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Security and resilience — Vehicle security barriers —

Part 1: Performance requirement, vehicle impact test method and performance rating

Sécurité et résilience — Barrières de sécurité pour véhicules —

Partie 1: Exigence de performance, méthode d'essai d'impact de véhicule et évaluation des performances

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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 document 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 292, *Security and resilience*.

This first edition cancels and replaces IWA 14-1:2013, which has been technically revised.

The main changes are as follows:

— this document has been brought into line with modern technology and practices;

— all figures have been reviewed and surface-placed barriers have been explicitly identified;

— additional reporting of furthest part of vehicle beyond vehicle security barrier datum;

— there has been a general review of all text and structure to provide clarification to test houses and other interested parties.

A list of all parts in the ISO 22343 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.

Security and resilience — Vehicle security barriers —

Part 1: Performance requirement, vehicle impact test method and performance rating

1 Scope

This document specifies impact performance requirements for a vehicle security barrier (VSB) and a test method for rating its performance when subjected to a single impact by a test vehicle not driven by a human being. It is applicable to test methods for vehicle penetration distances not exceeding 25 m.

This document is applicable to all manufacturers and procurers of VSBs, where they are used to protect people in any public or private location from the impact of vehicle attacks.

This document does not apply to the performance of a VSB or its control apparatus when subjected to:

— slow speed encroachment;

— slow speed nudging and ramming;

— blast explosion;

— ballistic impact;

— manual attack, with the aid of the vehicle (multiple impacts at slow speed);

— manual attack, with the aid of tools (excluding vehicles);

— electrical manipulation;

— attack on the control systems by any means.

NOTE 1 For manual attack, a variety of test methods exist. For assessing intruder resistance of building components, see LPS 1175[6].

NOTE 2 The VSB is designed and tested on the basis of:

a) vehicle type, mass and speed of the assessed vehicle-borne threat;

b) its geographical application (e.g. climate conditions);

c) intended site location (e.g. rigid or non-rigid soil/finished surface).

It does not apply to guidance on design, the operational suitability of a VSB or other impact test methods.

NOTE 3 Guidance on the selection and specification of a VSB by type and operational suitability is given in ISO 22343-2.

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 22300, *Security and resilience — Vocabulary*

ASTM C31/C31M, *Standard practice for making and curing concrete test specimens in the field*

ASTM C39/C39M–18, *Standard test method for compressive strength of cylindrical concrete specimens*

EN 12390-2, *Testing hardened concrete — Part 2: Making and curing specimens for strength tests*

EN 12390-3, *Testing hardened concrete — Part 3: Compressive strength of test specimens*

SAE J211/2, *Instrumentation for Impact Test — Part 2: Photographic Instrumentation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22300 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

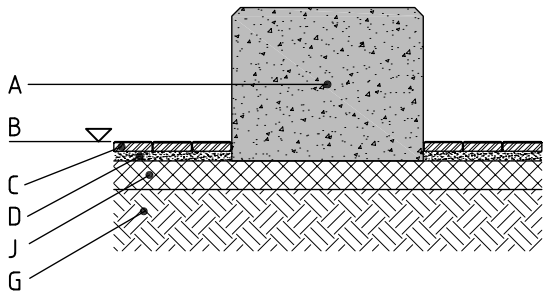
— IEC Electropedia: available at https://www.electropedia.org/

3.1
vehicle security barrier
VSB
passive, active, portable or linear barrier used to prevent potentially hostile vehicular access to a site

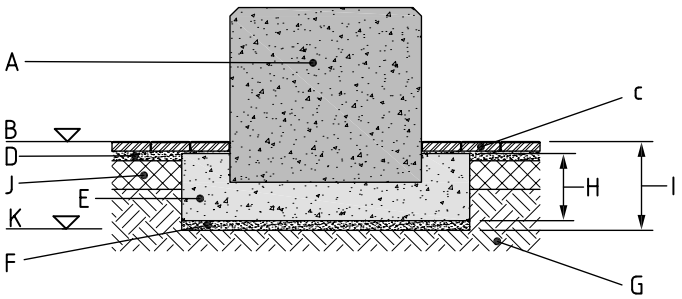
Note 1 to entry: Types of VSB and their application are discussed in ISO 22343-2.

3.2
vehicle security barrier foundation
VSB foundation
foundation and surrounding test location ground into which the *VSB* (3.1) is installed

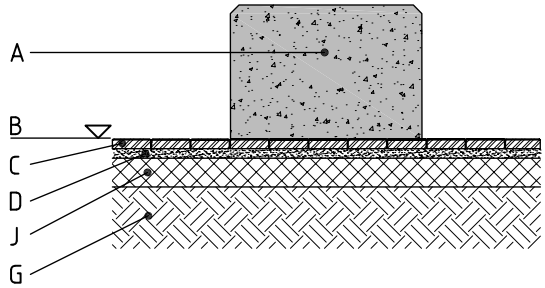
Note 1 to entry: Typical foundations that can be presented for test are illustrated in Figure 1.



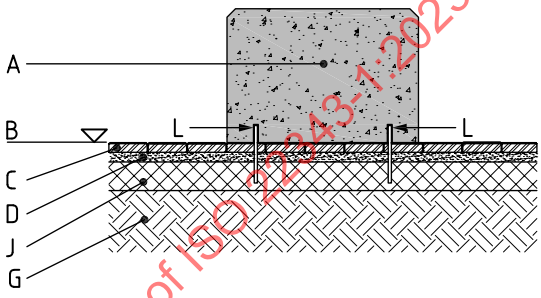
a) VSB rebated



b) VSB integral/proprietary



c) VSB on test site ground (surface placed)



d) VSB anchored/pinned/bolted to test site ground

Key

A	VSB	G	natural ground
B	existing finishing level	H	foundation thickness
C	paviors	I	depth of foundation excavation
D	pavior bedding	J	base construction
E	foundation	K	formation level
F	blinding concrete	L	connections

Figure 1 — Examples of VSB installations — Section view

3.2.1
integral vehicle security barrier foundation
integral VSB foundation
VSB foundation (3.2) that is a structural component of the *VSB* (3.1)

3.2.2
proprietary vehicle security barrier foundation
proprietary VSB foundation
VSB foundation (3.2) designed and sized solely for use with a specific *VSB* (3.1)

Note 1 to entry: A surface pinned VSB can need a concrete plinth into which fixings can be installed, this plinth should be recorded as part of the VSB foundation.

3.2.3
test site ground
surrounding land, in which the vehicle security barrier (VSB) foundation is situated or placed on which the VSB is installed for testing

3.3
test vehicle
commercially available vehicle and load bed

Note 1 to entry: The vehicle having an unmodified chassis and unmodified frontal structure, used in an impact test to evaluate the performance of a VSB (see Table 2).

Note 2 to entry: Modifications that are permissible include the addition of a load bed (in accordance with the vehicle manufacturer's instructions) and methods to restrain movement of ballast.

Note 3 to entry: See Table 2 for test vehicle type and test mass

3.3.2
ballast
mass added to the test vehicle to bring the test vehicle mass within tolerance

Note 1 to entry: Table 1 specifies the permissible quantities of secured and unsecured ballast.

3.3.3
crew cab
four-door compartment of an N1G vehicle for driver and passengers

3.3.4
day cab
driver compartment of an N1 vehicle that does not include overnight facilities

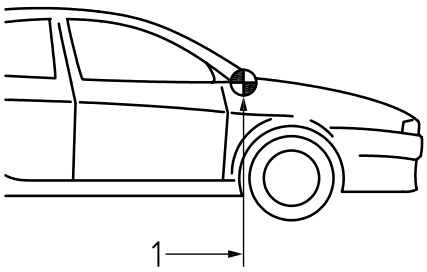
3.3.5
unladen mass
mass of test vehicle, excluding *ballast* (3.3.2) but with manufacturer's equipment, quantities of engine oil and coolant, and minimum amount of fuel

Note 1 to entry: A minimum amount of fuel is required to ensure engine operation during the test which in turn facilitates power steering and braking systems.

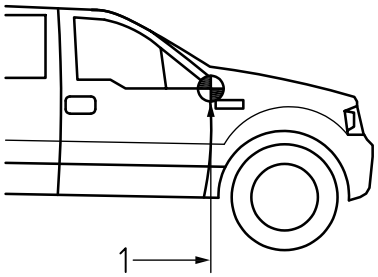
3.4
datum
fixed point or line to where all measurements pre- and post-impact are taken

3.4.1
vehicle datum point
fixed point on a vehicle to where all measurements pre and post impact are taken

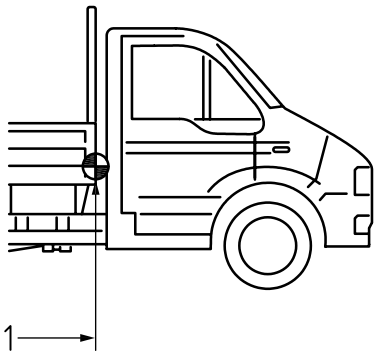
Note 1 to entry: For a car (M1) or 4x4 crew cab pick-up (N1G) vehicle [see Figure 2 a) and Figure 2 b)], a reference line passing through the centre of the A-pillars, at the lowest point of the windscreen. For N1, N2 or N3 vehicles [see Figure 2 c), Figure 2 d) and Figure 2 e)],], a reference line intersecting the lower load bed leading edge and the vehicle chassis rail.



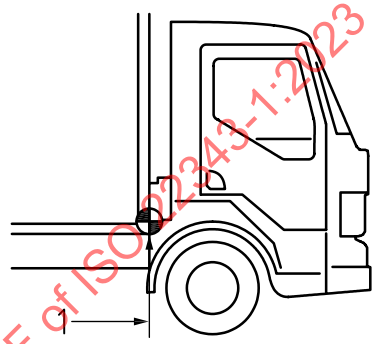
a) Car (M1)



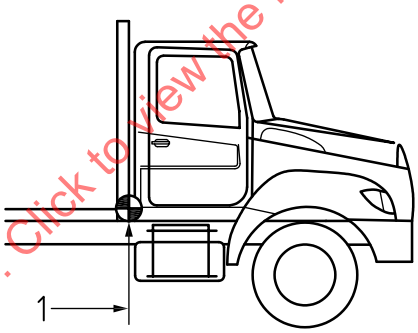
b) 4x4 crew cab pick-up (N1G)



c) Day cab vehicle (N1)



d) Large goods vehicle (LGV) N2A, N3C, N3D, N3F and N3G



e) Large goods vehicle (LGV) N2B and N3E

Key

1 vehicle datum point

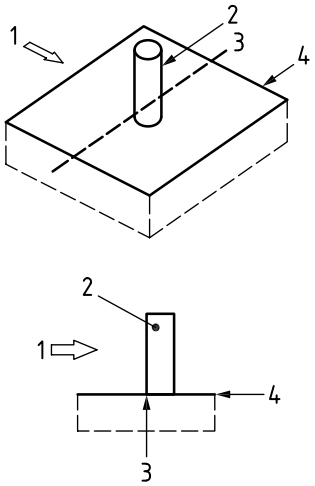
Figure 2 — Vehicle datum point — Side view

3.4.2
vehicle security barrier datum line
VSB datum line
horizontal line marked on the ground pre-impact, vertically aligned with the foremost point of the *vehicle security barrier (VSB)* (3.1) structure designed to withstand the impact

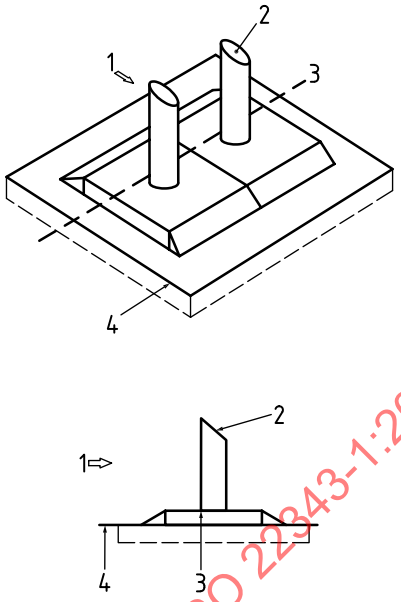
Note 1 to entry: The VSB front face can be flat and perpendicular to the ground. In this case, the whole VSB front face is in line with the VSB datum line. In the case of a blocker, it is the furthest protrusion of the VSB structure designed to withstand the impact [see Figure 3 e)].

Note 2 to entry: The front face of the VSB is not the same as the front face of the VSB foundation or any supporting structure. In the case of a ditch, it is the point where the front face of the ditch meets the ground level.

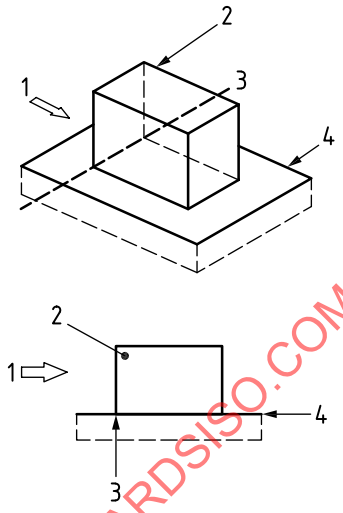
Note 3 to entry: The VSB datum line is illustrated in Figure 3.



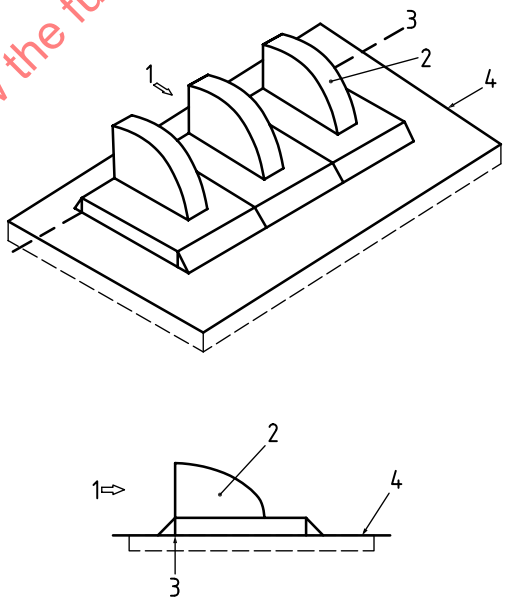
a) Bollard



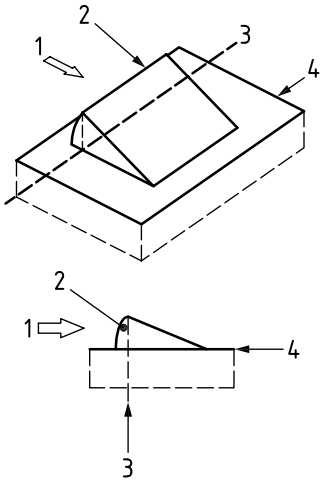
b) Surface-placed bollard



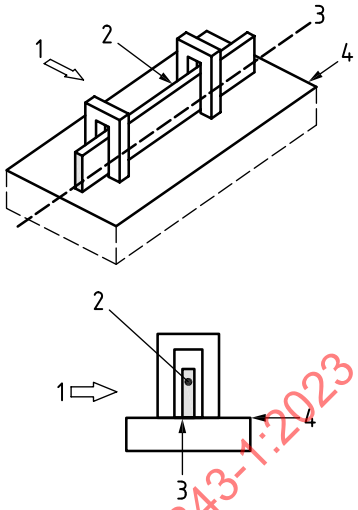
c) Planter, wall, balustrade



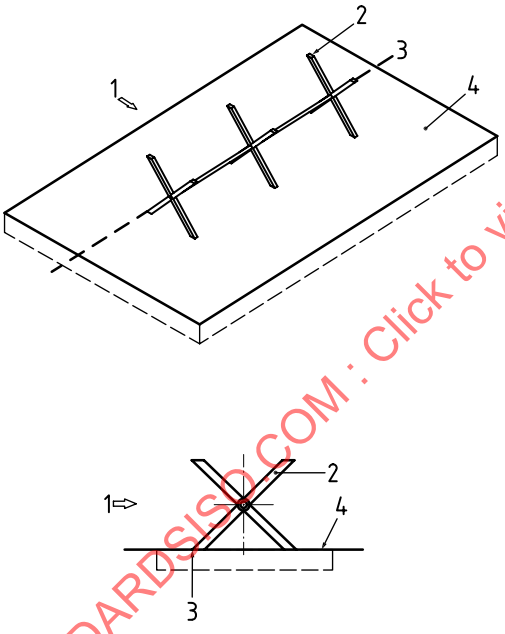
d) Surface-placed barrier



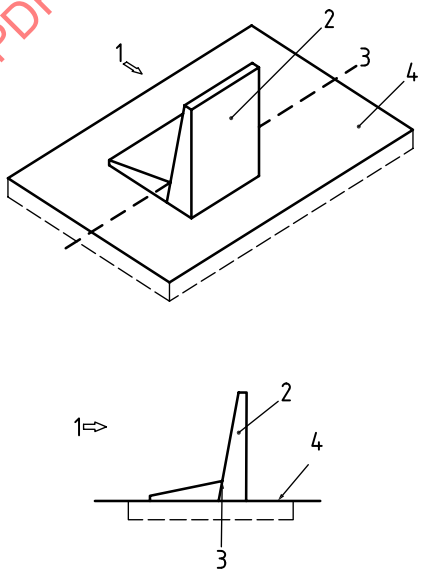
e) Blocker



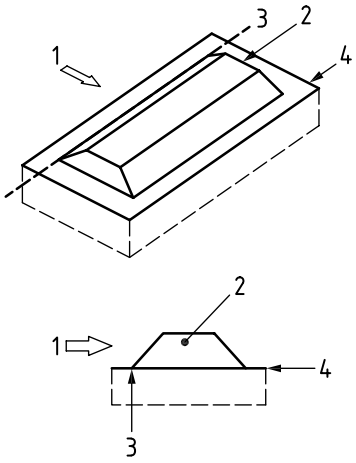
f) Gate barrier, rising/swing arm barrier



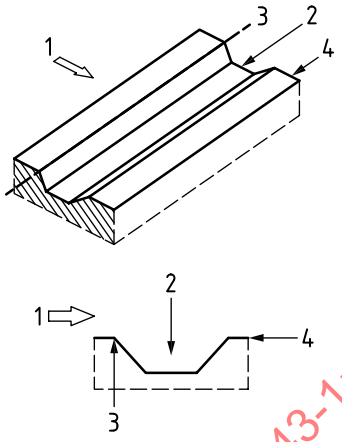
g) Surface-placed barrier



h) Surface-placed barrier



i) Bund/berm



j) ditch

Key

1	direction of impact	3	VSB datum line
2	VSB	4	ground level

NOTE 1 ISO 22343-2 provides information on the different types of VSB available.

NOTE 2 For e), refer to Note 1 in 3.4.2.

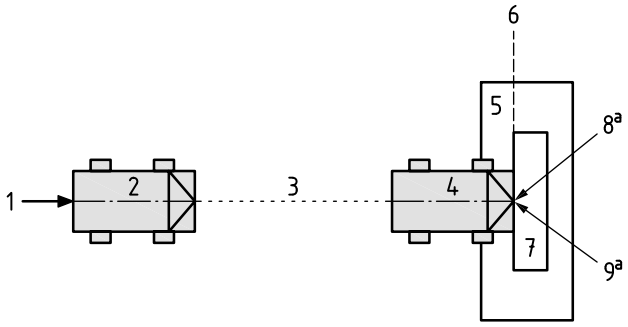
Figure 3 — Examples of VSB datum line — Isometric and side view

3.5
impact
sequence of events between a moving vehicle engaging with a *vehicle security barrier (VSB)* (3.1)

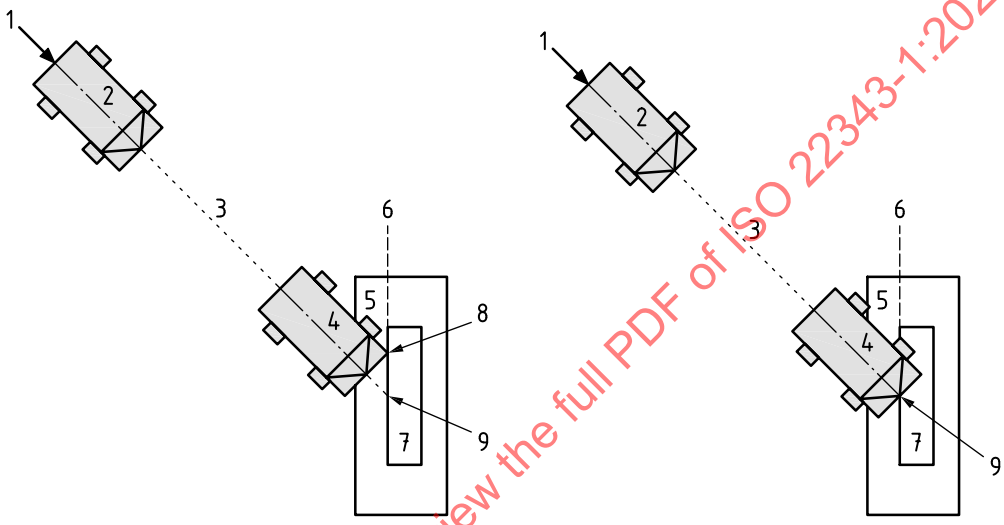
3.5.1
impact speed
velocity of the freely moving test vehicle before reaching the initial contact point

3.5.2
impact angle
angle >0° and ≤ 90° in the horizontal plane between the *vehicle security barrier (VSB) datum line* (3.4.2) and the vehicle approach path into the *VSB* (3.1)

Note 1 to entry: The impact angle is illustrated for clarity in Figure 4.



a) Impact angle = 90°



b) Impact angle = 45°

Key

1	centre line of the test vehicle	6	VSB datum line (impact face)
2	test vehicle, pre-impact	7	VSB
3	vehicle approach path	8	initial contact point
4	test vehicle at impact	9	target impact point
5	VSB foundation/test surface		

[a] For an impact test with a 90° impact angle, the target impact point and initial contact point are the same.

Figure 4 — Impact angle, target impact point and initial contact point — Aerial view

3.5.3
target impact point
intersection between the longitudinal centre line of the test vehicle and the lateral position on the *vehicle security barrier (VSB)* (3.1) impact face

Note 1 to entry: The target impact point is illustrated for clarity in Figure 4 and is used to determine test vehicle to VSB alignment for impact angles > 45°. For an impact test with a 90° impact angle, the target impact point and the initial contact point are the same.

3.5.4
initial contact point
location of the interface between the test vehicle and *vehicle security barrier (VSB)* (3.1) impact face at moment of impact

Note 1 to entry: The initial contact point is illustrated for clarity in Figure 4 and is used to determine test vehicle to VSB alignment for impact angles ≤ 45°.

3.6
data
record of information gathered pre-impact, during impact and post-impact between the test vehicle and *vehicle security barrier* (3.1)

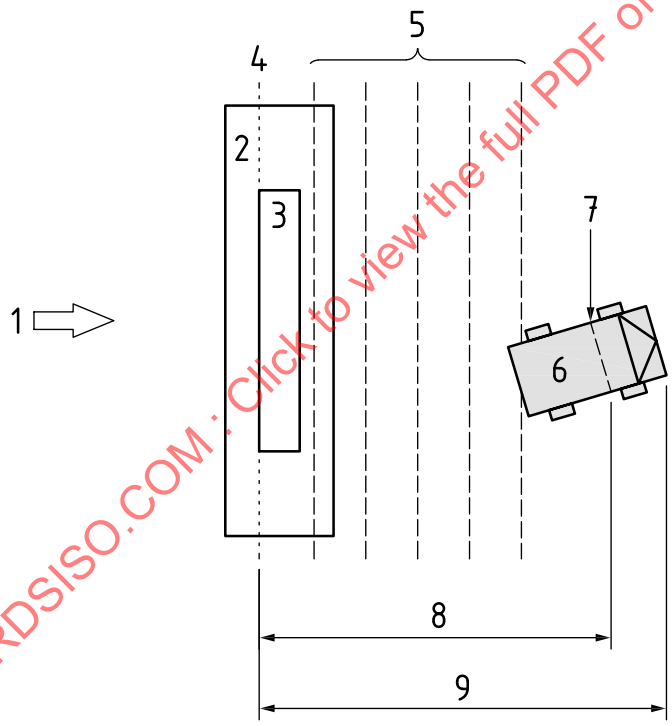
3.6.1
vehicle penetration distance
maximum perpendicular distance between the *vehicle security barrier (VSB) datum line* (3.4.2) and either:

a) where there is < 90° yaw and/or pitch of the *test vehicle* (3.3), the *vehicle datum point* (3.4.1); or

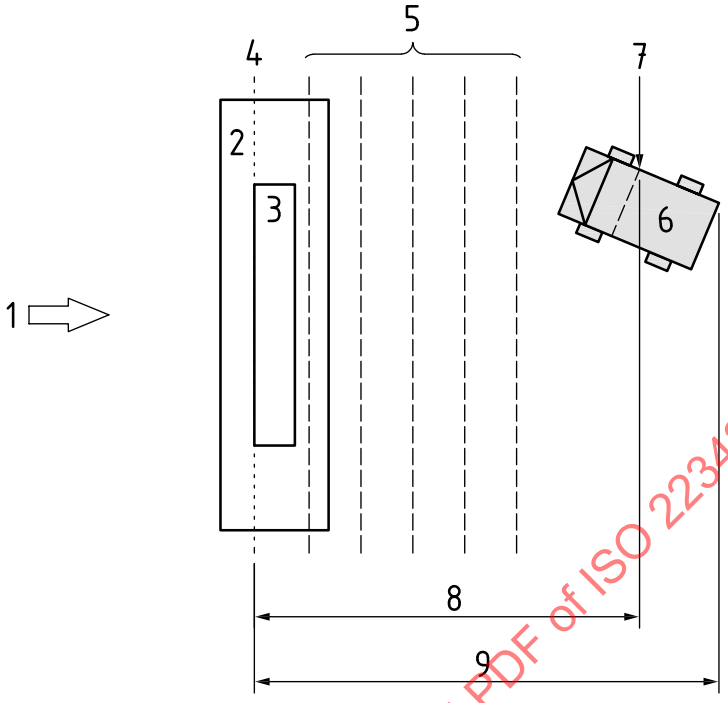
b) where there is ≥ 90° yaw and/or pitch of the test vehicle, the furthest part of the load bed (for N1, N_2 and N3 vehicles) or furthest part of the vehicle (M1 and N1G vehicles), achieved either dynamically (during impact) or statically (post-impact), whichever is the greater

Note 1 to entry: Vehicle penetration distance is illustrated in Figure 5 a) and Figure 6 with < 90° yaw and/or pitch of the test vehicle.

Note 2 to entry: Vehicle penetration distance is illustrated in Figure 5 b) (aerial view) with ≥ 90° yaw and/or pitch of the test vehicle.



a) Impact at 90° to the VSB datum line, with < 90° yaw and/or pitch of the test vehicle



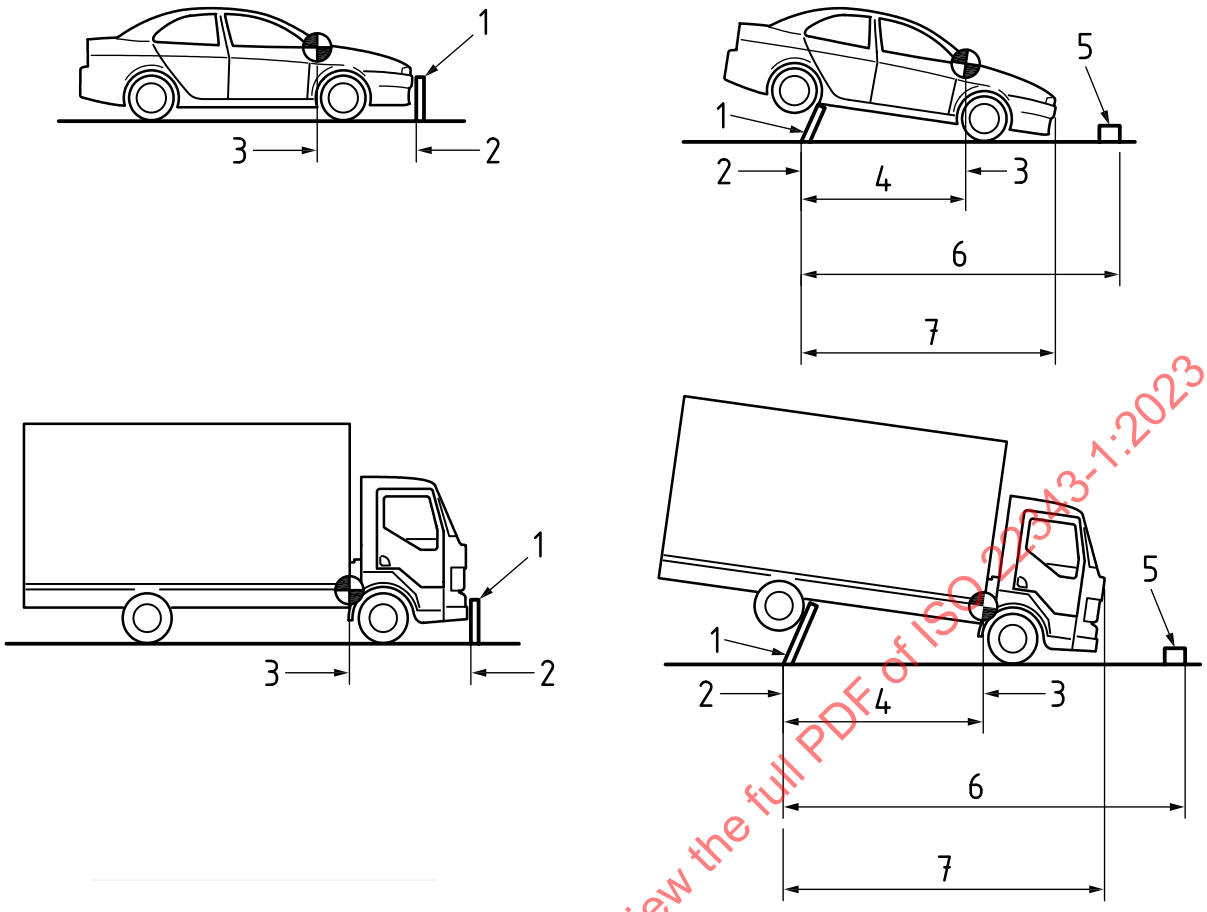
b) Impact at 90° to the VSB datum line, into a VSB with an angled impact face, with ≥ 90° yaw and/or pitch of the test vehicle (i.e. test vehicle facing towards the VSB post-impact)

Key

1 direction of impact
2 VSB foundation/test surface
3 VSB
4 VSB datum line
5 distance marks at ground level
6 test vehicle, post impact
7 vehicle datum point
8 vehicle penetration distance
9 VSB datum line to furthest part of vehicle (observation)

NOTE See Note 2 to 6.2 for distance marks for vehicle penetration.

Figure 5 — Vehicle penetration distance — Aerial views



a) Pre-impact **b) Post-impact**

Key

1 VSB (e.g. bollard)
2 VSB datum line
3 vehicle datum point
4 vehicle penetration distance
5 major debris
6 major debris distance
7 VSB datum to furthest part of vehicle

Figure 6 — Vehicle penetration distance and major debris distance — Side views

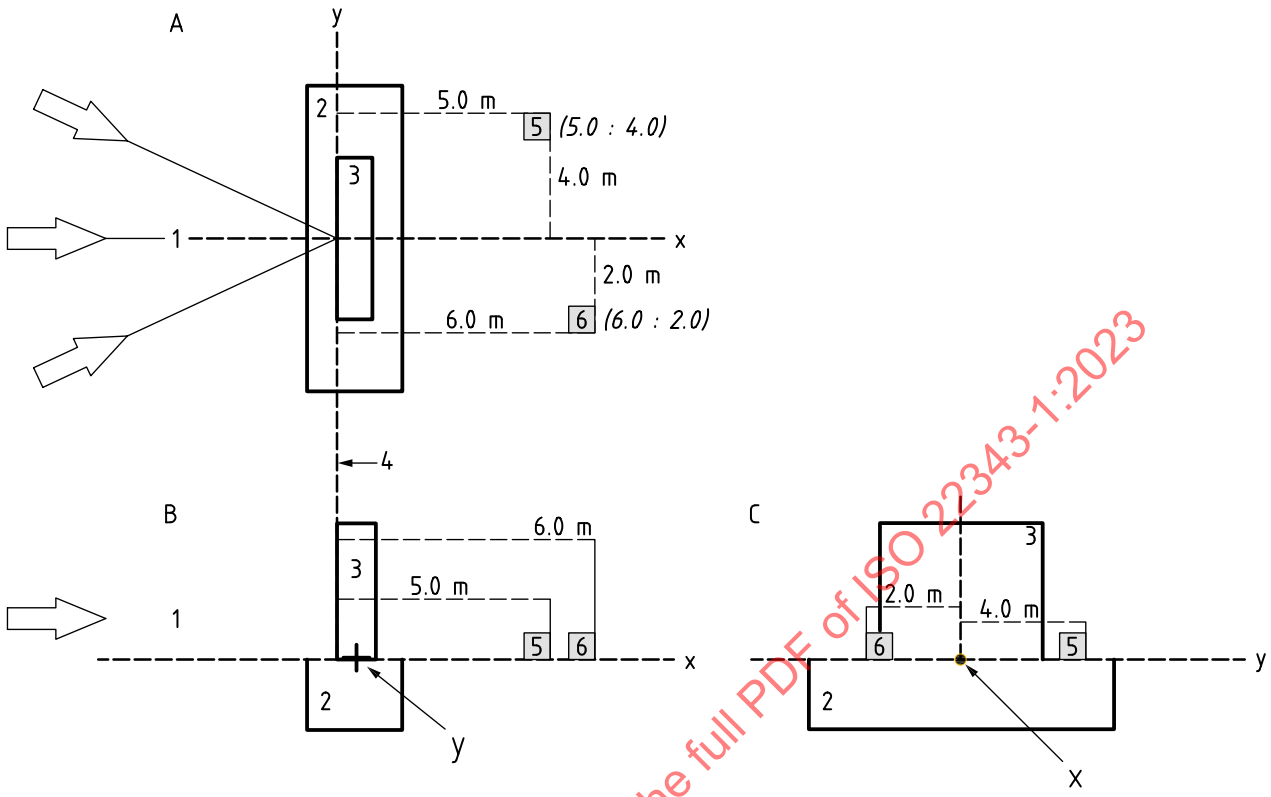
3.6.2
major debris
piece of *vehicle security barrier (VSB)* (3.1), vehicle or *ballast* (3.3.2) with a mass of ≥2 kg that becomes totally detached during the vehicle-VSB *impact* (3.5)

3.6.3
major debris distance
dimension measured from and perpendicular to the *vehicle security barrier datum line* (3.4.2), to the furthest edge of the outermost piece of *major debris* (3.6.2)

Note 1 to entry: Major debris distance is illustrated for clarity in Figure 6.

3.6.4
major debris coordinates
position of *major debris* (3.6.2) measured in the x- and y-axes from either the *target impact point* (3.5.3) where the *impact angle* (3.5.2) is > 45°, or from the initial contact point where the impact angle is ≤ 45°

Note 1 to entry: Major debris coordinates are illustrated for clarity in Figure 7.



Key

A	aerial view	2	VSB foundation
B	side view – y is going into page (symbol +)	3	VSB
C	end view – x is coming out of page (symbol •)	4	VSB datum line
1	direction of impact (three examples)	5, 6	major debris and its coordinates

Figure 7 — Major debris coordinates system — Aerial, side and end views

3.7
client
person(s) or organization commissioning the *test house* (3.8) to undertake an *impact* (3.5) test

Note 1 to entry: The client can be, for example, the manufacturer, government agency, distributor, designer, prospective purchaser or installer of the vehicle security barrier to be tested.

3.8
test house
person(s) or organization carrying out the vehicle *impact* (3.5) test

4 VSB performance requirement

When tested in accordance with the test method in Clause 6, the VSB shall affect the test vehicle by:

a) preventing it from advancing beyond the VSB datum line; or

b) redirecting the vehicle such that it remains on the non-protected side of the VSB; or

c) bringing it to a halt beyond the VSB datum line (vehicle penetration).

In the event of c), the impact of the test vehicle with the VSB shall render the vehicle immobile by:

— causing damage to the vehicle such that it is not able to progress under its own power;

— becoming entangled with the vehicle such that it is not able to progress under its own power; or

— catching, trapping, or lifting the vehicle such that it is not able to progress under its own power.

NOTE 1 Test data supporting the above are to be recorded within the report.

NOTE 2 Where vehicle penetration beyond the VSB datum line is greater than 25 m, a performance rating is not awarded (see Clause 7).

5 VSB documentation

5.1 General

The following information and documentation shall be submitted to the test house before the vehicle impact test:

NOTE 1 This information sets the technical basis for the test activity.

a) VSB manufacturer details;

b) client details (where different to the VSB manufacturer);

c) whether the VSB is a prototype or is in production;

d) VSB product name (type and model);

e) the test parameters against which the VSB is to be tested, including:

   1) test vehicle (see 6.1.1);

   2) target impact point and impact angle (see 6.3);

   3) target impact speed (see 6.6);

f) whether the following optional assessments are to be included in the test:

   1) pedestrian intruder access;

   2) occupant injury;

g) which face of the VSB is the front face (i.e. the face designed to resist impact) and how this is marked on the VSB;

h) general arrangement and detailed drawings, installation drawings and installation instructions (drawings should state that they are to be used for the installation of the VSB being tested and should be labelled with the VSB product name (type and model) [see 5.1 d)] and version number that is being tested);

i) drawings shall be provided such that the test house can undertake the checks for product conformity (see 5.2);

   NOTE 2 An example of technical drawing components for VSBs is given in Annex B.

j) parts list (if available);

k) certificates confirming material specifications;

l) foundation specification:

   1) foundation type: none, proprietary, integral;

   2) reinforcement detail and bar bending schedule;

   3) concrete specification and strength;

   4) soil grade, compaction, moisture content and bearing capacity (where soil is part of the foundation or installation) (see 6.4.4);

   5) finished surface (e.g. tarmac, concrete, granite pavement);

m) operating manual/instructions;

n) for bollards, the bollard array and its foundation (e.g. single or multiple arrangement);

   NOTE 3 This includes, for example, use of a foundation with a capacity of three bollards but to be tested with only one bollard installed.

o) for linear VSBs, the length of the VSB to be tested;

   NOTE 4 The length of a linear VSB chosen for impact testing can impact performance.

p) whether the VSB is a passive or active VSB and whether it is to be tested as passive or active;

q) for an active VSB, the means by which it is to be operated for the test (e.g. powered or manual);

r) whether the VSB has been previously tested including a reference to the previous test [e.g. test house and test reference number or test report number(s)].

   NOTE 5 The test house can obtain other relevant information (e.g. information for disposal and/or recycling of the VSB, details of toxic or dangerous materials in the VSB and safety issues).

Documents supplied to a test house shall be considered proprietary and shall be retained, handled and stored by the test house accordingly, unless instructed otherwise by the client.

5.2 Conformity between VSB and documentation

The VSB shall conform to its accompanying documentation (see 5.1). Any nonconformity identified at any stage of testing (e.g. manufactured product, foundation or installation of the VSB) shall be logged and reported to the client by the test house. The resolution of the nonconformity shall be recorded through the provision of revised drawings prior to completion of the test report or a modified VSB prior to continuation of the test programme.

A set of modified drawings identified by an updated issue number shall be provided together with a list of dated amendments.

6 Test method

6.1 Apparatus

6.1.1 Test vehicle.

A model representative of the vehicle parc having characteristics and dimensions within the vehicle specifications given in Table 1 apply. The test vehicle shall be not more than 10 years old for vehicle types M1 and N1G, and not more than 15 years old for vehicle type N1, N2A, N2B, N3C, N3D N3E, N3F and N3G.

The test vehicle should be selected on the basis of the VSB's application, including its geographical application, where known.

If using a vehicle with a rigid box, consideration should be given to how any ballast movement can be filmed during the impact (see 6.1.7).

Graphical representations of typical vehicles corresponding to requirements are given in Table 2.

For transparency and impartiality, the test house should always supply the test vehicle to ensure it meets the requirements of this document.

The test vehicle shall meet the requirements for road worthiness for the following:

a) tyres and wheels;

b) suspension;

c) wheel alignment;

d) bodywork;

e) brakes;

f) chassis;

g) engine, where the means of delivering the test vehicle to the VSB is by vehicle self-power.

NOTE The engine can be running to aid test preparation. Electronic sensors can also be deactivated to avoid altering the test vehicle's behaviour, e.g. a safety braking system triggering due to the absence of a driver.

Vehicles used for testing should be unmodified and not be fitted with additional items of load handling equipment.

Table 1 — Test vehicle specification

Parameter	Vehicle classification									
	M1	N1G	N1	N2A	N2B	N3C	N3D	N3E[i]	N3F[i]	N3G[i]
	Type of test vehicle[a]									
	Car	Crew cab 4x4 pick-up	Day cab Flat bed[h]	2-axle rigid Cab over	2-axle rigid Cab behind	2-axle rigid Cab over	2-axle rigid Cab over	3-axle rigid Cab behind	3-axle rigid Cab over	4-axle rigid Cab over
Maximum gross vehicle mass (GVM) (kg)	not applicable	not applicable	3 500	8 000	14 970	20 500	20 500	27 300[j]	26 000	36 000
Minimum unladen mass (kg)	1 235	1 700	1 675	3 575	5 200	6 100	6 100	9 750	8 500	10 500
Maximum ballast (kg)[b,c]	340	875	1 925	3 775	1 750	1 250	6 150	20 340	15 900	19 900
Test vehicle mass (kg)	**1 500**	**2 500**	**3 500**	**7 200**	**6 800**	**7 200**	**12 000**	**29 500**	**24 000**	**30 000**
Tolerance (kg)[d]	±75	±75	±100	±150	±150	±150	±250	±590	±400	±400
Vehicle length (mm)[e]	4 500	5 200	6 200	7 610	8 340	9 560	9 560	7 640	8 600	9 600
Tolerance (mm)	±360	±600	±380	±1 520	±1 670	±1 910	±1 910	±1 910	±1 910	±1 910
Vehicle width (mm)[f]	1 760	1 850	2 100	2 400	2 400	2 500	2 500	2 400	2 500	2 500
Tolerance (mm)	±150	±200	±175	±200	±200	±225	±225	±200	±225	±225
Wheel base (mm)[g]	2 700	3 200	3 805	4 310	5 275	5 910	5 910	5 600	5 700	6 800
Tolerance (mm)	2±540	±500	±710	±830	±1 100	±1 250	±1 250	±1 250	±1 250	±1 250
Height from ground to lowest edge of the chassis rail at the front (mm) when ballasted	not applicable	435	440	515	630	700	700	700	810	810
Tolerance (mm)		±75	±100	±100	±100	±150	±150	±150	±100	±100

[a] The types of vehicle are illustrated in Table 2. Not all vehicles illustrated will be available in all markets.

[b] Where instrumentation is used, it forms part of the secured ballast (see 6.5.4.1).

[c] When an anthropomorphic dummy (ATD) is used in the test, it shall be 75 kg and shall be installed and fastened by a seat belt. The ATD mass shall not contribute to the test vehicle mass; therefore, the ATD shall be added after the test vehicle mass has been set within tolerance.

[d] Tolerances for mass are quoted for practicality. The test vehicle mass should be as close as is practicable to the nominal value.

[e] Including an attached load bed.

[f] Not including mirrors.

[g] Length between the extreme axles.

[h] Rear-wheel drive.

[i] Bulk carrier vehicles (N3E, N3F and N3G) should be loaded with unsecured ballast (sand/soil) to meet the test vehicle mass (see 6.5.4.2).

[j] Users of this document should refer to ASTM 2656 to ensure compatibility.

Table 2 — Vehicle classifications used for vehicle impact testing

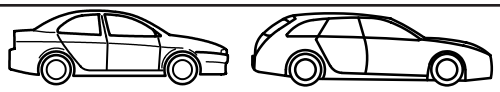
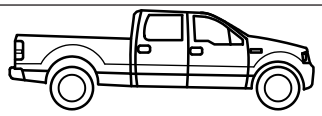
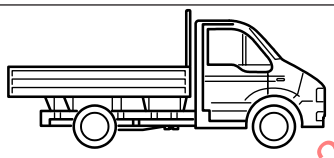
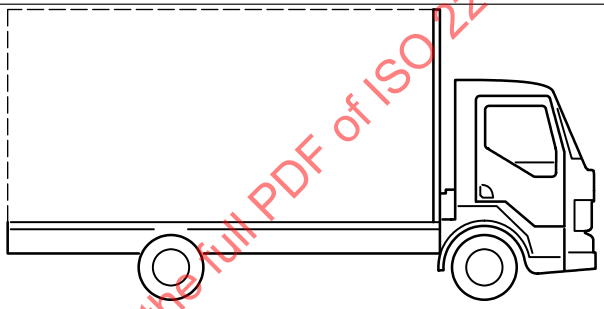
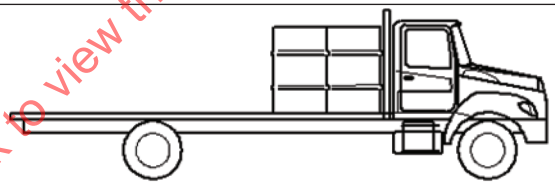
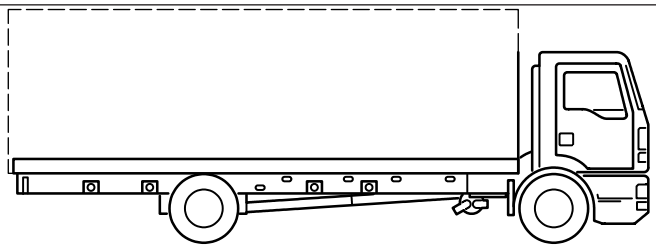
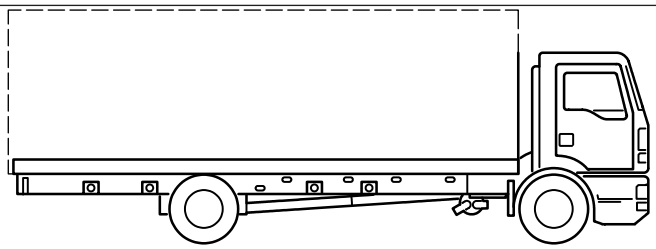
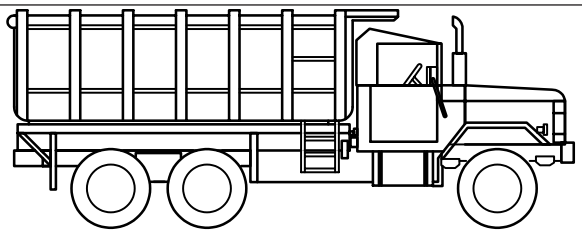
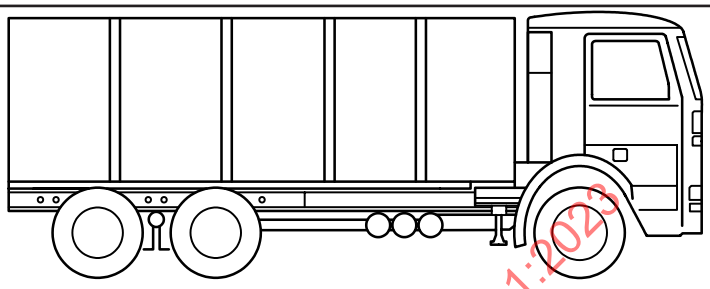
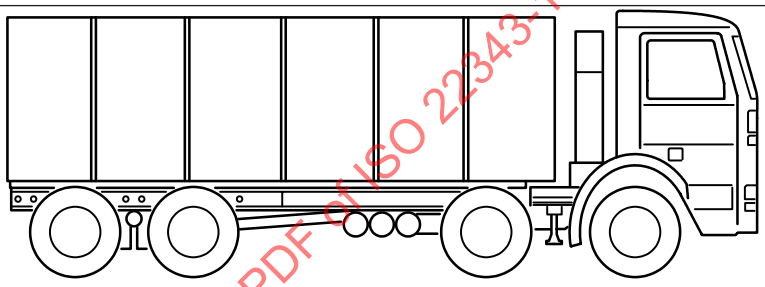
Test vehicle	UNECE vehicle classification GVM (kg)	Test mass (kg)	Illustration
Car	M1	1 500	
4x4	N1G (crew cab)	2 500	
Flat bed	N1 (single cab)	3 500	
Large goods vehicle (LGV)	N2A GVM 8 000 kg 2-axle rigid (flat bed, open curtain side or rigid box)	7 200	
	N2B GVM 14 970 kg 2-axle rigid (flat bed, open curtain side or rigid box)	6 800	
	N3C GVM 20 500 kg 2-axle rigid (flat bed, open curtain side or rigid box)	7 200	
Large goods vehicle (LGV)	N3D GVM 20 500 kg 2-axle rigid (flat bed, open curtain side or rigid box)	12 000	
	N3E GVM 27 300 kg 3-axle rigid (tipper body)	29 500	

Table 2 *(continued)*

Test vehicle	UNECE vehicle classification GVM (kg)	Test mass (kg)	Illustration
	N3F GVM 26 000 kg 3-axle rigid (tipper body)	24 000	
	N3G GVM 36 000 kg 4-axle rigid (tipper body)	30 000	

6.1.2 Method of propulsion: winch cable or other equipment, which shall be capable of delivering the test vehicle to the VSB at the specified impact speed. It shall be capable of propelling the test vehicle in a stable manner and in a straight line, to a point where the vehicle is released and is able to travel freely until reaching the initial contact point.

This release point should be determined in accordance with the longitudinal position of the winch attachment device to the test vehicle in order for the test vehicle to travel freely for speed measurement purposes and impact.

6.1.3 Equipment for measuring speed, which shall be capable of measuring the freely moving vehicle's impact speed along the vehicle approach path (before the initial contact point) to an accuracy of ± 2 %.

NOTE The maximum distance between the measurement being taken and initial contact point is given in 6.7.3 a).

A minimum of two independent methods of speed recording should be used. The determination of impact speed is an essential parameter. Suitable methods can include a timing gate, determination of winch cable speed, the use of pressure pads activated by the passage of the test vehicle, the analysis of high-speed film records or attaching a calibrated "fifth wheel" to the test vehicle.

6.1.4 Equipment for measuring impact angle, which shall be capable of measuring angles to an accuracy of ± 1°.

6.1.5 Equipment for measuring distance, which shall be capable of measuring to an accuracy of ± 2 %.

6.1.6 Equipment for measuring mass, which shall be capable of measuring vehicle mass for the following categories:

a) for vehicle categories M1, N1G, capable of measuring mass to an accuracy of ± 5 kg per axle;

b) for vehicle categories N1, N2A, N2B, N3C, N3D, N3E, N3F and N3G, capable of measuring mass to an accuracy of ± 50 kg per axle;

c) major debris, capable of measuring mass to an accuracy of ± 1 kg.

6.1.7 Video camera equipment, which shall be capable of recording the behaviour of the VSB and foundation movement, the test vehicle motion pre-impact from a minimum of 8 m before the initial contact point and post-impact to a minimum of 25 m beyond the VSB datum line, and the ballast during impact.

NOTE Where the test vehicle has a rigid box, the ballast can be observed with an onboard camera.

High-speed cameras shall be operated at a minimum of 200 frames per second.

Higher frame rates can be useful to give greater detail of the impact. However, image resolution should not be reduced in order to achieve higher frame rates.

Photographic instrumentation specifications shall be in accordance with SAE J211/2.

The lens error, as referenced by SAE J211/2:2022, 3.1.1, shall not exceed 3 % for lenses less than 50 mm focal length, and shall not exceed 1 % for lenses equal to or greater than 50 mm focal length.

High speed camera equipment should be capable of producing noise-free, correctly exposed results in all year-round natural outdoor lighting conditions without resorting to the use of electronic gain or non-standard film processing to correct the exposure.

6.1.8 Camera layout, for which the minimum camera layout shall be as follows, as illustrated in Figure 8:

a) A high-speed static camera (see Figure 8, Camera A), ground based, in-line with the VSB and with an unobstructed view of the VSB impact face. This camera may be used to determine the height of the initial contact point and/or target impact point, dynamic vehicle penetration distance, the impact speed and the post-impact speed of the test vehicle. Characteristics of the test vehicle impacting into the VSB can also be recorded.

b) A high-speed static camera (see Figure 8, Camera B), ground based, in-line with and facing the vehicle approach path. This camera may be used to determine if the target impact point/initial contact point is within the tolerance and to show the characteristics of the test vehicle impacting into the VSB. The impact angle determines whether the target impact point or initial contact point is used to assess the impact accuracy (see 6.3).

c) A high-speed static camera (see Figure 8, Camera C), overhead and located in such a way as to cover the test vehicle motion from a minimum of 3 m before the initial contact point and a minimum of 5 m past the VSB datum line. Camera C may be used to record the impact angle, the static and dynamic vehicle penetration distances and the major debris distance/coordinates up to a minimum of 5 m past the VSB datum line. If the only method to measure impact angle is an overhead camera(s), and weather conditions mean it is dangerous to deploy and/or operate an overhead camera(s), the test should be delayed until it is safe to proceed.

d) A real-time panning camera (see Figure 8, Camera D), sited at right angles to the vehicle approach path. It shall be located so as to record the test vehicle travel either pre-impact for a minimum of 5 m to post impact to a maximum of 25 m, or to full completion of the impact sequence, whichever is achieved first.

NOTE 1 Camera D records the test vehicle and the VSB interaction in real time: pre-impact, during and post-impact.

The location of this camera shall be determined by the test house based on their site safety requirements.

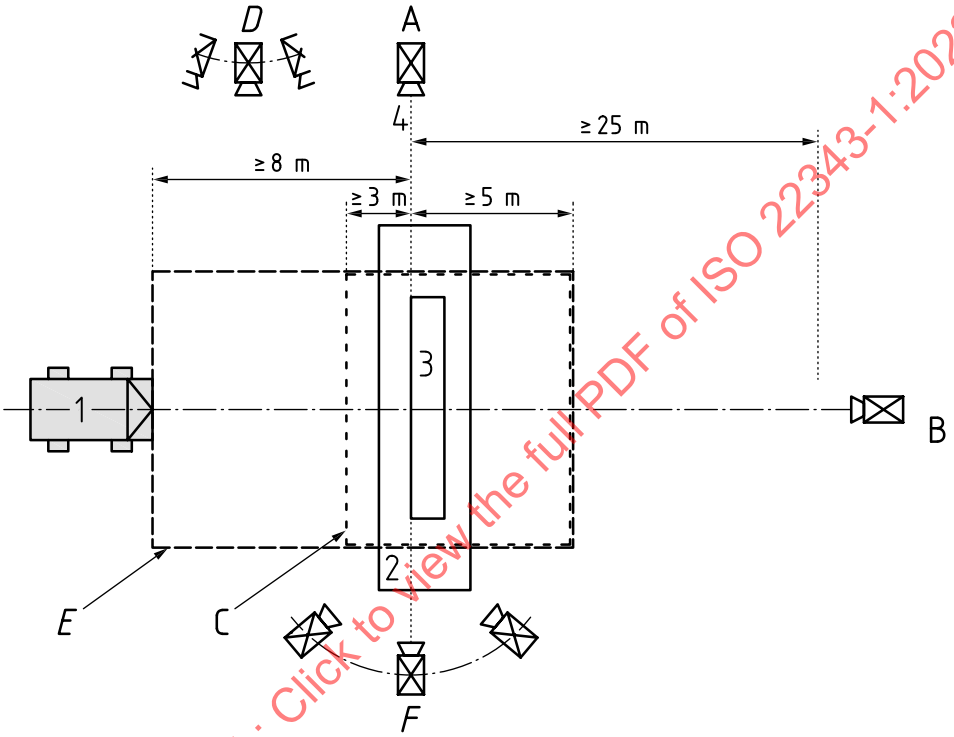
Additional high-speed cameras can be used as backups and/or to provide extra viewing points where the VSB has specific components that need to be assessed (e.g. the foundations, hinges). The test house and the client should agree on the location of such cameras.

In addition, recommended cameras to use are as follows:

— A second high-speed static camera (see Figure 9, Camera E) overhead and located in such a way to cover the test vehicle motion from a minimum of 8m before the initial contact point and past the VSB datum to a maximum of 25 m.

NOTE 3 The use of two overhead high-speed static cameras (see Figure 8) enables recording of a high level of detail of the initial impact and a more general shot covering more of the impact sequence.

f) A high-speed static camera (see Figure 8, Camera F), ground based, to record the interaction of the test vehicle and the VSB.



Key

1	test vehicle	3	VSB
2	VSB foundation/ground surface	4	VSB datum line

Cameras A, D and F are illustrated as being on particular sides of the VSB, but they can equally be positioned on the opposite sides of the vehicle centre line, although cameras A and F should not be on the same side.

Camera	Required orrecommended	Description
A	Required	high-speed static camera, ground-based
B	Required	high-speed static camera, ground-based
C	Required	overhead high-speed static camera
D	Required	real-time panning camera
E	Recommended	overhead high-speed static camera in conjunction with Camera C
F	Recommended	high-speed static camera, ground-based

Figure 8 — Layout for required and recommended cameras

6.2 Test site

The impact test site shall meet the following requirements:

a) The test site ground shall be flat with a gradient not exceeding 2,5 % in any plane. It shall be of sufficient size to enable the test vehicle to be accelerated to the required speed and controlled so that the vehicle approach path to the VSB is stable (negligible roll, pitch and yaw).

b) The test site ground used for the test, the VSB and the foundation to the VSB shall be clear of standing water (e.g. puddles), ice and/or snow at the time of the test.

c) Measures shall be taken in order to minimize dust or water spray generation from the test site ground and the test vehicle during the impact test so that photographic records are not obscured.

d) To enable the test vehicle exit characteristics to be evaluated, the test site ground shall extend not less than 25 m beyond the rear face of the VSB and shall be firm and free of obstructions (e.g. equipment, stored materials, redundant VSBs).

e) The test site shall have uniform ground properties such that the stability of the vehicle and performance of the VSB are minimized during the impact sequence.

f) The test site ground shall be marked to indicate the VSB datum line and for the post-impact determination of the vehicle penetration distance (static and dynamic), the major debris distance and major debris coordinates.

NOTE 1 Suitable means of marking the test site ground with a contrasting colour include painting lines and using grids or target markers.

NOTE 2 Markings indicating nominal distances beyond the VSB datum line (e.g. 1 m, 2 m, 3 m, 4 m, 5 m; see Figure 5) can be used as a visual aid for setting up the overhead camera(s) and for assisting in the measurement of the vehicle penetration distance (static and dynamic), the major debris distance (see Figure 6) and major debris coordinates (see Figure 7).

NOTE 3 Markings indicating a distance of 25 m, as a radius from the VSB target impact point and VSB datum line, can be used as an aid for assisting in the measurement of the vehicle penetration distance (static and dynamic).

Where the vehicle motion is controlled within the 25 m area created, by the application of an external braking system (fitted for safety purposes by the test facility), or the vehicle engaging with any obstruction, then a performance rating shall not be awarded.

6.3 Target impact point, initial contact point and impact angle

6.3.1 Target impact point

Where the impact angle is > 45°, the target impact point shall be achieved to an accuracy in accordance with Table 3.

In the case of bollards (passive or active), the impact angle and the target impact point should take into account the design features of the bollard (e.g. symmetry and construction) and its foundation design (e.g. reinforcement and bollard installation).

The reason for choosing the target impact point location on the VSB shall be stated in the test report (see 6.8.1.)

6.3.2 Initial contact point

Where the impact angle is ≤ 45°, the initial contact point shall be used to assess the accuracy of the vehicle impact and shall be achieved to an accuracy in accordance with Table 3.

NOTE Being within the initial contact point tolerance (see Table 3) is difficult to achieve for shallow impact angles (i.e. ≤ 45°) due to a small angular change moving the lateral position of the initial contact point along the VSB impact face. Being within the impact angle tolerance (see 6.3.3) does not necessarily mean the initial contact point is within tolerance.

Table 3 — Target impact point/initial contact point accuracy for all impact angles

VSB impact face[a] width, w[b] mm	Accuracy mm
$w < 400$	±100
$400 \leq w < 1\,500$	±150
$1\,500 \leq w$	±300
EXAMPLE 1 A planter with an impact face width of 1 400 mm being hit by a test vehicle at an impact angle of 90°, has a target impact point accuracy of ± 150 mm.	
EXAMPLE 2 A bollard with an impact face width of 200 mm being hit by a test vehicle at an impact angle of 30°, has an initial contact point accuracy of ± 100 mm.	
[a] The part of the VSB structure designed to withstand the impact.	
[b] Dimension facing the vehicle approach path, usually referred to as the width (e.g. diameter of a bollard, width of a blocker, length of a gate beam).	

6.3.3 Impact angle

The impact angle shall be:

a) 90° to the VSB datum line; or

b) the angle to the VSB datum line that on testing is most likely to cause failure to conform to Clause 4, where 90° does not represent this; or

c) where testing a VSB for use at a specific site, an angle between 5° and 85° to the VSB datum line at 5° increments (i.e. 5°, 10°, 15° … 75°, 80° or 85°).

The impact angle shall be achieved within a tolerance of ± 2°.

NOTE Testing at a shallow impact angle (e.g. ≤ 45°) can decrease the accuracy of the initial contact point (see Note to 6.3.2).

6.4 VSB preparation

6.4.1 General

Photographs shall be taken to record the preparation and installation of the VSB and its foundation.

The VSB shall be of contrasting colour to the test vehicle and the surroundings.

NOTE The VSB can be painted an appropriate colour to aid visibility in the camera footage.

6.4.2 Installation

The VSB shall be installed in accordance with the detailed drawings and installation instructions provided in accordance with 5.1. Any conformance discrepancies shall be addressed in accordance with 5.2.

The ground conditions into which the VSB is installed shall be recorded and, where required, measured in accordance with 6.4.4.

NOTE Depending on the VSB, installation can involve location of the VSB in a VSB foundation or directly on the test site ground (see Figure 1).

The VSB should be installed in the orientation specified in the documentation [see 5.1 g)].

If a proprietary foundation is being designed for the VSB, advice should be sought from a suitably qualified civil and/or structural engineer who can demonstrate experience in the impact testing of VSBs.

6.4.3 Foundation

Where concrete is used to form the VSB foundation, test specimens shall be taken in accordance with either EN 12390-2 (cubes) or ASTM C31/C31M (cylinders). Any modification to the concrete formulation shall be recorded and reported by the test facility.

Local weather conditions affect the curing rate of concrete below 5 °C and above 25 °C and consideration should be given to the common and recognized practices for the casting of concrete in such conditions.

Test specimens shall be tested for compressive strength in accordance with either EN 12390-3 (cubes) or ASTM C39/C39M–18 (cylinders).

A test specimen shall be tested within ± 24 h of the test day and the strength recorded.

The concrete strength of the test specimen tested within ± 24 h of the test day in accordance with this subclause shall be recorded together with the number of days since the concrete was poured, and shall be declared as the minimum strength required for installation of the VSB.

Where the test day is ≥ 28 days from the concrete being poured, the 28-day strength shall be declared as the minimum strength required for installation of the VSB.

The frequency of testing the concrete strength of the specimen shall be in accordance with Table 4.

Where multiple batches of concrete are required for the installation, for each batch of concrete, the concrete strength and the location of where it was poured in the installation shall be recorded.

Specimens should be taken from each concrete batch and tested in accordance with this subclause.

Table 4 — Concrete specimen testing schedule

Time between concrete pour and test day	Day specimen is tested			
Days	Day 7	Day 14	Day 28	Test day
0 to 7	—	—	yes	yes
8 to 14	yes	—	yes	yes
15 to 27	yes	yes	yes	yes
≥ 28	yes	yes	yes	—

NOTE 1 Specimens are tested at intervals after the installation date (i.e. after the concrete has been poured), to allow the curing rate to be monitored and to determine the concrete strength. For example:

a) if the test day is 5 days after the concrete is poured, specimens are tested at 5 days (the test day) and 28 days;

b) if the test day is 11 days after the concrete is poured, specimens are tested at 7 days, 11 days (the test day) and 28 days;

c) if the test day is 17 days after the concrete is poured, specimens are tested at 7 days, 14 days, 17 days (the test day) and 28 days;

d) if testing ≥ 28 days after the concrete is poured, specimens are tested at 7 days, 14 days and 28 days.

NOTE 2 Recording the concrete strength at 28 days is necessary to give a consistent means to compare installations, irrespective of when the vehicle impact test was carried out.

6.4.4 Soil

Where subgrade is used to form the VSB foundation, the grade and bearing capacity shall be measured and recorded.

NOTE 1 Example soil specifications can be found in ASTM F2656, Reference [7] and EN 12767:2019, Annex B.

A minimum value of 75 kn/m^2 should be achieved.

Where soil is used to form the VSB foundation, the compaction and moisture content shall be measured and recorded not more than 72 h before the test.

NOTE 2 The soil compaction can be recorded by nuclear density testing or the California Bearing Ratio (CBR). One method for calculating the CBR is the dynamic cone/drop weight penetrometer. The soil moisture content can be measured using a moisture meter.

6.4.5 Markers

A marker shall be applied to the target impact point (for an impact angle > 45°) or initial contact point (for an impact angle of ≤ 45°) on the VSB so as to be visible by Camera B (see 6.1.8).

NOTE 1 This is to assist in measuring and verifying the target impact point or initial contact point (see 6.3).

If the VSB (e.g. a bollard) is intended to be part of an array but is being tested individually, markers that remain stationary during the impact shall be put down either side of the VSB, along the VSB datum line. The position of the marker in relation to the impact point shall be measured and recorded.

NOTE 2 These markers are to aid in the evaluation of the post-impact vehicle access (see Annex C) by indicating the intended locations of other VSBs in the array.

6.5 Test vehicle preparation

6.5.1 General

The test vehicle or vehicle cab shall be of a contrasting colour to the VSB in order to:

a) aid visibility in the camera footage;

b) provide distinction between the VSB and impact vehicle for test evaluation from images.

Vehicle manufacturer details, company logos and index plates should be removed or covered for anonymity.

6.5.2 Test vehicle dimensions

The test vehicle dimensions shall be verified against the test vehicle specification (see Table 1) for the dimensions (mm) and the details recorded in accordance with Annex A.

6.5.3 Vehicle condition

The tyres shall be inflated to the tyre manufacturer's recommended pressures.

The test vehicle shall be as clean as is reasonably practicable and any deposits that can cause dust on impact shall be removed prior to testing.

6.5.4 Ballast

6.5.4.1 All secured ballast shall be located symmetrically about the centre-line of the test vehicle and shall be evenly distributed.

The secured ballast shall be fixed to the test vehicle such that it is rigidly held on the load bed (for N1G, N1, N2 and N3 test vehicles) and remains fixed up to the moment of impact.

NOTE Good practice methods of securing the ballast include the use of chains, fixed frames and fixing to the load bed.

The vehicle axle weight limits for the test vehicle shall not be exceeded when the test vehicle is ballasted.

6.5.4.2 The unsecured ballast used for the vehicle types N3E, N3F and N3G shall comprise a loose fill: this is identified as unsecured ballast and shall be evenly distributed so as not to exceed vehicle axle weight limits.

NOTE Loose fill can typically comprise soil, sand or similar materials typically transported by these vehicle types.

6.5.5 Reference points

The vehicle datum point shall be marked with a reference point (e.g. quartered target marker). For an N1, N2 or N3 test vehicle, additional reference points on the chassis shall be made towards the rear of the test vehicle (if the chassis is visible) and their longitudinal distances from the vehicle datum point recorded. These reference points shall be visible to Camera A (see 6.1.8).

NOTE 1 A reference point on the chassis enables the vehicle datum point to be determined if the front of the test vehicle/chassis is distorted due to the test vehicle impact with the VSB.

A reference point(s) (e.g. quartered target marker) shall be applied to the centre-line of the test vehicle so as to be visible by the head-on camera and an overhead camera (see 6.1.8, B and C, respectively).

A reference point(s) (e.g. quartered target marker) shall be applied to the target impact point (for an impact angle > 45°) or initial contact point (for an impact angle of ≤ 45°) on the VSB so as to be visible by Camera B (see 6.1.8).

NOTE 2 This is to assist in measuring and verifying the target impact point (see 6.3).

Where the VSB is tested in an array (e.g. twin bollards), reference points should be placed on the test vehicle, corresponding to the extremities of the gap between the VSBs (i.e. the inside edges of the bollards), so as to be visible by Camera B (see 6.1.8).

6.5.6 Occupant injury

Where the determination of occupant severity indices is requested (optional), measurement and recording equipment (see 6.7.3) shall be attached.

NOTE The acceleration severity index (ASI) and theoretical head impact velocity (THIV) are examples of occupant severity indices.

6.6 Impact speed

The impact speed shall be selected from Table 5.

Table 5 — Vehicle impact speed

Vehicle classification	Impact speed (km/h)[a]						
	16^{+3}_{-1}	32^{+3}_{-1}	48^{+3}_{-1}	64^{+3}_{-1}	80^{+4}_{-2}	96^{+4}_{-2}	112^{+4}_{-2}
M1	yes	yes	yes	yes	yes	yes	yes
N1G	yes	yes	yes	yes	yes	yes	yes
N1	yes	yes	yes	yes	yes	yes	no
N2	yes	yes	yes	yes	yes	no	no
N3	yes	yes	yes	yes	yes	no	no

[a] The impact speed shall be stated in km/h in the test report.

6.7 Test procedure

6.7.1 Pre-impact data

6.7.1.1 VSB foundation

For the VSB foundation, the following shall be recorded:

a) the date the foundation was cast;

b) the results of the test specimen in accordance with 6.4.3;

c) the type of foundation (proprietary VSB foundation, integral VSB foundation);

d) details of supporting ground conditions and recorded values of sub soil grade and bearing capacity in accordance with 6.4.4;

e) for a surface-placed VSB: the surface finish material and its specification.

6.7.1.2 VSB

For the VSB, the following shall be recorded:

a) the height of the initial contact point from ground level;

NOTE Typically the initial contact point is where the test vehicle front bumper first touches the VSB impact face.

b) the angle of the impact face with respect to the horizontal plane for bollards, gateposts and latch points;

c) the angle of the impact face with respect to the VSB foundation for bollards, gateposts and latch points (normally 90°);

d) the location within the foundation and installation depth (see Figure 9) (this location should be such that standard finish depths are accounted for in the impact test);

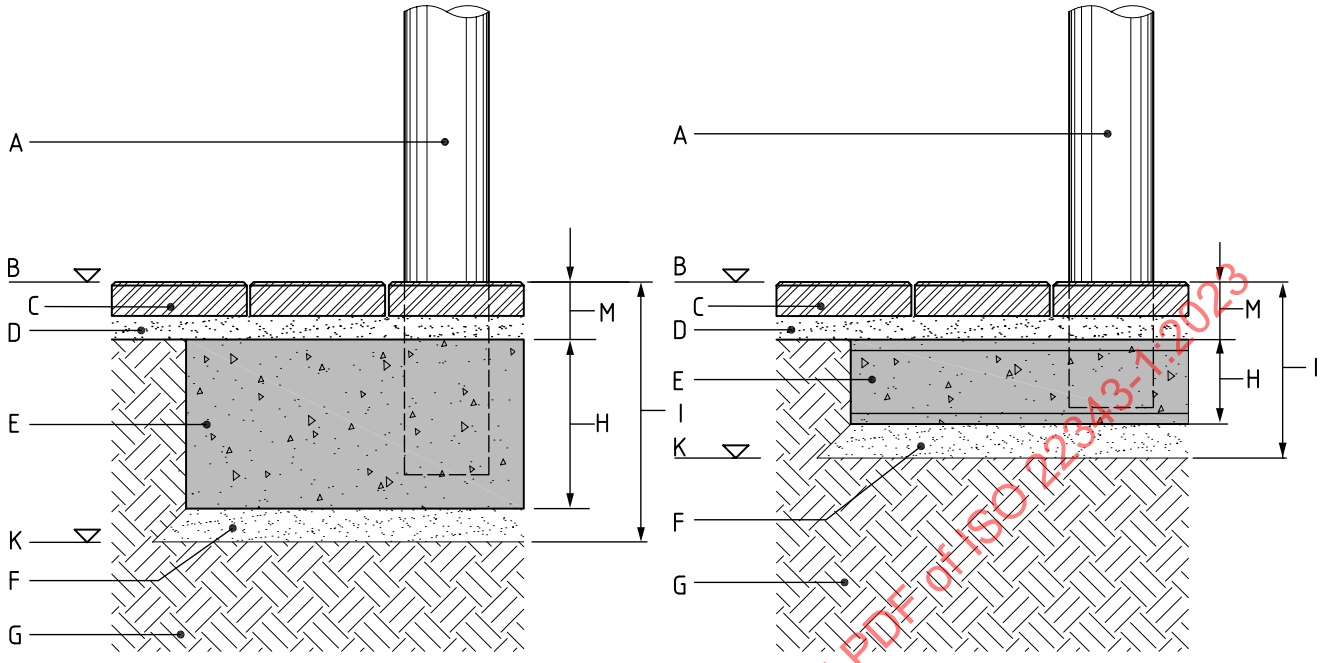
e) photographs, including those at 90° and 45° to the impact face of the VSB;

f) photographs of the finish surface of the VSB and the condition of the surface beyond the VSB;

g) for an active VSB, using a real-time camera, the operating cycle (e.g. rising/sliding/swinging), stating the functionality (see 5.1) and the means by which it is operated for the test (e.g. powered or manual).

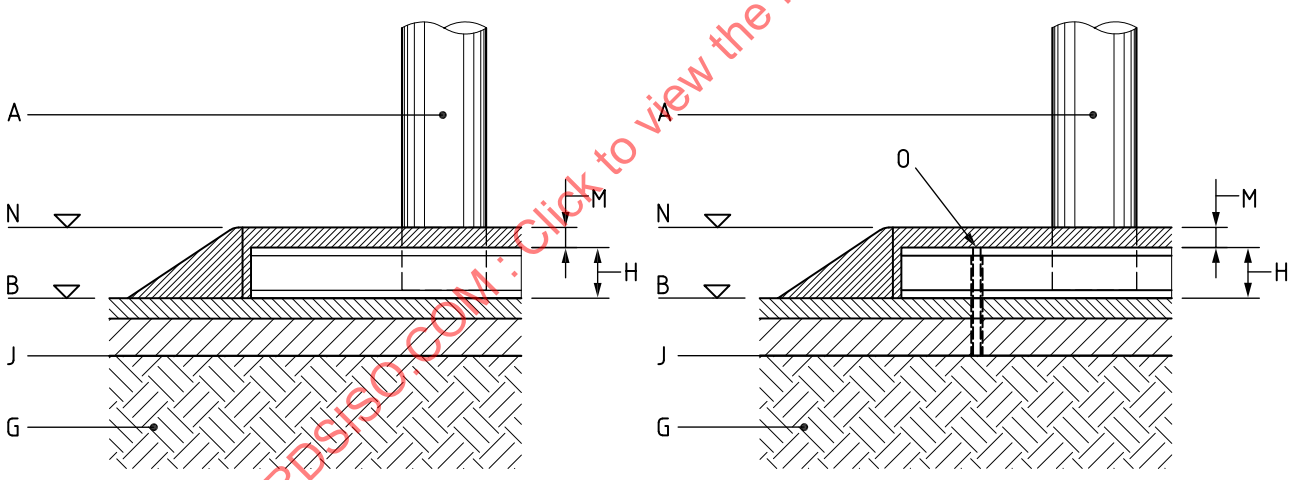
Photographs should be taken of all the faces of the VSB (i.e. from north, south, east and west).

Photographs should be taken of the specific design features of a VSB (e.g. hinges, pins, joints, welds) to aid test data analysis.



a) Deep foundation

b) Shallow foundation



c) Surface placed

d) Surface placed pinned

Key

A	VSB	H	foundation thickness
B	existing finished level	I	depth of foundation excavation
C	paviors	J	base construction
D	pavior bedding	K	formation level
E	foundation	M	thickness finish
F	blinding concrete	N	new finishes level
G	natural ground	O	pin

Figure 9 — Foundation terminology

6.7.1.3 Test vehicle

For the test vehicle, the following shall be recorded:

a) mass to a tolerance as specified in Table 1;

b) dimensions in accordance with Annex A to a tolerance as specified in Table 1;

NOTE 1 Measurements of the test vehicle are recorded to aid test data analysis and comparability with other tests.

c) for nominal test vehicle masses 1 500 kg (M1) and 2 500 kg (N1G) to a tolerance as specified in Table 1, the location of the centre of gravity of the test vehicle in the test condition including added ballast;

NOTE 2 ISO 10392 specifies methods for determining the location of the centre of gravity of a road vehicle.

d) for nominal vehicle test masses 3 500 kg [N1], 6 800 kg [N2B], 7 200 kg [N2A and N3C], 12 000 kg [N3D], 29 500 kg [N3E], 24 00 kg [N3F] and 30 000 kg [N3G] to a tolerance as specified in Table 1, the location of the centre of gravity of the added ballast;

e) the centre of gravity of the ballast shall be calculated and shall not exceed the values issued by the vehicle manufacturer;

NOTE 3 Vehicle manufacturers supply details of a standard method for the calculation of the centre of gravity for the vehicle load to body- and coach-builders.

f) exterior photographs of the test vehicle, including those at 90° and 45° to the longitudinal vehicle axis and VSB (and interior of the vehicle if required to aid an assessment of occupant injury);

g) photographs of the test vehicle positioned next to the VSB at the target impact point, including 90° and 45° to the longitudinal vehicle axis and VSB.

NOTE 4 Angular rate sensors can be used for determining the yaw, roll and pitch of the test vehicle (which can aid analysis of test data). Accelerometers and angular rate sensors are required for determining occupant severity indices (see EN 1317-1 or Reference [7] for the method).

6.7.1.4 Cameras

For the cameras, the following shall be recorded:

a) the camera specifications (e.g. real time/high speed and the recording frame rate, i.e. real time: 24 frames per second, high speed: 200 frames per second);

b) the camera layout.

6.7.1.5 Target impact point with an impact angle > 45°

For the target impact point, the following shall be recorded for an impact angle > 45°:

a) the height of prescribed target impact point from ground level;

b) the distance of prescribed target impact point(s) from the centre point of the VSB (for two adjacent VSBs, where the test vehicle is directed towards the gap at an impact angle of 90°, two planned initial contact points (one on each VSB) should be measured with respect to the centre point of the gap between the VSBs);

c) the impact angle.

6.7.1.6 Target impact point with an impact angle ≤ 45°

For the target impact point, the following shall be recorded for an impact angle ≤ 45°:

a) the height of prescribed initial contact point from ground level;

b) the distance of prescribed initial contact point from the centre point of the VSB;

c) the impact angle.

The impact angle dictates whether the target impact point or initial contact point is marked and used for accuracy purposes (see 6.3.1).

6.7.2 Impact

Propel the test vehicle (see 6.1.1) by winch or other suitable equipment (see 6.1.2) or by engine power in a straight line and under stable conditions up to the point of release such that it travels freely until reaching the initial contact point.

The test vehicle at impact shall be:

a) travelling freely (see 6.1.2) when measuring its impact speed (see 6.7.3);

b) free of restraint by external control of the steering or any other method (e.g. by engine power or by braking) pre-impact, during or post-impact, while the test vehicle is within 25 m of the VSB datum.

NOTE If b) is enacted, then the VSB will not receive a performance rating. See Clause 7.

6.7.3 Impact data

The following impact data shall be recorded:

a) the impact speed (km/h), using equipment for measuring speed (see 6.1.3) along the vehicle approach path no further than 5 m before the initial contact point;

b) the impact angle (degrees), using equipment for measuring angles (see 6.1.4);

NOTE 1 Methods of measuring the impact angle include overhead photography.

c) the target impact point/initial contact point (depending on the impact angle, see 6.7.1), using equipment for measuring distance (see 6.1.5), including:

1) the height of contact between the test vehicle (e.g. mid height of bumper) and VSB from ground level;

2) the distance along the VSB impact face from the prescribed target impact point/initial contact point to the actual impact point/initial contact point (refer to 6.7.2), using reference points on the test vehicle and VSB (see 6.5.5);

d) pre-impact, during and post-impact behaviour of the VSB and test vehicle motion up to 25 m beyond the VSB datum line, as well as the distribution of major debris using photographic equipment (see 6.1.7).

NOTE 2 Where data acquisition equipment is used, the amount of occupant injury can be assessed using occupant severity indices (see 6.5.6).

6.7.4 Post-impact data

Where post-impact vehicle access data are required, these may be obtained in accordance with Annex C.

Still photographs shall be taken *in situ* including the following:

a) the test vehicle axes at 90° and 45°;

b) the interior and exterior of the test vehicle;

c) VSB, foundation and test surface;

d) test vehicle;

e) major debris;

f) VSB, test vehicle and major debris in the same frame;

g) debris field;

h) post-impact of VSB after test vehicle has been removed.

Photographs should be taken of all the faces of the VSB and the test vehicle (i.e. from north, south, east and west).

Photographs should be taken of the specific design features of a VSB (e.g. hinges, pins, joints, welds) and points of interest post-impact (e.g. fractures, breaks, buckles) to aid test data analysis.

Each photograph should have a unique reference attached to it (e.g. test number).

The vehicle penetration distance (static and dynamic) shall be recorded.

NOTE 1 For the majority of tests, the vehicle penetration distance is measured according to Figure 5 a). In the instance where there is > 90° yaw and/or pitch, measurements follow the example of Figure 5 b).

The maximum distance that an item of major debris has travelled shall be recorded.

NOTE 2 Major debris distance and major debris coordinates are illustrated in Figure 6 and Figure 7. As an observation, additional major debris items and their coordinates can be recorded using distance measurement equipment (see 6.1.5).

Any damage and distortion to the following shall be recorded:

— VSB;

— VSB foundation and test surface;

— test vehicle.

Any irregularities in the gap between the VSB and its foundation with and without the test vehicle in place (as necessary) shall be recorded.

In the event of the VSB being displaced and the foundation remaining stationary, measurements of the VSB displacement relative to its pre-impact position and the foundation should be recorded as an observation (see Annex D).

NOTE 3 Examples of damage/distortion to record include detached components, foundation cracks and vehicle bodywork. For bollards, gateposts and beams, an example of damage/distortion includes deformation of sections.

Where test specimens of the foundation are taken on the day of test (±24 h) and other selected days (see 6.4.3), record and report the results of all test specimens obtained in accordance with 6.4.3.

The test vehicle alignment shall be recorded for a test with a prescribed impact angle of:

— > 45°: the distance along the VSB impact face from the prescribed (not actual) target impact point to the actual impact point, and determine whether it meets the accuracy specified in Table 3 (see also 6.3.1);

— ≤ 45°: the distance along the VSB impact face from the prescribed (not actual) initial contact point to the actual initial contact point, and determine whether it meets the accuracy specified in Table 3 (see also 6.3.2).

NOTE 4 For information about the target impact point, see 6.3.1, and for the initial contact point, see 6.3.2.

Where occupant severity indices data are requested to assess injury, evaluate the occupant severity indices by analysing test data from the instrumentation present on the test vehicle (see 6.7.3).

6.7.5 Disposal of the test vehicle

Test vehicles or their components shall not be sold or returned to the vehicle parc after they have been subjected to impact.

6.8 Test report

6.8.1 General

A test report shall be prepared for each vehicle impact test.

A test report should not be released without having all the information required in Clause 5.

The test report shall include as a minimum:

a) a summary of results in accordance with 6.8.2;

b) a reference to this impact test document, i.e. ISO 22343-1:2023:

c) the name or trademark and address of the VSB manufacturer;

d) the name of the client (where different to the VSB manufacturer);

e) the date of the test;

f) the name and address of the test house and their accreditation status;

g) the VSB product name, including type and model;

h) the VSB product documentation (see Clause 5);

i) the VSB product description, including:

   1) product type;

   2) pre-test alignment of the product and foundation (i.e. for a bollard measure the angle of inclination) (see Annex D);

   3) surface-placed systems intended mode of operation (i.e. surface engagement, friction, inertia, deformation);

j) the VSB foundation description, including:

   1) foundation type;

   2) depth of foundation excavation (m), to two decimal places;

   3) foundation thickness (m) to two decimal places;

   4) foundation finish (m) to two decimal places;

   5) surface-placed and fixed systems:

      i) method of fixing;

ii) number of fixings;

iii) description of fixings;

6) surface-placed systems:

i) description of the surface onto which the VSB is placed;

ii) condition of surface at time of test (wet/dry);

NOTE See Figure 9.

k) the test vehicle description (see 6.1.1), including:

1) vehicle classification (see Table 2);

2) vehicle type (see Table 2);

3) test mass (see Table 2);

4) country of origin;

5) manufacturer;

6) model;

7) year of manufacture;

l) the impact point, including:

1) location of target impact point where impact angle > 45° or initial contact point where impact angle ≤ 45°) (see 6.3.1);

2) explanation of why the target impact point or initial contact point was chosen (see 6.3.2);

3) target impact angle (see 6.3.3);

4) target impact speed (see 6.6);

5) target impact alignment (see 6.7.1.5);

m) the test apparatus used (see 6.1);

n) the VSB preparation used (see 6.4), including:

1) natural ground test results;

2) sub-grade test results;

3) concrete test specimen results (see 6.4.3);

o) the test vehicle preparation data (see 6.5);

p) the test results achieved, including:

1) impact data: impact speed, impact angle, impact alignment (see 6.7.4);

2) post-impact data (see 6.7.4);

3) performance rating (see Clause 7);

q) the post-impact data, including:

1) vehicle penetration distance, both:

i) dynamic (m), to one decimal place;

ii) static (m), to one decimal place;

NOTE 2 The maximum distance recorded is used for the performance rating (see Clause 7).

2) major debris measurement;

3) description of damage to the VSB, the VSB foundation and surface damage;

4) description of damage to the vehicle and assessment of vehicle drivability (if requested by the client, this may include vehicle and pedestrian accessibility assessment (see Annex C)).

6.8.2 Summary of results

The test report shall include a summary of results, including the following information:

a) general:

1) a reference to this impact test document, i.e. ISO 22343-1:2023;

2) the name or trademark and address of the VSB manufacturer;

3) the name of the client (where different to the VSB manufacturer);

4) the date of the test;

5) the name and address of the test house and their accreditation status, [see 6.8.1 f)];

6) the VSB product name (type and model);

b) inputs:

1) the VSB foundation, including:

i) surface (placed or pinned), shallow or deep (see Figure 9);

ii) concrete (rigid) or soil (non-rigid);

iii) prescribed strength of concrete (to zero decimal places);

iv) test day strength of concrete (to zero decimal places);

v) soil grade;

vi) soil compaction;

vii) soil moisture content;

viii) soil bearing capacity;

NOTE 1 Item iv) is the minimum value to be quoted by the manufacturer for the VSB when tested in accordance with this document.

2) the VSB arrangement tested;

i) foundation for single unit VSB, or foundation for more than one unit VSB applied;

c) test vehicle, including:

1) the vehicle classification (see Table 2);

2) the mass (kg), to zero decimal places;

3) the supplier (e.g. test house);

4) the target impact speed (km/h), to one decimal place;

5) the target impact angle (°), to zero decimal places;

d) results:

1) whether the test vehicle was immobilized;

2) whether the test vehicle was restrained or deflected;

3) the impact kinetic energy (kJ) to zero decimal places;

4) the vehicle penetration distance, both:

i) dynamic (m), to one decimal place;

ii) static (m), to one decimal place;

5) the performance rating in accordance with this document, i.e. ISO 22343-1:2023;

6) the test parameters recorded:

i) distance from target to actual impact point/initial contact point;

ii) impact angle;

iii) impact speed;

7) the major debris furthest item, coordinates and mass, to one decimal place (see 6.7.4);

e) observations:

1) any additional major debris coordinates and mass, to one decimal place (see 6.7.4);

2) where applicable, the gap/opening created:

i) vehicle (>1,2 m) (if yes, state dimensions) (see Annex C);

ii) pedestrian intruder (measure gap using test block) (see Annex C);

3) where applicable, any occupant injury (e.g. ASI, THIV), to one decimal place (if recorded, state occupant severity indices) (see 6.7.4);

4) where applicable, a graph of deceleration.

NOTE 2 Items 3) to 4) are not required to be measured unless specifically requested by the client.

7 Performance rating

7.1 General

Where the requirements of Clause 4 are met, the VSB shall be rated in accordance with the performance rating classification code.

NOTE The award of a performance rating does not imply that a barrier will perform, as rated for this single impact test, in all site applications and against all vehicles types or test options (mass, speed or impact angle) specified in this document.

7.2 Classification code

The performance rating classification code shall comprise the following information listed as a chain of results (e.g. ISO 22343-1 Blocker V/2500[N1G]/48/90:7.6/5.0 as exemplified in Table 6):

a) a reference to this impact test document, i.e. ISO 22343-1:2023;

b) the VSB;

c) the test type;

NOTE This document only covers one type of test: the vehicle impact test (V).

d) the test vehicle mass;

e) the vehicle classification:

1) impact speed;

2) impact angle;

3) vehicle penetration distance;

f) the maximum recorded penetration distance (dynamic/static) recorded, which shall be used for the performance rating;

g) the maximum recorded distance of major debris of 2 kg or greater beyond the VSB datum.

Where the penetration (dynamic or static) is greater than 25 m, the VSB shall not be awarded a performance rating.

Table 6 — Example of performance rating

Performance rating = ISO 22343-1: Anon Bollard V/7200[N3C]/48/90:2.6/5.0		
Parameter	**Rating**	**Explanation**
VSB	Bollard	Product type
Test type	V	Vehicle impact test
Test vehicle mass	7 200	7 200 kg
Vehicle classification	N3C	2-axle rigid
Impact speed	48	48 km/h
Impact angle	90°	90° respectively to the impact face of the VSB
Vehicle penetration distance	2,6	The test vehicle penetrated 2,6 m beyond the VSB datum line
Major debris	5,0	The furthest point that major debris, greater than 2 kg landed beyond the VSB datum

8 Product information

The following product information for the tested VSB shall be made available via publication by the manufacturer:

a) a reference to this impact test standard, i.e. ISO 22343-1:2023;

b) the VSB product name (type and model);

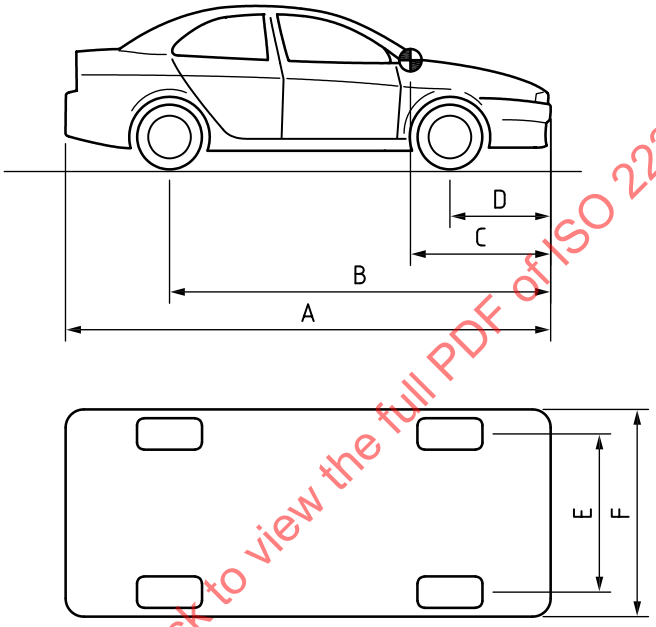
c) the performance rating in accordance with Clause 7.

It is recommended that manufacturers consider providing product information via printed and electronic mediums (i.e. manufacturer's or licensed agent's website).

Annex A
(normative)

Test vehicle specification measurements

Test vehicle specification measurements shall be measured and recorded for test vehicle M1 in accordance with Figure A.1.



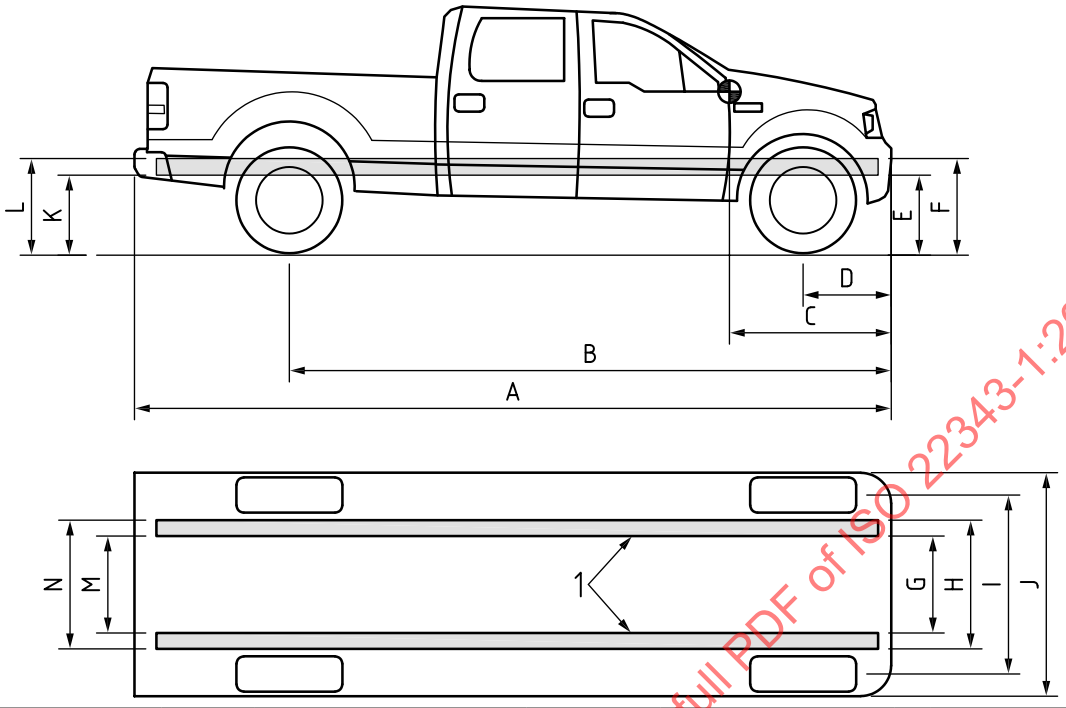
ISO 22343-1:				
Test house:		Test ref. no.:		
Vehicle classification:	M1	Type of test vehicle:	Car/estate car	
Test vehicle mass (kg):		Number of drive axles:	4x2	
Tyre size (inches):		VIN:		
Wheel base (mm) [= B – D]:				
Test vehicle dimensions (mm):				
A	D			
B	E			
C	F			

Key

⊕	vehicle datum point	D	vehicle front to front axle
A	vehicle length	E	front wheel track width
B	vehicle front to rearmost axle	F	vehicle width
C	vehicle front to vehicle datum point		

Figure A.1 — M1 test vehicle specification measurements

The N1G test vehicle specification measurements shall be measured and recorded in accordance with Figure A.2.



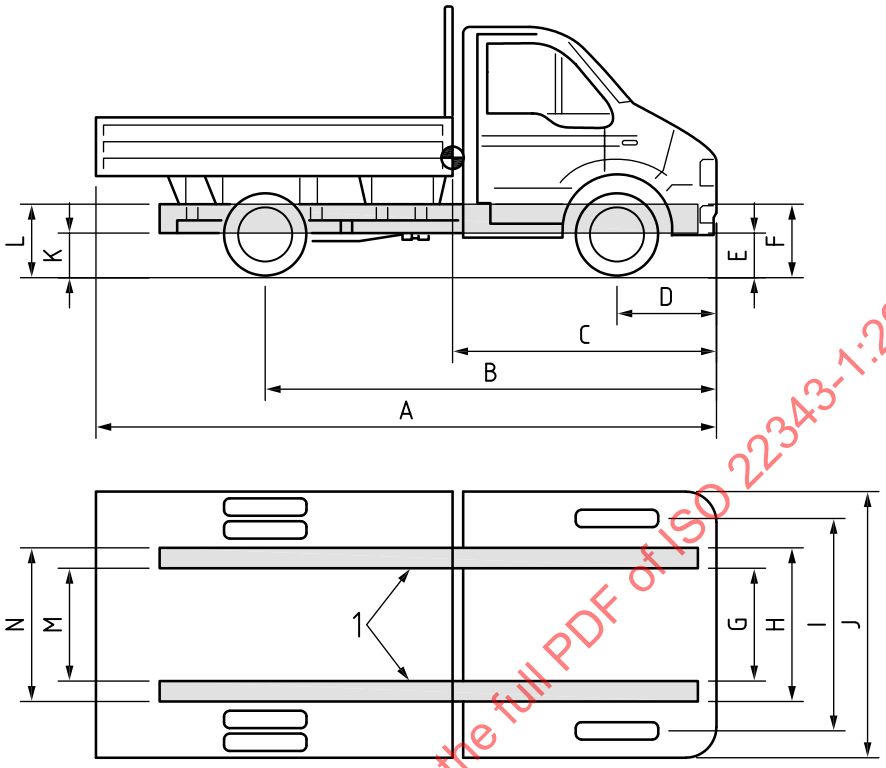
ISO 22343-1:					
Test house:			Test ref. no.:		
Vehicle classification:	N1G		Type of test vehicle:	Crew cab pick-up	
Test vehicle mass (kg):			Number of drive axles:	4x4	
Tyre size (inches):			VIN:		
Wheel base (mm) [= B – D]:					
Test vehicle dimensions (mm):					
A	D	G	J	M	
B	E	H	K	N	
C	F	I	L		

Key

⊕	vehicle datum point	G	distance between inside edges of chassis rails at front
1	chassis rail	H	distance between outside edges of chassis rails at front
A	vehicle length	I	front wheel track width
B	vehicle front to rearmost axle	J	vehicle width
C	vehicle front to vehicle datum point	K	height from ground level to bottom of chassis rear
D	vehicle front to front axle	L	height from ground level to top of chassis rear
E	height from ground level to bottom of chassis front	M	distance between inside edges of chassis rails at rear
F	height from ground level to top of chassis front	N	distance between outside edges of chassis rails at rear

Figure A.2 — N1G test vehicle specification measurement

The N1 test vehicle specification measurements shall be measured and recorded in accordance with Figure A.3.



ISO 22343-1:				
Test house:		Test ref. no.:		
Vehicle classification:	N1	Type of test vehicle:	Day cab vehicle	
Test vehicle mass (kg):		Number of drive axles:	4x2	
Tyre size (inches):		VIN:		
Wheel base (mm) [= B – D]:				
Test vehicle dimensions (mm):				
A	D	G	J	M
B	E	H	K	N
C	F	I	L	

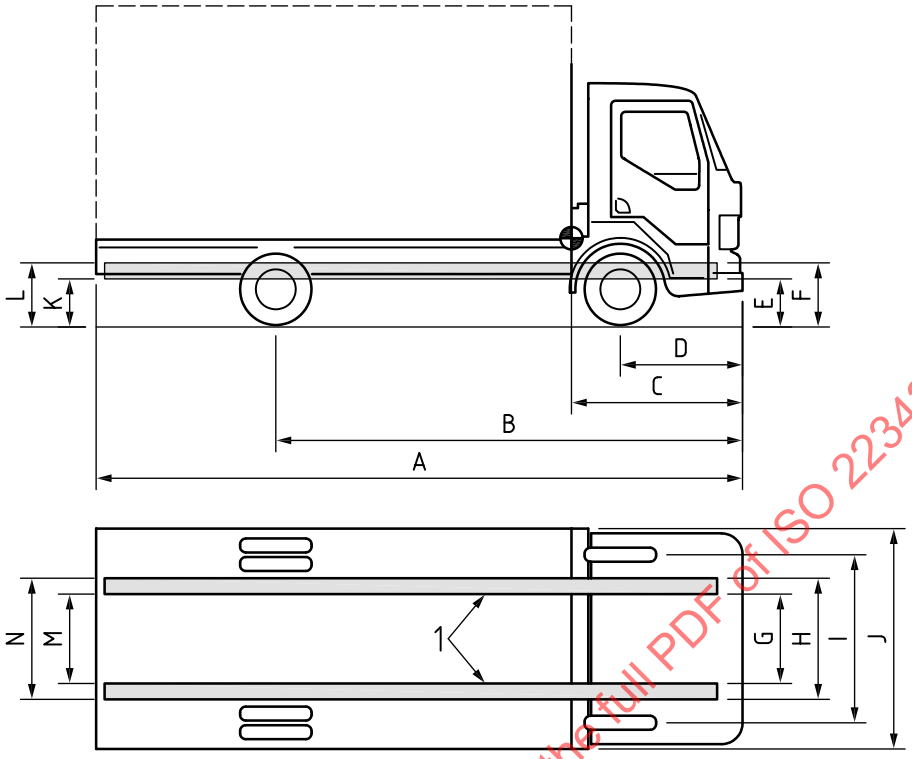
Key

⊕	vehicle datum point	G	distance between inside edges of chassis rails at front
1	chassis rail	H	distance between outside edges of chassis rails at front
A	vehicle length	I	front wheel track width
B	vehicle front to rearmost axle	J	vehicle width
C	vehicle front to vehicle datum point	K	height from ground level to bottom of chassis rear
D	vehicle front to front axle	L	height from ground level to top of chassis rear
E	height from ground level to bottom of chassis front	M	distance between inside edges of chassis rails at rear
F	height from ground level to top of chassis front	N	distance between outside edges of chassis rails at rear

NOTE Single or twin rear wheels are permitted; this figure illustrates single rear wheels.

Figure A.3 — N1 test vehicle specification measurements

The N2A test vehicle specification measurements shall be measured and recorded in accordance with Figure A.4.



ISO 22343-1:				
Test house:		Test ref. no.:		
Vehicle classification:	N2A	Type of test vehicle:	2-axle rigid	
Test vehicle mass (kg):		Number of drive axles:		
Tyre size (inches):		VIN:		
Wheel base (mm) [= B – D]:				
Test vehicle dimensions (mm):				
A	D	G	J	M
B	E	H	K	N
C	F	I	L	

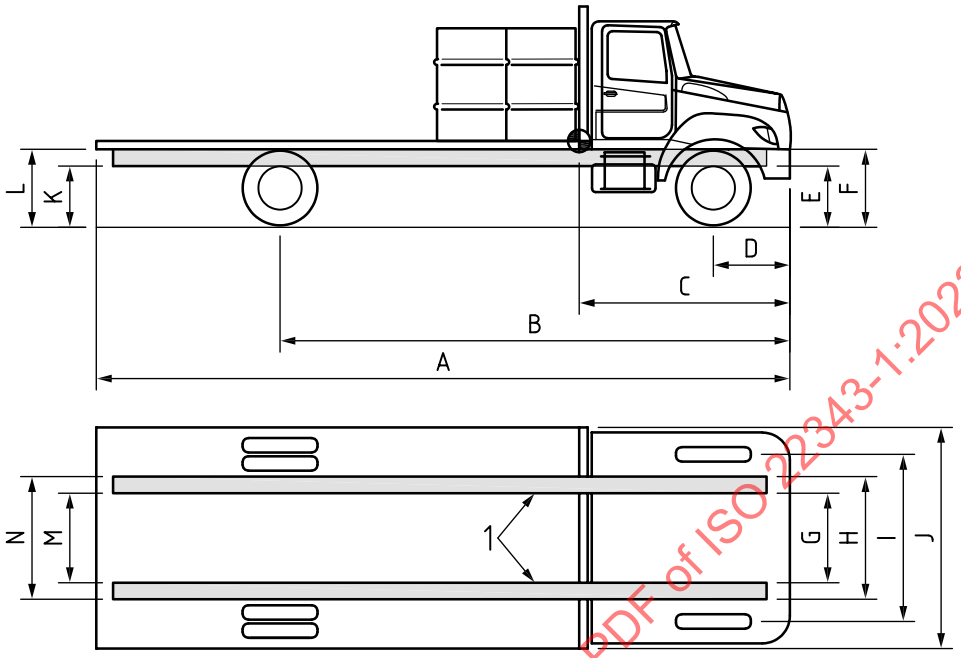
Key

⊕	vehicle datum point	G	distance between inside edges of chassis rails at front
1	chassis rail	H	distance between outside edges of chassis rails at front
A	vehicle length	I	front wheel track width
B	vehicle front to rearmost axle	J	vehicle width
C	vehicle front to vehicle datum point	K	height from ground level to bottom of chassis rear
D	vehicle front to front axle	L	height from ground level to top of chassis rear
E	height from ground level to bottom of chassis front	M	distance between inside edges of chassis rails at rear
F	height from ground level to top of chassis front	N	distance between outside edges of chassis rails at rear

NOTE Single or twin rear wheels are permitted; this figure illustrates single rear wheels.

Figure A.4 — N2A test vehicle specification measurements

The N2B test vehicle specification measurements shall be measured and recorded in accordance with Figure A.5.



ISO 22343-1:				
Test house:		Test ref. no.:		
Vehicle classification:	N2B	Type of test vehicle:	2-axle rigid	
Test vehicle mass (kg):		Number of drive axles:		
Tyre size (inches):		VIN:		
Wheel base (mm) [= B – D]:				
Test vehicle dimensions (mm):				
A	D	G	J	M
B	E	H	K	N
C	F	I	L	

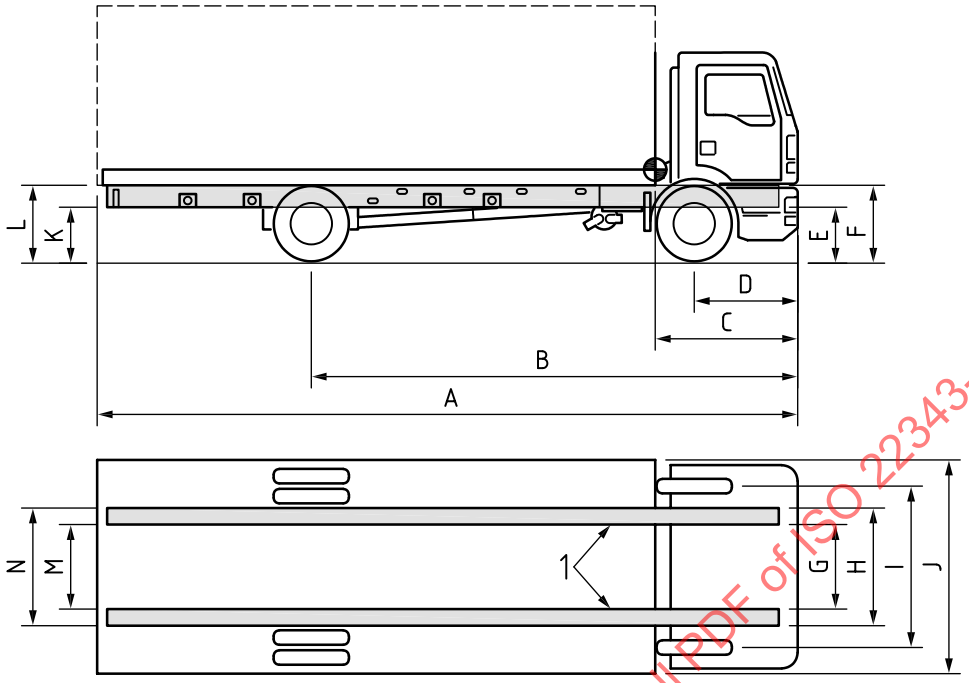
Key

⊕	vehicle datum point	G	distance between inside edges of chassis rails at front
1	chassis rail	H	distance between outside edges of chassis rails at front
A	vehicle length	I	front wheel track width
B	vehicle front to rearmost axle	J	vehicle width
C	vehicle front to vehicle datum point	K	height from ground level to bottom of chassis rear
D	vehicle front to front axle	L	height from ground level to top of chassis rear
E	height from ground level to bottom of chassis front	M	distance between inside edges of chassis rails at rear
F	height from ground level to top of chassis front	N	distance between outside edges of chassis rails at rear

NOTE Single or twin rear wheels are permitted; this figure illustrates single rear wheels.

Figure A.5 — N2B test vehicle specification measurements

The N3C and N3D test vehicle specification measurements shall be measured and recorded in accordance with Figure A.6.



ISO 22343-1:				
Test house:		Test ref. no.:		
Vehicle classification:		Type of test vehicle:	2-axle rigid	
Test vehicle mass (kg):		Number of drive axles:		
Tyre size (inches):		VIN:		
Wheel base (mm) [= B – D]:				
Test vehicle dimensions (mm):				
A	D	G	J	M
B	E	H	K	N
C	F	I	L	

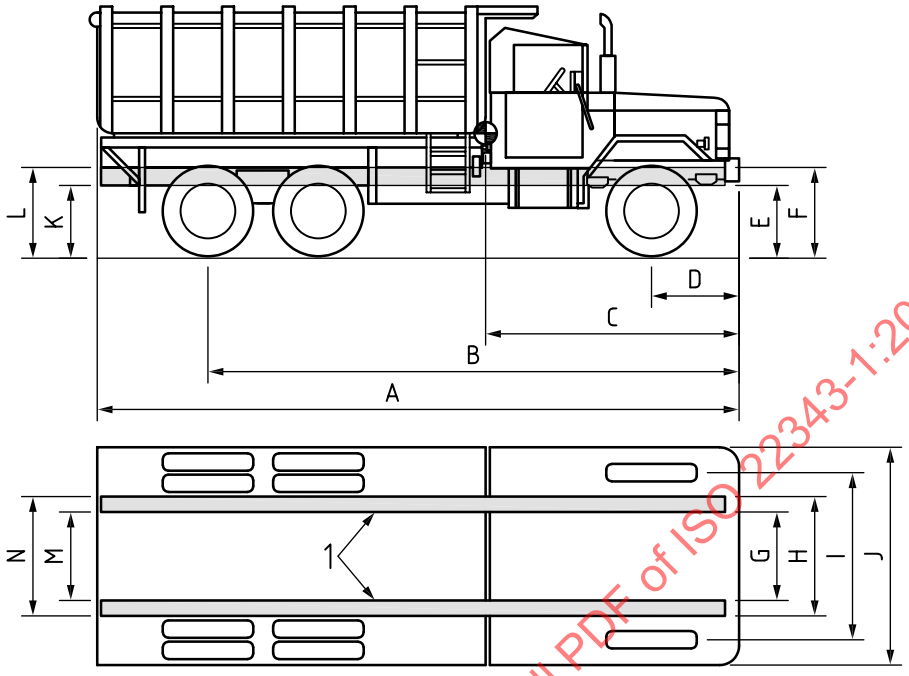
Key

⊕	vehicle datum point	G	distance between inside edges of chassis rails at front
1	chassis rail	H	distance between outside edges of chassis rails at front
A	vehicle length	I	front wheel track width
B	vehicle front to rearmost axle	J	vehicle width
C	vehicle front to vehicle datum point	K	height from ground level to bottom of chassis rear
D	vehicle front to front axle	L	height from ground level to top of chassis rear
E	height from ground level to bottom of chassis front	M	distance between inside edges of chassis rails at rear
F	height from ground level to top of chassis front	N	distance between outside edges of chassis rails at rear

NOTE Single or twin rear wheels are permitted; this figure illustrates single rear wheels.

Figure A.6 — N3C and N3D test vehicle specification measurements

The N3E test vehicle specification measurements shall be measured and recorded in accordance with Figure A.7.



ISO 22343-1:				
Test house:		Test ref. no.:		
Vehicle classification:	N3E	Type of test vehicle:	3-axle rigid	
Test vehicle mass (kg):		Number of drive axles:		
Tyre size (inches):		VIN:		
Wheel base (mm) [= B – D]:				
Test vehicle dimensions (mm):				
A	D	G	J	M
B	E	H	K	N
C	F	I	L	

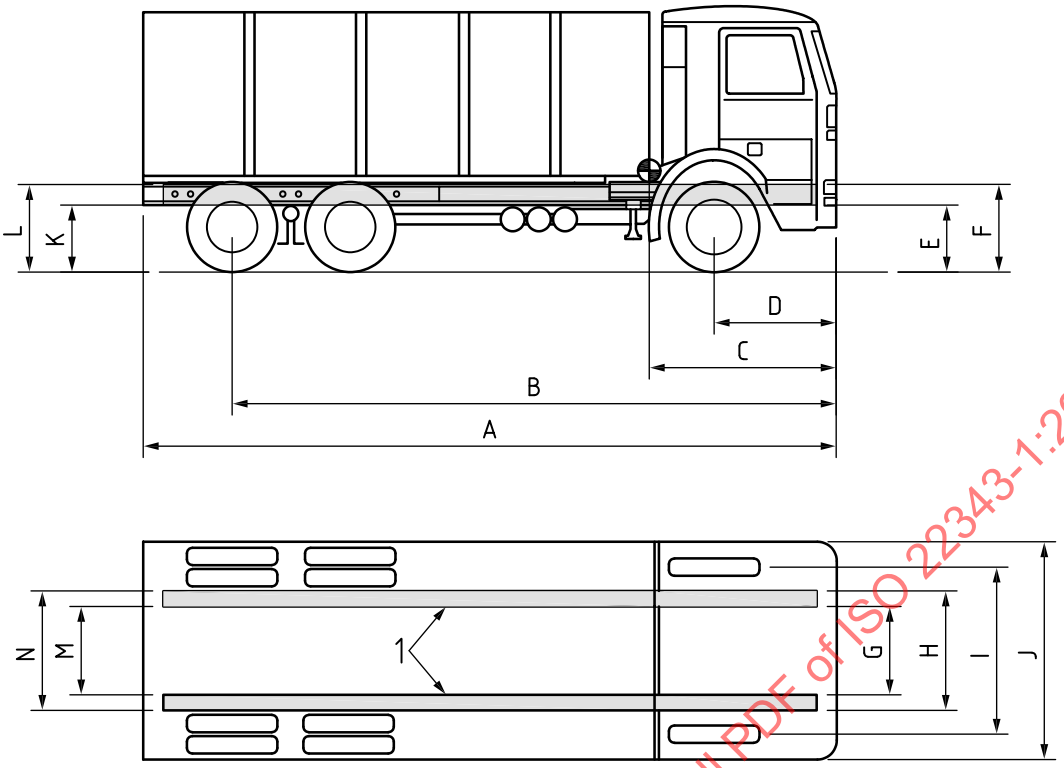
Key

⊕	vehicle datum point	G	distance between inside edges of chassis rails at front
1	chassis rail	H	distance between outside edges of chassis rails at front
A	vehicle length	I	front wheel track width
B	vehicle front to rearmost axle	J	vehicle width
C	vehicle front to vehicle datum point	K	height from ground level to bottom of chassis rear
D	vehicle front to front axle	L	height from ground level to top of chassis rear
E	height from ground level to bottom of chassis front	M	distance between inside edges of chassis rails at rear
F	height from ground level to top of chassis front	N	distance between outside edges of chassis rails at rear

NOTE Single or twin rear wheels are permitted; this figure illustrates single rear wheels.

Figure A.7 — N3E test vehicle specification measurements

The N3F test vehicle specification measurements shall be measured and recorded in accordance with Figure A.8.



ISO 22343-1:				
Test house:			Test ref. no.:	
Vehicle classification:	N3F		Type of test vehicle:	3-axle rigid
Test vehicle mass (kg):			Number of drive axles:	
Tyre size (inches):			VIN:	
Wheel base (mm) [= B – D]:				
Test vehicle dimensions (mm):				
A	D	G	J	M
B	E	H	K	N
C	F	I	L	

Key

⊕	vehicle datum point	G	distance between inside edges of chassis rails at front
1	chassis rail	H	distance between outside edges of chassis rails at front
A	vehicle length	I	front wheel track width
B	vehicle front to rearmost axle	J	vehicle width
C	vehicle front to vehicle datum point	K	height from ground level to bottom of chassis rear
D	vehicle front to front axle	L	height from ground level to top of chassis rear
E	height from ground level to bottom of chassis front	M	distance between inside edges of chassis rails at rear
F	height from ground level to top of chassis ront	N	distance between outside edges of chassis rails at rear

NOTE Single or twin rear wheels are permitted; this figure illustrates single rear wheels.

Figure A.8 — N3F test vehicle specification measurements