BS EN 1317-3:2010

BSI Standards Publication

Road restraint systems

Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions

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National foreword

This British Standard is the UK implementation of EN 1317-3:2010. It supersedes BS EN 1317-3:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/509/1, Road restraint systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Road restraint systems - Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions

Dispositifs de retenue routiers - Partie 3: Classes de performance, critères d'acceptation des essais de choc et méthodes d'essai pour les atténuateurs de choc

Rückhaltesysteme an Straßen - Teil 3: Leistungsklassen, Abnahmekriterien für Anprallprüfungen und Prüfverfahren für Anpralldämpfer

This European Standard was approved by CEN on 29 April 2010.

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This European Standard exists 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 Management Centre has the same status as the official versions.

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Foreword

This document (EN 1317-3:2010) has been prepared by Technical Committee CEN/TC 226 “Road equipment”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2011, and conflicting national standards shall be withdrawn at the latest by January 2011.

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

This document supersedes EN 1317-3:2000.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

EN 1317 consists of the following parts:

— EN 1317-1, *Road restraint systems — Part 1: Terminology and general criteria for test methods*;

— EN 1317-2, *Road restraint systems — Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets*;

— EN 1317-3, *Road restraint systems — Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions*;

— ENV 1317-4, *Road restraint systems — Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers*;

— prEN 1317-4, *Road restraint systems — Part 4: Performance classes, impact test acceptance criteria and test methods for transitions of safety barriers* (under preparation: this document will supersede ENV 1317-4:2001 for the clauses concerning transitions);

— EN 1317-5, *Road restraint systems — Part 5: Product requirements and evaluation of conformity for vehicle restraint systems*;

— prEN 1317-6, *Road restraint systems — Pedestrian restraint systems — Part 6: Pedestrian Parapet* (under preparation);

— prEN 1317-7, *Road restraint systems — Part 7: Performance classes, impact test acceptance criteria and test methods for terminals of safety barriers* (under preparation: this document will supersede ENV 1317-4:2001 for the clauses concerning terminals);

— prEN 1317-8, *Road restraint systems — Part 8: Motorcycle road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers* (under preparation)..

Annex A is normative.

The significant technical changes incorporated in this revision are:

a) Deletion of PHD;

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b) Introduction of the measure of VCDI;

c) Reduction of impact angle tolerance to ± 1°;

d) Introduction of combined limit deviation of speed and angle for side tests;

e) New Annex A (normative) – Detailed test report template.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Based on safety considerations, the design of roads may require the installation of crash cushions at certain locations. These are designed to reduce the severity of vehicle impact with a more resistive object.

The standard specifies the levels of performance, required of crash cushions, for the restraint and/or redirection of impacting vehicles.

The impact severity of vehicles in collision with crash cushions is rated by the indices Theoretical Head Impact Velocity (THIV), and Acceleration Severity Index (ASI) (see EN 1317-1).

The different performance levels will enable national and local authorities to specify the performance class of crash cushions.

Attention is drawn to the fact that the acceptance of a crash cushion will require the successful completion of a series of vehicle impact tests (see Tables 1, 2, 3, etc.) as well as compliance with the full standard.

1 Scope

This European Standard specifies requirements for the performance of crash cushions during vehicle impacts. It specifies performance classes and acceptance criteria for impact tests, which should be read in conjunction with EN 1317-1 and EN 1317-5.

The modifications included in this European Standard are not a change of test criteria, in the sense of EN 1317-5:2007+A1:2008, ZA.3.

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.

EN 1317-1:2010, *Road restraint systems — Part 1: Terminology and general criteria for test methods*

3 Abbreviations

ASI: Acceleration Severity Index

THIV: Theoretical Head Impact Velocity

4 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1317-1:2010 and the following apply.

4.1
obstacle
item or hazard being protected from vehicular impact by the presence of a crash cushion

4.2
front face of the obstacle
surface closest to a plane drawn perpendicular to the centre line of the crash cushion

4.3
family of crash cushions
multiple performance product that can be assembled to form different models from the same set of components, to obtain different shapes and performances, with the same working mechanism for the system and its components

4.4
crash cushion head
structural beginning of a crash cushion, i.e. first point at which the system offers significant resistance to an impact in the direction defined in 5.2

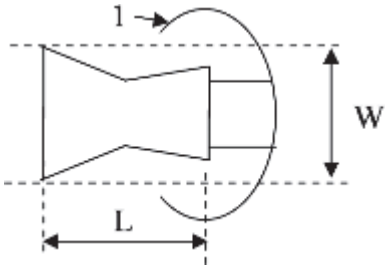
NOTE 1 In some designs, a non-structural beginning (head) may be included which offers no significant resistance to an impact. The crash cushion head is defined by the manufacturer and accepted by the test house performing the test.

NOTE 2 If no agreement is reached between the manufacturer and the test house regarding the definition of the crash cushion head, the test can be performed according to the manufacturer's definition and a note should be added to the test report outlining the diverging points of view.

4.5
structural length of a crash cushion
L
length of a crash cushion to be used to define the impact points, i.e. the longitudinal distance from the head of the crash cushion to the rearmost point of the system required to achieve the declared performance

4.6
crash cushion width
W
maximum horizontal distance between the approach side and the departure side of the crash cushion, measured orthogonally to its centre line

NOTE See Figure 1.

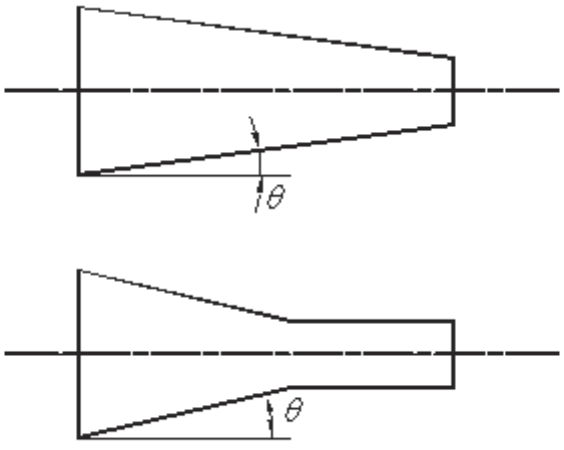


Key
1 Non structural head
L Structural length of the crash cushion
W Crash cushion width

Figure 1 — Example of crash cushion width

4.7
taper angle
maximum angle in plan view from a parallel of the center line and the angled side of the crash cushion

NOTE See Figure 2.



Key
θ Taper angle

Figure 2 — Example of taper angle

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4.8
trapezoidal envelope
trapezium surrounding the plan profile of the crash cushion, having a minimum plan area as shown in Figures 4 and 5

NOTE Any essential supporting structure should be included within this envelope.

5 Performance classes

5.1 General

Crash cushions shall comply with requirements given in 5.2 to 5.6 when tested in accordance with impact test criteria defined in Table 1.

Vehicle specifications and deviations shall conform to EN 1317-1.

5.2 Types of crash cushion

Types of crash cushion shall be:

a) redirective (R): crash cushions which contain and redirect vehicles;

b) non-redirective (NR): crash cushions which contain but do not redirect vehicles.

5.3 Vehicle impact tests

Vehicle impact test descriptions shall be as given in Table 1.

Table 1 — Vehicle impact test descriptions for crash cushions

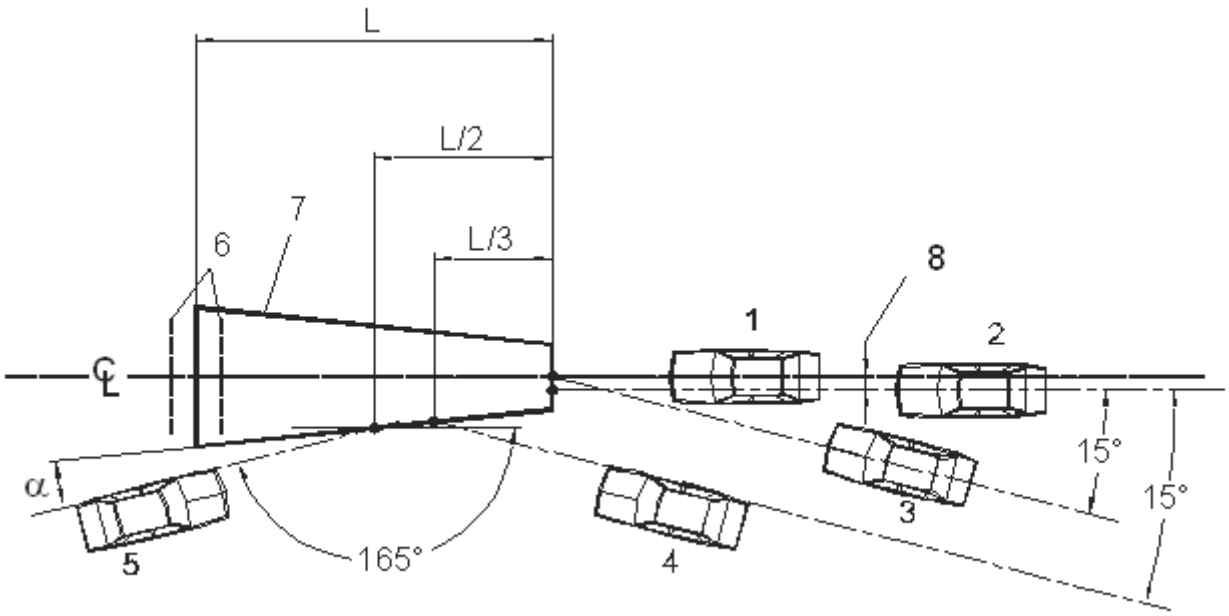
Test[a]	Approach	Total vehicle mass kg	Velocity km/h	Figure 3 Test no.
TC 1.1.50	Frontal centre	900	50	1
TC 1.1.80		900	80	
TC 1.1.100		900	100	
TC 1.2.80		1 300	80	1
TC 1.2.100			100	
TC 1.3.110		1 500	110	1
TC 2.1.80	Frontal, ¼ vehicle offset	900[b]	80	2
TC 2.1.100			100	
TC 3.2.80	Head (centre), at 15°	1 300	80	3
TC 3.2.100		1 300	100	
TC 3.3.110		1 500	110	
TC 4.2.50	Side impact at 15°	1 300	50	4
TC 4.2.80		1 300	80	
TC 4.2.100		1 300	100	
TC 4.3.110		1 500	110	
TC 5.2.80	Side impact at 165°	1 300	80	5
TC 5.2.100		1 300	100	
TC 5.3.110		1 500	110	

[a] Test notation is as follows:

TC	**1**	**2**	**80**
Test of crash cushion	Approach	Test vehicle mass	Impact speed

[b] For this test condition, the ATD shall be located at the more distant location from the centre line of crash cushion.

Test 5 (see Figure 3) shall not be run for a crash cushion of non-parallel form when, at the relevant impact point, the angle (α) of the vehicle path to the traffic face of the crash cushion is less than 5°.



Key
1 Test 1
2 Test 2
3 Test 3
4 Test 4
5 Test 5
6 Alternative locations for front face of obstacle
7 Crash cushion
8 1/4 vehicle width
For further details see Figure 5a).

Figure 3 — Vehicle approach paths for tests 1 to 5

5.4 Performance levels

The crash cushion performance classes shall be as given in 5.6 and Table 2. These are classified according to an increasing energy absorption capacity. A successfully tested crash cushion at a given performance level, shall be considered as having met the test conditions of lower levels.

Table 2 — Performance levels for crash cushions

Level	Acceptance test					
50	TC 1.1.50	-	-	-	TC 4.2.50[a]	-
80/1	-	TC 1.2.80	TC 2.1.80	-	TC 4.2.80[a]	-
80	TC 1.1.80	TC 1.2.80	TC 2.1.80	TC 3.2.80	TC 4.2.80[a]	TC 5.2.80[a]
100	TC 1.1.100	TC 1.2.100	TC 2.1.100	TC 3.2.100	TC 4.2.100[a]	TC 5.2.100[a]
110	TC 1.1.100	TC 1.3.110	TC 2.1.100	TC 3.3.110	TC 4.3.110[a]	TC 5.3.110[a]

[a] Relevant for the redirective crash cushions only.

5.5 Impact severity

Vehicle occupant impact severity shall be assessed by the indices ASI and THIV as given in EN 1317-1:2010.

The severity levels shall be determined as shown in Table 3 as a function of the values of the ASI and THIV indices.

Impact severity level A affords a greater level of safety for the occupants of an errant vehicle than level B and is preferred.

The highest impact severity level from a series of tests shall denote the severity level of the crash cushion family.

Table 3 — Vehicle impact severity values

Impact severity levels	Index values		
A	ASI ≤ 1,0	and	THIV ≤ 44 km/h in tests 1,2 and 3 THIV ≤ 33 km/h in tests 4 and 5
B	1,0 < ASI ≤ 1,4		THIV ≤ 44 km/h in tests 1,2 and 3 THIV ≤ 33 km/h in tests 4 and 5
NOTE The limit value for THIV is higher in tests 1, 2 and 3 because experience has shown that higher values can be tolerated in frontal impacts (also because of better passive safety in this direction). Such a difference in tolerance between frontal and lateral impacts is already considered in the ASI parameter, which therefore does not need to be changed.			

5.6 Families of crash cushions

A family of crash cushion models shall be derived from a single parent crash cushion once the latter has been successfully tested to this standard.

A reduced matrix of tests shall be completed for the other family members in accordance with Tables 4 to 9. The models in the family cover a range of performance classes, width and taper angles.

Provided that the models in the family:

a) are assembled from the same set of components;

b) have the same product name;

c) have the same working mechanism for the system and for the components,

the family, specified by the drawings of all the models, can be tested as a single product with multiple performance levels. If the tests specified by the family test matrix are passed, the crash cushion is accepted as a multiple performance product, i.e. each model is accepted in the relevant performance class. All the cushions in the family shall be of the same type, i.e. all redirective or all non-redirective.

If the parent crash cushion has the minimum taper angle/width and belongs to the highest performance class, the test matrix is the one shown in Table 4, 5, 6 or 7, depending on the highest velocity of the family.

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Table 4 — Parent Crash Cushion with minimum taper angle/width, 110 km/h

Performance class km/h	Taper angle/width		
	Minimum	Intermediate	Maximum
110	All Tests	-	TC 1.1.100 TC 4.3.110[a]
100	TC 1.2.100	-	TC 4.2.100[a]
80	TC 1.2.80	-	TC 4.2.80[a]
50	TC 1.1.50	-	TC 4.2.50[a]
[a] Relevant for the redirective crash cushions only.			

Table 5 — Parent Crash Cushion with minimum taper angle/width, 100 km/h

Performance class km/h	Taper angle/width		
	Minimum	Intermediate	Maximum
100	All Tests	-	TC 1.1.100 TC 4.2.100[a]
80	TC 1.2.80	-	TC 4.2. 80[a]
50	TC 1.1.50	-	TC 4.2. 50[a]
[a] Relevant for the redirective crash cushions only.			

Table 6 — Parent Crash Cushion with minimum taper angle/width, 80 km/h

Performance class km/h	Taper angle/width		
	Minimum	Intermediate	Maximum
80	All Tests	-	TC 1.1.80 TC 4.2.80[a]
50	TC 1.1.50	-	TC 4.2.50[a]
[a] Relevant for the redirective crash cushions only.			

Table 7 — Parent Crash Cushion with minimum taper angle/width, 50 km/h

Performance class km/h	Taper angle/width		
	Minimum	Intermediate	Maximum
50	All Tests	-	TC 1.1.50 TC 4.2.50[a]
[a] Relevant for the redirective crash cushions only.			

If the parent crash cushion has the minimum taper angle/width, belongs to the 100 km/h performance class and the group also covers the 110 km/h performance class, the test matrix shall be as the one shown in Table 8.

Table 8 — Parent Crash Cushion with minimum taper angle/width, 100 km/h

Performance class km/h	Taper angle/width		
	Minimum	Intermediate	Maximum
110	TC 1.3.110 TC 3.3.110	-	TC 4.3.110[a]
100	All Tests	-	TC 1.1.100 TC 4.2.100[a]
80	TC 1.2.80	-	TC 4.2.80[a]
50	TC 1.1.50	-	TC 4.2.50[a]
[a] Relevant for the redirective crash cushions only.			

If the parent crash cushion has the maximum taper angle/width, belongs to the 100 km/h performance class and the group also covers the 110 km/h performance class, the test matrix is the one in Table 9.

Table 9 — Parent Crash Cushion with maximum taper angle/width, 100 km/h

Performance class km/h	Taper angle/width		
	Minimum	Intermediate	Maximum
110	TC 1.3.110 TC 3.3.110	-	TC 4.3.110[a]
100	TC 1.2.100 TC 4.2.100[a] TC 5.2.100	-	All Tests
80	TC 1.2.80	-	TC 4.2.80[a]
50	TC 1.1.50	-	TC 4.2.50[a]
[a] Relevant for the redirective crash cushions only.			

Every component in the component set shall be present at least in one test. If not, additional tests shall be performed within the performance class of the parent model.

Tables 4, 5, 6 and 7 shall apply when lower velocity models are obtained from the next higher performance models, just removing a component in the last third of the latter. In other cases, Approach 1 tests with the light vehicle shall be added to the first column of the relevant test matrix.

If a model with Impact Severity level B is obtained from one with an Impact Severity level A by simply removing some component from the last third of the latter, the new model can be accepted with a single test with approach 1 and with the heaviest applicable vehicle.

A multiple performance product may lack one or more models, corresponding to one or more cells in the test matrix; in this case, cells can be deleted in the test matrix, from the bottom and from the top, with the following limitations:

d) the row of the parent model shall not be affected;

e) the cell in the first column shall not be deleted unless all the relevant row is deleted.

NOTE 1 The minimum and maximum taper angle and width are specified by the design of the system.

NOTE 2 Intermediate taper angles may be more than one or they may be absent, as specified by the design.

NOTE 3 If the design has only one taper angle, this taper angle is considered to be the minimum and the first column of the relevant table applies; Table 9 is not applicable.

The highest impact severity level from a series of tests shall denote the severity level of the crash cushion family.

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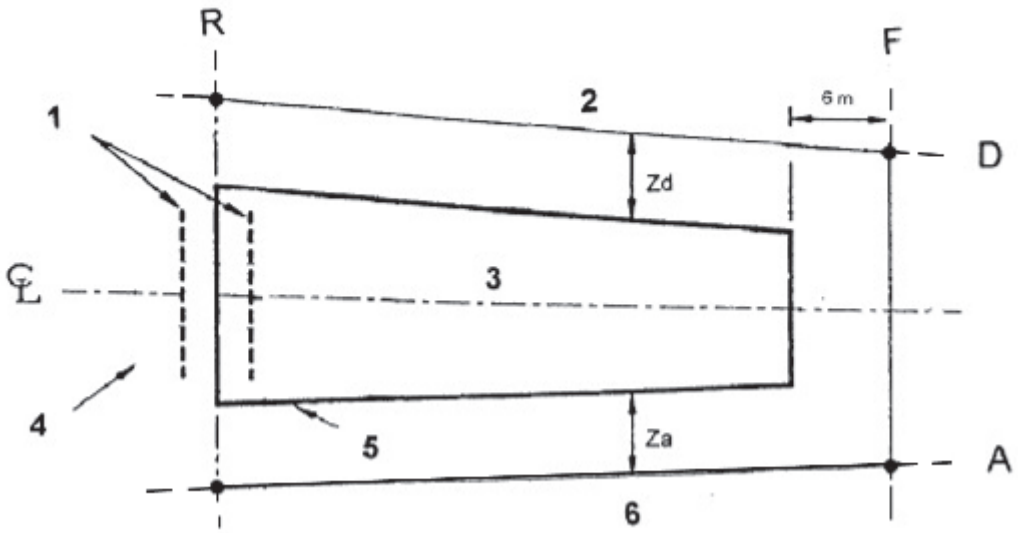
6 Impact test acceptance criteria

6.1 General

The plan profile of the crash cushion under test shall be inscribed within a trapezoidal envelope having a minimum plan area as shown in Figures 3 and 5 and any essential supporting structure shall be included within this envelope.



Key
1 Alternative locations for front face of obstacle
2 Departure side
3 Crash cushion centre line
4 Exit area
5 Trapezoidal envelope enclosing crash cushion
6 Approach side

NOTE For R, F, D, A, Za and Zd, see 6.3.

Figure 4 — Ground reference plan

For completion of a successful test the impact acceptance criteria and measurement as specified in 6.2 to 6.6 shall apply.

6.2 Crash cushion behaviour

Elements of the crash cushion shall not penetrate the passenger compartment of the vehicle. There shall be no deformations of, or intrusions into, the passenger compartment that could cause serious injuries to the occupants.

All totally detached parts of the crash cushion with a mass greater than 2,0 kg shall be included in the determination of the displacement classification (see 6.5).

Foundations, ground anchorages and fixings shall perform according to the design of the crash cushion. The deformed crash cushion shall not encroach into the front surface of the obstacle.

6.3 Test vehicle behaviour

The vehicle shall not roll over (including rollover of the vehicle onto its side) during or after impact.

The post-impact trajectory of the test vehicle shall be evaluated by means of the exit box shown in Figure 4. The exit box is limited by:

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a) the rebound line F, perpendicular to the crash cushion centre line, 6 m upstream of the crash cushion head;

b) the two side lines A and D, parallel to the two sides of the trapezoidal envelope defined in Clause 6, are at distances Za on the approach side and Zd on the departure side;

c) the line R is perpendicular to the centre line at the end of the crash cushion;

d) a broken line, see Figure 4, represents the front face of the obstacle to be protected; this line shall be specified in the design of the crash cushion and reported in the test report — it may be inside or outside the crash cushion envelope.

For different tests, the vehicle post-impact trajectory shall be restricted by the following criteria:

e) in any test the vehicle shall not cross the broken line representing the front face of the obstacle;

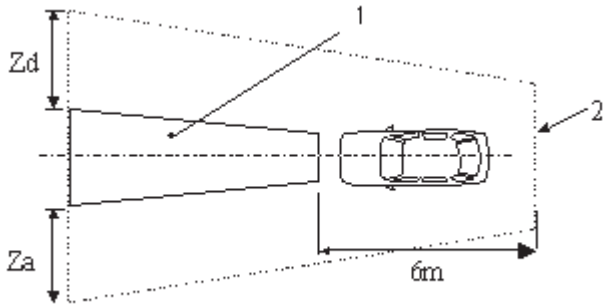
f) in tests 1 to 5 the wheels of the vehicle shall not encroach the lines of the exit box specified in Table 10 unless the velocity of the vehicle centre of mass at the instant of encroachment is less than or equal to 11 km/h. In this case for the determination of the redirection zone the vehicle is considered not having passed the relevant exit box control line.

Table 10 — Exit box

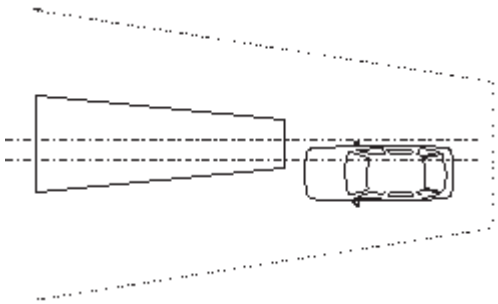
Test	Exit box control lines
1	F, A, D, R
2 to 4	F, A, D
5	A

The classes of crash cushions Z1, Z2, Z3 and Z4 shall be ranked according to the distances Za and Zd given in Table 11 and shown in Figures 4, 5a) and 5b).

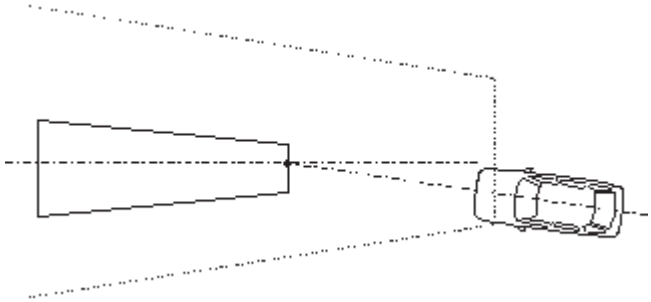
Test 1



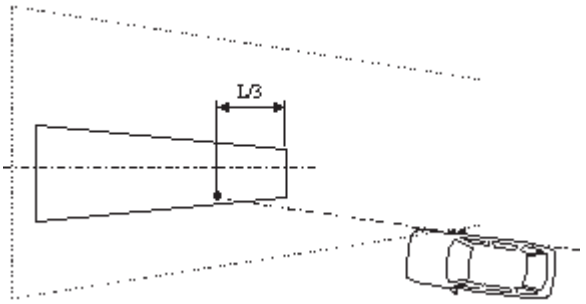
Test 2



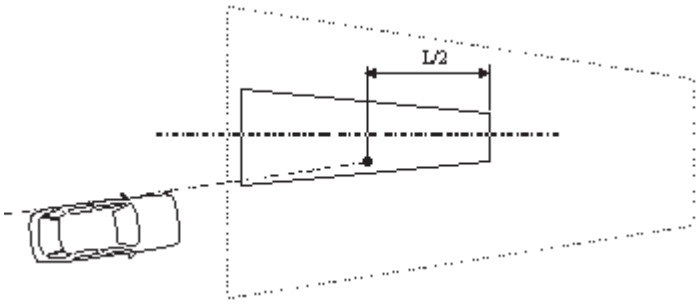
Test 3



Test 4

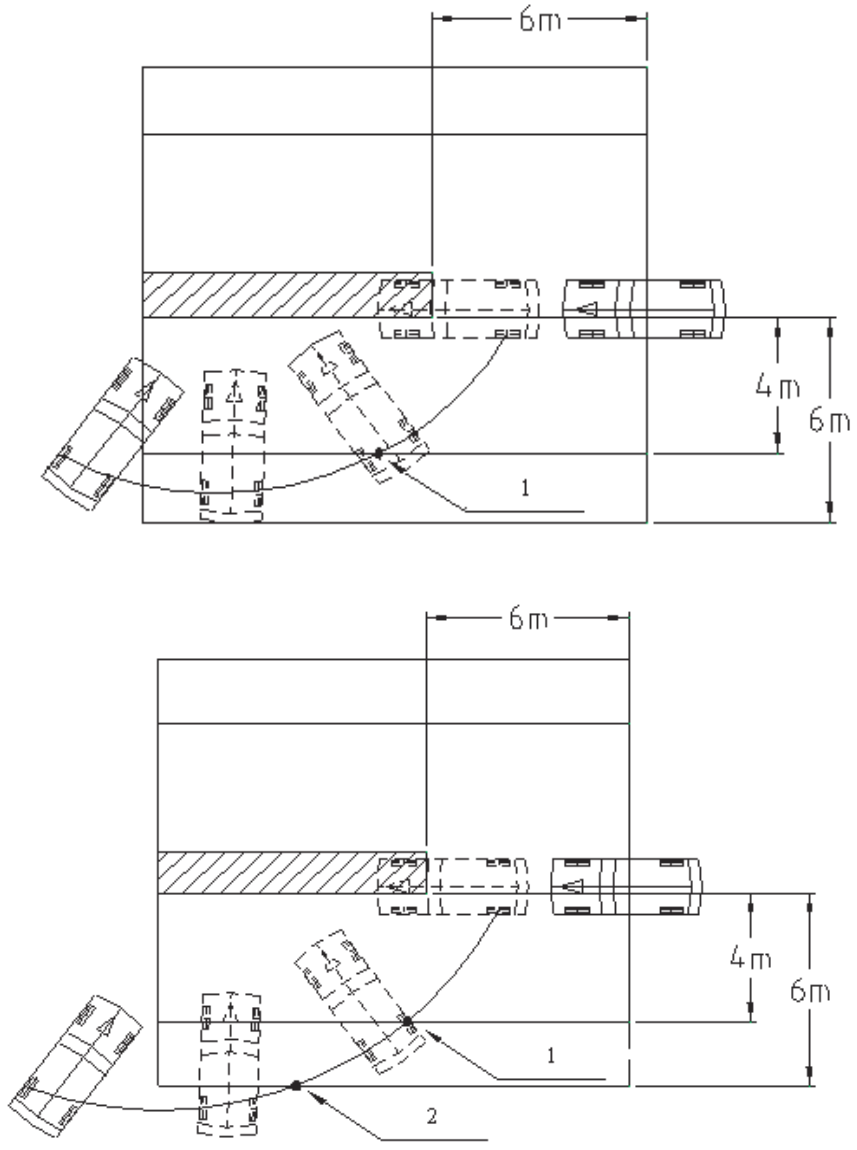


Test 5



Key
1 Crash cushion
2 Redirection zone

a) Vehicle Exit Box



V_p = Prescribed impact speed

Velocity at point A (wheel crossing the 4 m line)	Velocity at point B (wheel crossing the 6 m line)	Classes of Z
≤ 10 % V_p or no crossing	≤ 10 % V_p or no crossing	Z1
> 10 % V_p	≤ 10 % V_p or no crossing	Z2
> 10 % V_p	> 10 % V_p	Fail

Key
1 Point A
2 Point B

b) Examples of Z Classification

Figure 5 — Vehicle Exit Box and Examples of Z

Table 11 — Redirection zone dimensions (Za and Zd)

Classes of crash cushion Z	Approach side	Departure side
	Za m	Zd m
Z1	4	4
Z2	6	6
Z3	4	≥ 4[a]
Z4	6	≥ 6[a]
[a] Test 3 (see Figure 3).		

6.4 Severity index

ASI and THIV shall be computed using at least the minimum amount of vehicle instrumentation as specified in 7.4.6. These values shall be quoted in the test report (see EN 1317-1).

The maximum values of ASI and THIV shall not exceed the values given in Table 3.

6.5 Crash cushion lateral displacement

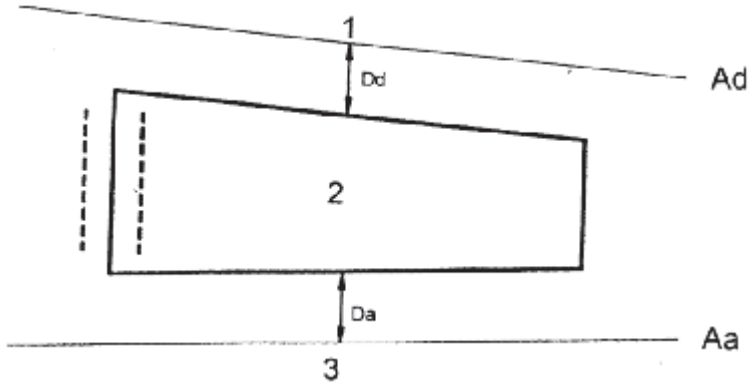
The permanent lateral displacement of the crash cushion, or any detached part greater than or equal to 2,0 kg, shall be measured and recorded in the test report, and shall be included in the determination of the permanent lateral displacement zone.

The eight classes D1 to D8 for the permanent lateral displacement of the crash cushion shall be as shown in Table 12. The permanent lateral displacement shall be measured and recorded in the test report. To meet classes D1 to D4, the crash cushion under test in Tests 1, 2, 3, 4 and 5 shall remain within distances Da and Dd from the design envelope. The displacement of Da and Dd are shown by lines Aa and Ad in Figure 6.

Table 12 — Permanent lateral displacement zones for crash cushions

Classes of crash cushion D	Displacement	
	Da m	Dd m
D1	0,5	0,5
D2	1,0	1,0
D3	2,0	2,0
D4	3,0	3,0
D5	0,5	≥ 0,5 Test 3, Figure 3
D6	1,0	≥ 1,0 Test 3, Figure 3
D7	2,0	≥ 2,0 Test 3, Figure 3
D8	3,0	≥ 3,0 Test 3, Figure 3

For classes D5 to D8, the crash cushion shall meet the same test conditions as classes D1, D2, D3 and D4 with the exception that, for Test 3, the crash cushion may move an unspecified distance on the departure side shown in Figure 6.



Key
1 Departure side
2 Trapezoidal envelope for crash cushion design
3 Approach side

Figure 6 — Crash cushion permanent displacement limits

6.6 Test vehicle deformation

The deformation of the interior of the vehicle shall be evaluated and recorded, in the form of VCDI, in all tests with passenger cars as described in EN 1317-1.

7 Test methods

7.1 Test site

Test site shall be according to EN 1317-1:2010, 5.1.

7.2 Test vehicle

Test vehicle shall be according to EN 1317-1:2010, 5.2.

7.3 Crash cushion

7.3.1 General

Detailed descriptions and design specifications of the crash cushion shall be included in the test report (see EN 1317-1) to enable verification of conformity of the installed system to be tested, with the design specification.

7.3.2 Installation

The installation of the crash cushion for the test, including its foundations, shall comply with the structural design details and with the on-road system details as given in the design specification.

7.3.3 Position of the impact point

The required impact point for Tests 1 to 5 shall be as defined in Figure 3.

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7.4 Accuracies and deviation of impact speeds and angles

7.4.1 Vehicle impact speed

Vehicle impact speed shall be measured along the vehicle approach path no further than 6 m before the impact point. The overall accuracy of speed measurement shall be within ± 1 %.

Impact speed shall be within a deviation of $\left\{\begin{matrix} 0,0 \\ +7,0 \end{matrix}\right\}$ %.

7.4.2 Vehicle exit speed

Vehicle exit speed shall be measured with an accuracy of ± 5 km/h.

7.4.3 Vehicle approach angle

Vehicle approach angle shall be measured along the vehicle approach path no further than 6 m before the impact point by a suitable method. The overall accuracy shall be within ± 0,5°.

Impact angle shall be within a deviation of ± 1,0°.

7.4.4 Vehicle impact point

The lateral displacement of the vehicle approach path shall be measured with an accuracy of ± 0,05 m. The permitted deviation for the lateral displacement of the vehicle path from its prescribed path shall be less than ± 0,10 m at the moment of contact.

7.4.5 Combined limit deviation of speed and angle (Frontal impact tests only)

To avoid large differences of impact energy, the maximum limit deviation for speed and angle shall not be combined.

At the upper angle tolerance of + 1° the upper speed limit deviation is reduced to + 5 %, and at the angle limit deviation of - 1,0° the lower speed limit deviation is increased to + 2 %.

The complete combined tolerance envelope shall be as shown in Figure 7.

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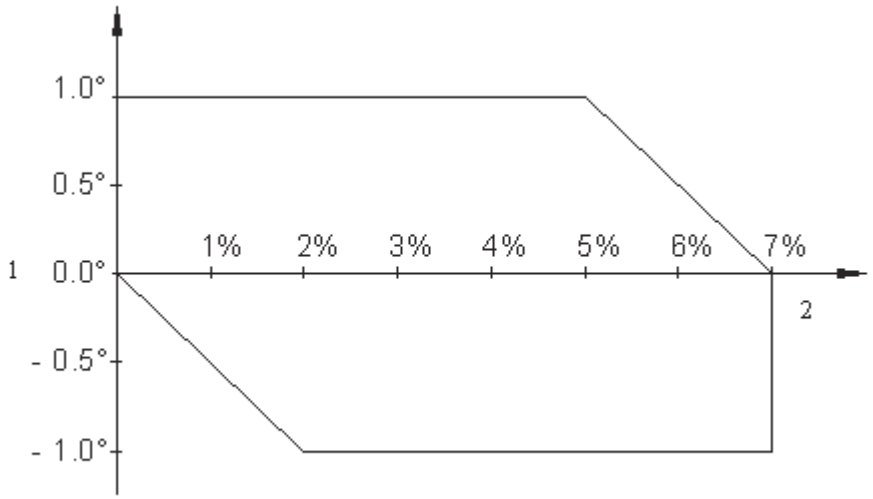


Key
1 Angle
2 Speed

Figure 7 — Envelope of combined tolerances

NOTE The given limit deviations only serve to take account of different test installations or test procedures and are not intended to provide a spectrum from which the energy of the test may be chosen.

In any case, the nominal values of Table 1 shall serve as a basis.

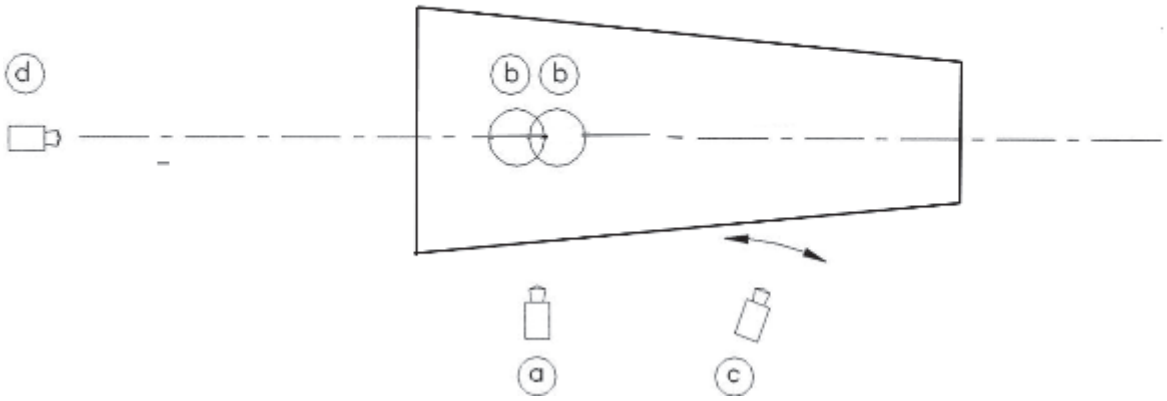
7.4.6 Vehicle instrumentation

Vehicle instrumentation shall be according to EN 1317-1:2010, Clause 6.

7.4.7 Photographic coverage

High speed cameras and/or high speed video cameras shall be operated at a minimum of 200 frames per second.

The photographic coverage shall be at minimum as indicated in Figure 8.



Key
a) One high speed camera looking normal to the crash cushion centre line
b) One or two overhead high-speed cameras, located in a way to cover the vehicle motion from at least 6 m before the impact point to a distance to record the performance of the crash cushion
c) One optional panned camera at normal speed sited at right angles to the path of the vehicle
d) One optional high speed camera looking from a position behind the impact pointing order to record the vehicle roll, vertical lift, penetration and sequence of action as the crash cushion is struck

NOTE The need for additional cameras should be considered to cover areas of special interest.

Figure 8 — Layout of cameras for recording tests – approaches 1 and 3

For Approaches 4 and 5, the photographic coverage to describe the crash cushion behaviour and the vehicle motion during and after impact shall be, at the minimum, as described below.

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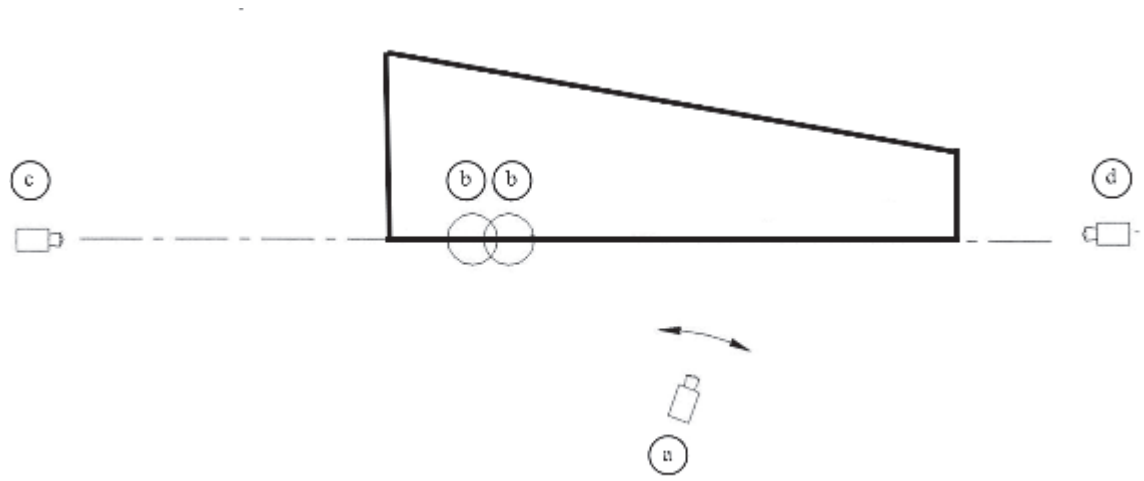

Key
a) One optional panned camera at normal speed to cover the path of the vehicle
b) One or two overhead high-speed cameras, located in a way to cover the vehicle motion from at least 6 m before the impact point to a distance to record the performance of the crash cushion
c) One high speed camera looking over the crash cushion from a point behind impact in order to record the vehicle roll, vertical lift, penetration and sequence of action as the system is struck
d) One high speed camera looking along the system from the opposite end to the camera in item c)

NOTE The need for additional cameras should be considered to cover areas of special interest.

Figure 9 — Layout of cameras for recording tests – Approaches 4 and 5

8 Test report

The test report shall be comply with Annex A.

Annex A
(normative)

Detailed Test Report Template

The test report shall include the following information as a minimum, in the order given. All drawings and associated documents shall be clearly numbered and dated.

Test Report Cover

1. Name of test laboratory
2. Date of report
3. Name of client
4. Name of test item
5. Date of test
6. Test number and/or test report number (version number if applicable)
7. Test type and reference to standard
8. Number of pages including annexes
9. Official test report language
10. Approval of report

Table of Contents

1 Test laboratory

1.1 Name
1.2 Address
1.3 Telephone number
1.4 Facsimile number
1.5 Internet address
1.6 Test site location
1.7 Name and address of the body which accredited the test laboratory
1.8 Notification/accreditation number with date of approval, valid at the time of testing

1.9 Additional information

2 Client

2.1 Name
2.2 Address
2.3 Telephone number
2.4 Facsimile number
2.5 Internet address
2.6 Additional information

3 Test item

3.1 Name of test item
3.2 Date of installation
3.3 Date of test
3.4 Laboratory's test reference number
3.5 Additional information

4 Test procedure

4.1 Test Type (according to Table 1)

4.1.1 Type of impact test (for example, TC 1.1.50) and issue of the standard
4.1.2 Additional information (e.g. details of other testing carried out within the crash cushion "Family")
4.1.3 Sketch of the envelope of the crash cushion, showing:
- The dimensions of the envelope;
- The position of the envelope relative to the crash cushion;
- The position of the expected impact point (with dimensions);
- The position of the real impact point (with dimensions);
- Approach and departure side;
- Position of nominal impact point

4.2 Test area

4.2.1 Description of type and condition of test area
4.2.2 Type of underground
4.2.3 Class/condition of underground
4.2.4 Additional Information

4.3 Installation and description of test item

4.3.1 Conformity between test item drawings and item tested (Yes/No)
4.3.2 Conformity between installation manual and item installed (Yes/No)
4.3.3 Description of the crash cushion tested which shall include, as a minimum:
- 4.3.3.1 Type of Crash Cushion – redirective (R) or non-redirective (NR)
- 4.3.3.2 Ground fixing details (including the depth of the fixings)
- 4.3.3.3 Total length of tested system in metres (m)
- 4.3.3.4 Crash cushion width in metres (m)
- 4.3.3.5 Taper Angle in degrees (°)
- 4.3.3.6 Height of the test item in the impact area in metres (m)
- 4.3.3.7 Position of obstacle to be protected
- 4.3.3.8 Any additional information to describe the crash cushion sufficiently

4.4. Description of test vehicle

4.4.1 Vehicle make and model
4.4.2 Model year and/or initial registration
4.4.3 Vehicle identification number (VIN)

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4.4.4 Vehicle mass ballast mass, ATD mass and total test mass, according to EN 1317-1:2010, Table 1
4.4.5 Location of the centre of mass of the vehicle in the test condition according to EN 1317-1:2010, Table1
NOTE For tests with cars, the centre of mass shall be measured without the ATD in the vehicle.
4.4.6 Position of vehicle instrumentation and measured displacement from vehicle centre of mass
4.4.7 Added ballast
4.4.7.1 Ballast type/description
4.4.7.2 General ballast position
4.4.7.3 Total ballast mass
4.4.8 ATD (if fitted):
4.4.8.1 ATD type
4.4.8.2 ATD mass
4.4.8.3 ATD position in vehicle
4.4.9 Dimensions and characteristics of vehicle, which shall include as a minimum:
4.4.9.1 Total vehicle length
4.4.9.2 Total vehicle width (excluding side mirrors)
4.4.9.3 Wheel track
4.4.9.4 Number of axles
4.4.10 Vehicle roadworthiness assessment (including date of assessment)
4.4.11 Any additional information

5 Results

5.1 Test Conditions

5.1.1 Actual impact speed in kilometres per hour (km/h)
5.1.2 % difference from nominal speed
5.1.3 Rebound speed (if required)
5.1.4 Vehicle exit speed of centre of mass when first wheel encroaches any of the lines specified in 6.3 and Figure 5
5.1.5 Actual impact angle in degrees (°)
5.1.6 Difference from nominal angle in degrees (°)
5.1.7 Actual position of impact point
5.1.8 Difference from nominal impact point
5.1.9 General description of test sequence
5.1.10 Air temperature and weather conditions
5.1.11 Any additional information

5.2 Test item

General
5.2.1 Permanent deflection of Crash Cushion (10 min to 15 min after impact)
5.2.2 Details of system parts over 2,0 kg totally detached:
5.2.2.1 Identification
5.2.2.2 Mass in kilograms (kg)
5.2.2.3 Final location measured at right angles from the centre line of the crash cushion. Detached parts on the approach side are indicated by a plus-sign, on the departure side by a minus-sign in front of the value.
5.2.2.4 Final location measured at right angle to the line R in Figure 4. Detached parts behind the line R are indicated by a plus-sign, in front of the line R by a minus-sign in front of the value.
5.2.3 Permanent lateral displacement of Crash Cushion (Da and Dd) in metres (m).
The final position of detached elements with a mass greater than 2,0 kg shall be included
5.2.4 Class of lateral displacement of Crash Cushion (D)
5.2.5 Length of contact in metres (m)
5.2.6 Actual impact point location
5.2.7 Description of damage to test item (including a listing of all damaged and/or displaced system parts), ground anchorages and fixings

Impact test acceptance criteria
5.2.8 Elements of Crash Cushion penetrated the passenger compartment of the vehicle (Yes/No) – if yes, description of penetration is required.

5.2.9 Deformations of and/or intrusions into the passenger compartment (Yes/No) – if yes, description of deformations and/or intrusions are required.
5.2.10 Deformed Crash Cushion encroached into the front surface of the obstacle (Yes/No) – if yes, description is required.
5.2.11 Foundations, ground anchorages and fixings perform according to the design of the Crash Cushion (Yes/No) – if no, description is required.

5.3 Test vehicle

General
5.3.1 General description of vehicle trajectory
5.3.2 Vehicle cockpit deformation index VCDI
5.3.3 Description of the damage and deformation to the test vehicle
5.3.4 Redirection zone dimensions (Za and Zd)
5.3.5 Class of redirection of Crash Cushion (Z)

Impact test acceptance criteria
5.3.6 Lateral displacement of the vehicle path from its prescribed path at the moment of contact less than 0,10 m (Yes/No)
5.3.7 Actual impact speed and angle within tolerance limits? (Yes/No)
5.3.8 Actual impact speed and angle combination within the tolerance envelope in Figure 7 (Yes/No)
5.3.9 Vehicle rolls over or rolls on the side during the test (Yes/No)
5.3.9 Vehicle intrudes the broken line representing the front face of the obstacle (Yes/No)
5.3.10 Wheels of the test vehicle encroaches the lines of the exit box (Yes/No) – if yes, description is required (see 6.3 for guidance).

5.4 Assessment of the impact severity

All severity indices shall be rounded to the nearest whole number, unless stated otherwise.
The filtering frequency applied to the raw data shall also be stated.

General
5.4.1 Graphs of linear accelerations and angular velocities

Impact test acceptance criteria
5.4.2 Acceleration severity index, ASI (rounded to one decimal place)
5.4.3 Theoretical head impact velocity, THIV
5.4.3.1 Time of flight of the theoretical head in milliseconds (ms)
5.4.3.2 THIV in kilometres per hour (km/h)

6 General statements

6.1 The test results in this report relate only to the VRS tested.
6.2 This report may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.
6.3 This report has been issued in the following languages:

7 Approval of report

7.1 Signature(s)
7.2 Name(s) of authorised and responsible person(s) of Test House
7.3 Position(s)
7.4 Date

8 Annexes

A. General test item arrangement drawings (overview drawing) of the complete item tested and all component drawings, both including number, date, dimensions and tolerances. All drawings to be authorised by the client, by signing the drawings.

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B. Crash cushion installation manual including dimensions and tolerances.
C. Photographs (with a minimum print size in height and width of 8 cm)
  C.1. Photographs of the test item to be tested before the test
  C.2. Interior and exterior photographs of the test vehicle before the test (including photographs of instrumentation location)
  C.3. Photographs of the test item after the test (including damage to the test item and detached parts greater than or equal 2 kg)
  C.4. Interior and exterior photographs of the test vehicle after the test (including the damage and deformation)
  C.5. Sequences and additional photographs (no specific photo size required)
D. Video records
E. Ground condition description

Bibliography

[1] EN 1317-5:2007+A1:2008, *Road restraint systems — Part 5: Product requirements and evaluation of conformity for vehicle restraint systems*

[2] ISO 6487, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

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