UIC CODE 553-1

2nd edition, October 2005

Translation

OR

Heating, ventilation and air-conditioning in coaches - Standard tests

Ventilation, chauffage et climatisation des voitures - Essais de type
Lüftung, Heizung und Klimatisierung der Reisezugwagen - Typenprüfung

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

Leaflet to be classified in Volumes:

V - Transport Stock

VI - Traction

Application:

With effect from 1 January 2000 for new train to be built
All members of the International Union of Railways

Record of updates

1st edition, January 1992	First issue under the title "Air-conditioning equipment in coaches - Standard tests".
2nd edition, October 2005	Revision of Leaflet on account of EN 13129-2:2001 and adaptation to comply with editor's guide M1.

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

Contents

Summary

This Leaflet defines a standard programme of tests as well as the method to be adopted for measuring the performance of air-conditioning equipment in accordance with the requirements set out in *UIC Leaflet 553*.

It is recommended that when testing air-conditioning equipment, functional tests should also be undertaken in respect of other equipment such as doors, toilet installations, power supply equipment, lighting, etc. in accordance with the relevant Leaflets.

1 - Scope

1.1 - The provisions of this Leaflet are applicable to the vehicles specified in *UIC Leaflet 553* (see Bibliography - page 34).

1.2 - The test conditions outlined in the Leaflet relate to coaches with compartments and coaches with open saloons according to *UIC Leaflet 567* (see Bibliography - page 34). This Leaflet also applies to vehicles of modified design. The special test conditions to apply in this case shall be agreed between the client and the test centre.

2 - Definitions

The essential technical terms and definitions relating to air-conditioning in vehicles are summarised in *UIC Leaflet 553*.

3 - Preliminary tests

The preliminary tests relate to the electrical equipment, the basic functions of the air-conditioning equipment, the functional logic of the control of the air-conditioning equipment and the air-tightness of the circuit.

4 - Air tests

o 4.1 - Static air tests

4.1.1 - Test conditions

The tests shall be carried out under the following conditions:

- Vehicle stationary and protected from weather,
- Height above sea level < 1 000 m,
- Speed of outside air << 4 m/s,
- Ambient temperatures between + 15 °C and + 30 °C.

4.1.2 - Air flow

The following air flows shall be determined:

- Outside air (or fresh air),
- Escaping air (where possible),
- Circulating air and/or conditioned air and/or mixed air.

4.1.3 - Differential pressures

The differential pressures between two defined areas can be revealed by means of the flow of smoke.

The measurements are to be taken in particular in the kitchens of restaurant cars, in mixed smoking/ non-smoking vehicles, in toilets and in areas used for technical purposes (e.g. drivers' cabs), in order to demonstrate that the air-conditioning equipment has been correctly designed to prevent the spread of odours.

4.2 - Dynamic air tests

4.2.1 - It is recommended that measurements be taken of the air velocity and/or of the pressures set up during running on the track. The measurements may relate to the following parts of the circuit:

- outside air,
- escaping air.

It is recommended that during these dynamic tests the functioning of the condenser fan of the cooling system should also be checked.

The results should be compared with those of the measurements taken with the vehicle stationary.

4.2.2 - Dynamic testing of the pressure protection system

to be provided.

4.3 - Comfort tests

O 4.3.1 - Critical air speed

The purpose of these test is to determine the three most uncomfortable seats (at least three) in the comfort zone (see Appendix G - page 32).

O 4.3.2 - Measurement of air speed without simulated occupation

These tests are to be carried out during regulation tests according to point 5.4 - page 8 during which no thermal or physical occupation is simulated.

4.3.3 - Measurement of air speed with simulated occupation

It is recommended that:

- the air speeds in the passenger accommodation should also be recorded during the regulation tests according to point 5.4 with simulated occupation (see point 9.2 - page 15),
- tests should be carried out using models to simulate the passengers in a compartment or in a seating unit.

5 - Air-conditioning tests

5.1 - General

5.1.1 - Appendix A - page 18 to page 26 outlines a minimum programme of tests for evaluating the comfort parameters specified in *UIC Leaflet 553*.

The order in which the tests are carried out is optional; they may be adapted to the physical characteristics of the climatic chamber and to the test facilities available. During the tests continuous recording shall be taken of:

- all the measured values at each of the measuring points defined in point 10 - page 17;
- the energy consumption of the air-conditioning equipment alone and also where applicable of the whole vehicle according to *UIC Leaflet 550* (see Bibliography - page 34).

5.1.2 - Where it is necessary to check other installations too, such as doors, toilet facilities, power supply equipment, lighting, etc., the relevant tests shall not in any way interfere with the air-conditioning measurements.

5.2 - Pre-heating test

The pre-heating test is defined in Appendix A.

Before commencement of the pre-heating tests the temperatures of the room air and of the interior surfaces of the vehicle must have adapted themselves to the outside air temperature and have remained stable for at least one hour ± 1 K.

5.3 - Pre-cooling test

The pre-cooling test is defined in Appendix A.

Before commencement of the pre-cooling tests the temperatures of the room air and of the interior surfaces of the vehicle must have adapted themselves to the outside air temperature and have remained stable for at least one hour ± 1 K. Then, before the pre-cooling test is actually begun, the vehicle is to be exposed to the sun for two hours with the doors and windows closed; the intensity of this equivalent solar radiation shall be as specified in *UIC Leaflet 553* for this vehicle.

5.4 - Regulation tests

5.4.1 - Procedure

The regulation tests shall be commenced with the air-conditioning equipment in a stabilised condition with the temperature control at the middle setting; in this condition, and while adhering to the comfort requirements specified in *UIC Leaflet 553*, there should have been no change in the average room temperature (Tic) over a period of 90 minutes or during three identical regulation cycles.

If any of the parameters (inside or outside) have undergone any change, the variation of the other parameters should be observed for 90 minutes or during 3 identical regulation cycles.

The results must satisfy the specified comfort conditions of *UIC Leaflet 553*.

5.4.2 - Functional test in heating mode

These tests are to be carried out at the following outside temperatures (Tem):

Zone I	**Zone II**	**Zone III**
Temperatures [ºC]	Temperatures [ºC]	Temperatures [ºC]
- - 10 0 + 10	- 20 - 10 0 + 10	- 40 - 10 0 + 10

5.4.2.1 - If the nominal room temperature is varied from the average towards the maximum or the minimum by regulating the temperature control, the requirements set out in *UIC Leaflet 553* are to be respected.

5.4.2.2 - In order to check the normal behaviour of the temperature variations in vehicles with compartments, the temperature controls are to be placed at the maximum setting in 20 % to 30 % of the compartments, and the controls in the remaining vehicles at the minimum setting. The same test is to be carried out with the controls in 70 % to 80 % of the compartments at the highest setting and the remainder at the lowest setting.

5.4.2.3 - In order to determine the effect of the rate of occupation on the regulation system the tests are to be carried out with full occupation and with partial occupation in accordance with point 9.2 - page 15.

5.4.2.4 - The purpose of the tests using wind is to make it possible to ascertain the performance and efficiency of the air-conditioning equipment, the air-tightness of the vehicle body and the effect on conditions around the air circulation apertures.

5.4.3 - Functional test in cooling mode

The tests are to be carried out in the following climatic conditions:

Zone I			Zone II			Zone III		
1	2	3	1	2	3	1	2	3
°C	%	W/m^2	°C	%	W/m^2	°C	%	W/m^2
40 28 22	40 70 80	800 600 500	35 28 22	50 70 80	700 600 500	28 22	45 80	600 500

Key:
1: temperature
2: relative humidity
3: equivalent intensity of solar radiation

5.4.3.1 - When changing the nominal room temperature from the average to the maximum or minimum by regulating the temperature control, the requirements set out in *UIC Leaflet 553* are to be respected.

5.4.3.2 - In order to check the normal behaviour of the temperature variations in vehicles with compartments the temperature controls are to be placed at the maximum setting in 20 % to 30 % of the compartments, and the controls in the remaining vehicles at the minimum setting. The same test is to be carried out with the controls in 70 % to 80 % of the compartments at the highest setting and the remainder at the lowest setting.

5.4.3.3 - In order to determine the effect of the level of occupation on the regulation system, the tests are to be carried out with full occupation and with partial occupation in accordance with point 9.2 - page 15.

5.4.3.4 - The purpose of the tests using wind is to make it possible to ascertain the performance and efficiency of the air-conditioning equipment, the air-tightness of the vehicle body and the effect on conditions near the air circulation apertures.

5.4.3.5 - The purpose of the tests involving exposure to the sun is to determine the effect of solar radiation on the control system. The first test is to extend over an exposure period of at least four hours; the following tests are to be carried out following the procedure described in point 5.4.1 - page 8.

5.4.4 - Tests with variable outside temperature

The purpose of the regulation tests with the outside temperature rising or falling by some 3 K per hour is to determine the behaviour of the air-conditioning equipment when changing over from the cooling to heating mode or vice-versa, with or without any additional interference due to the level of occupation of the vehicle or the intensity of the solar radiation.

A further object of the tests is to ascertain the conditions for switching on the heating and/or ventilation and/or cooling functions. In this case the corresponding average outside temperature (Tem) must be kept constant for 30 minutes.

6 - Functional tests in extreme outside conditions

The operation of the air-conditioning installation in the extreme outside temperatures defined in *UIC Leaflet 553* shall be tested.

7 - Additional tests

o 7.1 - Frost protection

7.1.1 - Purpose of test

The object of the test is to confirm that the installations for the supply of water and the closed-circuit toilets in the vehicle as defined in *UIC Leaflet 563* (see Bibliography - page 34) do not sustain any damage as a result of ice formation.

7.1.2 - Test procedure

- The water tanks shall be filled with water with a temperature of < 15 °C at least five hours before commencement of the test. For each type of container, one is to be quarter filled and another three quarters filled.

- A functional check of the installations is to be carried out.

- Before the test is begun the outside temperature is to be held steady at - 10 °C and the mean room temperature in the passenger accommodation at + 20 °C for five hours.

- Cooling test at an outside temperature of - 10 °C for a period of at least 12 hours without any power input.

- Upon completion of the test a functional check of the installations shall be undertaken.

The temperatures of the tanks, of the discharge valves, of the pipes and of those components exposed to the risk of freezing, should be continuously monitored during the test. The test shall be discontinued in the event of risk of freezing.

o 7.2 - Determination of the k value

7.2.1 - Purpose of test

The object of the test is to determine whether the coefficient k defining the thermal quality of a vehicle (effectiveness of the thermal insulation and the effect of heat losses) in accordance with *UIC Leaflet 567*, is attained in both the stationary and the moving vehicle.

7.2.2 - Determination

The k value is defined by the following formula:

$$k = \frac{P}{Ae \times (Tim - Tem)}$$

where:

- Ae [m^2] is the exterior developed surface of the walls, including the insulation of the roof, of the floor and of the side walls of the body of the whole vehicle or of the parts considered. In the case of specific vehicle types, the surface is to be agreed between the contractor and the test centre.

- P [W] is the thermal output which needs to be provided inside the vehicle in order to ensure that in normal conditions the temperature differential between the mean room temperature (Tim) and the mean outside temperature (Tem) is maintained; Tim is to be measured at a height of 1.1 m above the floor of the vehicle or of the relevant parts. The distribution of the measuring points must be as indicated in Appendix F - page 31.

7.2.3 - Procedure

The air and circulation apertures are to be closed off without any thermal insulation. The electrical and intake air-conditioning equipment of the vehicle shall be switched off. The windows and doors should be closed. The intercommunication passages shall be closed by means of the doors or using a seal with a k value of $< 0,5\ W/m^2K$.

Interior vehicle heating shall consist of independent adjustable low-radiation units which are to be positioned in the comfort zone and/or in the adjacent accommodation areas. Fans must be provided to ensure adequate air circulation inside the vehicles. The energy consumption is to be determined separately for the heating equipment and the fans. The fans are to be positioned above the heating equipment so that the air flow is directed downwards.

All the measured parameters are to be monitored at least every five minutes.

- The difference between Tim and Tem shall be 25 K $\pm$ 5 K,
- The tests are to be carried out at Tem = + 5 °C $\pm$ 5 K.

If the k measurement is not recorded in a wind tunnel, the following conditions are to be respected:

- the Tem measurement point shall be a distance of 10 cm from the side wall;
- a continuous flow of air shall be ensured on the onter surface;
- a detailled record shall be kept of the order and results of measurements.

The performance of the heating units and of the fans shall be kept constant. The k value can be determined if the temperatures are stabilised as follows:

- the variation in the values of Tem and (Tim - Tem) after three hours shall not be below 0,1 K;
- the temperature differential at the various measuring points (interior and exterior) must be less than 2 K.

The k value is to be calculated with the temperatures constant taking account of the values measured during the previous hour.

7.2.4 - Scope of tests

7.2.4.1 - The measurements are to be taken:

- with the vehicle stationary (wind speed in the climatic chamber S-15 km/h);
- at a wind speed corresponding to the speed for which the vehicle has been approved or at the maximum attainable wind speed in the climatic chamber.

7.2.4.2 - The k values shall be established separately for the complete vehicle, the passenger accommodation and the vestibules.

7.3 - Thermografy

As a qualitative aid to the assessment of the thermal insulation of the vehicle a thermographic study is recommended.

This will be useful for detecting cold bridges and will facilitate the implementation of constructive measures for the improvement of comfort in the passenger accommodation and for reducing the energy consumption of the air-conditioning equipment.

o 7.4 - Noise and vibrations

Measurements of noise and vibrations generated by the air-conditioning installations shall be taken at extreme summer temperatures for the zone specified, in accordance with *UIC Leaflet 553* and *ENV 12299* (see Bibliography - page 34).

8 - Measuring methods and measuring instruments

8.1 - Principles

The measuring method employed shall be capable of taking continuous measurements with a minimum scanning rate of one minute for all the measured values.

8.2 - Temperatures

8.2.1 - Air temperature

The measuring instruments used must be of class S according to *ISO 7726, Table 2* (see Bibliography - page 34), with a maximum deviation of ± 0,25 K throughout the recording period.

8.2.2 - Surface temperature

When measuring the surface temperatures precautions shall be taken against outside interference due for instance to radiation, convection and heat transfer. The classification of the measuring instruments shall correspond to those specified in point 8.2.1.

8.3 - Relative air humidity

The measuring instruments used must correspond to class C of *ISO 7726, Table 2*.

8.4 - Air velocity

The measuring method employed must be capable of taking continuous measurements with a scanning rate of one measured value per second over a period of at least one minute. The arithmetic means and the standard deviations shall be calculated for each measuring period.

The measuring instruments used must correspond to class S according to *ISO 7726*.

8.5 - Air flow

The air flow shall be determined using a calibrated measuring method ensuring a minimum accuracy of 5 % (It is essential that these parameters be recorded continuously).

8.6 - Simulated vehicle speed

The velocity of the air around the vehicle shall be established using a calibrated measuring method with an accuracy of at least ± 1 m/s.

8.7 - Equivalent intensity of solar radiation

The equivalent intensity of the solar radiation is to be measured using a calibrated measuring system. This measurement shall be taken adopting the method described in Appendix F - page 31.

8.8 - Energy consumption and electrical power

The measuring instruments employed must exhibit an accuracy to within at least 0,5 %.

9 - Characteristics of test equipment

9.1 - General

The climatic chamber must have been approved by a recognised centre.

9.2 - Occupation

The full or partial occupation in the comfort zone (see Appendix A - page 18 to page 26) shall be simulated in accordance with the requirements of *UIC Leaflet 553* in respect of thermal aspects.

In order to simulate the perceptible heat, low-radiation heaters must be used, the surface temperature of which must be below 40 °C.

To simulate humid (latent) heat, water should be evaporated. The component of perceptible heat generated by the humidifying equipment shall be taken into consideration when making a general assessment of the perceptible heat.

9.3 - Temperature of climatic chamber (Tem) and uniformity of temperature in the wind tunnel

The temperature of the climatic chamber must comply with the following requirements in the temperature ranges specified:

- Temperature fluctuation with time in static conditions: ≤ 0,5 K;
- The temperature difference between the various measuring points must not exceed 2 K regardless of the wind velocity, in accordance with Appendix H - page 33.

For the temperature distribution (difference between the hottest and the coolest measuring point) the measured parameters for determining the temperature of the climatic chamber (Tem) shall be in accordance with point 10.2 - page 17.

9.4 - Measurement of relative humidity

The relative air humidity may not vary by more than 5 % during the test (in the stationary condition).

9.5 - Simulation of (wind) speed

Suitable blowers are required in order to simulate the aerodynamic characteristics of a train or of a fleet of vehicles.

The measured wind velocity is to be corrected to take account of the effects on the walls of the climatic wind tunnel and in order to maintain a uniform heat transfer while running on open track.

9.6 - Equivalent intensity of solar radiation

The equipment used for simulating the solar radiation based on the characteristic of the terrestrial radiation intensity "global radiation" of 1 120 W/m^2 according to *CIE No. 20* (see Bibliography - page 34), shall consist of lamps with a characteristic conforming to the following table:

Wavelength **(mm)**	**Levels of total radiation as a percentage of terrestrial radiation according to CIE No. 20** **(%)**	**Permissible deviation** **(%)**
280 - 400	6,1	± 3
400 - 800	51,8	± 5
800 - 3 000	42,1	± 5

10 - Distribution of measuring points

10.1 - Distribution of measuring points in the vehicle

10.1.1 - Measuring points for temperatures in the comfort zone

These are given in Appendices C - page 28, D - page 29 and E - page 30.

10.1.2 - Measuring points for surface temperatures

These are given in Appendix F - page 31.

10.1.3 - Measuring points for the temperature at the intake apertures

In the preliminary tests the hottest point is to be determined.

10.1.4 - Measuring points for air velocity in the comfort zone

These are given in Appendix G - page 32.

10.1.5 - Measuring points for air velocity in the comfort zone

These are to be arranged at the geometrical centre point of the compartments as defined in Appendix D - page 29.

10.2 - Distribution of the measuring points in the climatic chamber

The measuring points for the mean temperature (Tem), the relative humidity and the wind velocity are defined in Appendix H - page 33.

Appendix A - Programme of tests

A.1 - Zone I

Table 1 : Tests at low outside temperatures - Winter

Test No.	Test Point	Designation of test	Mean outside temperature (Tem) °C	Relative air humidity %	Wind velocity km/h	Simulation of occupation %	Sun %	Setting of thermostat	Comments
101	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Min	
102	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Normal medium	
103	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Max	
104	5.2	Pre-heating test	+ 0	-	5 to 15	0	0	Max	
105	5.4.2.1	Regulation test	+ 0	-	5 to 15	0	0	Max	
106	5.4.2.1	Regulation test	+ 0	-	5 to 15	0	0	Normal medium	
107	5.4.2.4	Regulation test	+ 0	-	≥ 120 [a]	0	0	Normal medium	
108	5.4.2.3	Regulation test	+ 0	-	5 to 15	At least 3 compartments fully occupied	0	Normal medium	The tests apply only to compartment coaches
109	5.4.2.3	Regulation test	+ 0	-	5 to 15	Fully occupied except front compartments	0	Normal medium	
110	5.4.2.2	Regulation test	+ 0	-	5 to 15	0	0	20 to 30 % of compartments maximum, the rest minimum	
111	5.4.2.2	Regulation test	+ 0	-	5 to 15	0	0	70 to 80 % of compartments maximum, the rest minimum	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 2 : Tests in extreme outside conditions

Test No.	Test Point	Designation of test	Mean outside temperature (Tem) °C	Relative air humidity %	Wind velocity km/h	Simulation of occupation %	Sun %	Setting of thermostat	Comments
112	6	Functional	- 15	-	5 to 15	0	0	Max	Functional test
113	5.4.2.1	Regulation	- 10	-	5 to 15	0	0	Max	
114	5.4.2.1	Regulation	- 10	-	5 to 15	0	0	Normal medium	
115	5.4.2.4	Regulation	- 10	-	≥ 120 [a]	0	0	Normal medium	
116	7.1	Frost protection	- 10	-	5 to 15	0	0		This test to be carried out after a regulation test at - 10 °C
117	7.2	k value	5 ± 2	-	5 to 15	0	0		

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 3 : Tests at variable outside temperature - Summer

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
201	5.4.4	Regulation test	0↗ + 22	↗80	5 to 15	0	0	Normal medium	Tem ↗3K/h
202	5.4.3	Regulation test	+ 22	80	5 to 15	0	0	Normal medium	
203	5.4.3.3	Regulation test	+ 22	80	5 to 15	100	0	Normal medium	
204	5.4.3.1	Regulation test	+ 22	80	5 to 15	100	0	Max	
205	5.4.3.1	Regulation test	+ 22	80	5 to 15	100	0	Min	
206	5.4.3.2	Regulation test	+ 22	80	5 to 15	100	0	20 to 30 % of compartments maximum, the rest minimum	The tests apply only to compartment coaches
207	5.4.3.2	Regulation test	+ 22	80	5 to 15	100	0	70 to 80 % of compartments maximum, the rest minimum	
208	5.4.4	Regulation test	+ 22↘+ 5	80↘	5 to 15	100	0	Normal medium	Tem ↘3 K/h
209	5.4.4	Regulation test	+ 5	-	5 to 15	100	100	Normal medium	
210	5.4.4	Regulation test	+ 5↗28	↘70	5 to 15	100	100	Normal medium	Tem ↗3 K/h
211	5.4.3.5	Regulation test	28	70	5 to 15	0	100	Normal medium	
212	5.4.3.5	Regulation test	28	70	5 to 15	0	0	Normal medium	
303-1	5.4.3.3 5.4.3.4 5.4.3.5	Regulation test	28	45	5 to 15	100	100	Min	
304-1	5.4.3.1	Regulation test	28	45	5 to 15	100	100	Normal medium	
305-1	5.4.3.1 5.4.3.2 5.4.3.4	Regulation test	28	45	≥ 120 [a]	100	100	Normal medium	
306-1	5.4.3.4	Regulation test	28	45	≥ 120 [a]	100	0	Normal medium	
307-1	5.4.3.4 5.4.3.5	Regulation test	28	45	≥ 120 [a]	0	0	Normal medium	

Table 3 : Tests at variable outside temperature - Summer

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
308-1	5.4.3.2	Regulation test	28	45	5 to 15	100	100	70 to 80 % of compartments maximum, the rest minimum	The tests apply only to compartment coaches
309-1	5.4.3.2	Regulation test	28	45	5 to 15	100	100	20 to 30 % of compartments maximum, the rest minimum	
310-1	5.4.3.3 5.4.3.4 5.4.3.5	Regulation test	28	45	≥ 120 [a]		100	Normal medium	
311-1	5.4.3.3 5.4.3.4 5.4.3.5	Regulation test	28	45	≥ 120 [a]		100	Normal medium	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 4 : Tests in extreme outside conditions

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
301	6	Functional	+ 45 or + 50	35 or 30	5 to 15	0	0	Min	Functional test
302	5.3	Pre-cooling test	40	40	5 to 15	0	100	Min	
303	5.4.3.3 5.4.3.4 5.4.3.5	Regulation test	40	40	5 to 15	100	100	Min	
304	5.4.3.1	Regulation test	40	40	5 to 15	100	100	Normal medium	
305	5.4.3.1 5.4.3.2 5.4.3.3 5.4.3.4	Regulation test	40	40	≥ 120 [a]	100	100	Normal medium	
306	5.4.3.4	Regulation test	40	40	≥ 120 [a]	100	0	Normal medium	
307	5.4.3.4 5.4.3.5	Regulation test	40	40	≥ 120 [a]	0	0	Normal medium	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

A.2 - Zone II

Table 5 : Tests at low outside temperatures

Test No.	Test Point	Designation of test	Mean outside temperature (Tem) °C	Relative air humidity %	Wind velocity km/h	Simulation of occupation %	Sun %	Setting of thermostat	Comments
101	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Min	
102	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Normal medium	
103	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Max	
104	5.2	Pre-heating test	+ 0	-	5 to 15	0	0	Max	
105	5.4.2.1	Regulation test	+ 0	-	5 to 15	0	0	Max	
106	5.4.2.1	Regulation test	+ 0	-	5 to 15	0	0	Normal medium	
107	5.4.2.4	Regulation test	+ 0	-	≥ 120 [a]	0	0	Normal medium	
108	5.4.2.3	Regulation test	+ 0	-	5 to 15	At least 3 compartments fully occupied	0	Normal medium	The tests apply only to compartment coaches
109	5.4.2.3	Regulation test	+ 0	-	5 to 15	Fully occupied except front compartments	0	Normal medium	
110	5.4.2.2	Regulation test	+ 0	-	5 to 15	0	0	20 to 30 % of compartments maximum, the rest minimum	
111	5.4.2.2	Regulation test	+ 0	-	5 to 15	0	0	70 to 80 % of compartments maximum, the rest minimum	
113-1	5.4.2.1	Regulation test	- 10	-	5 to 15	0	0	Max	
114-1	5.4.2.1	Regulation test	- 10	-	5 to 15	0	0	Normal medium	
115-1	5.4.2.4	Regulation test	- 10	-	≥ 120 [a]	0	0	Normal medium	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 6 : Tests in extreme outside conditions

Test No.	Test Point	Designation of test	Mean outside temperature (Tem) °C	Relative air humidity %	Wind velocity km/h	Simulation of occupation %	Sun %	Setting of thermostat	Comments
112	6	Functional	- 25	-	5 to 15	0	0	Max	Functional test
113	5.4.2.1	Regulation test	- 20	-	5 to 15	0	0	Max	
114	5.4.2.1	Regulation test	- 20	-	5 to 15	0	0	Normal medium	
115	5.4.2.4	Regulation test	- 20	-	≥ 120 [a]	0	0	Normal medium	
116	7.1	Frost protection	- 10	-	5 to 15	0	0		This test to be carried out after a regulation test at - 10 °C
117	7.2	k value	5 ± 2	-	5 to 15	0	0		

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 7 : Tests at variable outside temperature - Summer

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
201	5.4.4	Regulation test	0↗+ 22	↗80	5 to 15	0	0	Normal medium	Tem ↗3 K/h
202	5.4.3	Regulation test	+ 22	80	5 to 15	0	0	Normal medium	
203	5.4.3.3	Regulation test	+ 22	80	5 to 15	100	0	Normal medium	
204	5.4.3.1	Regulation test	+ 22	80	5 to 15	100	0	Max	
205	5.4.3.1	Regulation test	+ 22	80	5 to 15	100	0	Min	
206	5.4.3.2	Regulation test	+ 22	80	5 to 15	100	0	20 to 30 % of compartments maximum, the rest minimum	The tests apply only to compartment coaches
207	5.4.3.2	Regulation test	+ 22	80	5 to 15	100	0	70 to 80 % of compartments maximum, the rest minimum	
208	5.4.4	Regulation test	+ 22↘+ 5	80↘	5 to 15	100	0	Normal medium	Tem ↘3 k/h
209	5.4.4	Regulation test	+ 5		5 to 15	100	100	Normal medium	
210	5.4.4	Regulation test	+ 5↗28	↗70	5 to 15	100	100	Normal medium	Tem ↗3 K/h
211	5.4.3.5	Regulation test	28	70	5 to 15	0	100	Normal medium	
212	5.4.3.5	Regulation test	28	70	5 to 15	0	0	Normal medium	
303-1	5.4.3.3 - 5.4.3.5	Regulation test	28	45	5 to 15	100	100	Min	
304-1	5.4.3.1	Regulation test	28	45	5 to 15	100	100	Normal medium	
305-1	5.4.3.1 - 5.4.3.4	Regulation test	28	45	≥ 120 [a]	100	100	Normal medium	
306-1	5.4.3.4	Regulation test	28	45	≥ 120 [a]	100	0	Normal medium	
307-1	5.4.3.4 - 5.4.3.5	Regulation test	28	45	≥ 120 [a]	0	0	Normal medium	

Table 7 : Tests at variable outside temperature - Summer

Test No.	Test Point	Designation of test	Mean outside temperature (Tem) °C	Relative air humidity %	Wind velocity km/h	Simulation of occupation %	Sun %	Setting of thermostat	Comments
308-1	5.4.3.2	Regulation test	28	45	5 to 15	100	100	70 to 80 % of compartments maximum, the rest minimum	The tests apply only to compartment coaches
309-1	5.4.3.2	Regulation test	28	45	5 to 15	100	100	20 to 30 % of compartments maximum, the rest minimum	
310-1	5.4.3.3 5.4.3.4 5.4.3.5	Regulation test	28	45	≥ 120 [a]	At least 3 compartments fully occupied	100	Normal medium	
311-1	5.4.3.3 5.4.3.4 5.4.3.5	Regulation test	28	45	≥ 120 [a]	Fully occupied except front compartments	100	Normal medium	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 8 : Tests in extreme outside conditions

Test No.	Test Point	Designation of test	Mean outside temperature (Tem) °C	Relative air humidity %	Wind velocity km/h	Simulation of occupation %	Sun %	Setting of thermostat	Comments
301	6	Functional	+ 40 or + 45	40 or 35	5 to 15	0	0	Min	Functional test
302	5.3	Pre-cooling test	35	50	5 to 15	0	100	Min	
303	5.4.3.3 - 5.4.3.5	Regulation test	35	50	5 to 15	100	100	Min	
304	5.4.3.1	Regulation test	35	50	5 to 15	100	100	Normal medium	
305	5.4.3.1 - 5.4.3.4	Regulation test	35	50	≥ 120 [a]	100	100	Normal medium	
306	5.4.3.4	Regulation test	35	50	≥ 120 [a]	100	0	Normal medium	
307	5.4.3.4 - 5.4.3.5	Regulation test	35	50	≥ 120 [a]	0	0	Normal medium	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

A.3 - Zone III

Table 9 : Tests at low outside temperatures - Winter

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
101	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Min	
102	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Normal medium	
103	5.4.2.1	Regulation test	+ 10	-	5 to 15	0	0	Max	
104	5.2	Pre-heating test	+ 0	-	5 to 15	0	0	Max	
105	5.4.2.1	Regulation test	+ 0	-	5 to 15	0	0	Max	
106	5.4.2.1	Regulation test	+ 0	-	5 to 15	0	0	Normal medium	
107	5.4.2.4	Regulation test	+ 0	-	≥ 120 [a]	0	0	Normal medium	
108	5.4.2.3	Regulation test	+ 0	-	5 to 15	At least 3 compartments fully occupied	0	Normal medium	The tests apply only to compartment coaches
109	5.4.2.3	Regulation test	+ 0	-	5 to 15	Fully occupied except front compartments	0	Normal medium	
110	5.4.2.2	Regulation test	+ 0	-	5 to 15	0	0	20 to 30 % of compartments maximum, the rest minimum	
111	5.4.2.2	Regulation test	+ 0	-	5 to 15	0	0	70 to 80 % of compartments maximum, the rest minimum	
113-1	5.4.2.1	Regulation test	- 10	-	5 to 15	0	0	Max	
114-1	5.4.2.1	Regulation test	- 10	-	5 to 15	0	0	Normal medium	
115-1	5.4.2.4	Regulation test	- 10	-	≥ 120 [a]	0	0	Normal medium	
113-2	5.4.2.1	Regulation test	- 20	-	5 to 15	0	0	Max	
114-2	5.4.2.1	Regulation test	- 20	-	5 to 15	0	0	Normal medium	
115-2	5.4.2.4	Regulation test	- 20	-	≥ 120 [a]	0	0	Normal medium	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 10 : Tests in extreme outside conditions

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
112	6	Functional	- 45	-	5 to 15	0	0	Max	Functional test
113	5.4.2.1	Regulation test	- 40	-	5 to 15	0	0	Max	
114	5.4.2.1	Regulation test	- 40	-	5 to 15	0	0	Normal medium	
115	5.4.2.4	Regulation test	- 40	-	≥ 120 [a]	0	0	Normal medium	
116	7.1	Frost protection	- 10	-	5 to 15	0	0		This test to be carried out after a regulation test at - 10 °C
117	7.2	k value	5 ± 2	-	5 to 15	0	0		

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Table 11 : Tests at variable outside temperature - Summer

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
201	5.4.4	Regulation test	0↗+ 22	↗80	5 to 15	0	0	Normal medium	Tem ↗3 K/h
202	5.4.3	Regulation test	+ 22	80	5 to 15	0	0	Normal medium	
203	5.4.3.3	Regulation test	+ 22	80	5 to 15	100	0	Normal medium	
204	5.4.3.1	Regulation test	+ 22	80	5 to 15	100	0	Max	
205	5.4.3.1	Regulation test	+ 22	80	5 to 15	100	0	Min	
206	5.4.3.2	Regulation test	+ 22	80	5 to 15	100	0	20 to 30 % of compartments maximum, the rest minimum	The tests apply only to compartment coaches
207	5.4.3.2	Regulation test	+ 22	80	5 to 15	100	0	70 to 80 % of compartments maximum, the rest minimum	
208	5.4.4	Regulation test	+ 22↘+ 5	80↘	5 to 15	100	0	Normal medium	Tem ↘3 K/h.
209	5.4.4	Regulation test	+ 5		5 to 15	100	100	Normal medium	
210	5.4.4	Regulation test	+ 5↗28	↘45	5 to 15	100	100	Normal medium	Tem ↗3 K/h
211	5.4.3.5	Regulation test	28	45	5 to 15	0	100	Normal medium	
212	5.4.3.5	Regulation test	28	45	5 to 15	0	0	Normal medium	

Table 12 : Tests in extreme outside conditions

Test		Designation of test	Mean outside temperature (Tem)	Relative air humidity	Wind velocity	Simulation of occupation	Sun	Setting of thermostat	Comments
No.	Point		°C	%	km/h	%	%		
301	6	Functional	+ 33 or + 38	55 or 45	5 to 15	0	0	Min	Functional test
302	5.3	Pre-cooling test	28	45	5 to 15	0	100	Min	
303	5.4.3.3 5.4.3.5	Regulation test	28	45	5 to 15	100	100	Min	
304	5.4.3.1	Regulation test	28	45	5 to 15	100	100	Normal medium	
305	5.4.3.1 5.4.3.4	Regulation test	28	45	≥ 120 [a]	100	100	Normal medium	
306	5.4.3.4	Regulation test	28	45	≥ 120 [a]	100	0	Normal medium	
307	5.4.3.4 5.4.3.5	Regulation test	28	45	≥ 120 [a]	0	0	Normal medium	
308-1	5.4.3.2	Regulation	28	70	5 to 15	100	100	70 to 80% of compartments maximum, the rest minimum	The tests apply only to compartment coaches
309-1	5.4.3.2	Regulation	28	70	5 to 15	100	100	20 to 30% of compartments maximum, the rest minimum	
310-1	5.4.3.3 5.4.3.4 5.4.3.5	Regulation	28	70	≥ 120 [a]	At least 3 compartments fully occupied	100	Normal medium	
311-1	5.4.3.3 5.4.3.4 5.4.3.5	Regulation	28	70	≥ 120 [a]	Fully occupied except front compartments	100	Normal medium	

a. Maximum speed of vehicle according to specification, or maximum wind speed in the wind tunnel.

Appendix B - Equivalent intensity of solar radiation (simulation of solar radiation)

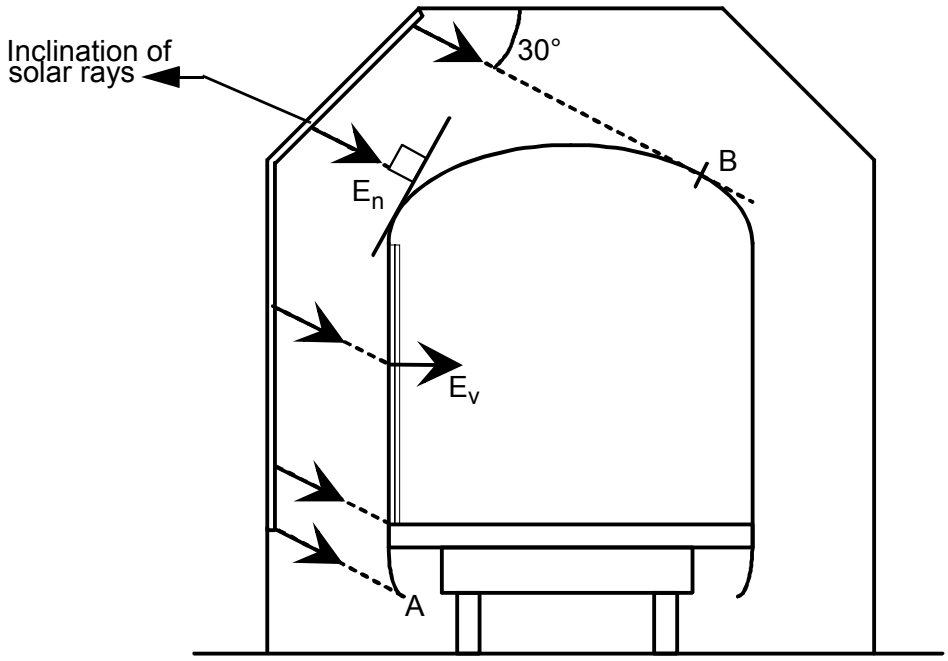

Fig. 1 - Simulation of solar radiation

- It is recommended that the solar rays should be directed between points A and B for all types of vehicle (on the compartment side in the case of passenger vehicles).
- The radiation equipment should be at least as long as the test vehicle.

Key to notation:

- E_n: Equivalent intensity of solar radiation on a surface perpendicular to the direction of radiation and in contact with the contour line of the vehicle.
- $E_v = E_n \times \cos 30° = E_n \times 0{,}866$: Equivalent intensity of solar radiation on the vertical surface of the vehicle.
- E_n is specified in *UIC Leaflet 553, Appendix C*.

Appendix C - Arrangement of measuring points for determining the mean room temperature (Tim) in the comfort zone and in the adjacent areas

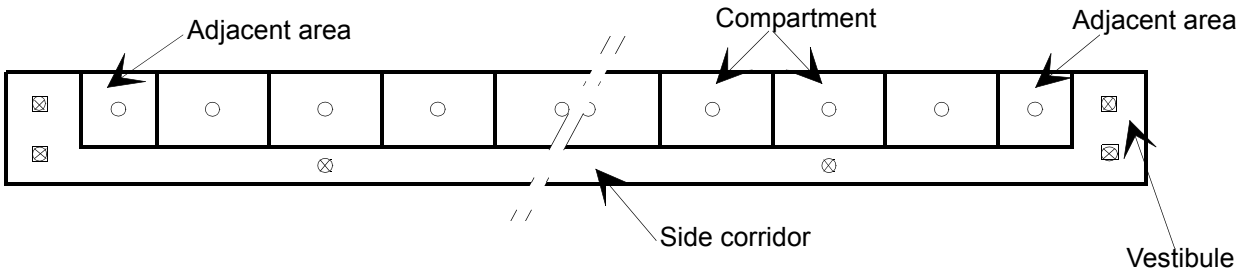

Fig. 2 - Coach with compartments

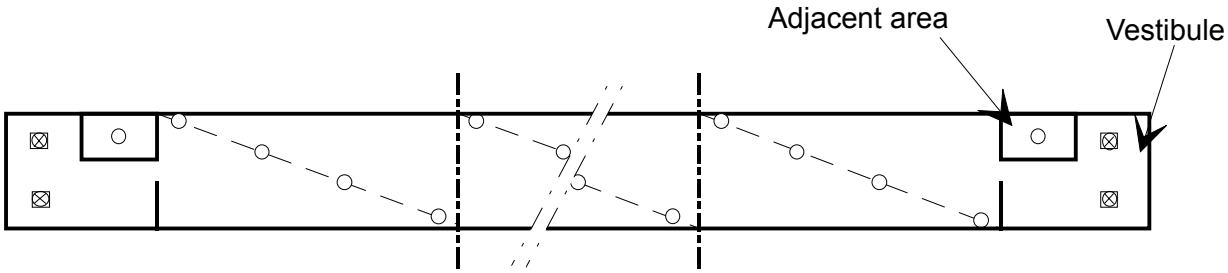

Fig. 3 - Open saloon coach

Key to notation: ○: Measuring points 1,1 m above floor level.
⊗: Measuring points 1,7 m above floor level.

Measuring points in compartments:	At the geometrical center of each compartment.
Measuring points in open saloons:	On the diagonal as shown in the above diagram (the passenger accommodation is divided into three equal parts).
Measuring points in side corridors (coach with compartments):	Along the longitudinal centre line of the corridor near the 2nd and next to last compartment.
Measuring points in the vestibules:	Along the central connecting axis between the entrance doors and 0,5 m away from them.
Measuring points in adjacent areas:	At the geometrical centre point.

NB : In the case of vehicles not conforming to the above arrangement (sleeping cars, couchette vehicles, restaurant cars, composite compartment and saloon coaches), the measuring points should be specfied as applicable.

Appendix D - Arrangement of measuring points for determining the differences in the extreme room temperatures and the relative humidity in the comfort zone

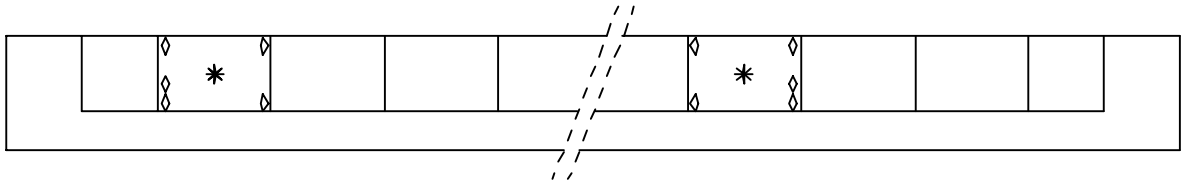

Fig. 4 - Coach with compartments

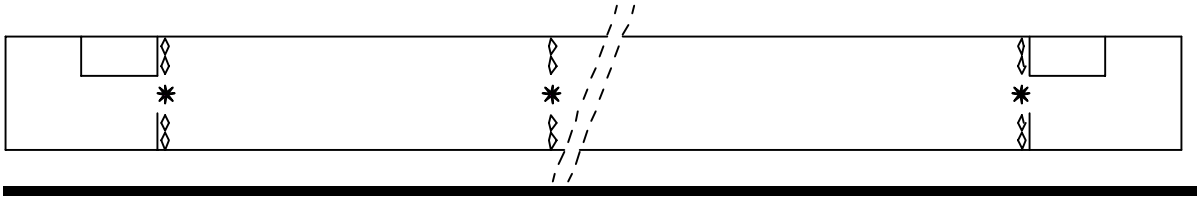

Fig. 5 - Open saloon coach

Key to notation: ◊: Measuring points according to Appendix E - page 30.
∗: Geometrical centre point of measuring zone.

Distribution of measuring points: See Appendix E.

Arrangement of measuring points in coach with compartments:

- On the seats identified with ◊ in a compartment next the entrance door.
- On the seats identified with ◊ in a compartment about 2/3 of the way along the coach.
- At the point identified with ∗ 1,7 m above floor level.

Arrangement of measuring points in open saloons:

- On the seats identified with ◊ in the set of seats adjacent to the entrance.
- On the seats identified with ◊ in a set at about the centre of the largest saloon.
- At the point identified with ∗ 1,7 m above floor level.

NB : In the case of vehicles not conforming to the above layouts (couchette coaches or restaurant cars), the positions of the measuring points are to be specified as applicable.

Appendix E - Arrangement of measuring points for determining the air velocities and the difference in the room temperature in the comfort zone

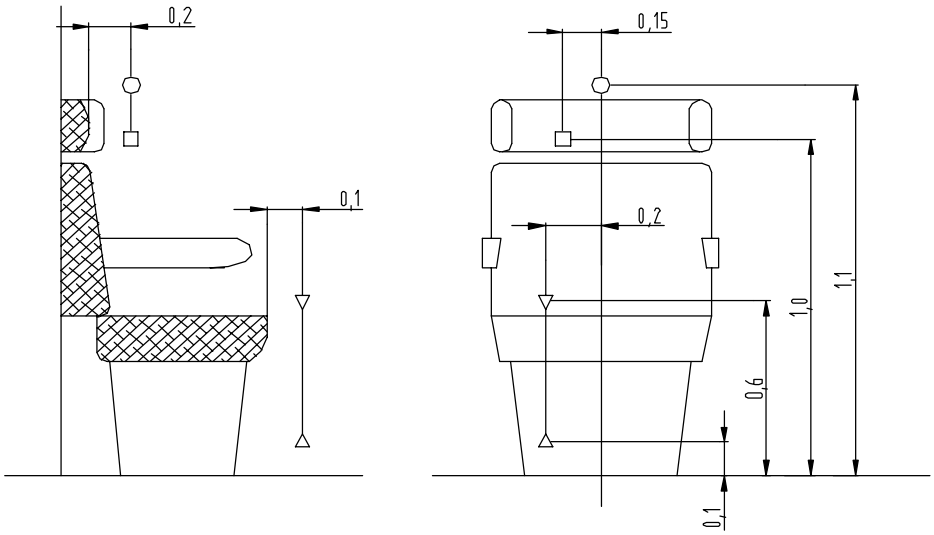

Fig. 6 - Seats

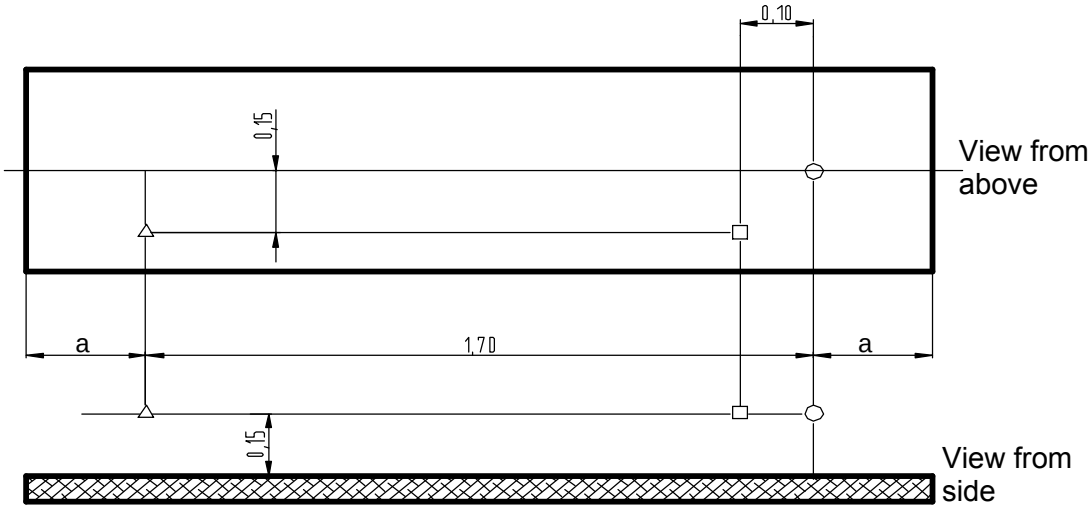

Fig. 7 - Berth and couchette areas

Key to notation:

◊ Measuring point (see Appendix D - page 29)
○ Head
□ Shoulder
▽ Knee
△ Foot

Appendix F - Arrangement of measuring points for determining surface temperatures

The measurements are to be taken in the same compartments or in the same areas, as defined in Appendix E - page 30.

F.1 - Floor and ceiling

The temperature is to be measured at the geometrical centre point of the areas as shown in Appendix E.

F.2 - Window

The temperature is to be measured at the geometrical centre point of the glass pane(s) forming the window.

F.3 - Window frame

The temperature is to be measured at the centre of each vertical panel of the window frame.

F.4 - Walls

- Wall at the side of a seat:
  The temperature is to be measured in the region of the shoulder and knee as shown in Appendix D - page 29.

- Other walls (next to an adjacent area):
  The temperature is to be determined as close as possible to the geometrical centre point of the wall.

Appendix G - Arrangement of measuring points for determining the air velocities in the comfort zone

G.1 - Defining the seats

The three most unfavourable seats are those positioned where the air velocity 1,1 m above floor level is highest.

G.2 - Arrangement of measuring points

The measuring points at each of the three seats should be at positions corresponding to the head (seated passenger), the shoulder and the feet as shown in Appendix E - page 30.

Appendix H - Arrangement of measuring probes in the climatic chamber

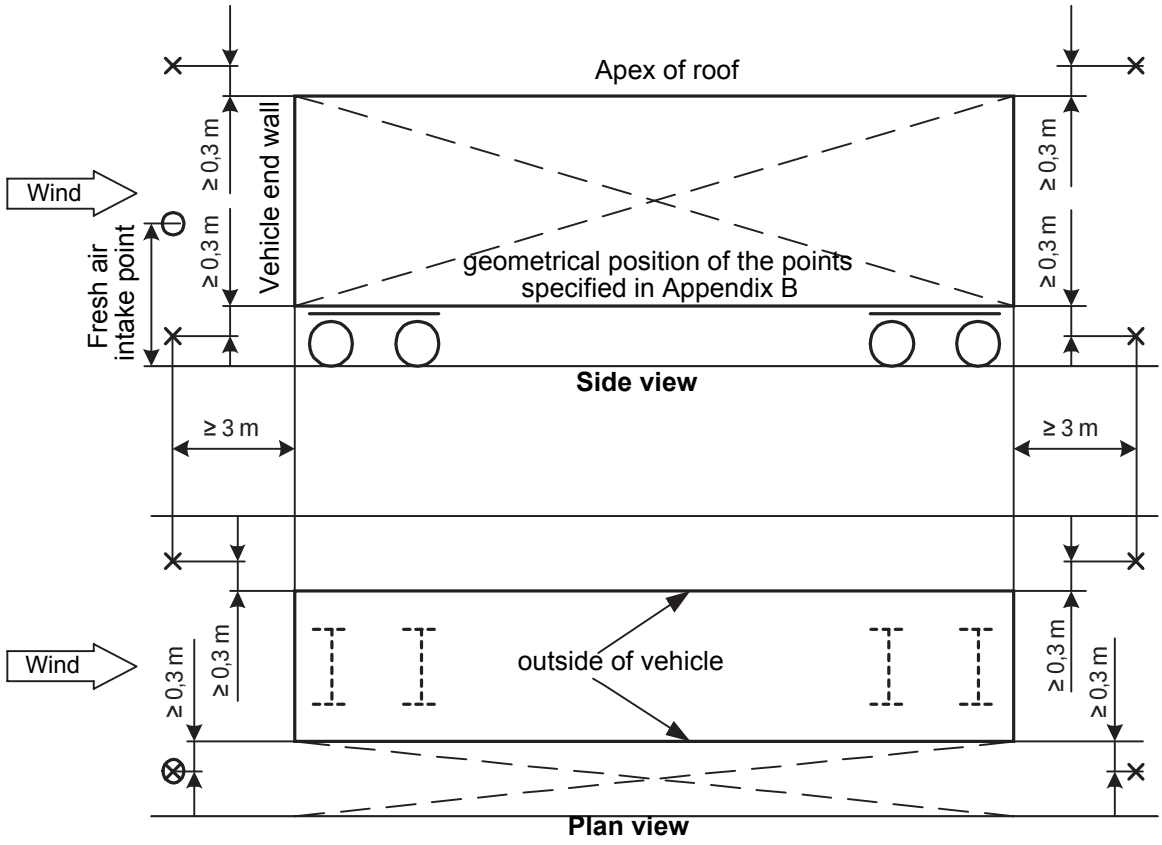

Fig. 8 - Arrangement of measuring points - Climatic chamber

Key to notation:

× Temperature probe

O Humidity probe

* Speed probe

Tem: Arithmetic mean of the 8 temperature measuring points

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Warning

Printed by the International Union of Railways (UIC)
16, rue Jean Rey 75015 Paris - France, October 2005
Dépôt Légal October 2005

ISBN 2-7461-0441-5 (French version)
ISBN 2-7461-0442-3 (German version)
ISBN 2-7461-0443-1 (English version)