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Road vehicles — Test method to evaluate the performance of autonomous emergency braking systems —

Part 2:
Car to pedestrian

Véhicules routiers — Méthode d'essai pour évaluer la performance des systèmes automatiques de freinage d'urgence —

Partie 2: Voiture à piéton

Reference number
ISO 22733-2:2023(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics, chassis components and driving automation systems testing*.

A list of all parts in the ISO 22733 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The capacity to avoid or mitigate a collision during -potential accident - is an important part of the performance of an autonomous braking system fitted in a road vehicle. This document is intended to assess performance of an autonomous braking under defined test scenario only.

NOTE Moreover, insufficient knowledge is available concerning the relationship between overall vehicle dynamic properties and accident avoidance. A substantial amount of work is necessary to acquire sufficient and reliable data on the correlation between accident avoidance and vehicle dynamic properties in general and the results of these tests in particular.

Road vehicles — Test method to evaluate the performance of autonomous emergency braking systems —

Part 2:
Car to pedestrian

1 Scope

This document specifies test methods to evaluate performance of the autonomous emergency braking system (AEBS) in car to pedestrian collision situations. Forward collision warning system (FCWS) is part of AEBS when it provides warning before braking intervention.

Vehicle to pedestrian accidents occur when a vehicle under test (VUT) drives in straight line and either a pedestrian walks longitudinal on the same road or the pedestrian is approaching perpendicular the road.

A system requiring a driver intervention is not in scope of this document.

NOTE Depending on accidentology only a part of the scenarios can be used for an evaluation of performance.

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.

ISO 8855, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

ISO 15037-1:2019, *Road vehicles — Vehicle dynamics test methods — Part 1: General conditions for passenger cars*

ISO 22733-1:2022, *Road vehicles — Test method to evaluate the performance of autonomous emergency braking systems — Part 1: Car-to-car*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8855 and ISO 15037-1 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
AEB
autonomous emergency braking
braking applied automatically by the vehicle in response to the detection of a likely collision to reduce the vehicle speed and potentially avoid the collision

Note 1 to entry: For a complete definition refer to ISO 22839.

3.2
CPFA-50
car-to-pedestrian farside adult 50 %
collision in which a vehicle travels forwards towards an adult pedestrian crossing its path running from the farside and the frontal structure of the vehicle strikes the pedestrian at 50 % of the vehicle's width when no braking action is applied

[SOURCE: Reference [4], Clause 2]

3.3
CPNA-25
car-to-pedestrian nearside adult 25 %
collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian at 25 % of the vehicle's width when no braking action is applied

[SOURCE: Reference [4], Clause 2]

3.4
CPNA-75
car-to-pedestrian nearside adult 75 %
collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian at 75 % of the vehicle's width when no braking action is applied

[SOURCE: Reference [4], Clause 2]

3.5
CPNC-50
car-to-pedestrian nearside child 50 %
collision in which a vehicle travels forwards towards a child pedestrian crossing its path running from behind and obstruction from the nearside and the frontal structure of the vehicle strikes the pedestrian at 50 % of the vehicle's width when no braking action is applied

[SOURCE: Reference [4], Clause 2]

3.6
CPLA-25
car-to-pedestrian longitudinal adult 25 %
collision in which a vehicle travels forwards towards an adult pedestrian walking in the same direction in front of the vehicle where the vehicle strikes the pedestrian at 25 % of the vehicle's width when no braking action is applied or an evasive steering action is initiated after a *forward collision warning (FCW)* (3.8)

[SOURCE: Reference [4], Clause 2]

3.7
CPLA-50
car-to-pedestrian longitudinal adult 50 %
collision in which a vehicle travels forwards towards an adult pedestrian walking in the same direction in front of the vehicle where the vehicle strikes the pedestrian at 50 % of the vehicle's width when no braking action is applied

[SOURCE: Reference [4], Clause 2]

3.8
FCW
forward collision warning
audio-visual warning provided automatically by the vehicle in response to the detection of a likely collision to alert the driver

3.9
PTa
pedestrian target adult
test device representing an adult pedestrian used to test active safety systems

[SOURCE: ISO 19206-2:2018, 3.2, modified — "Adult" has been added to the term and the definition.]

3.10
PTc
pedestrian target child
test device representing a child pedestrian used to test active safety systems

[SOURCE: ISO 19206-2:2018, 3.2, modified — "Child" has been added to the term and the definition.]

3.11
TTC
time to collision
remaining time before the *vehicle under test (VUT)* (3.15) strikes the pedestrian target (PT), assuming that the VUT and PT would continue to travel with the speed it is travelling

3.12
$T_{\mathbf{AEB}}$
time where the *autonomous emergency braking (AEB)* (3.1) system activates

Note 1 to entry: Activation time is determined by identifying the last data point where the filtered acceleration signal is below -1,0 m/s^2, and then going back to the point in time where the acceleration first crossed -0,3 m/s^2.

3.13
$T_{\mathbf{FCW}}$
time where the audible warning of the *forward collision warning (FCW)* (3.8) starts

Note 1 to entry: The starting point is determined by audible recognition or video analysis.

3.14
$T_{\mathbf{impact}}$
speed at which the profiled line around the front end of the *vehicle under test (VUT)* (3.15) coincides with the square box around the *pedestrian target adult (PTa)* (3.9), *pedestrian target child (PTc)* (3.10) as shown in the Figure 1

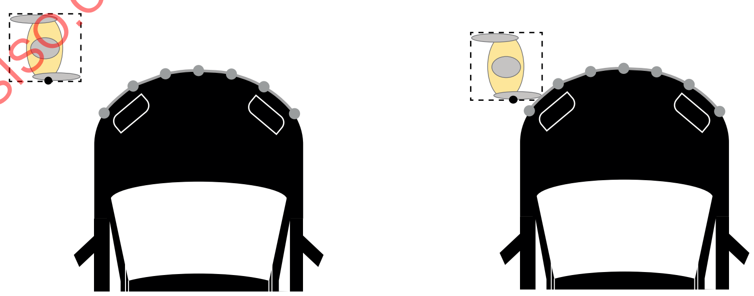


Figure 1 — Definition of impact

3.15
VUT
vehicle under test
vehicle tested according to this document with a pre-crash collision mitigation or avoidance system on board

3.16
vehicle width
widest point of the vehicle ignoring the rear-view mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mud-guards and the deflected part of the tyre side-walls immediately above the point of contact with the ground

4 Reference system and variables

4.1 Coordinate system

For VUT and PT use the convention specified in ISO 8855 in which the x-axis points towards the front of the vehicle, the y-axis towards the left and the z-axis upwards (right hand system), with the origin at the most forward point on the centreline of the VUT for dynamic data measurements as shown in Figure 2.

Viewed from the origin, roll, pitch and yaw rotate clockwise around the x, y and z axes respectively. Longitudinal refers to the component of the measurement along the x-axis, lateral refers the component along the y-axis and vertical refers the component along the z-axis.

This reference system should be used for both left (LHD) and right-hand drive (RHD) vehicles tested.

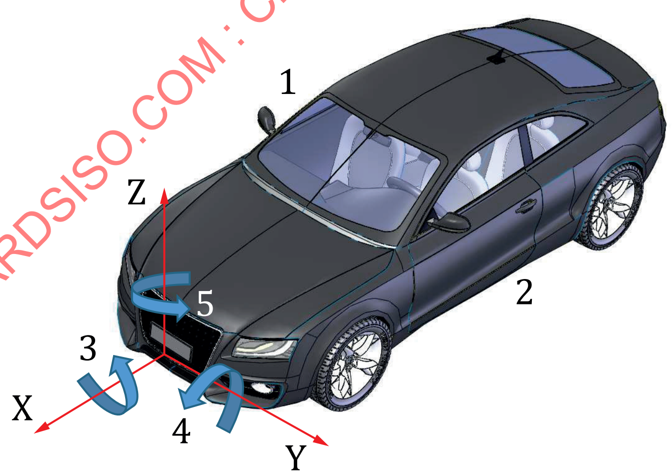
The nearside is swapped as per LHD and RHD vehicles. Figure 2 shows the near and farside of the vehicle for an LHD vehicle.

The reference earth frame according to ISO 8855:2011, 2.8 is defined as:

— X_E axis: intended straight line path projected on the ground to front;

— Y_E axis: perpendicular to X axis on the ground to left;

— Z_E axis: perpendicular to the ground to the top.



Key

X longitudinal(X)
Y lateral(Y)
Z vertical(Z)
1 NEAR SIDE
2 FAR SIDE
3 roll (φ)
4 pitch (θ)
5 yaw (Ψ)

Figure 2 — Coordinate system and notation (LHD and RHD), nearside and farside for LHD vehicle

4.2 Lateral path errors

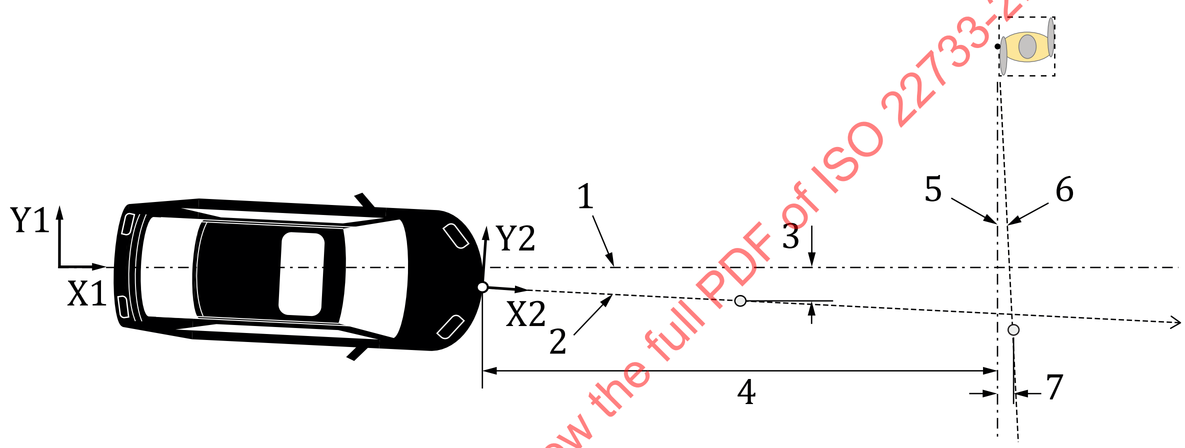
Vehicle lateral path error is determined as the lateral distance between the centre of the front of the VUT when measured in parallel to the intended straight-lined path as shown in Figure 3.

Pedestrian perpendicular lateral path error is determined as the lateral distance between pedestrian hip point when measured in parallel to the intended straight-lined path as shown in Figure 3.

For longitudinal test scenarios such as CPLA-25 and CPLA-50 shown in Figure 9, pedestrian perpendicular lateral path error is determined as the lateral distance between pedestrian hip point when measured in parallel to the intended pedestrian straight lined path.

Vehicle lateral path error = Y_{VUT} error

Pedestrian perpendicular lateral path error = Y_{PT} error



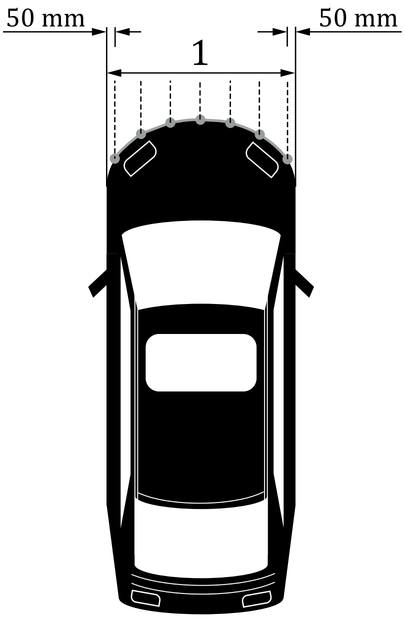
Key

1 intended VUT path
2 VUT path
3 Y_{VUT} error
4 $X_{distance}$
5 intended pedestrian path
6 pedestrian path
7 Y_{PT} error

Figure 3 — Definition of impact

4.3 Profiles for impact speed determination

A virtual profiled line is defined around the front end of the VUT. This line is defined by straight line segments connecting seven points that are equally distributed over the vehicle width minus 50 mm on each side. The theoretical x and y coordinates are provided by the OEMs and verified by the test laboratory (see also Figure 4).



Key

1 vehicle width

Figure 4 — Virtual profile line around vehicle front end

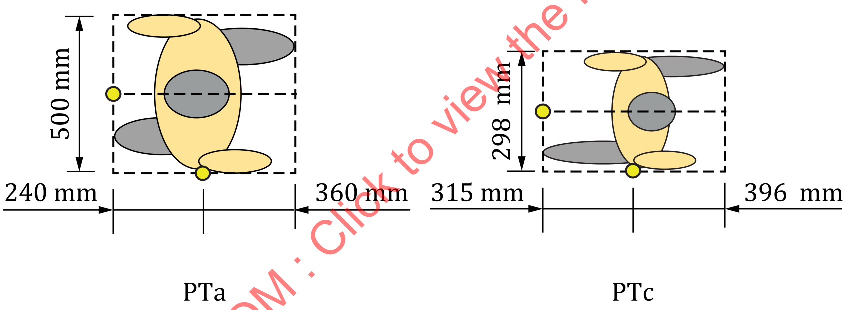


Figure 5 — Virtual box dimensions around PTa and PTc

Around the PT a virtual box is defined which is used to determine the impact speed. The dimensions of this virtual box are shown in Figure 5. For crossing scenarios, the reference point of the PT is the hip point and for the longitudinal scenario a virtual point where the centreline of the dummy crosses the virtual box.

5 Variables to be measured

Table 1 lists all relevant variables to be measured. All dynamic data shall be sampled and recorded at a frequency of at least 100 Hz. PT and VUT data shall be synchronized by using the differential GPS (DGPS) time stamp of the PT.

Table 1 — Variables to be measured

Variable		Symbol
Time	T_0 equals TTC = 4 s	T_0
	T_{AEB}, time when AEB activates	T_{AEB}
	T_{FCW}, time when FCW activates	T_{FCW}
	T_{impact}, time when VUT impacts PT	T_{impact}
Position	Position of the VUT during the entire test	X_{VUT}, Y_{VUT}
	Position of the PT during the entire test	X_{PT}, Y_{PT}
Speed	Speed of the VUT during the entire test:	V_{VUT}
	— V_{impact}, speed when VUT impacts PT	V_{impact}
	— V_{rel_impact}, relative speed of VUT with respect to PT when VUT impacts PT in longitudinal direction testing	V_{rel_impact}
	Speed of the PT during the entire test	V_{PT}
Yaw velocity	Yaw velocity of the VUT during the entire test	$\dot{\psi}_{VUT}$
	Yaw velocity of the PT during the entire test	$\dot{\psi}_{PT}$
Acceleration	Acceleration of the VUT during the entire test	A_{VUT}
	Acceleration of the PT during the entire test	A_{PT}
Steering wheel angular velocity	Angular velocity of the steering wheel during the entire test	$\dot{\Omega}_{VUT}$

6 Measuring equipment

6.1 Description

VUT and PT shall be equipped with data measurement and acquisition equipment to sample and record data with an accuracy of at least:

— VUT speed to 0,1 km/h;

— PT speed to 0,1 km/h;

— VUT lateral and longitudinal position to 0,03 m;

— PT position in the direction of movement to 0,03 m;

— VUT yaw rate to 0,1°/s;

— VUT longitudinal acceleration to 0,1 m/s^2;

— VUT steering wheel velocity to 1,0°/s.

6.2 Transducer installation

The transient vehicle pitch changes shall not adversely affect the measurement of the velocity and distance variables for the chosen transducer system.

6.3 Calibration

All transducers shall be calibrated according to the manufacturer's instructions. The transducer manufacturer's recommended application software and firmware version shall be used. If parts of the measuring system can be adjusted, such calibration shall be performed immediately before the beginning of the tests.

6.4 Data processing

Filter the measured data as follows:

- position and speed are not filtered and are used in their raw state;
- acceleration with a 12-pole phaseless Butterworth filter with a cut off frequency of 10 Hz;
- yaw rate with a 12-pole phaseless Butterworth filter with a cut off frequency of 10 Hz;
- force with a 12-pole phaseless Butterworth filter with a cut-off frequency of 10 Hz.

7 Test conditions

7.1 General

The test conditions shall be in accordance with ISO 15037-1:2019, Clause 5, unless otherwise specified below.

7.2 General data

General data on the test vehicle and test conditions shall be recorded as specified in ISO 15037-1.

7.3 Test track

Conditions for test track shall be in accordance with ISO 22733-1:2022, 7.3.

7.4 Weather conditions

Weather conditions shall be in accordance with ISO 22733-1:2022, 7.4.

7.5 Surroundings

Surroundings shall be in accordance with ISO 22733-1:2022, 7.5.

7.6 VUT

7.6.1 General vehicle condition

The VUT condition shall be in accordance with the vehicle manufacturers' specifications, particularly with respect to the suspension geometries, power train (e.g. differentials and locks) configuration, and tyre fitment.

7.6.2 AEBS settings

AEBS settings shall be in accordance with ISO 22733-1:2022, 7.6.2.

7.6.3 Deployable pedestrian protection systems

AEBS settings shall be in accordance with ISO 22733-1:2022, 7.6.2.

7.6.4 Tyres

Tyre conditions shall be in accordance with ISO 22733-1:2022, 7.6.4.

7.6.5 Braking system

Braking system conditions shall be in accordance with ISO 22733-1:2022, 7.6.5.

7.6.6 Other influencing system

Other influencing systems shall be in accordance with ISO 22733-1:2022, 7.6.6.

7.6.7 Loading conditions

Loading conditions of VUT shall be in accordance with ISO 22733-1:2022, 7.6.7.

8 Test procedures

8.1 Test preparation

8.1.1 Brake conditioning

Brake conditioning procedure for VUT shall be in accordance with ISO 22733-1:2022, 8.1.1.

8.1.2 Tyre conditioning

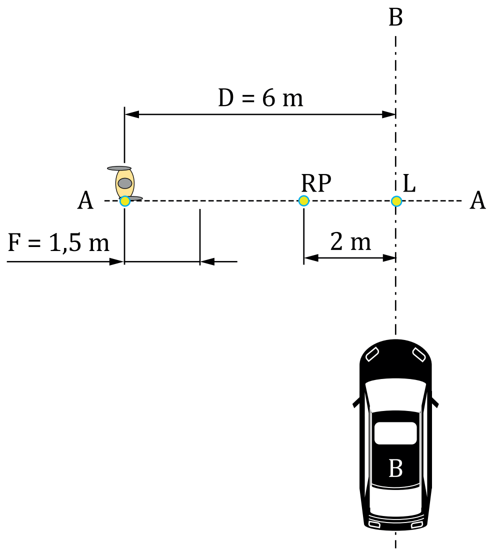
Tyre conditioning procedure for VUT shall be in accordance with ISO 22733-1:2022, 8.1.2.

8.2 Test scenarios

The performance of the system is assessed in different scenarios. For AEB Pedestrian the scenarios CPFA-50, CPNA-25, CPNA-75, CPNC-50 and CPLA are considered as shown in Figures 6, 7, 8 and 9 respectively.

For each AEB pedestrian scenario, positions of the PT and dimensions and colour of the obstruction vehicles can be changed to better reflect traffic accident situations of a country. If this is the case, modifications to the scenario shall be reported.

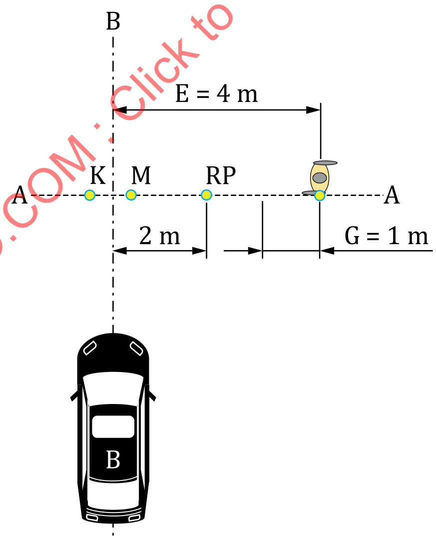
For testing purposes, assume a straight-line path equivalent to the centreline of the lane in which the collision occurred, hereby known as the test path. Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.



Key

Axe AA: trajectory of pedestrian dummy H-point
Axe BB: axis of centreline of VUT
Distance D: dummy H-point, start position to 50 % impact
Distance F: dummy acceleration distance (running)
Point L: impact position for 50 % scenarios
Point RP: reference point (dummy H-point)

Figure 6 — CPFA-50 scenario, adult running from farside

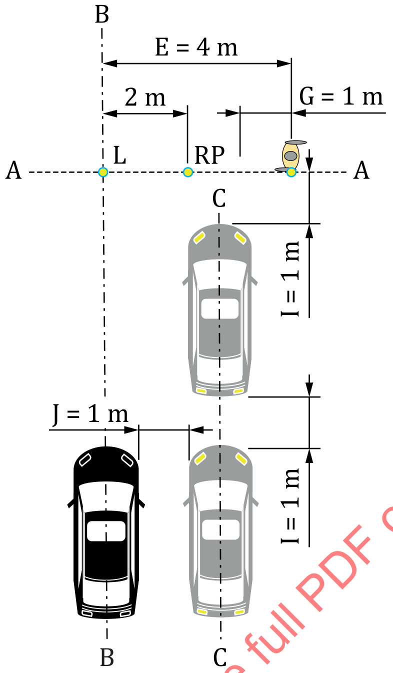


Key

Axe AA: trajectory of pedestrian dummy H-point
Axe BB: axis of centreline of VUT
Distance E: dummy H-point, start to 50 % impact (nearside)
Distance G: dummy acceleration distance (walking)
Point K: impact position for 75 % nearside scenario
Point M: impact position for 25 % nearside scenario

Point RP: reference point (dummy H-point)

Figure 7 — CPNA-25 and CPNA-75 scenarios, walking adult from nearside



Key

Axe AA: trajectory of pedestrian dummy H-point

Axe BB: axis of centreline of VUT

Axe CC: axis of centreline of obstruction vehicle which is parallel to BB

Distance G: dummy acceleration distance (running)

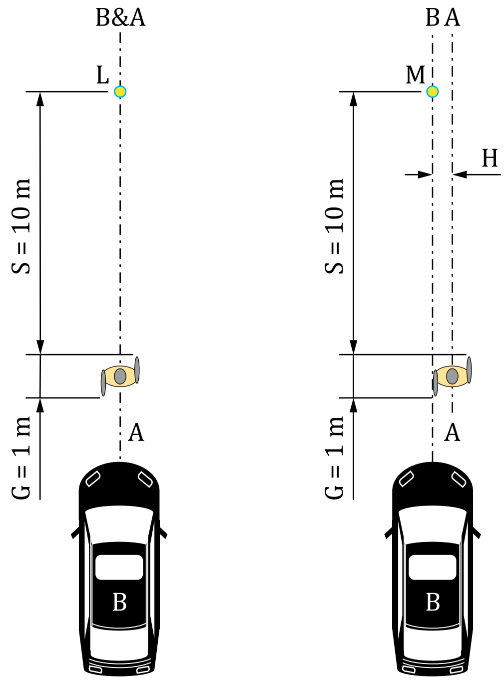
Distance E: dummy H-point to front of obstruction vehicle

Distance J: between VUT and target obstruction vehicle

Point L: impact position for 50 % nearside scenario

Point RP: reference point (dummy H-point)

Figure 8 — CPNC-50 scenario, running child from nearside from obstruction vehicles



Key

Axe AA: trajectory of pedestrian dummy

Axe BB: axis of centreline of VUT

Distance G: dummy acceleration distance

Distance S: dummy steady state distance

Distance H: impact point offset for 25 %

Point L: impact position for 50 % longitudinal scenario

Point M: impact position for 25 % longitudinal scenario

Figure 9 — CPLA scenario, longitudinal walking adult

Test speed starts from 20 km/h to collision for AEBS, and from 50 km/h to collision for FCW as described in Table 2 to measure limiting performance of AEBS. If testing until collision is not possible or deemed not practical due to safety concerns or limitations to testing facility, test can be performed until a designated maximum speed determined in consultation with parties involved, for example until 60 km/h.

Different performance metrics shall be applied for testing until collision and testing until a designated speed.

Table 2 — Speed range for AEBS test

	CPFA-50	CPNA-25	CPNA-75	CPNC-50	CPLA-50	CPLA-25
Type of test	AEBS					FCW
VUT speed	From 20 km/h to collision or a designated maximum speed					From 50 km/h to collision or a designated maximum speed
Target speed	8 km/h	5 km/h				
Impact location	50 %	25 %	75 %	50 %	50 %	25 %
Lighting conditions [a]	Day	Day and night		Day	Day and night	

[a] Depending on the purpose of the test, tests with night lighting condition and/or with vehicle lights on can be performed with conditions defined in the EuroNCAP protocol. If the specified night conditions cannot be met at the test site, other night conditions can be adopted if agreed between parties involved.

Table 2 *(continued)*

	CPFA-50	CPNA-25	CPNA-75	CPNC-50	CPLA-50	CPLA-25
Vehicle lights (night) [a]		Low beam			High beam	

[a] Depending on the purpose of the test, tests with night lighting condition and/or with vehicle lights on can be performed with conditions defined in the EuroNCAP protocol. If the specified night conditions cannot be met at the test site, other night conditions can be adopted if agreed between parties involved.

For the CPNA-75 scenario the following additional tests are performed as part of the prerequisite verification:

— test speed of 20 km/h with an PTa speed of 3 km/h;

— test speed of 10 km/h (or min. idle speed in 1^{st} gear) with an PTa speed of 5 km/h.

NOTE This prerequisite verification test is not part of performance evaluation.

8.3 Test conduct

Before every test run, drive the VUT around a circle of maximum diameter 30 m at a speed less than 10 km/h for one clockwise lap followed by one anticlockwise lap, and then manoeuvre the VUT into position on the test path. If requested by the OEM an initialisation run may be included before every test run. Bring the VUT to a halt and push the brake pedal through the full extent of travel and release.

For vehicles with an automatic transmission select D. For vehicles with a manual transmission select the highest gear where the RPM will be at least 1,500 at the test speed. If fitted, a speed limiting device or cruise control may be used to maintain the VUT speed, unless the vehicle manufacture shows that there are interferences of these devices with the AEBS in the VUT. Apply only minor steering inputs as necessary to maintain the VUT tracking along the test path.

Perform the first test a minimum of 90 s and a maximum of 10 min after completing the tyre conditioning, and subsequent tests after the same time period. If the time between consecutive tests exceeds 10 min repeat the tyre conditioning procedures and recommence testing.

Between tests, manoeuvre the VUT at a maximum speed of 50 km/h and avoid riding the brake pedal and harsh acceleration, braking or turning unless strictly necessary to maintain a safe testing environment.

The performance of "perception" sensors, i.e. the sensors that define a target is one that needs a braking activation, is an important part of AEBS performance. Then it is important that perception sensors cannot have the target continuously in their field from one test run to the other. Therefore, it is requested to drive the VUT around a circle before every test rerun.

8.4 Test execution

8.4.1 Speeds

Accelerate the VUT and PT to the respective test speeds.

For manual or automatic accelerator control, it needs to be assured that during automatic brake the accelerator pedal does not result in an override of the system. The accelerator pedal needs to be released when the initial test speed is reduced by 5 km/h. There shall be no operation of other driving controls during the test, e.g. clutch or brake pedal.

The subsequent test speed for the next test is incremented with 5 km/h. Stop testing when the actual speed reduction seen in the tests above 40 km/h is less than 20 km/h or when the manufacturer predicts no performance.

8.4.2 Validity criteria

The test shall start at T_0 (4s TTC) and is valid when all boundary conditions are met between T_0 (for CPLA -AEB T_0 -1s) and T_{AEB} and/or T_{FCW} :

Speed of VUT (GPS-speed)	Test speed +0,5 km/h
Lateral deviation from VUT test path	0 ± 0,05 m
Lateral deviation from PT test path	
— crossing scenarios	0 ± 0,05 m
— longitudinal scenarios	0 ± 0,15 m
— lateral velocity	0 ± 0,15 m/s
Yaw velocity	0 ± 1,0°/s
Steering wheel velocity	0 ± 15,0°/s
Speed of PT during steady state	±0,2 km/h
Speed of PT or EBT during steady state	±0,2 km/h
Start of steady state	
— PT nearside	3,0 m from vehicle centreline
— PT farside	4,5 m from vehicle centreline
— PT longitudinal	10 m and 28 m from vehicle impact point

8.4.3 End of test conditions

The end of a test is considered when one of the following occurs:

— $V_{VUT} = 0\,km/h$ (crossing) or $V_{VUT} = V_{PT}$ (longitudinal);

— contact between VUT and PT;

— PT has left the VUT path or VUT has left the PT path.

For tests where the FCW function is assessed, the end of a test is considered when one of the following occurs:

— $V_{VUT} = 0\,km/h$ (crossing) or $V_{VUT} = V_{PT}$ (longitudinal);

— $T_{FCW} < 1,5\,s$ TTC, after which an evasive action can be started.

NOTE For AEBS tests where FCW function is assessed, the end of the test is considered when the vehicle is decelerated or stopped by AEBS.

9 Performance metrics

9.1 Performance metrics for test until collision

The following metrics are defined to evaluate the performance of an AEBS when the test is performed until collision occurs. Record the time history of the variables defined in Clause 5 and obtain the following characteristic values and list them in Table 3.

9.1.1 Speed of VUT (V_{VUT}) and speed of VUT at which collision is last avoided (V_{VUT})$_{cla}$

Record the intermediate speeds of VUT when VUT speed is increased according to Table 2 until collision, and determine the speed of VUT at which collision is last avoided.

9.1.2 Impact speed of VUT at which collision first occurs: V_{IMPACT}

It is the speed at which VUT impacts PT when the collision occurs for each AEB pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased according to Table 2.

9.1.3 Activation time of AEBS (T_{AEB}) and activation time of AEBS at which collision is last avoided (T_{AEB})$_{cla}$

It is the activation time of AEBS for each AEBS pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased according to Table 2, and the activation time of AEBS when collision is last avoided.

9.1.4 Activation time of FCW (T_{FCW}) and activation time of FCW at which collision is last avoided (T_{FCW})$_{cla}$

It is the activation time of FCW for AEBS pedestrian scenario CPLA-25 when the VUT speed is increased according to Table 2, and the activation time of FCW when collision is last avoided.

9.1.5 Mean longitudinal acceleration of the VUT (A_{VUT}) and mean longitudinal acceleration of the VUT at which collision is last avoided (A_{VUT})$_{cla}$

It is the mean value of longitudinal acceleration of VUT from T_{AEB} to complete stopping for each AEBS pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased according to Table 2, and the mean longitudinal acceleration of the VUT when collision is last avoided.

9.1.6 Maximum yaw rate of the VUT ($\dot{\Psi}_{VUT}$)$_{max}$ and maximum yaw rate of the VUT at which collision is last avoided ($\dot{\Psi}_{VUT}$)$_{max,cla}$

It is the maximum value of yaw rate of VUT for each AEBS pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased according to Table 2, and the maximum value of yaw rate of VUT when collision is last avoided.

9.1.7 Lateral path error of the VUT (Y_{VUT}) and lateral path error of the VUT at which collision is last avoided (Y_{VUT})$_{cla}$

It is the lateral path error of VUT for each AEBS pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased according to Table 2, and the lateral path error of VUT when collision is last avoided.

9.1.8 Maximum steering wheel velocity of VUT ($\dot{\Omega}_{VUT}$)$_{max}$ and maximum steering wheel velocity at which collision is last avoided ($\dot{\Omega}_{VUT}$)$_{max,cla}$

It is the maximum value of steering wheel velocity of VUT for each AEBS pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased according to Table 2, and the maximum value of steering wheel velocity of VUT when collision is last avoided.

Table 3 — Performance evaluation metrics for testing until collision

Testing until collision								
Variables	Values							
V_{VUT} [km/h]	20,0	25,0	30,0	35,0	40,0	....	value where collision is last avoided $(V_{VUT})_{cla}$	value at collision
V_{IMPACT} [km/h]	–	–	–	–	–	–	–	V_{IMPACT}
T_{AEB} [s]							$(T_{AEB})_{cla}$	
T_{FCW} [a] [s]							$(T_{FCW})_{cla}$	
A_{VUT} [m/sec²]							$(A_{VUT})_{cla}$	
$(\dot{\Psi}_{VUT})_{max}$ [deg/sec]							$(\dot{\Psi}_{VUT})_{max,cla}$	
Y_{VUT} [m]							$(Y_{VUT})_{cla}$	
$(\dot{\Omega}_{VUT})_{max}$							$(\dot{\Omega}_{VUT})_{max,cla}$	

a T_{FCW} is for only CPLA-25 scenario with initial velocity of 50 km/h up to collision.

9.2 Performance metrics for test until the designated maximum speed where no collision occurs

The following metrics are defined to evaluate the performance of an AEBS when the test is performed until the designated maximum speed where no collision occurs. Record the time history of the variables defined in Clause 5 and obtain the following characteristic values and list them in Table 4.

9.2.1 Speed of VUT (V_{VUT}) until the designated maximum speed $(V_{VUT})_{ds}$

Record the intermediate speeds of VUT when VUT speed is increased according to Table 2 until the designated maximum speed.

9.2.2 Activation time of AEBS (T_{AEB}) and activation time of AEBS at the designated maximum speed $(T_{AEB})_{dms}$

It is the activation time of AEBS for each AEBS pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased according to Table 2, and the activation time of AEBS at the designated maximum speed.

9.2.3 Activation time of FCW (T_{FCW}) and activation time of FCW at the designated maximum speed $(T_{FCW})_{dms}$

It is the activation time of FCW for AEBS pedestrian scenario CPLA-25 when the VUT speed is increased according to Table 2, and the activation time of FCW at the designated maximum speed.

9.2.4 Mean longitudinal acceleration of the VUT (A_{VUT}) and mean longitudinal acceleration of the VUT at the designated maximum speed $(A_{VUT})_{dms}$

It is the mean value of longitudinal acceleration of VUT from TAEB to complete stopping for each AEBS pedestrian scenarios CPFA-50, CPNA-25, CPNA-75 and CPNC-50 when the VUT speed is increased