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Title: BS EN 17420 Draft Railway applications - Vehicle front design for trams with respect to pedestrian safety.

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

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Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Railway applications - Vehicle front design for trams with respect to pedestrian safety

Applications ferroviaires - Conception de l'extrémité des véhicules pour tramways en ce qui concerne la sécurité des piétons

Bahnanwendungen - Fahrzeugkopfgestaltung von Straßenbahn-/Tramfahrzeugen im Hinblick auf den Passantenschutz

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 256.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 17420:2025) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede CEN/TR 17420:2020.

1 Scope

This document is applicable to tram vehicles in accordance with EN 17343. Tram-Train vehicles, on track machines, infrastructure inspection vehicles and road-rail machines in accordance with EN 17343 and demountable machines/machinery are not in the scope of this document.

This document describes passive safety measures to reduce the consequences of collisions with pedestrians. These measures provide the last means of protection when all other possibilities of preventing an accident have failed, i.e.

- design provisions for the vehicle front to minimize the impact effect on a pedestrian when hit,
- design provisions for the vehicle front for side (lateral) deflections in order to minimize the risk of being drawn under the vehicle on flat ground (embedded track),
- design provisions for the vehicle body underframe to not aggravate injuries to a pedestrian/body lying on the ground,
- provisions to prevent the pedestrian from being over-run by the leading wheels of the vehicle.

This document focuses on the consequences of the primary and tertiary impact. The consequences of a secondary impact are out of the scope of this document.

The following measures to actively improve safety are not in the scope of this document:

- colour of front;
- additional position lights;
- additional cameras;
- driver assistance systems;
- additional acoustic warning devices, etc.;
- view of the driver / mirrors;
- consequences for pedestrian injuries due to secondary impact with infrastructure (side posts, concrete ground, poles, trees, etc.).

The provisions of this document only apply to new vehicles.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 15663:2017+A2:2024, *Railway applications – Vehicle reference masses*

EN 17343:2023, *Railway applications – General terms and definitions*

3 Terms and definitions

For the purposes of this document, the following terms and definitions given in EN 17343:2023 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

tram vehicle

urban rail vehicle designed to run on a tram network

[SOURCE: EN 17343:2023, 3.1.7.1.2.2]

3.2

collision scenario

collision scenario derived from accident analysis that is applicable for design and assessment

3.3

head injury criterion

HIC

measure of the likelihood of head injury stemming from impact or acceleration

Note 1 to entry: The HIC is calculated using the following formula:

$$HIC_{15} = (t_2 - t_1) \left[\frac{\int_{t_1}^{t_2} a_R dt}{(t_2 - t_1)} \right]^{2,5}$$

where

t_1 represents the start of the time interval,

t_2 represents the end of the time interval,

HIC_{15} is the maximum value of HIC for $(t_2 - t_1) \leq 15$ ms,

a_R is the resultant acceleration

$$a_R = \sqrt{a_X^2 + a_Y^2 + a_Z^2}$$

where

a_X , a_Y and a_Z represent the accelerations in g in X, Y and Z directions.

Note 2 to entry: The 15 ms time frame relates to the original biomechanical testing used to establish the HIC as an injury criterion commonly accepted for impacts against fixed surfaces.

Note 3 to entry: This criterion can be used to assess the safety regarding vehicles, personal protective gear and sports equipment.

3.5

tram system

urban rail system operated on infrastructure shared with road traffic and/or its own infrastructure

Note 1 to entry: The tram system comprises the tram network, related rolling stock, and the associated operation.

Note 2 to entry: Sections of the route can be signal controlled.

Note 3 to entry: A tram network can be linked to other rail networks.

Note 4 to entry: For tram systems having sections segregated from road traffic the term light rail system (LRS) is used.

Note 5 to entry: Road traffic includes road users like cars, pedestrians, cyclists, wheelchair users, etc.

[SOURCE: EN 17343:2023, 3.1.4.2]

3.6

rescue mannequin

life size model of a person used in tests to simulate what happens to people when a vehicle gets into an accident (with a pedestrian)

3.7

anthropomorphic test device

ATD

model or mannequin of a person used in tests

3.8

pedestrian

walking, standing or lying person

Note 1 to entry: In this context, person can refer to an adult or a child.

Note 2 to entry: Any recommendations defined in this document for walking or standing persons will also improve the impact effect on cyclists (self-propelled or on e-bikes), skaters, persons in wheel chairs, or children in baby buggies, etc. Persons on e-scooters, motorbikes, etc. are not considered.

3.9

pedestrian deflector

technical device that pushes the pedestrian out of the path of the tram vehicle in case of a collision

3.10

pedestrian anti-crush mechanism

PACM

device that prevents a pedestrian to be crushed

Note 1 to entry: Example of a PACM is a trap basket or a drop down tray.

3.11

front cover

front fairings

outside front panels of the tram vehicle structure below the windscreen, i.e. streamlining

3.13**vehicle width****VW**

overall width of the vehicle excluding additionally fixed equipment like mirrors and cameras

4 Symbols and abbreviations

ATD	Anthropomorphic Test Device
HIC	Head Injury Criterion
PACM	Pedestrian Anti-Crush Mechanism (fr: dispositif anti-écrasement d'un piéton (DAEP))
VW	Vehicle Width
HBM	Human body model
TOR	Top of rail

5 Front design of tram vehicles**5.1 Objective / concept**

The objectives of this document are to provide protection for pedestrians by reducing the risk of severe injuries, of being trapped under the tram vehicle, of being hit by underfloor equipment, and of being run over by the wheels of the tram vehicle. All tram vehicles shall have a design that enables a pedestrian's body to be deflected rather than to be run over during an impact. The pedestrian is considered to have been deflected onto the side once the pedestrian has been moved out of the path of the tram vehicle.

The provisions given in this document contribute to minimizing the consequences for the pedestrian in the primary impact and the risk to be run over by the wheels of the tram vehicle (see 7.3).

5.2 Sequence of an impact

The entire sequence of an impact can be divided into three phases. All three phases can cause severe injuries to the involved pedestrian:

- phase 1 is considered as primary impact. A pedestrian, standing or walking in front of a moving tram vehicle, comes in contact with the tram vehicle's front end. It is assumed that the pedestrian is moving perpendicular to the direction of the tram vehicle. Consequently, the tram vehicle hits the pedestrian at his side.
- phase 2 is considered as secondary impact. Once being hit by the tram vehicle the pedestrian is thrown forward or to the side. As a consequence, the pedestrian impacts on the infrastructure (e.g. pavement, track, side poles).
- phase 3 is considered as tertiary impact. As a consequence of Phase 2 the pedestrian might lay on the track, be overrun by the tram vehicle and collide again with the lower parts of the tram vehicle.

5.3 Reference collision scenarios

The following reference collision scenarios with pedestrians shall be assessed:

- type A: Collision with a passing pedestrian in the front area of the tram vehicle;
- type B: Collision with a lying pedestrian on the ground in front of the tram vehicle.

Collision type A covers the effects of a primary impact and influences the effects of the downstream phases.

The tertiary impact is regarded to be covered by the collision type B.

6 Reference collision scenario type A

6.1 Introduction

The general approach is to achieve compliance with the geometrical requirements specified in 6.3.

If it is not possible to comply with all geometric parameters, numerical simulations shall be carried out to demonstrate the ability to limit the risk of severe injuries and to encourage lateral ejection. Nevertheless, the criteria for h_s and for the avoidance of sharp edges in the front surface shall still be fulfilled in this case (from 6.3).

The provisions of this section focus on the side impact against a pedestrian at the tram vehicle front (i.e. passing pedestrian). Two categories of pedestrians are identified:

- a 6-year-old child, 1 100 mm in height;
- a medium-sized adult, 1 750 mm in height.

If the provisions are fulfilled for these two categories, the design characteristics of the tram vehicle front will also be beneficial to the impact effect in collisions with other sizes of pedestrians.

6.2 Front surface

6.2.1 General

The front surface consists of the impact surface and the extended impact surface up to a height of 1 750 mm from TOR.

6.2.2 Impact surface

The impact surface is part of the front of a tram vehicle predestined for contact with pedestrians in case of a collision and with the most likely possibility of severe injuries.

The width of the impact surface is 50 % of the maximum vehicle width centred to the vehicle centre line (see Figure 1) and shall be used for evaluation of the geometric requirements. The impact surface is divided into two zones:

- centre zone: impact surface from the centre line up to 15 % of VW;
- intermediate zone: impact surface between 15 % and 50 % of VW.

The projection surface from the front view is used to derive the impact surface.

Based on the current requirements for visibility the impact surface is not assumed to interfere with the A-pillars of the vehicle front. If the impact surface overlaps the A-pillars nevertheless, then the impact surface may be reduced to the width between the A-pillars at a height of 1 750 mm from the ground, minus 100 mm on each side.

6.2.3 Extended impact surface

The extended impact surface is adjacent to the impact surface and covers the range from 50 % to 75 % of the maximum vehicle width.

The impact surface and extended impact surface are displayed in Figure 1:

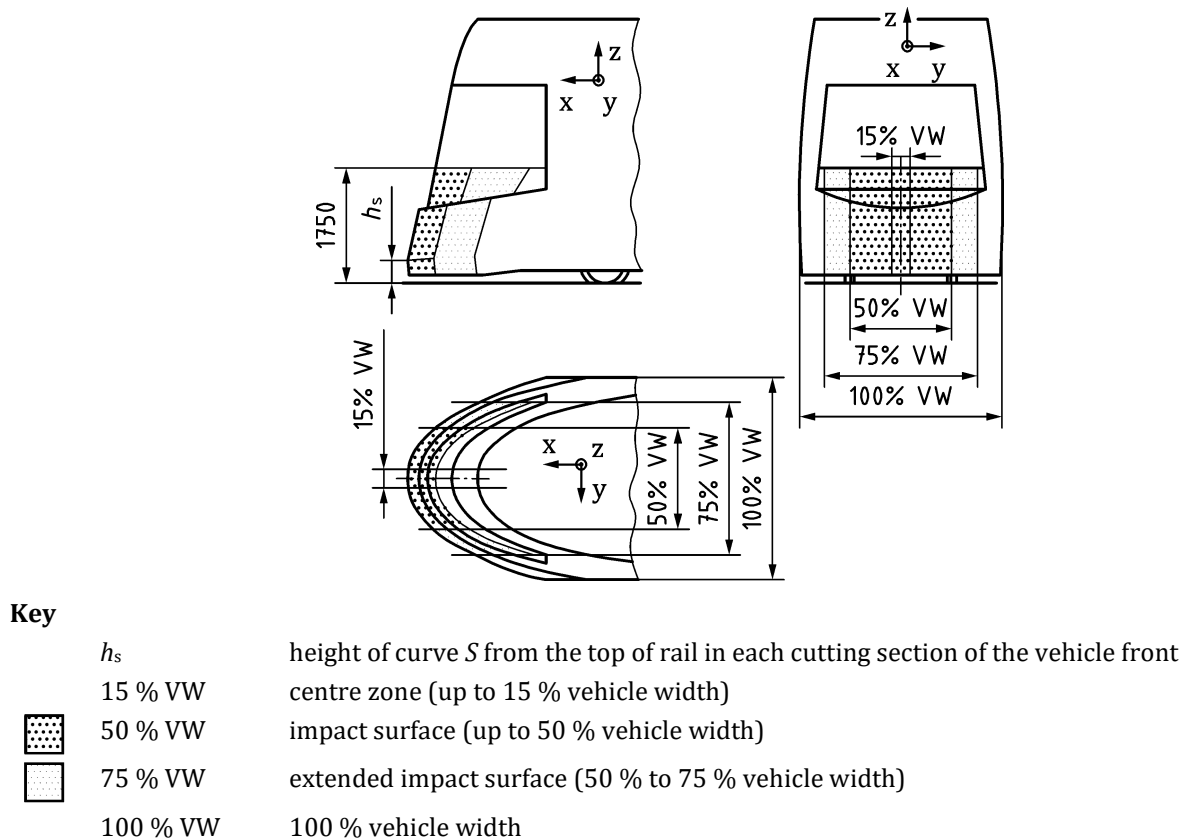


Figure 1 — Front surfaces

6.3 Geometric criteria to reduce the severity of injuries

6.3.1 General

If the compliance with the geometric provisions given in this Clause is proven, the HIC value is assumed to stay below 1 000. In this case, any additional numerical analyses (according to 6.4) for this proof are not mandatory.

6.3.2 Objective of the desired kinematics

In order to limit severe injuries, in particular to the head, the body kinematic to be favoured is either to block the shoulder and the torso as quickly as possible while limiting the rotation of the torso or to progressively impact the pedestrian starting from the lower legs up to the torso and shoulders.

All tram vehicles shall have a design that enables a body to be deflected rather than be run over in an accident. The objective is to limit the risk of intrusion of a pedestrian, including a child, under the tram vehicle.

6.3.3 Evaluation points

The criteria mentioned are intended to ensure a lateral deflection of a body in case of collision with a pedestrian. Additionally, the risk of fatal head injury at all points of the potential impact surface is reduced. The head injury criterion (HIC) shall not exceed a value of 1 000 over any time interval of up to 15 ms. Figure 2 shows the entire vehicle width and the angle α of tangents at the front in height of the foremost points to ensure an efficient deflection to the side.

The values of the geometric parameters at the specific points shall be measured to ensure compliance with the criteria. In case of a symmetrical vehicle, regarding the XZ plane, the values may be measured for one half only.

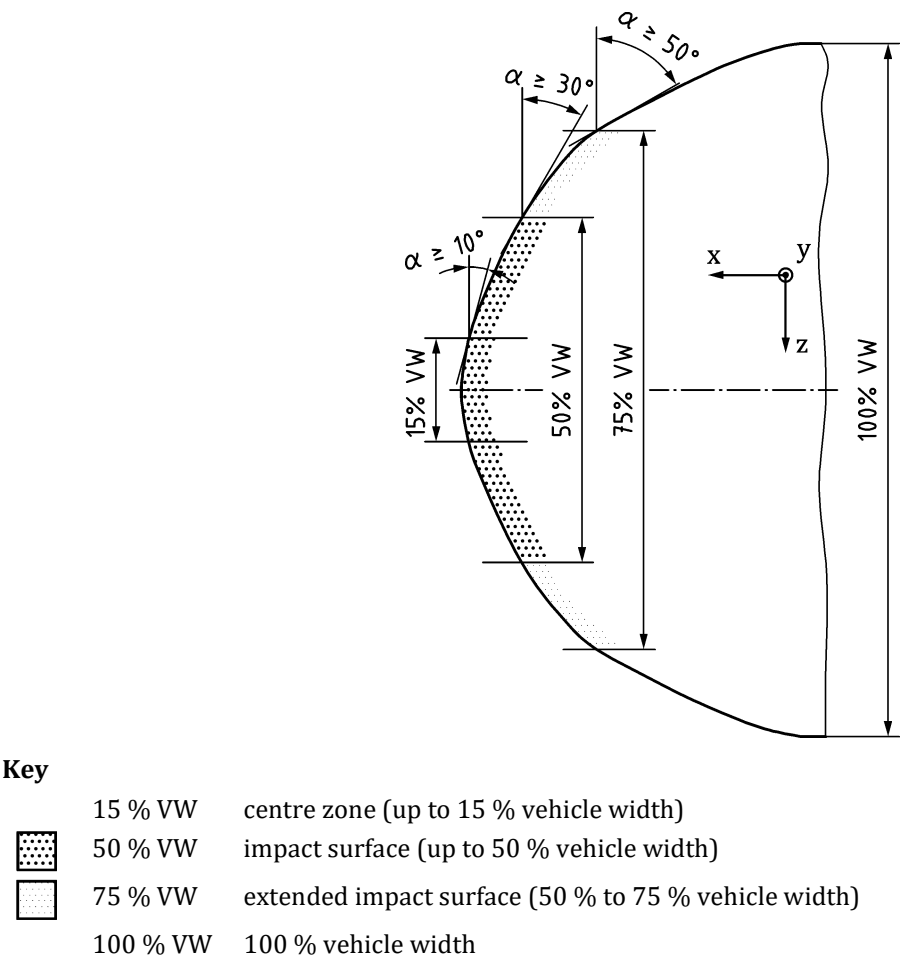


Figure 2 — Evaluation points

6.3.4 Geometric parameters

The parameters β , γ , d_B and d_G shall be applied at all points on the impact surface.

The geometric parameters as shown in Figure 3 are taken into account: