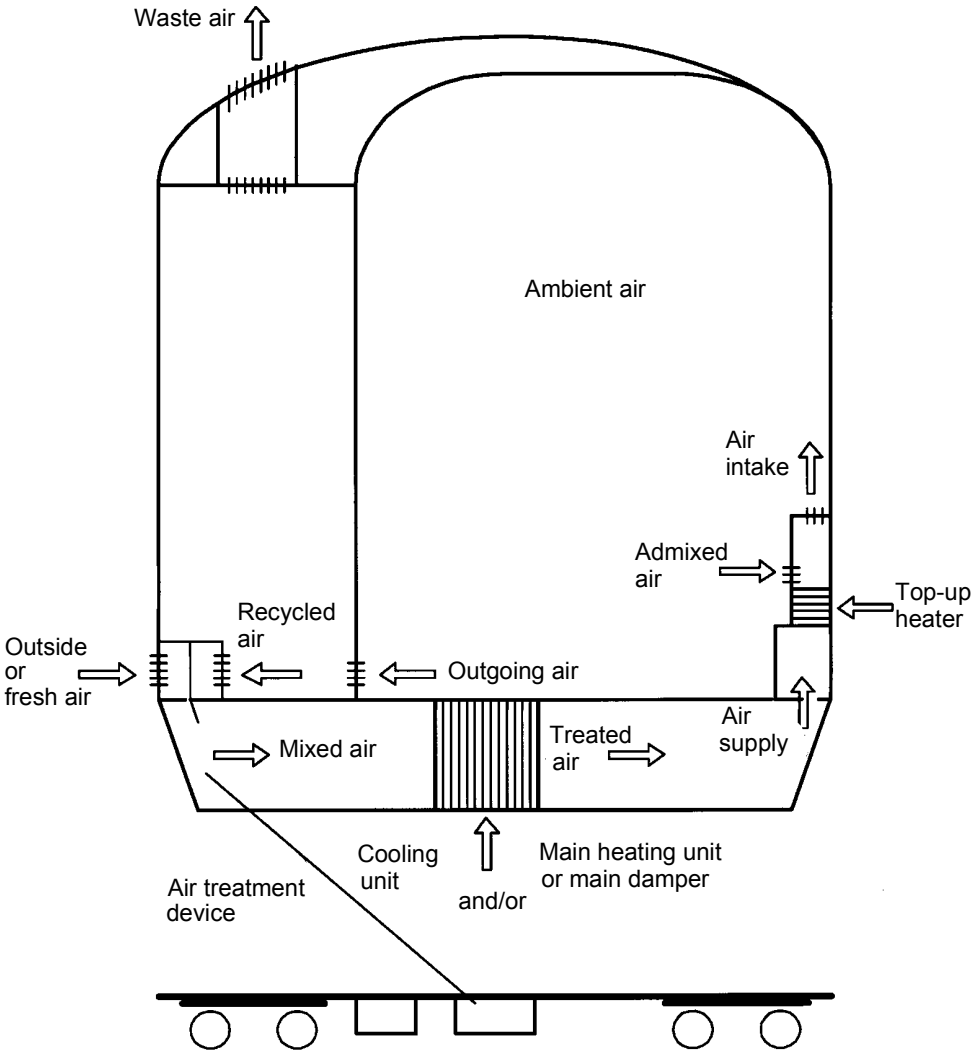

Fig. 1 - Illustration of railway-specific terms

Appendix B - General conditions of comfort

B.1 - Temperatures in areas for the use of passengers

B.1.1 - When the regulator is set to the centre position, the theoretical temperature (Tic) in areas for the use of passengers shall lie within the range shown in Appendix E - page 20 irrespective of the outside air temperature.

B.1.2 - Coaches without cooling equipment need only comply with the conditions specified in point B.1.1 when the outside air temperature is sufficient to maintain this inside temperature.

B.1.3 - The mean ambient temperature in passenger accommodation (Tim) shall not deviate from the theoretical value (Tic) by more than ±1.

B.1.4 - Adjustment of the temperature regulator setting shall vary the temperature by at least 1°C in under 15 minutes.

B.1.5 - When the theoretical temperature (Tic) in passenger areas varies within the range provided for in Appendix E owing to a shift in the mean outside temperature (Tem) (e.g. when travelling through long tunnels), adjustment of the mean ambient temperature (Tim) shall be limited to 0,1 K per minute.

B.1.6 - At a temperature measurement level of 1,1 m above floor level, the difference between minimum and maximum values shall not be greater than 2 K. Variation of up to 3 K is allowed in couchette cars and sleeping cars.

B.1.7 - At the measurement levels of 0,1 m and 1,7 m above floor level, the difference between minimum and maximum ambient temperatures shall not be greater than 2 K.

B.2 - Temperatures in ancillary areas

B.2.1 - Mean side corridor temperature

This temperature is the arithmetic mean of the temperatures measured at a height of 1,7 m above floor level in accordance with the procedure described in *UIC Leaflet 553-1*.

When heating, the mean side corridor temperature shall not be more than 6 K below the theoretical ambient temperature in the passenger accommodation.

When cooling, the mean side corridor temperature shall not be more than 5 K above the theoretical ambient temperature in the passenger accommodation.

B.2.2 - Mean temperature in entrance vestibules

This temperature to the arithmetic mean of the temperatures measured at a height of 1,7 m above floor level in accordance with the procedure described in *UIC Leaflet 553-1*.

This average shall either lie somewhere between the outside temperature and the theoretical ambient temperature or correspond to the outside temperature. Under extreme conditions, the mean temperature in entrance vestibules shall not fall below +10°C when heating nor exceed +35°C when cooling.

Furthermore, the mean temperature at 0,1 m above floor level in entrance vestibules shall always be higher than 4°C when heating.

B.2.3 - Temperature in telephone boxes

The temperature at the measurement point of 1,1 m above the geometric centre of the box floor:

- when heating: shall not be more than 6 K below the theoretical ambient temperature in passenger accommodation,
- when cooling: shall not be more than 6 K above the theoretical ambient temperature in passenger accommodation.

B.2.4 - Temperature in WCs and wash rooms

The temperature at the measurement point of 1,1 m above the geometric centre of the WC/wash room floor:

- when heating: shall not fall below 20°C,
- when cooling: shall not be more than 6 K above the theoretical ambient temperature in passenger accommodation.

B.2.5 - Temperature in baby changing facilities

The temperature at the measurement point of 1,1 m above the geometric centre of the floor:

- when heating: shall not fall below 22°C,
- when cooling: shall not be more than 4 K above the theoretical ambient temperature in passenger accommodation.

B.2.6 - Temperature in catering facilities

The temperature at the geometric centre point of the horizontal axis of the staff work area, positioned over 0,5 m away from the heat-emitting appliances, which release 50% of the heat generated when functioning smoothly, shall not fall below the theoretical ambient temperature nor exceed it by more than 6 K.

o B.3 - Relative humidity

At all ambient temperature values listed in point B.1.6 - page 14, the relative humidity shall comply with the values given in Appendix F - page 21.

o B.4 - Surface temperatures

B.4.1 - Walls and ceilings

The temperature of these inner surface areas of the passenger accommodation shall not be more than 7 K below the mean ambient temperature (Tim) when the coach is heated.

B.4.2 - Windows

When the coach is stationary and heated, the inner surface temperature of the following components shall not fall short of the mean ambient temperature (Tim) by more than the values indicated below:

- window panes: 12 K,
- frames: 9 K.

B.4.3 - Floors

The floor surface temperature shall not be lower than +8°C one hour after completion of the pre-heating period, and deviation from the mean ambient temperature (Tim) shall not exceed 10 K three hours after completion of pre-heating.

B.4.4 - Air inlets

Temperatures at accessible air inlets:

- when heating: shall not exceed 35°C,
- during pre-heating: shall not exceed 65°C,
- during pre-cooling and cooling: shall not fall below 5°C.

O B.5 - Air velocity

The air velocity in the comfort zones shall not exceed the maximum values laid down in Appendix G - page 22.

Outside the comfort zones, an air velocity of 0,05 m/s or more is required to avoid "static areas".

Variations in air velocity at air inlets shall be steady and may not be greater than ±20% over 20 seconds.

B.6 - Air supply

B.6.1 - Fresh air

O **B.6.1.1 -** The volume of fresh air pumped into the passenger accommodation areas by the forced-air ventilation system must comply with the values listed in Appendix H - page 23.

R **B.6.1.2 -** It is recommended that the volume of fresh air supplied to smoking areas be increased by 5 m^3/h per seat.

O B.6.2 - Recycled air

B.6.2.1 - An air recycling system shall provide back-up climate control in the event of the fresh air intake system being temporarily obstructed.

B.6.2.2 - Where coaches contain both smoking and non-smoking areas, the air for recycling shall be drawn from the non-smoking area.

o B.6.3 - Ventilation of catering facilities

In non-cooled catering areas, the ventilation system shall ensure air renewal of 100 m^3/h at a rating of 1 kW.

To avoid odours spreading, food-preparation areas shall be maintained at a lower pressure level than other areas in the same coach.

o B.6.4 - Ventilation of sanitary facilities

To ensure a change of air in WCs, air shall be supplied at a rate of at least 20 m^3 per hour and per toilet. To avoid odours spreading, WCs shall be maintained at a lower pressure level than the entrance vestibules.

All air leaving the sanitary facilities shall be pumped straight out of the coach.

o B.6.5 - Ventilation of technical areas

Air expelled from technical equipment fitted on the coach (e.g. switch box) shall be pumped straight out of the coach.

Air flow in technical areas (e.g. drivers cab) shall be kept at a lower pressure level to prevent any air from escaping into the entrance vestibules or passenger accommodation.

Appendix C - Classification of countries into climate zones

Table 1 : Winter climate zones

Winter	Minimum temperature	Countries
Zone I	-10°C	Great Britain, Greece, Portugal, Spain
Zone II	-20°C	Albania, Austria, Belgium, Bosnia-Hezgovina, Bulgaria, Croatia, Czech Republic, Denmark, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, former Yugoslav Republic of Macedonia, Romania, Serbia-Montenegro, Slovakia, Slovenia, Switzerland
Zone III	-40°C	Finland, Norway, Sweden

Table 2 : Summer climate zones

Summer	Maximum outside temperature	Relative humidity	Solar heating equivalent (En)	Countries
Zone I	+40°C	40%	800 W/m^2	Greece, Italy, Portugal, Spain
Zone II	+35°C	50%	700 W/m^2	Albania, Austria, Belgium, Bosnia-Hezgovina, Bulgaria, Croatia, Czech Republic, Denmark, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, former Yugoslav Republic of Macedonia, Romania, Serbia-Montenegro, Slovakia, Slovenia, Switzerland
Zone III	+28°C	45%	600 W/m^2	Finland, Great Britain, Norway, Sweden

Appendix D - Heat emission from a person, clothed normally and seated

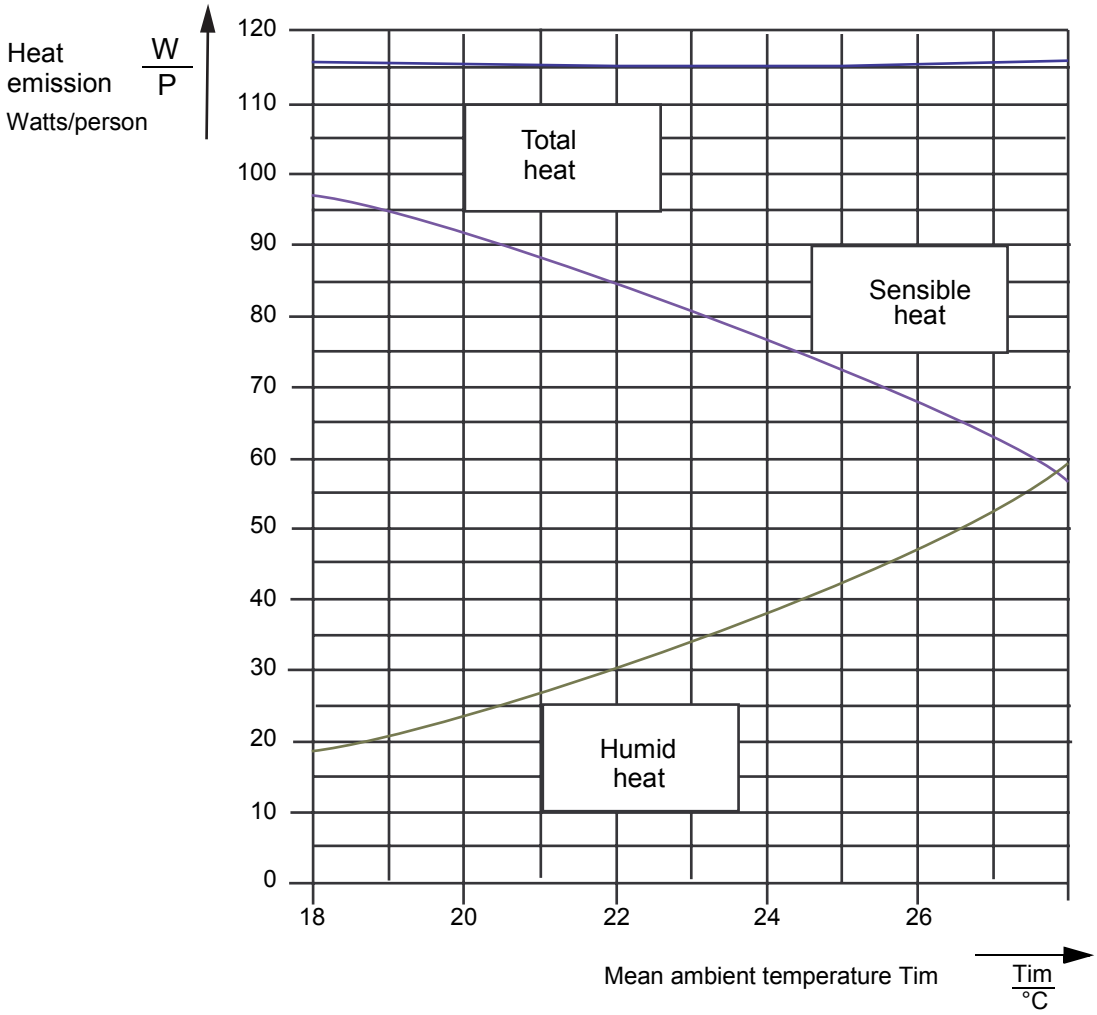

Fig. 2 - Heat emission from a person

Appendix E - Curve for the theoretical ambient temperature

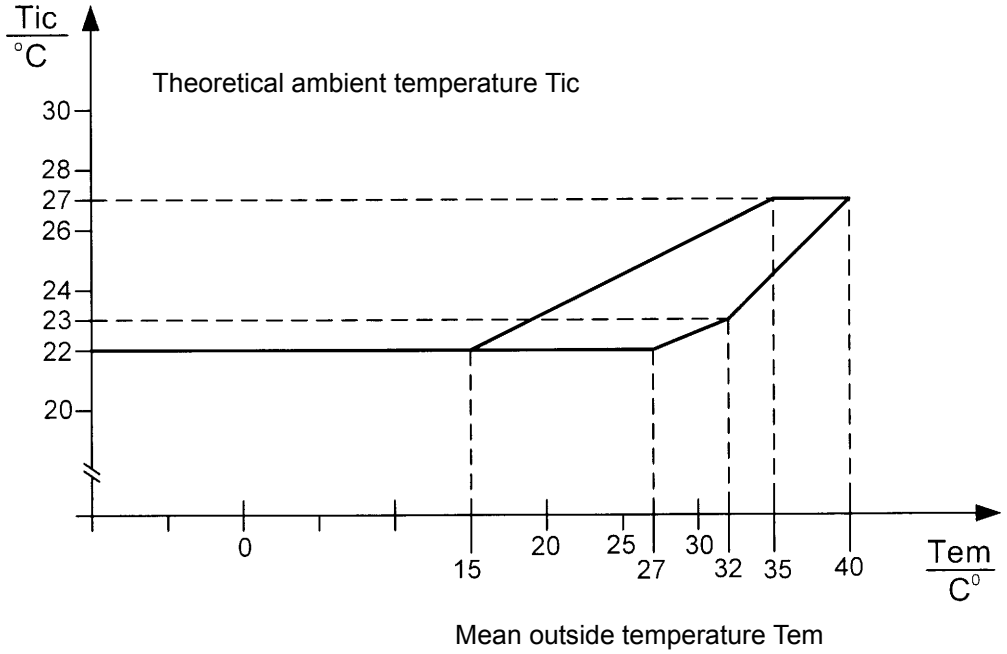

Fig. 3 - Curve for the theoretical ambient temperature

The curve for adjusting the room temperature as a function of the outside temperature shall be specified by each railway; it shall be located within the zone indicated in the diagram above.

Appendix F - Air humidity in the comfort zone

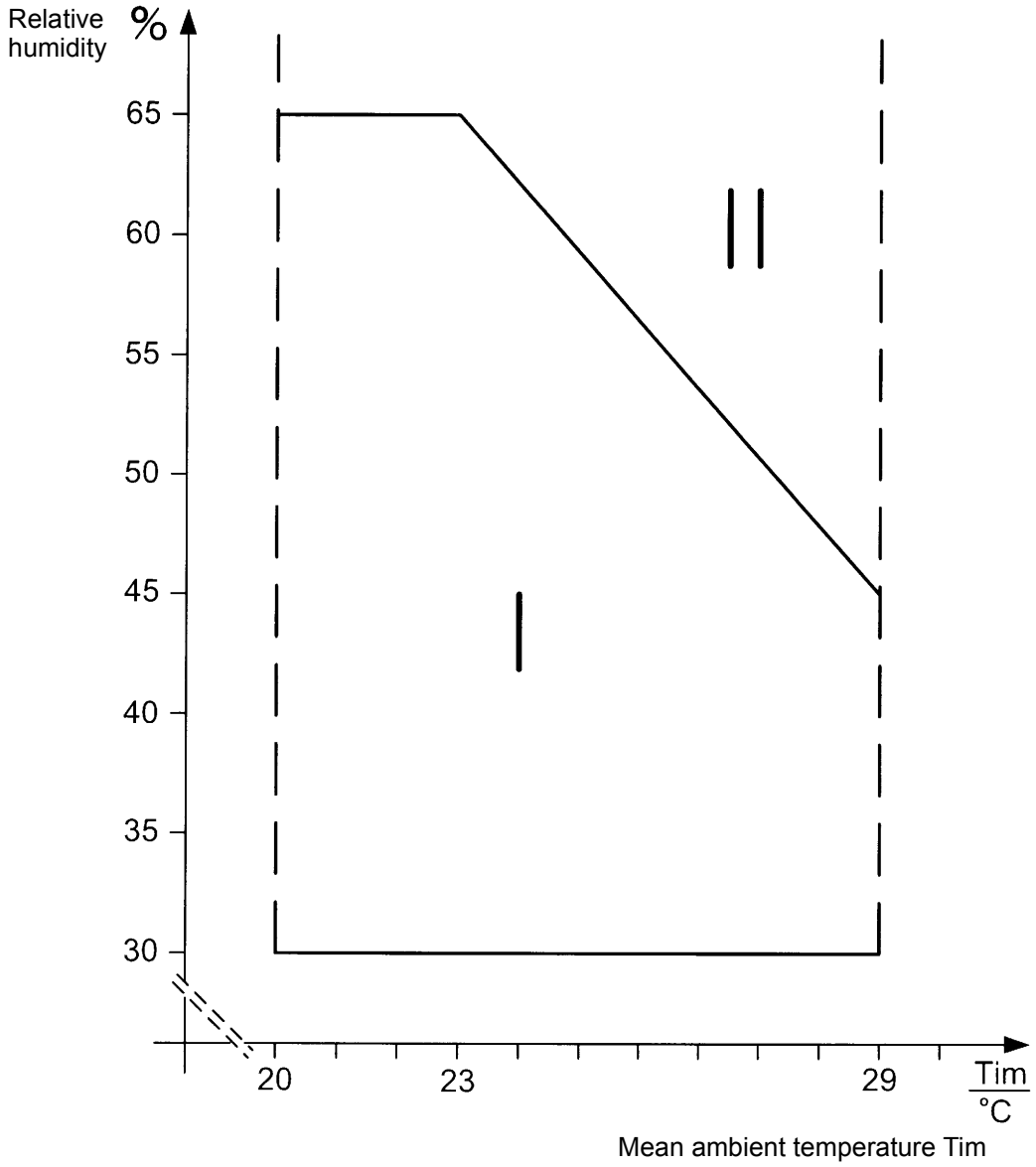

Fig. 4 - Air humidity in the comfort zone

The permissible comfort zone is within area I.

Appendix G - Permissible air velocity

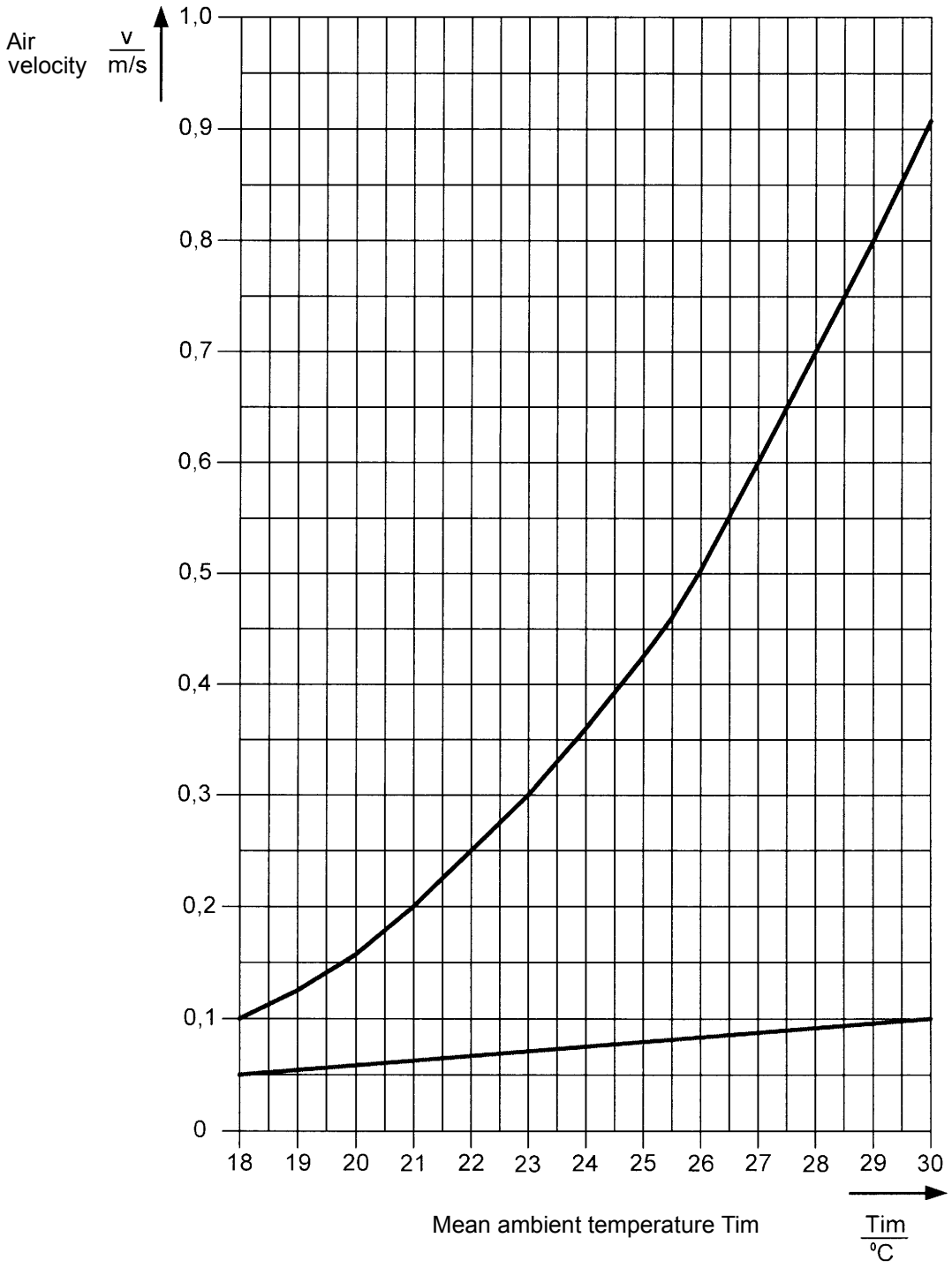

Fig. 5 - Permissible air velocity

Appendix H - Fresh air intake as a function of outside temperature (Te)

H.1 - Air-conditioned coaches

Outside temperature (Te)	Minimum fresh air intake at +20°C and 50% humidity
Te ≤ -20°C	10 m^3/h per seat or berth
-20°C < Te ≤ -5°C	15 m^3/h per seat or berth
-5°C < Te ≤ +26°C	20 m^3/h per seat or berth
Te > +26°C	15 m^3/h per seat or berth

H.2 - Air-heated coaches

Outside temperature (Te)	Minimum fresh air intake at +20°C and 50% humidity
Te ≤ -20°C	10 m^3/h per seat or berth
-20°C < Te ≤ -5°C	15 m^3/h per seat or berth
-5°C < Te < +20°C	20 m^3/h per seat or berth
Te ≥ +20°C and Tim ≥ +24°C	≥20 m^3/h per seat or berth

Glossary

Admixed air Ambient air drawn from the room and recycled.

Air heating Combined ventilation and heating equipment.

Air intake Treated air fed into a room; may be topped up with admixed air.

Air supply Treated air fed in through ducts.

Air treatment device Equipment to transmit, filter and/or mix air and heat and/or cool it.

Air-conditioning equipment
Piece of equipment used for ventilation, and/or heating and cooling and/or dehumidification.

Ambient air Air in a room.

Ambient temperature (Tir) Actual temperature of ambient air.

Ancillary rooms Areas in which passengers or staff may spend brief periods of time.

Catering facilities Area or room in which trained staff prepare and/or sell meals and drinks.

Climate control equipment
System used for ventilation and/or heating and/or cooling and/or air-filtering.

Comfort An individual's feeling of well-being resulting from his/her air-conditioned environment.

Comfort zone Area in compartments or saloons between 0,1 m and 1,7 m above floor level and more than 0,2 m away from all walls and partitions.

Cooling unit Centralised or decentralised cooling equipment.

Cooling Process designed to reduce or maintain the ambient temperature.

Dehumidification Process designed to reduce the water content of ambient air.

Forced-air ventilation system
Mechanical air circulation system.

Heat transfer coefficient (k)
This is the heat flow per surface unit divided by the difference between the reference temperatures in the coach areas separated by the corresponding walls. It is expressed in W/m^2K.
The k value takes account of the effectiveness of outer surface heat insulation and the effect of air penetrating through doors, windows or various apertures owing to draughts when the vehicle is moving. It may refer to the entire vehicle or merely parts thereof.

Heating Process designed to increase or maintain the ambient temperature.

Main heating unit or main bank of heaters
Centralised or decentralised system of heating elements used for heating. May be combined with forced-air ventilation.

Mean ambient temperature (Tim)
Arithmetically calculated average ambient temperature at a height of 1,1 m above floor level (measured in accordance with the procedure in UIC Leaflet 553-1).

Mean outside temperature (Tem)
Arithmetically calculated average outside temperature (measured in accordance with the procedure in UIC Leaflet 553-1).

Mixed air Mixture of fresh and recycled air.

Outgoing air Air escaping out of a vehicle.

Outside or fresh air Air drawn in from the environment.

Pre-cooling Process designed to reduce the ambient temperature in unoccupied coaches.

Pre-heating Process designed to increase the ambient temperature in unoccupied coaches.

Recycled air Air drawn out of a room to be re-used.

Solar heating equivalent Total radiation per m^2 on a surface normally exposed directly to the radiation source. Radiation is emitted by a light source (equivalent to natural solar radiation) at an angle of 30° to the horizontal axis.

Technical areas or installations
Areas or rooms in a railway vehicle subject to specific conditions, chiefly in respect of the handling of waste air on account of the technical installations they contain (e.g. switch boxes, driver's cabs).

Theoretical ambient temperature (Tic)
Stipulated temperature to be reached in a room.

Top-up heater Decentralised heater used to increase heat locally.

Treated air Air that might have been filtered in a treatment device and / or has been subject to an energy exchange.

Ventilation Non-mechanical air circulation system.

Waste air Air escaping out of a coach.

Window transmission factor (τ)
This factor expresses the ratio of the energy flow penetrating though the window panes into the coach interior to the energy flow within the coach.

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Warning

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