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**Road vehicles — Ergonomic  
requirements for the driver's  
workplace in line-service buses —**

**Part 1:  
General description, basic requirements**

*Véhicules routiers — Exigences ergonomiques du poste de conduite  
dans les bus de ville —*

*Partie 1: Description générale, exigences de base*



Reference number  
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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16121-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 13, *Ergonomics applicable to road vehicles*.

This second edition cancels and replaces the first edition (ISO 16121-1:2005), which has been technically revised.

ISO 16121 consists of the following parts under the general title *Road vehicles — Ergonomic requirements for the driver's workplace in line-service buses*:

- Part 1: *General description, basic requirements*
- Part 2: *Visibility*
- Part 3: *Information devices and controls*
- Part 4: *Cabin environment*

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## Introduction

Poor ergonomics in the driver's workplace in buses designed to provide scheduled urban and interurban services increase the already high physical and mental strains on the drivers.

It is the aim of this part of ISO 16121 to supply the designer of line-service buses with information about how to develop an overall ergonomic concept for the driver's workplace. The recommended requirements on the driver's workplace for line-service buses made in this part of ISO 16121 are based on the scientific conclusions of the research project "Driver's workplace in the line-service bus". This was conducted in Germany and summarized in the VDV 234 [3] recommendation. Further comprehensive ergonomic studies related to the design of an enhanced driver workplace conducted in the United States, Canada, the Netherlands, Sweden and the United Kingdom [4, 5, 6, 7, 8] have been considered and found to provide recommendations covering similar areas.

This part of ISO 16121 sets out to consider the practical implications for all ranges of drivers, but particularly those with statures from 1,55 m (small female) to 2,0 m (large male). These statures include shoes (~30 mm).

It is also essential that the designer refers to the specifications and requirements of all parts of ISO 16121 (Parts 1 to 4) before completing the design of a driver's workplace.

It should be noted that where there is also national legislation covering any of the subjects contained herein, then both should be complied with. However, if a contradiction between the two should arise in any specific area, then the legislation should prevail for that specific point only. Other technical solutions, at least equal with regard to ergonomics, should not be excluded.

12/03/2013 08:46:45 MST

# Road vehicles — Ergonomic requirements for the driver's workplace in line-service buses —

## Part 1: General description, basic requirements

### 1 Scope

This part of ISO 16121 applies to the driver's workplace in low-floor line-service buses designed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum weight exceeding five metric tonnes and an overall width exceeding 2,30 m.

This part of ISO 16121 contains basic requirements for an ergonomic and comfortable seating position, which is essential to keep drivers in a good state of health. The dimensions and mounting positions of a driver's seat, pedals and steering should be carefully chosen to enable drivers to sit in an ergonomic seating position, i.e. sitting at angles which comply with the given ranges of comfort and to allow some variation when seated.

### 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.

ISO 2575, Road vehicles — *Symbols for controls, indicators and tell-tales*

ISO 6549, Road vehicles — *Procedure for H- and R-point determination*<sup>1)</sup>

ISO 10326-1, Mechanical vibration — *Laboratory method for evaluating vehicle seat vibration — Part 1: Basic requirements*

ISO 16121-3, Road vehicles — *Ergonomic requirements for the driver's workplace in line-service buses — Part 3: Information devices and controls*

### 3 Terms and definitions

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

#### 3.1

##### **low-floor**

vehicle in which at least 35 % of the area available for standing passengers (or of its forward section in the case of an articulated vehicle) forms a single area without steps, reached through at least one service door by a single step from the ground

#### 3.2

##### **required values**

values representing present state of the art that, when applied, achieve an acceptable level of ergonomic design

1) International Standard withdrawn.

## 3.3

### **recommended values**

values representing the preferred ergonomic conditions that are desirable for the future development of the driver's workplace

## 3.4

### **zero-X-plane**

vertical transverse plane through the Accelerator Heel Point (AHP), vertical to the longitudinal median plane of the bus

## 3.5

### **zero-Y-plane**

median plane of driver (in driving posture) parallel to the longitudinal median plane of the bus

## 3.6

### **zero-Z-plane**

horizontal plane through the Accelerator Heel Point (AHP)

## 3.7

### **Accelerator Heel Point**

#### **AHP**

intersection of the driver's right heel, when the foot is positioned against the accelerator pedal in its idle position, and the surface of the depressed floor covering or other heel support

## 3.8

### **heel point line**

#### **AHP line**

intersection line of the zero-X-plane with the zero-Z-plane

## 4 Basic requirements

### 4.1 Dimensions

#### 4.1.1 Reference system

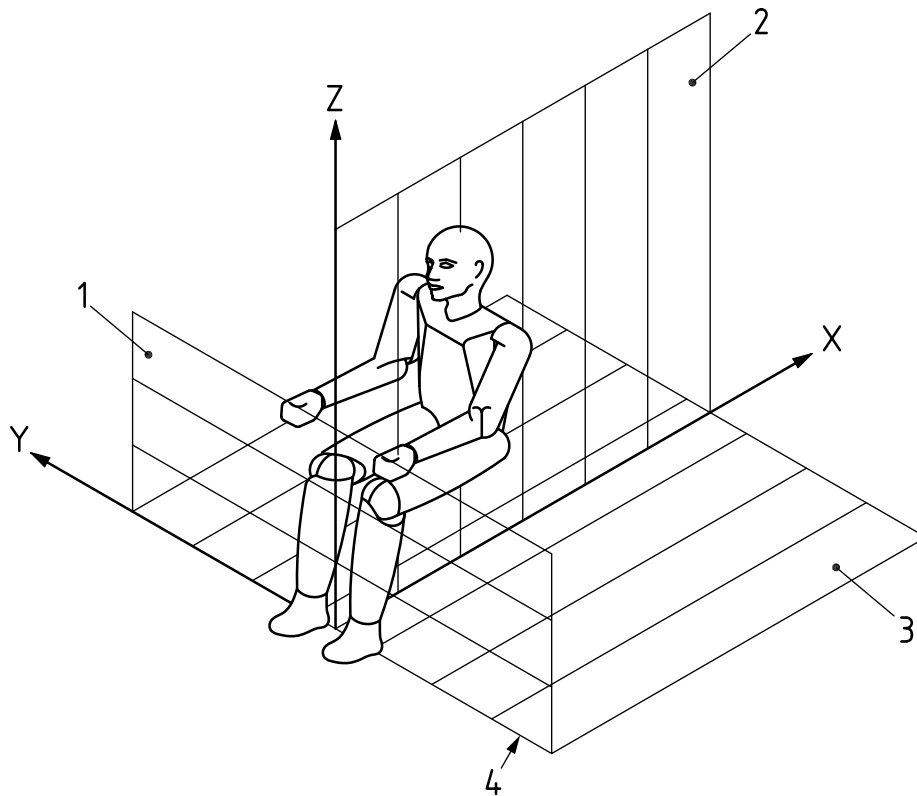
All dimensions in the driver's workplace refer to a driver-based system of coordinates (see Figure 1).

The reference system is formed by the zero-X-plane, zero-Y-plane and zero-Z-plane, which are perpendicular to each other.

The intersection point (coordinate origin) of all three planes corresponds to the AHP projected onto the zero-Y-plane. The intersection line of the zero-X-plane with the zero-Z-plane is referred to as the AHP Line.

The X, Y and Z axes are oriented so that the negative coordinate range lies in front of the zero-X-plane, on the left of the zero-Y-plane and below the zero-Z-plane, when one is looking in the direction of driving forward.





#### Key

- 1 zero-X-plane
- 2 zero-Y-plane
- 3 zero-Z-plane
- 4 AHP line

**Figure 1 — Driver-based system of coordinates**

#### 4.1.2 Tolerances

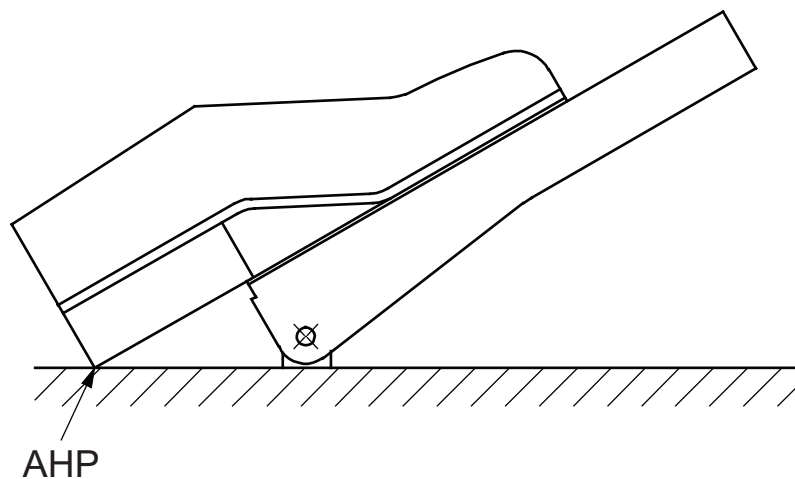
For linear measures a tolerance of  $\pm 10$  mm shall be valid, unless otherwise specified. This tolerance, however, is not applicable when dimensions are specified as a range of values (e.g.  $x = 10$  mm to 30 mm).

#### 4.1.3 AHP

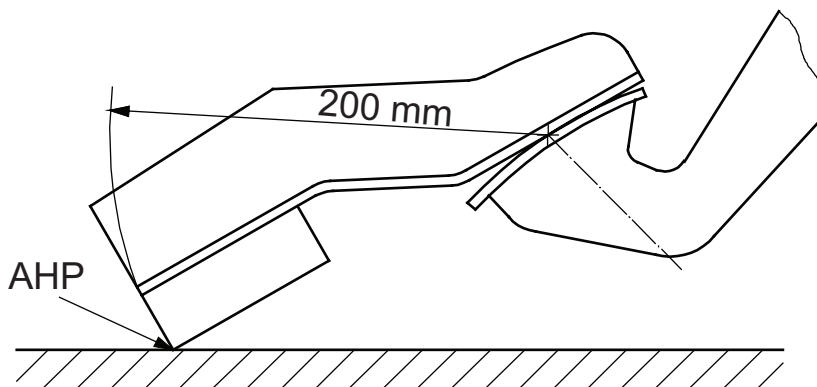
The AHP is defined for three basic types of throttle pedal design as follows:

- For treadle (organ) type pedals (see Figure 2a), the AHP is the intersection of the depressed floor or other heel support with a line projected from the upper surface of the throttle pedal.
- For hanging (pendulum) type pedals (see Figure 2b), the AHP is the point which intersects with the depressed floor or other heel support when an arc 200 mm in length is taken from the centre of the pedal surface.
- For treadle (organ) type pedals with a fixed heel stop (see Figure 2c), the AHP shall be taken as the intersection between the heel stop and the pedal surface.

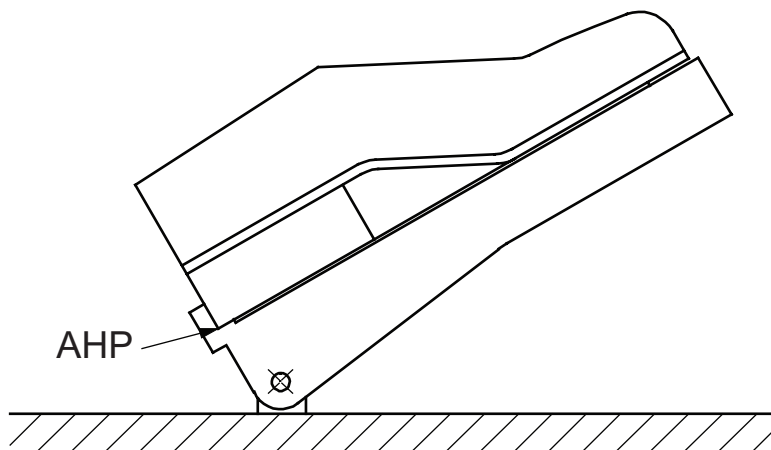
In all cases, the AHP shall lie on the vertical centreline of the pedal.



a) Treadle type pedal with no heel stop



b) Pendulum type pedal



c) Treadle type pedal with heel stop

Figure 2 — Determination of Accelerator Heel Point, AHP

## 4.2 Driver's workplace in general

### 4.2.1 Size of driver's workplace

#### 4.2.1.1 Driver's workplace length

The length of the driver's workplace (inside dimension) shall be such that the driver can attain the full range of adjustment (see Table 1), including swivel (where such a mechanism is fitted) without restriction. The depth of the footwell shall be at least 350 mm (see Figure 3) forward of AHP.

#### 4.2.1.2 Driver's workplace width

The width of the driver's workplace shall be chosen in such a way that sufficient distance to all interior surfaces to either side of the driver (laterally from head to foot) and sufficient leg freedom are available, including space for seat swivel. For the protection of the fingers a clearance distance of 25 mm from the outer extremities of the seat shall be kept.

The minimum lateral elbow room ( $y_{\min}$ ) in the shoulder range shall be 800 mm for all seat positions during driving.

### 4.2.2 Access to the driver's workplace

In low-floor buses, the driver's workplace should be arranged on a platform. It is recommended that this platform be at a height of  $300 \pm 50$  mm above the floor and be reached by a single step. If the platform height is greater than 350 mm, steps with equal height shall be provided with a maximum height of 250 mm and a minimum height of 125 mm.

Clear and unrestricted access to the driver's workplace shall be ensured, with a passage width of at least 500 mm.

These requirements are for normal entrance to the driver's workplace and do not necessarily apply to additional emergency exit doors.

### 4.2.3 Stowage space

In the driver's workplace, a space for the driver's bag should be provided, e.g. in the cabin door. The stowage dimensions (length  $\times$  height  $\times$  width) for the driver's bag should be at least 480 mm  $\times$  330 mm  $\times$  170 mm (240 mm preferred, where possible).

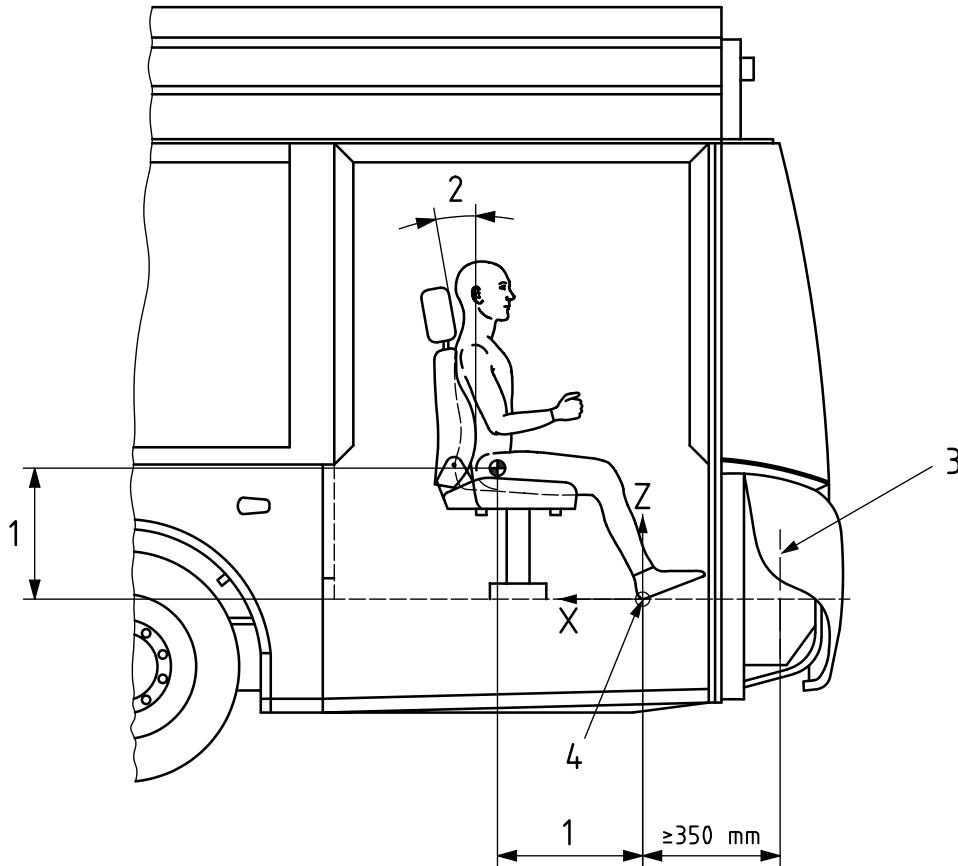
It should be possible to open the bag for the withdrawal of objects in the compartment. For personal objects needed during the drive (e.g. sunglasses) additional, easy-to-reach, non-slip stowage space should be available.

A coat hook should be provided inside the driver's cabin. A coat hung on the coat hook shall not interfere with the operation of controls nor obstruct the driver's view. Optionally, a hanger may be provided.

A lockable compartment for valuables shall be available.

### 4.2.4 Wall

A wall should be provided behind the driver.



**Key**

- 1 Table 1, item 1
- 2 Table 1, item 10
- 3 footwell depth
- 4 AHP

**Figure 3 — Side view of driver's cab**

**4.3 Driver's seat**

**4.3.1 Positioning, seat dimensions and adjustment ranges**

The centreline of the steering wheel should be positioned in line with the centreline of the driver. However, an offset of up to 25 mm is permitted.

For a healthy and comfortable seat posture, the seat dimensions and adjustment ranges listed in the column titled "Required" in Table 1 shall be provided (see also Figure 5). The reference seat H-point referred to is the design H-point according to ISO 6549, but located at the middle of the fore/aft and vertical seat adjustment range (see Figure 4).

**Table 1 — Seat dimensions and adjustment ranges for the driver**

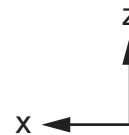
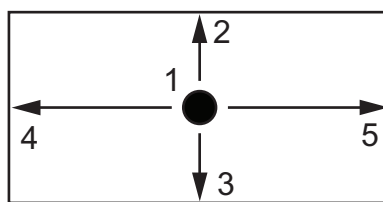
Dimensions in millimetres

Subject		Required	Recommended	Remarks
1	seat H-point reference location (at the middle of the fore/aft and vertical seat adjustment range)		X = 600-650 Y = 0 Z = 510	a
2	seat adjustment range, horizontal	≥ 200	≥ 230	≥ 100 fore and aft
3	seat adjustment range, vertical	≥ 100	≥ 130	≥ 50 up and down
4	depth of seat area	400 – 450	390 – 500 adjustable	
5	width of seat area (total)	≥ 450	≥ 480	
6	inclination of seat area	5° ± 5°	5° ± 10° adjustable	b
7	height of seat back	≥ 500	≥ 600	
8	seat back width (total)	≥ 475	—	
9	seat back width (lumbar region)	≥ 270	300 – 340	
10	inclination range of back-rest (to vertical)	+10° to +25° adjustable	0° to 30° adjustable	
11	height of head-restraint's top edge (above seat squab)	≥ 840	—	c
12	height of head restraint	≥ 120	—	c
13	width of head restraint	≥ 250	—	c
14	weight adjustment for damping of the seat		45 kg – 130 kg	

a To account for stature differences of drivers in various countries, a range of x-coordinates of the reference H-point is provided. It is left to the vehicle manufacturer to decide the appropriate reference H-point x-coordinate to use.

b Positive angle = front of seat cushion upward.

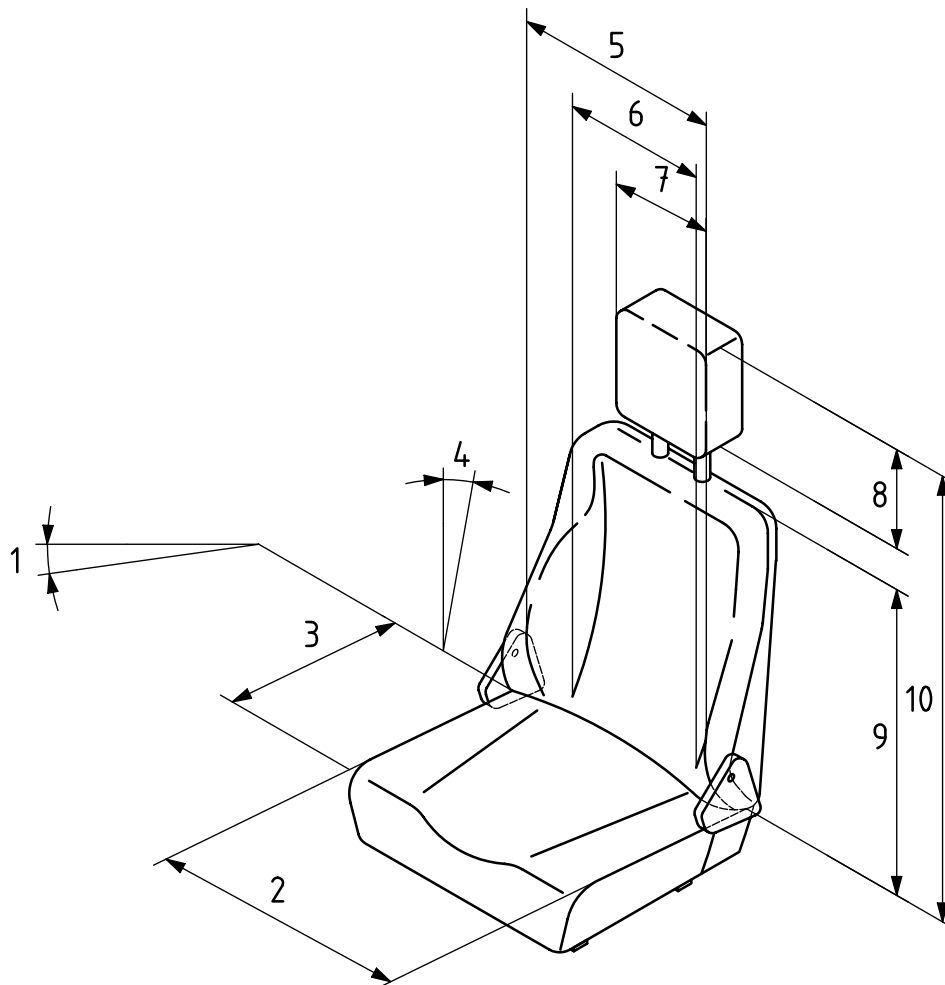
c If head restraint is provided.



**Key**

- 1 Table 1, item 1 (reference H-point)
- 2 Table 1, item 3 (≥50 mm up from reference H-point)
- 3 Table 1, item 3 (≥50 mm down from reference H-point)
- 4 Table 1, item 2 (≥100 mm rear of reference H-point)
- 5 Table 1, item 2 (≥100 mm forward from reference H-point)

**Figure 4 — Reference H-point location within the seat adjustment range**



**Key**

1	Table 1, item 6	6	Table 1, item 9
2	Table 1, item 5	7	Table 1, item 13
3	Table 1, item 4	8	Table 1, item 12
4	Table 1, item 10	9	Table 1, item 7
5	Table 1, item 8	10	Table 1, item 11

**Figure 5 — Driver's seat**

**4.3.2 Seat control**

The seat shall be able to be adjusted manually, i.e. without the use of tools, from the driver's seated position. The adjustment functions shall be: seat longitudinal and height adjustment. Capability of adjustment of seat back inclination, seat cushion inclination, seat cushion depth, lumbar support in height and curvature and head-restraint (where fitted) in height and inclination is recommended. As an option, a power-driven seat, with memory for basic settings, is permitted.

**4.3.3 Swivel mechanism (optional)**

If seat swivel is required due to the type and positioning of the ticketing equipment, sufficient leg room shall be provided for the driver. The swivelling range shall be limited by integrated end stops. The seat shall automatically lock itself in the driving position. Controls for unlocking shall be easily accessible.

#### 4.3.4 Suspension

The seat shall be equipped with a suspension. The natural frequency of that suspension shall take into account the natural frequency of the complete vehicle. The system shall be tuned in such a way that a transfer ratio of  $< 1$  is maintained under typical operation.

NOTE For a definition of “transfer ratio” see ISO 10326-1.

#### 4.3.5 Seat upholstery

The seat shall have a breathable upholstery. Optionally, a seat with heating and/or inside ventilation may be provided.

#### 4.3.6 Operating manual

Seat controls shall be clearly marked according to ISO 2575. Additional instruction for the correct adjustment of the seat shall be provided.

### 4.4 Pedals

#### 4.4.1 Design of the pedals

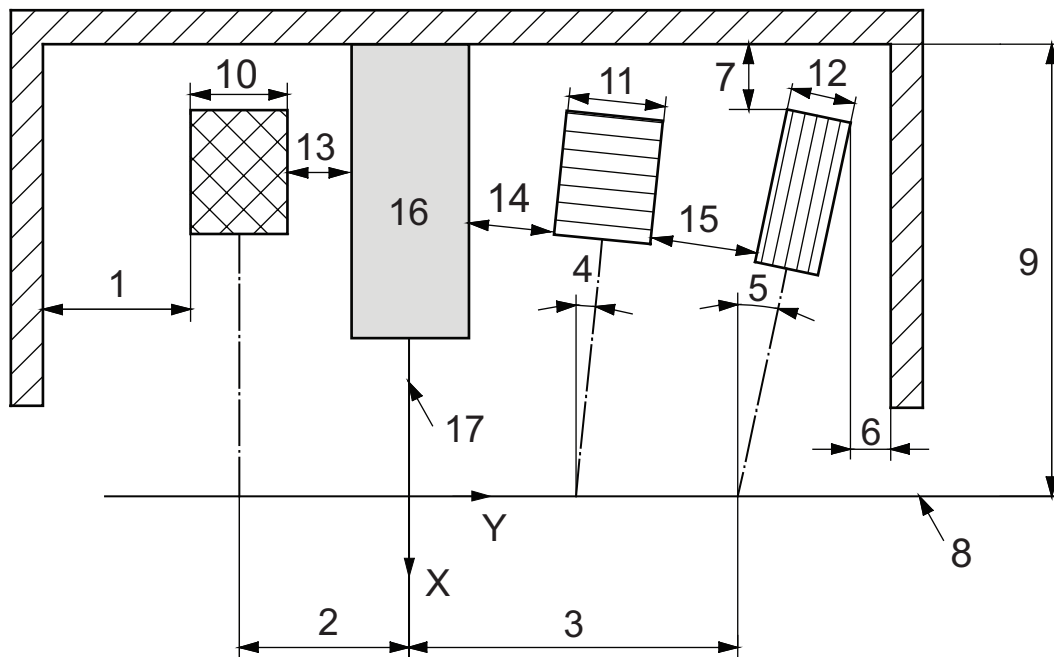
The accelerator pedal and brake pedal should be arranged in such a way that the foot movement is rotational during operation.

#### 4.4.2 Position and arrangement

As regards the position, arrangement and operating forces of the pedals, the values quoted in Table 2 shall be met (see Figure 6).

The operating forces refer to a lever arm of 200 mm (distance from heel point to the centre of the pedal surface, pedal in idle position).

The height of the clutch pedal should be similar to the height of the brake pedal, to allow for symmetrical movements of the right and left leg of the driver. The difference in height between the brake and clutch pedals should be  $\leq 20$  mm for the type of pendulum pedals shown in Figure 2b). The difference in height is measured in side view as the vector distance between the contact points of the manikin ball of foot on each pedal pad. See Figure 2b).



**Key**

- |   |                   |    |                      |
|---|-------------------|----|----------------------|
| 1 | Table 2, item 3.5 | 10 | Table 2, item 3.6    |
| 2 | Table 2, item 3.1 | 11 | Table 2, item 2.5    |
| 3 | Table 2, item 1.1 | 12 | Table 2, item 1.9    |
| 4 | Table 2, item 2.1 | 13 | Table 2, item 3.7    |
| 5 | Table 2, item 1.2 | 14 | Table 2, item 2.6    |
| 6 | Table 2, item 1.7 | 15 | Table 2, item 1.8    |
| 7 | Table 2, item 1.6 | 16 | Steering column      |
| 8 | AHP line          | 17 | Centreline of driver |
| 9 | Table 2, item 4.1 |    |                      |

**Figure 6 — Arrangement of foot controls**

**Table 2 — Position and arrangement of pedals**

Dimensions in millimetres

Subject		Required	Recommended	Remarks
<b>1</b>	<b>accelerator</b>			
1.1	coordinates of Accelerator Heel Point (X/Y/Z)	0/ ≤ 300/0	0/ ≤ 250/0	
1.2	rotation of pedal compared to zero-Y-plane	8°–15°	12°	
1.3	idle position	32° – 60°	43° – 49°	a
1.4	operating angle	20° – 30°	20°	
1.5	operating force	25 N – 40 N	30 N – 35 N	
a Accelerator pedal shall not be positioned higher than brake pedal. b Maximum force according to national legislation.				



Table 2 (continued)

Subject		Required	Recommended	Remarks
1.6	longitudinal clearance between accelerator pedal and bodywork (in X direction)	$\geq 50$		
1.7	lateral clearance between accelerator pedal and bodywork (in Y direction)	$\geq 30$		
1.8	clearance between accelerator pedal and brake pedal		50 - 75	
1.9	width of accelerator pedal		$\geq 40$	
<b>2</b>	<b>brake</b>			
2.1	rotation of pedal compared to zero-Y-plane	$0^\circ - 8^\circ$	$5^\circ$	
2.2	idle position	$43^\circ - 60^\circ$	$43^\circ - 49^\circ$	a
2.3	operating angle	$20^\circ - 30^\circ$	$25^\circ$	
2.4	force for maximum braking	b	$\leq 250$ N	
2.5	width of brake pedal		$\geq 60$	
2.6	clearance between brake pedal and any component to the left of the pedal, e.g. steering column cover		$\geq 30$	
<b>3</b>	<b>clutch (where fitted)</b>			
3.1	distance longitudinal axis of pedal to zero-Y-plane	-115 to -165	-130	
3.2	rotation of pedal compared to zero-Y-plane	$0^\circ$		
3.3	pedal travel in direction of pedal motion	170 max	150	
3.4	force to disengage	$\leq 150$ N	20 N - 120 N	
3.5	lateral distance between clutch and bodywork	$\geq 100$	100 - 150	
3.6	width of clutch pedal		$\geq 60$	
3.7	clearance between clutch pedal and any component to the right of the pedal, e.g. steering column cover		$\geq 30$	
<b>4</b>	<b>footwell</b>			
4.1	Depth of footwell (from AHP line)	$\geq 350$		
a Accelerator pedal shall not be positioned higher than brake pedal.				
b Maximum force according to national legislation.				

#### 4.4.3 Foot rest

For the support of the left foot, a foot rest with dimensions as stated in Table 3 shall be provided to the left of the steering column or to the left of the clutch pedal.

Table 3 — Position and arrangement of foot rest

Dimensions in millimetres

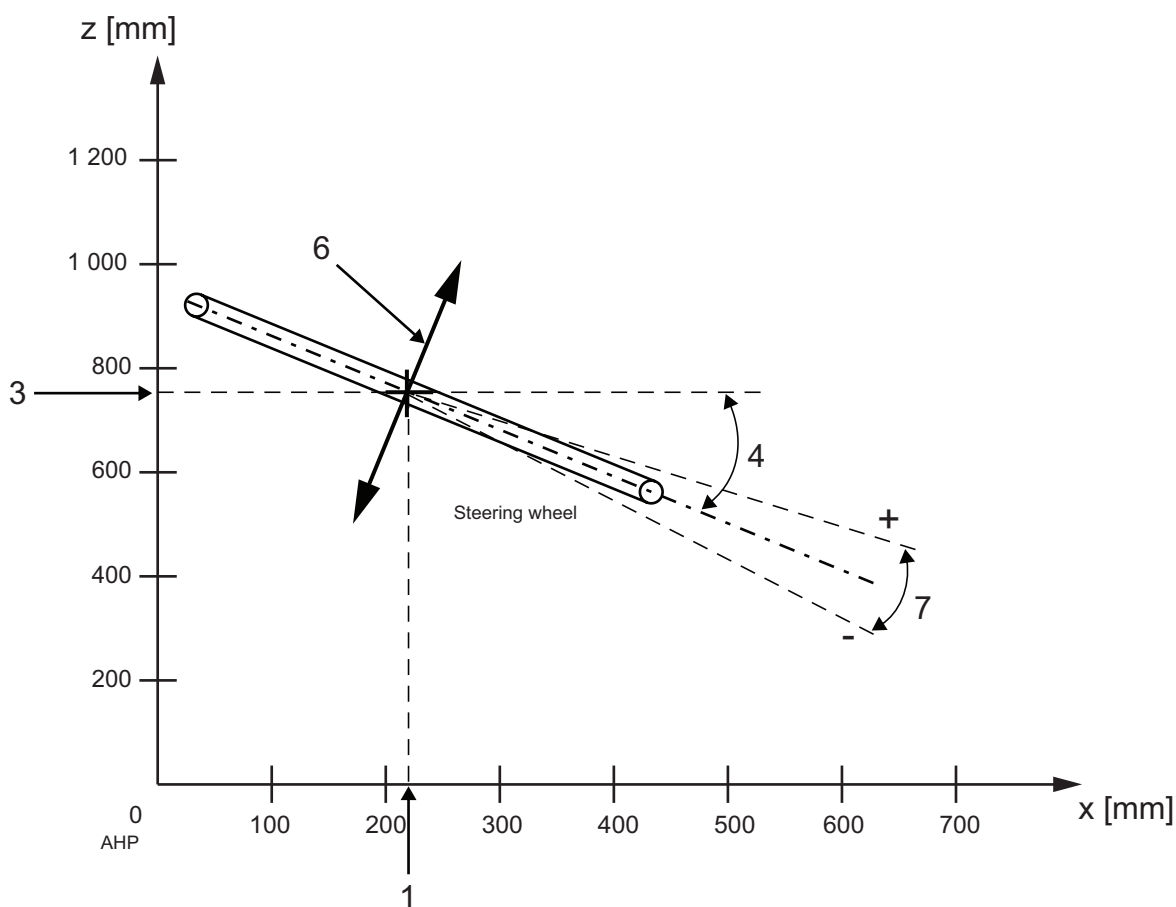
Subject	Required	Recommended	Remarks
angle to horizontal plane	$25^\circ - 30^\circ$		
length	$\geq 300$	$\geq 350$	

Table 3 (continued)

Subject	Required	Recommended	Remarks
width	≥ 100	≥ 150	
lateral clearance to clutch pedal (where fitted)	≥ 30	≥ 50	

### 4.5 Steering wheel

Steering wheel adjustments shall be provided which permit the variation and locking of the steering wheel position without the driver having to move from the normal driving position and releasing the safety belt. Values given in the column titled “Required” in Table 4 for the position and size of the steering wheel shall be met (see Figure 7).



**Key**

- 1 Table 4, item 1
- 3 Table 4, item 3
- 4 Table 4, item 4
- 6 Table 4, item 6
- 7 Table 4, item 7

Figure 7 — Mid-position of steering wheel adjustment range

Table 4 — Position and size of steering wheel

Dimensions in millimetres

Subject		Required	Recommended	Remarks
1	position of the centre of the plane described by the steering wheel rim		X = 170 - 220	a
2			Y = 0 ± 25	
3		Z = 800 ± 40	Z = 770	
4	side view angle of wheel rim plane		$\alpha = 27^\circ$	b
5	diameter	≤ 500	450 ± 25	c
6	axial adjustment range	≥ 80	≥ 110	d
7	angular adjustment range	$\alpha \pm 5^\circ$	$\alpha \pm 10^\circ$	
<p><sup>a</sup> The recommended distance between the steering wheel centre point and the AHP line depends on the distance between the reference H-point and the AHP line. The distance between the reference H-point and the centre of the wheel rim should be 430 mm.</p> <p><sup>b</sup> <math>\alpha</math> is the angle of steering wheel rim plane to the horizontal.</p> <p><sup>c</sup> Minimum diameter shall be determined by legal requirements for steering effort.</p> <p><sup>d</sup> The preferred axial adjustment range is +55 and -55 mm from the steering wheel centre point described in items 1.2 and 3.</p>				

The steering wheel spokes shall be arranged in such a way that the requirements on instruments located in zone A, defined in ISO 16121-3, are met.

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