BS EN 15551:2017

BSI Standards Publication

Railway applications — Railway rolling stock — Buffers

National foreword

This British Standard is the UK implementation of EN 15551:2017. It supersedes BS EN 15551:2009+A1:2010 which is withdrawn.

The UK committee draws users' attention to the distinction between normative and informative elements, as defined in Clause 3 of the CEN/CENELEC Internal Regulations, Part 3.

Normative: Requirements conveying criteria to be fulfilled if compliance with the document is to be claimed and from which no deviation is permitted.

Informative: Information intended to assist the understanding or use of the document. Informative annexes do not contain requirements, except as optional requirements, and are not mandatory. For example, a test method may contain requirements, but there is no need to comply with these requirements to claim compliance with the standard.

When speeds in km/h require unit conversion for use in the UK, users are advised to use equivalent values rounded to the nearest whole number. The use of absolute values for converted units should be avoided in these cases. Please refer to the table below for agreed conversion figures:

INS, RST and ENE speed conversions	
km/h	**mph**
7	4.5
9	5.5
10	6
12	7.5
20	12.5

The UK loading gauge is much smaller than the gauge in Europe and the maximum axle load is higher at 25.4 tonnes. As a consequence of this, longer thinner wagons are built to maximise the pay load of wagons carrying lower density products.

In order to maximise the volumetric capacity of the wagon body within this overall length, we have continued to use 520 mm buffers with a head radius of 1250 mm to cater for the tighter curves found in many UK terminals, (for example Oleo OP176GX buffers). As EN 15551 is referenced in the Wagon TSI, any new wagons would have to be built with 620 mm buffer and 2750 mm head radius.

This would have three effects:

1) The wagon bodies would have to be shorter to allow for the longer buffers within the same 18 300 mm overall length with a corresponding loss of payload of typically 1 tonne on every journey.

2) The use of the 2750 mm head radius would push the drawbar loads over the 250 kN limit, when negotiating 70 m curves, which would necessitate lengthening the screw couplings every time the wagons went into tight terminals and tightening them again once they were back on the mainline. This would cause delays to arrivals and departures, add cost and present an additional safety hazard to the shunters.

3) If the 520 mm buffer is no longer used for new build wagons, the manufacturers will eventually cease to make them. The vast majority of UK bogie wagons are fitted with these buffers and any new casings required to replace worn ones would then need to be specially made at a vast increase in cost.

Therefore wagons for use exclusively in UK may continue to use 520 mm projection buffers and the corresponding UK screw coupling, see EN 15566.

The UK participation in its preparation was entrusted by Technical Committee RAE/3, Railway Applications - Rolling Stock Products, to Subcommittee RAE/3/-/7, Railway applications - Couplers.

A list of organizations represented on this subcommittee 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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Date	Text affected

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English Version

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Applications ferroviaires - Matériel roulant ferroviaire - Tampons

Bahnanwendungen - Schienenfahrzeuge - Puffer

This European Standard was approved by CEN on 24 September 2016.

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European foreword

This document (EN 15551:2017) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

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 July 2017 and conflicting national standards shall be withdrawn at the latest by July 2017.

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 15551:2009+A1:2010.

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 2008/57/EC.

For relationship with EU Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document.

NOTE After the publication of EN 16839, *Railway applications — Rolling stock — Head stock layout*, as a European Standard, the overlapping content and all items not pertinent to the product "Buffer" will be removed from this document.

Compared with EN 15551:2009+A1:2010, the following main changes have been done:

a) the “Introduction” was checked upon and revised;

b) Clause 1 “Scope” was revised;

c) Clause 2 “Normative references” as well the final “Bibliography” were checked upon and revised;

d) Clause 3 was modified:

   1) damping (3.11) was deleted and the calculation of damping in 3.8;

   2) definitions of stored energy and absorbed energy for static and dynamic condition were added as 3.12 to 3.15;

   3) the term “technical specification” was added as 3.16;

e) the term “elastic device” was replaced by “elastic system”;

f) the classification of crashworthy buffers was added as new Subclause 4.5;

g) tests for type tests and series tests were defined in the new Table 2 and modified in Table 7;

h) the static requirements in Table 5 have been changed;

i) Table C.2 "Nature of inspection and tests" was revised;

j) for friction and ring springs the two Subclauses C.2.4 "Static characteristics" and C.2.5 "Dynamic characteristics" were added;

k) Annex E was revised with the specification of the high sided test wagons;

l) Table H.1 was revised and new materials were added;

m) Annex I was modified to be analogous to prEN 16839 (this annex will be deleted after EN 16839 is published);

n) in Annex J, the test for crashworthy buffers was modified;

o) the following figures were modified:

   1) Figure 1 — Force-stroke diagram for stored and absorbed energy;

   2) Figure 2 — Mounting of buffers with non metallic inserts or heads;

   3) Figure 6 — Marking;

   4) Figure 7 — Boundary dimensions and minimum surface of buffer heads;

   5) Figure A.1 — Dimension of the maximum space envelope of buffer – Side view;

   6) Figure B.1 — Location of measurement;

   7) Figure K.1 — Dimension of the maximum space of the buffer;

p) editorial modifications were carried out.

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Introduction

This European Standard is based on UIC 526-1, UIC 526-3, UIC 527-1, UIC 528, UIC 573, UIC 827-1 and UIC 827-2.

1 Scope

This European Standard defines the requirements for buffers with 105 mm, 110 mm and 150 mm stroke for vehicles or units which use buffers and screw coupling. It covers the functionality, interfaces and testing procedures, including pass fail criteria, for buffers.

NOTE 1 Typically, buffers with a stroke of 105 mm are used on freight wagons and locomotives, buffers with a stroke of 110 mm are used on coaches and locomotives and buffers with a stroke of 150 mm are used on freight wagons.

It defines the different categories of buffers, the space envelope, static and dynamic characteristics and energy absorption.

It includes a calculation method to determine the minimum size of the buffer head to avoid override between buffers.

It defines the static and dynamic characteristics of the elastic systems.

It also defines the requirements for buffers with integrated crash elements (crashworthy buffers) for tank wagons for dangerous goods.

The requirements of this European Standard also apply to buffers of locomotives and passenger coaches which need to meet the crashworthiness requirements of EN 15227 for normal service only. The properties for the energy absorbing function are defined in EN 15227 and the requirements specified in Clause 7 for tank wagons for dangerous goods are not applicable to the buffers of these locomotives and passenger coaches.

Diagonal buffers are excluded from this European Standard.

For the crashworthy buffers of locomotives, cab cars or passenger coaches according to EN 15227, and tank wagons for dangerous goods or buffers which form part of a combined system consisting of a special buffer and a deformation element, interchangeability with freight wagon buffers is not required, and therefore the requirements of 5.2 (Fixing on vehicle and interchangeability), 5.3 (Buffer dimensions) do not apply, those of 5.4 (Mechanical characteristics of buffers) and 5.6 (Marking) apply with restrictions.

NOTE 2 For tank wagon subjected to dangerous goods regulation, see [35].

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1370, *Founding — Examination of surface condition*

EN 10025-2, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10168, *Steel products — Inspection documents — List of information and description*

EN 10204, *Metallic products — Types of inspection documents*

EN 10243-1, *Steel die forgings — Tolerances on dimensions — Part 1: Drop and vertical press forgings*

EN 12663 (all parts), *Railway applications — Structural requirements of railway vehicle bodies*

EN 15227, *Railway applications — Crashworthiness requirements for railway vehicle bodies*

EN ISO 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method (ISO 148-1)*

EN ISO 148-2, *Metallic materials — Charpy pendulum impact test — Part 2: Verification of testing machines (ISO 148-2)*

EN ISO 148-3, *Metallic materials — Charpy pendulum impact test — Part 3: Preparation and characterization of Charpy V-notch test pieces for indirect verification of pendulum impact machines (ISO 148-3)*

EN ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868)*

EN ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method (ISO 6507-1)*

EN ISO 6507-2, *Metallic materials — Vickers hardness test — Part 2: Verification and calibration of testing machines (ISO 6507-2)*

EN ISO 6507-3, *Metallic materials — Vickers hardness test — Part 3: Calibration of reference blocks (ISO 6507-3)*

EN ISO 6507-4, *Metallic materials — Vickers hardness test — Part 4: Tables and hardness values (ISO 6507-4)*

EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1)*

EN ISO 11469, *Plastics — Generic identification and marking of plastics products (ISO 11469)*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 815-1, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 815-2, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 2: At low temperatures*

3 Terms and definitions

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

3.1
buffer
absorber device of compressible type, comprising a housing and an elastic system, fitted at each side of the end of vehicles which need to be in contact with other rolling stock

Note 1 to entry: For this European Standard, buffer means side buffer.

3.2
housing
assembly consisting of a plunger, a buffer base and an anti-rotation device but without elastic system

Note 1 to entry: Casing or body are other words for housing, but only housing is used in this European Standard.

3.3
plunger
movable part of the housing consisting of a sliding and guiding tube and an active face named buffer head

3.4
base
part of the housing fixed to the rolling stock headstock

Note 1 to entry: The base consists of a guiding tube and a supporting plate (flange).

3.5
anti-rotation device
device preventing the rotation of the plunger around the longitudinal axis of the buffer

3.6
batch
group of component parts of the same type, originating from the same melt of raw material and having undergone the same process of manufacturing

3.7
elastic system
system that allows the reversible deflection of the plunger and absorbing energy during buffing or running operation

Note 1 to entry: Spring system is another common word for elastic system.

3.8
stroke
deflection of the buffer in the operating range of the elastic system

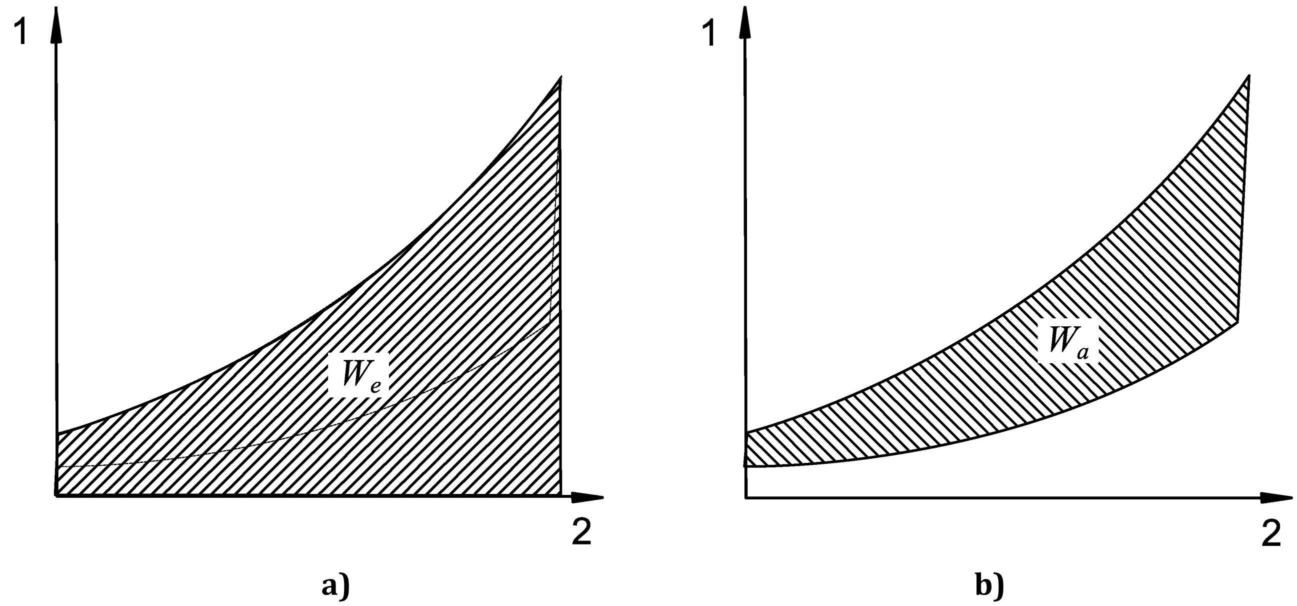
Note 1 to entry: For the purpose of this document, the plastic deformation of crashworthy buffers is not included in the stroke.

3.9
stored energy
W_e
energy (W_e) stored by a buffer for a given stroke

Note 1 to entry: The stored energy is represented, on the force-stroke diagram, by the hatched area lying between the compressive curve, the axis of the abscissa and the straight line, perpendicular to the axis, corresponding to the stroke under consideration, see Figure 1 a).

3.10
absorbed energy
W_a
energy (W_a) absorbed by a buffer for a given stroke

Note 1 to entry: The absorbed energy is represented, on the force-stroke diagram, by the hatched area lying between the compressive curve and the return curve, see Figure 1 b).



Key

1 force in kN

2 stroke in mm

stored energy W_e in kJ

absorbed energy W_a in kJ

Figure 1 — Force-stroke diagram for stored and absorbed energy

Note 2 for entry: Damping is a ratio of absorbed energy divided by stored energy and it is calculated using the following formula:

$$d_{\%} = \frac{W_a}{W_e} \cdot 100\ \%$$

where

$d_{\%}$ is the damping, in %.

3.11
crashworthy buffer
buffer with an additional function to allow plastic deformation to absorb a specified energy due to abnormal impacts

3.12
static stored energy
W_{es}
stored energy during a static test

3.13
dynamic stored energy
W_{ed}
stored energy during a dynamic test

3.14
static absorbed energy
W_{as}
absorbed energy during a static test

3.15
dynamic absorbed energy
W_{ad}
absorbed energy during a dynamic test

3.16
technical specification
document describing specific parameters and/or product requirements as an addition to the requirements of this standard

4 Classification and designation

4.1 General

Buffers are classified according to their stroke and their dynamic energy capacity W_{ed}.

4.2 Buffers with buffer stroke 105 mm (Categories A, B and C)

These buffers are classified according to their dynamic energy capacity W_{ed} as specified in Table 1.

Table 1 — Buffer stroke 105 mm

Buffer category	Dynamic energy capacity W_{ed} kJ
A	≥ 30
B	≥ 50
C	≥ 70

105 mm-stroke buffers are designated by the letter of their buffer category.

4.3 Buffers with buffer stroke 110 mm

Buffers with a stroke of 110 mm are generally used on coaches to protect them against buffing impacts at speeds of up to 10 km/h.

110 mm-stroke buffers are designated by the letter “P”.

NOTE UIC 528 does not specify a designation for this buffer.

4.4 Long stroke buffer 150 mm

Wagons used for carriage of impact-sensitive goods may be fitted with 150 mm stroke buffers in order to maintain the accelerations exerted on goods at the lowest level possible while complying with the minimum requirements of EN 12663-2.

NOTE The possibilities for use of hydrodynamic buffers are described in Bibliographical Entry [32].

150 mm-stroke buffers are designated by the letter “L”.

4.5 Crashworthy Buffers

Crashworthy buffers are identified by an additional designation letter “X”.

4.6 Interaction coupling/buffer

To ensure that the train is able to negotiate curves of 150 m radius safely, the static characteristics of draw gears and buffers should be coordinated.

In order to meet this requirement for vehicles, a guideline value of 250 kN for bogie vehicles should not be exceeded for the compression force of a pair of buffers in contact in a curve of 150 m.

To determine the compression force for vehicles, the calculation method shown under Section 3 of RP 32 of ORE B 36 [33] may be used (the method described in this report is also applicable for coaches and locomotives). This calculation method may also allow stress levels to be determined on smaller radius curves. If the coupling practice creates pretension forces, these shall be taken into account.

NOTE 1 Using the calculation for the curve in according with RP 32 of ORE B 36 [33] also gives confidence for an S curve of 150 m with an intermediate straight of 6 m.

NOTE 2 When EN 16839 is published, these paragraphs or parts of paragraphs will not be relevant.

5 Requirements

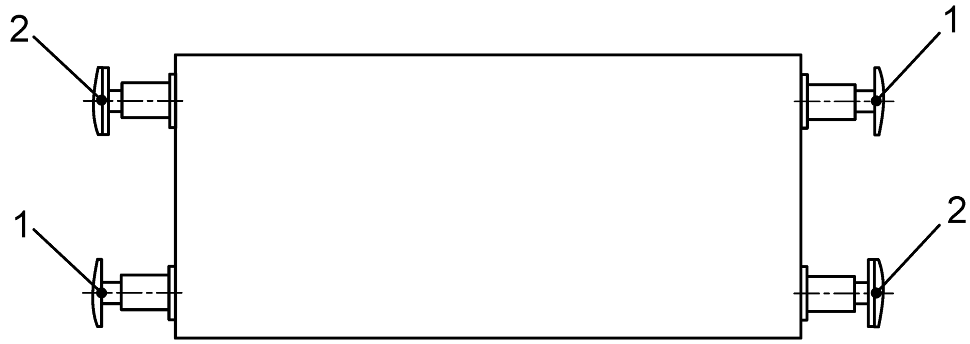
5.1 General

Table 2 gives a resume of testing to be carried out on buffers or their components in order to facilitate the use of this document.

Table 2 — Testing on buffers or their components

Test are made on	Description of the test and related clause	Type Test	Series Test	Test for new Buffers	Test for new housing (with approved elastic system)	Test for new elastic system (with approved housing)
Elastic system: Rubber/elastomer	Spring element: hardness, elongation, compression, etc., see C.1.3	X	X	X	—	X
	Spring element/set: dimensions, bonding, hardness, see C.1.8	X	X	X		X
Elastic system: Ring spring	Stroke-Force Diagram (Static characteristic), see C.2.2	X	X	X		X
	Endurance test, see C.2.3	X		X		X
Elastic system: Hydrodynamic/hydrostatic	Tests on properties of absorbing energy medium, see C.3.3	X		X		X
All elastic systems:	Stroke-Force Diagram (Static characteristic), see Annex D	X	X	X	—	X
Buffer:	Tests of mechanical resistance, see 5.4 and Annex B	X	—	X	X	—
	Stroke-Force Diagram (Static characteristic), see 5.5.2 and Annex D	X	X	X	—	X
	Load, Stroke, Acceleration on impact (Dynamic characteristic), see 5.5.3 and Annex E	X	—	X	—	X
	Endurance test under service load, see 5.5.4 and Annex F	X	—	X	—	X
	Endurance test with buffing load, see 5.5.4 and Annex G	X	—	X	—	X
Crashworthy buffers:	Impact test, see Annex J	X	—	X	X	X

Housings which differ only in the buffer head plate material or insert are considered to be identical. The total length of both buffers on each end of the vehicle shall be the same, see Figure 2.



Key

1 buffer with metallic head

2 buffer with non-metallic insert or head

Figure 2 — Mounting of buffers with non-metallic insert or head (top view for freight wagons)

When a non-metallic insert or head is provided on one of the two buffers per wagon end, it should be placed diagonally according to Figure 2.

Two buffers shall be fitted at each vehicle end with the same elastic system, category, head dimension, stroke and type of housing.

5.2 Fixing on vehicle and interchangeability

The buffers shall be fixed to the vehicle headstock by means of four bolted M 24 fasteners.

For 105 mm and 150 mm stroke buffers for freight wagons, when interchangeability is required the dimensions and spacing of the holes needed on the buffer support plate for its fixing on the headstock are given in Figure 3.

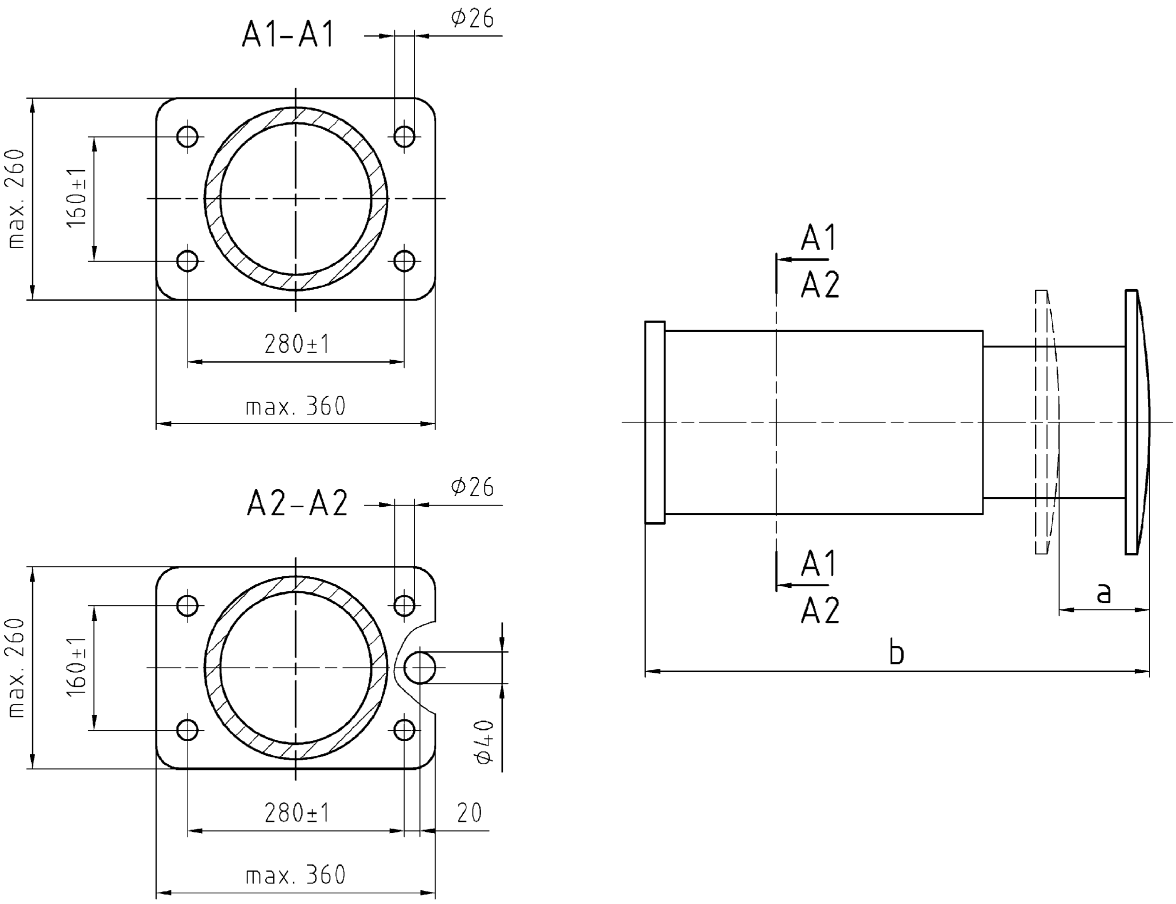
The 105 mm stroke buffer flange shall cover the location for the pin (see cross section A1 – A1 of Figure 3). This pin is to prevent the fixing of a 105 mm stroke buffer where a long stroke buffer is required.

The 150 mm stroke buffer flange shall have a location for the pin (see location and dimension of the flange in cross section A2 – A2 of Figure 3).

For crashworthy buffers or buffers which form part of a combined system consisting of a special buffer and a deformation element, a different mounting of the buffers (e.g. position of flange, bolt diameter, quantity of bolts and their position) may be used, whereupon Figure 3 is not applicable.

NOTE Interchangeability is not required for these buffers.

Dimensions in millimetres



Key

A1 – A1 section is for 105 mm stroke buffer

A2 – A2 section is for long stroke buffer

a is the stroke 105 mm or 150 mm

b is the buffer length (see Table 3)

Figure 3 — Fixing dimensions of 105 mm and 150 mm stroke buffers for interchangeability

5.3 Buffer dimensions

Common dimensional characteristics for all buffer categories are provided in Table 3 and Figure 3.

Table 3 — Buffer dimensional characteristics

	Stroke 105 mm buffer mm	**Stroke 110 mm buffer** mm	**Stroke 150 mm buffer** mm
Stroke ***a***	$\left(105^{0}_{-5}\right)$	$\left(110^{0}_{-5}\right)$	$\left(150^{0}_{-5}\right)$
Buffer length ***b***	620	650	665

The space envelope of the buffer is specified in Annex A.

The buffer shall be equipped with an anti-rotation device preventing free rotation on longitudinal axis. The maximum allowed rotation is set at ± 2° for buffer when they are new.

The width of the buffer head shall be as specified in 6.2.

For the crashworthy buffers of locomotives, cab cars or passenger coaches, or buffers which form part of a combined system consisting of a special buffer and a deformation element, a different mounting of the buffers (e.g. position of flange, bolt diameter, quantity of bolts and their position) may be used; and the buffer length *b* defined in Table 3 is not applicable.

5.4 Mechanical characteristics of buffers

The entire buffer unit shall be capable of withstanding the loads specified in Table 4:

Table 4 — Proof loads for buffers

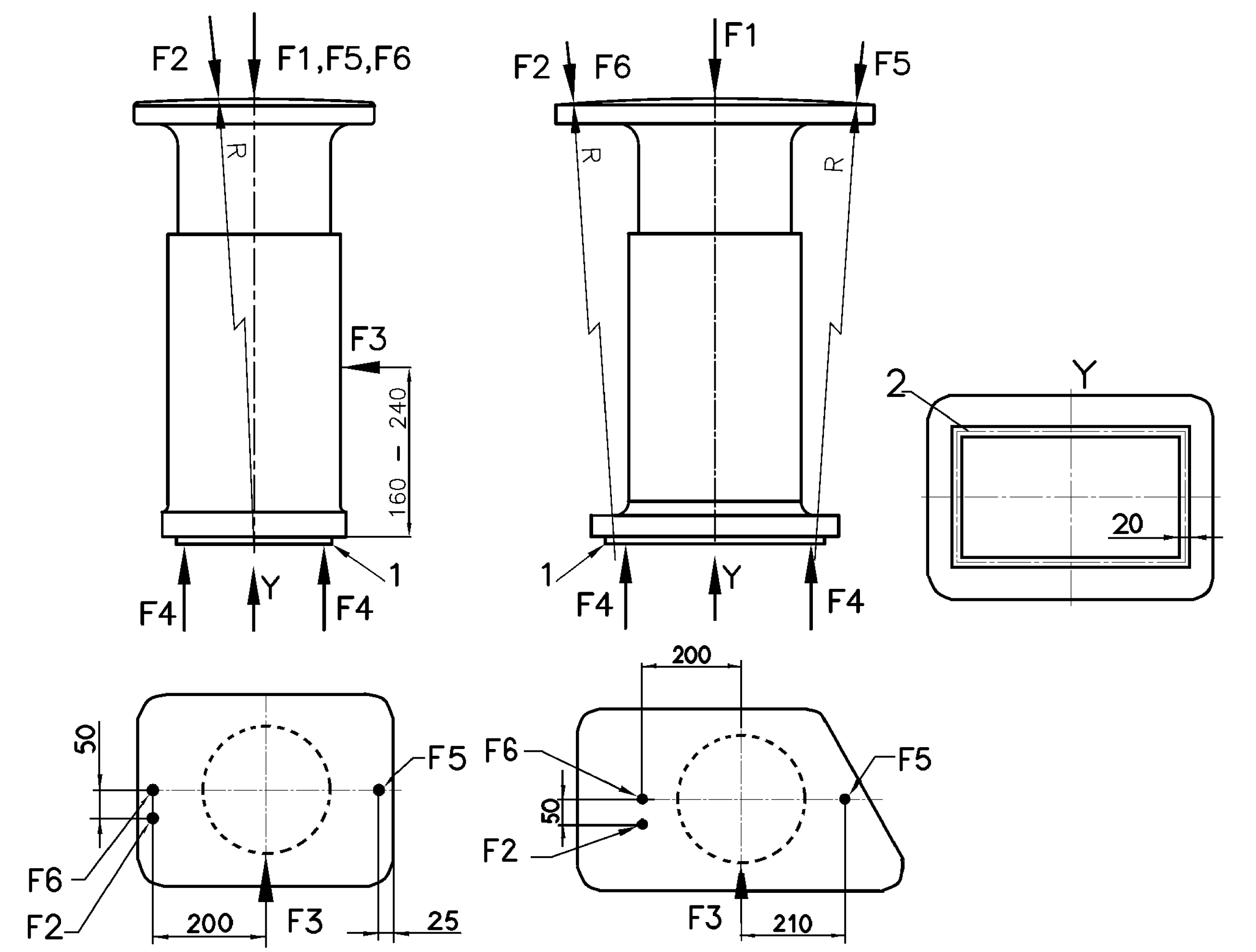
	Force F_i **for stroke 105 mm and 150 mm** kN	**Force F_i** **for stroke 110 mm** kN
Longitudinal force (centred) F1, exerted on the buffer head	≥ 2 500	≥ 1 250
Longitudinal force (off-centre) F2, exerted on the buffer head	≥ 500	≥ 300
Vertical force F3, exerted on the body of the buffer	≥ 200	≥ 200
Total longitudinal force F4, exerted by the base plate of the buffer on a test frame	≥ 2 500	≥ 1 250
Longitudinal force F5 for buffer heads > 450 mm, exerted on the buffer head	≥ 250	≥ 250
Life-cycle test on customer request, force F6	≥ 250	≥ 250

Conditions governing the application of these forces are set out in Figure 4. The corresponding test methods are specified in Annex B.

After each of the tests F1, F2, F3 and F5, the buffer shall continue to be in a condition that allows normal functioning (to be checked with one complete loading along the longitudinal axis), and any permanent deformation shall fall within the tolerance range stipulated for manufacture (measurement points see Figure B.1). In addition, the diameters measured on the main buffer components shall not have changed by more than 0,2 % (measurement diameter see Figure B.1). Table B.1 shows an example for the documentation of test results. After Test F4, the base plate shall not show any permanent deformation (in comparison with the initial measurement). After Test F6, no visible cracks shall appear.

For crashworthy buffers or buffers which form part of a combined system consisting of a special buffer and a deformation system, proof loads F1, F3 and F4 are not applicable. To test the other proof loads, a different way of mounting from that indicated in Figure 4 shall be chosen in order to represent the real mounting and load situation on the vehicle as close as practically possible.

Dimensions in millimetres



Key

1	support frame (used with for testing with F4)
2	centre line of fastening bolts on the support frame
F1 to F6	indicated location and forces for testing
R	radius of buffer head
NOTE	Buffer plate not drawn to scale and rotated.

Figure 4 — Points of application of forces

5.5 Elastic systems

5.5.1 Types of elastic systems

— Rubber elastomer or other elastomer elastic systems;

— friction spring/ring spring;

— hydrodynamic or hydrostatic systems;

— combined spring.

See Annex C for requirements.

5.5.2 Static characteristics

The static characteristics common to all categories of buffers in position and direction of F1 are defined in Table 5.

These characteristics shall be measured as specified in Annex D on a complete buffer.

Table 5 — Static characteristics

	Buffer with 105 mm stroke	**Buffer with 110 mm stroke with conventional springs**	**Buffer with 110 mm stroke with hydrodynamic and hydrostatic springs**	**Buffer with 150 mm stroke**
Stroke				
Initial	10 kN to 50 kN	7,5 kN to 20 kN	7,5 kN to 50 kN	10 kN to 90 kN
after 25 mm	30 kN to 130 kN	10 kN to 40 kN	—	30 kN to 130 kN
after 50 mm	—	—	60 kN to 200 kN	—
after 60 mm	100 kN to 400 kN	50 kN to 160 kN	—	80 kN to 220 kN
after 100 mm	350 kN to 1 000 kN	—	—	150 kN to 390 kN
after 105 mm	—	300 kN to 1 000 kN	≤ 600 kN	—
after 125 mm	—	—	—	200 kN to 520 kN
after 145 mm	—	—	—	350 kN to 880 kN
Stored energy (W_e) for an effort not exceeding 1 000 kN	≥ 12,5 kJ	≥ 10 kJ	—	—
Stored energy (W_e) for a force ≤ 880 kN	—	—	—	≥ 18 kJ
Stored energy (W_e) for a force ≤ 600 kN	—	—	≥ 12 kJ	—
Absorbed energy (W_a) corresponding to the preceding stored energy for the first cycle	≥ 0,5 W_e	≥ 0,5 W_e	≥ 0,5 W_e	≥ 0,5 W_e
Absorbed energy (W_a) corresponding to the preceding stored energy for the second and third cycle	≥ 0,42 W_e	≥ 0,42 W_e	≥ 0,42 W_e	≥ 0,42 W_e

Table 5 applies to the temperature range – 25 °C to + 45 °C.

For friction spring/ring spring and buffer with 105 mm stroke, after 25 mm stroke, the static characteristic could be between 30 kN and 170 kN if the feasibility is confirmed by service experience. The interaction between coupling and the buffer needs further consideration for this configuration.

Tests on hydrodynamic and hydrostatic springs shall also determine whether the reaction force exerted by the buffer at compression of 30 mm, 60 mm and 100 mm depths, respectively remains virtually constant for 10 min.

5.5.3 Dynamic characteristics

Dynamic characteristics are those obtained when a test vehicle fitted with the buffers to be tested is impacted by another test vehicle.

The values imposed are designed to ensure adequate protection of the passengers, the goods carried and of the vehicle structure against buffing impact, particularly in marshalling yards.

5.5.4 Type testing

The following type tests shall be undertaken:

— dynamic testing as specified in Annex E;

— endurance testing under service load for elastic system as specified in Annex F;

— endurance testing for life-cycle simulation as specified in Annex G.

5.6 Marking

Buffers shall be marked as indicated in Figure 5 and Figure 6. This marking system is also applicable for buffers of 110 mm stroke.

The minimum size of the letters is defined in Figure 6.

This marking shall be applied during manufacture or inserted on a securely fixed metal plate depending on the method of manufacture.

Dimensions in millimetres

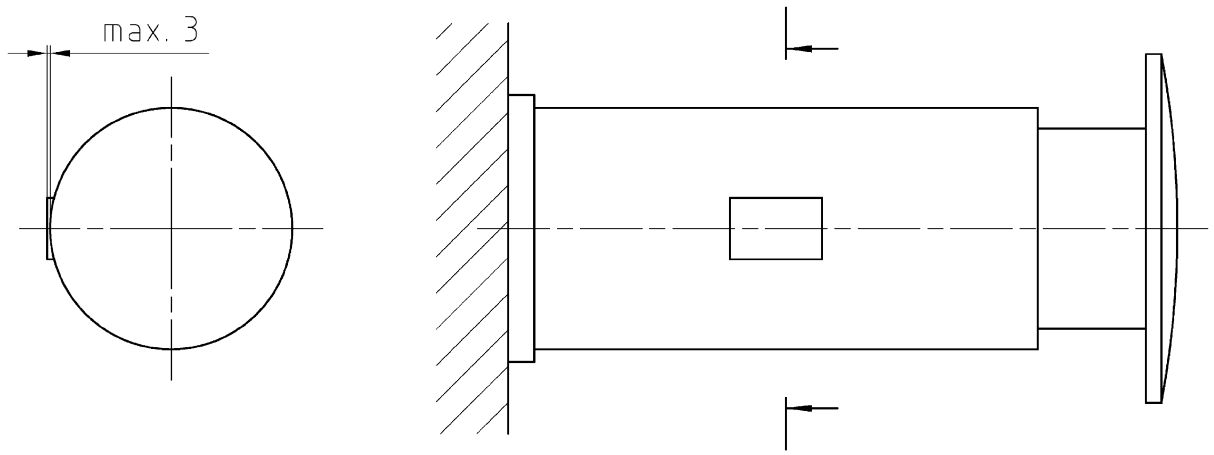
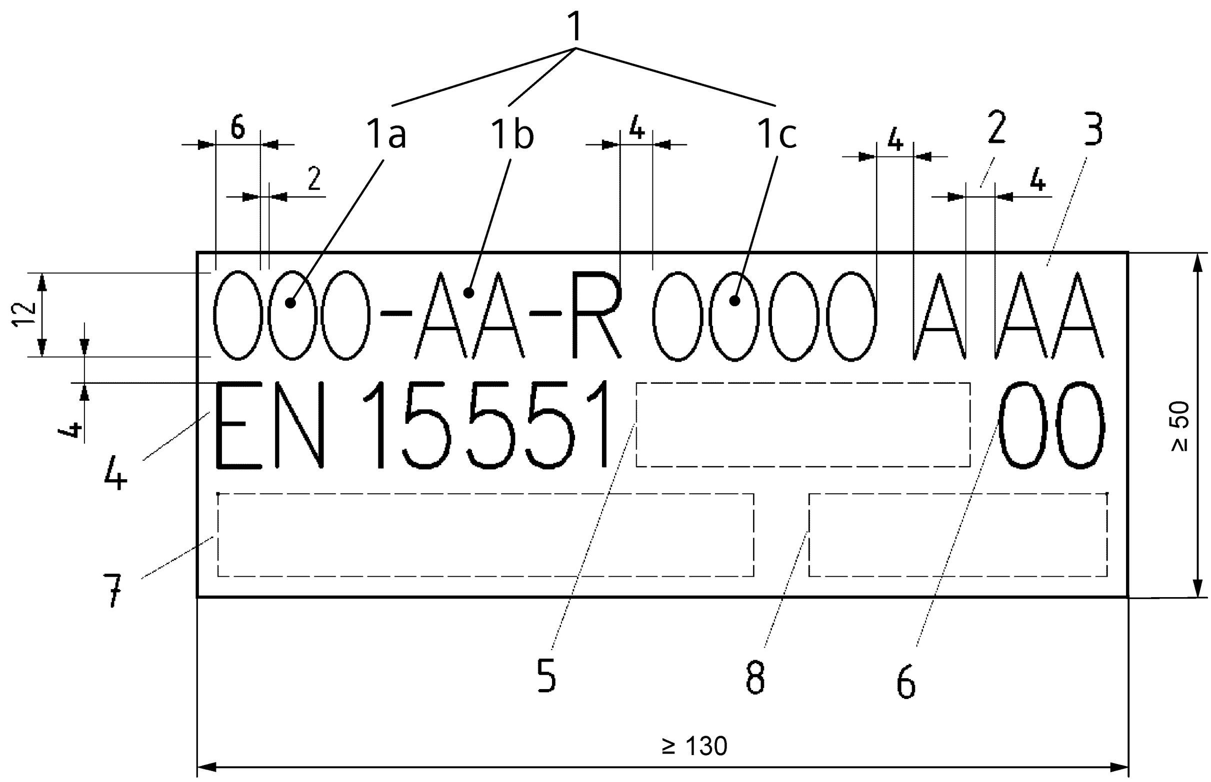


Figure 5 — Location of the mark

For crashworthy buffers or buffers, which form part of a combined system of a special buffer and a deformation element, a different place or a different technology than a metal plate may be chosen. However, the layout and letter size as defined in Figure 6 shall be maintained.

The legibility and durability of the marking shall be specified in the technical specification.

Dimensions in millimetres



Key

1 stroke – designation or category letter (followed by “X” for crashworthy buffers) – buffer head radius
  1a) indication stroke
  1b) buffer category including crashworthy buffer digit “X”
  1c) buffer head radius
2 type of buffer head
  S – standard
  P – synthetic material
  H – hardened (for hardness > 450 HV)
3 type of elastic system
  F – friction spring
  R – rubber spring
  P – polymer spring
  S – hydrostatic capsule
  D – hydrodynamic capsule
  For combined elastic systems, combine the letters, e.g. FD – friction spring/hydrodynamic capsule
4 EN 15551
5 manufacturer’s marking
6 two last digit of production year
7 identification number of Notified Body or other certification body (optional)
8 owner’s marking (optional)

Figure 6 — Marking

Additional markings may be given if this is requested in the technical specification.

6 Housing

6.1 Plunger and base

The plunger or base shall not have cracks, lack of material or any other defect that affects its performance.

6.2 Buffer head

6.2.1 Materials

6.2.1.1 General

Buffer head materials shall be compatible with each other and with the materials currently used in operation.

Compatible buffer head materials are listed in H.2.

For new buffer head materials the compatibility with existing buffer materials shall be demonstrated. H.1 gives guidelines on how to do so.

6.2.1.2 Hardness of buffer head

For steel buffer head, the hardness *HV* of active surfaces measured at a depth of 0,5 mm from the surface shall be greater than or equal 160 HV30.

6.2.1.3 Roughness of the surface

The following provisions apply only to buffer heads made of steel.

The roughness value R_a for the surface condition of buffer heads expressed by the mean arithmetic deviation shall be $R_a \leq 25$ µm.

For cast parts, minimum quality level for roughness for unmachined surfaces shall be 2S1 according to EN 1370 and for surfaces finished by hand grinding, minimum quality level for roughness shall be 4S2 according to EN 1370.

For forged parts, minimum quality level for roughness shall be according to EN 10243-1.

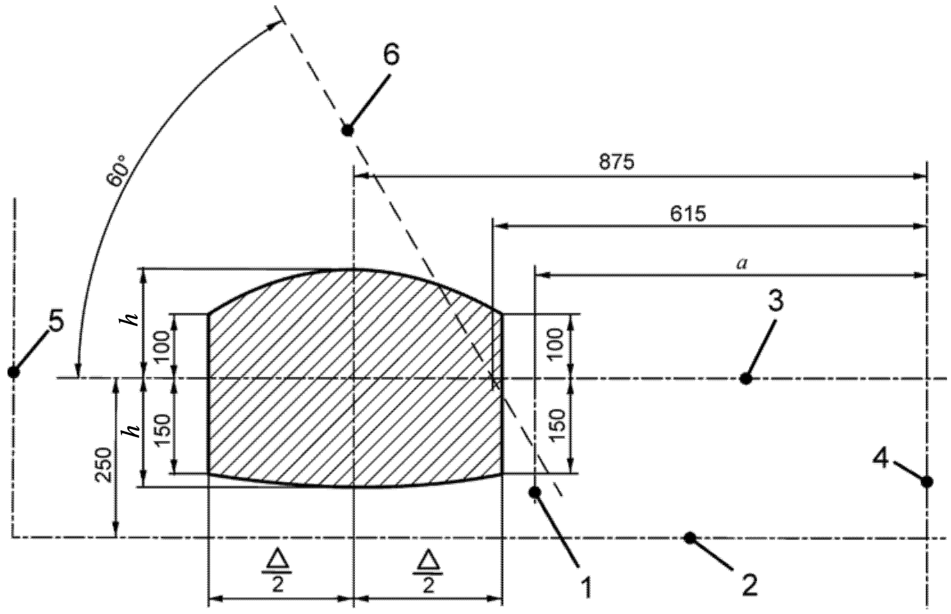
6.2.2 Boundary dimensions

Buffer heads shall not exceed the limits shown in Figure 7:

— LINE 1 towards the vehicle centre line, for wagons, a vertical line situated 600 mm from the vehicle centre line and for coaches and locomotives equipped with 110 mm stroke buffers, a vertical line situated 540 mm from the vehicle centre line. This limit ensures, generally, the observance of the space to be kept free for the shunter;

— LINE 2 towards the ground, a horizontal line situated 250 mm below the centre line of the buffers.

Dimensions in millimetres



Key

1	internal limit
2	lower limit
3	level of buffer centre line
4	wagon centre line
5	construction gauge limit
6	limit for vehicles with interconnecting gangway
(hatched)	minimum surface

	for wagons	for coaches and locomotives with 110 mm stroke buffer
a distance from key No. 4 to No.1, in mm	600	540
h half height of buffer plate, in mm	170	180

Figure 7 — Boundary dimensions and minimum surface of buffer heads

For buffers 550 mm wide, the minimum size may be reduced two times by *R* 50 in the lower corners of the buffer head.

6.2.3 Standard dimensions of buffer head

6.2.3.1 General

The theoretical half width of the buffer head $\left(\frac{\Delta}{2}\right)$ shall be calculated according to Annex I.

The buffer heads shall not have any irregularities that might pose problems for shunting staff. The edges of their working surfaces shall be rounded with a radius of at least 50 mm and the edge of the buffer head shall have a curvature of (5_0^{+2}) mm. These requirements shall also apply on non-metallic inserts or head reaching the dimension of the metallic buffer plate.

6.2.3.2 Buffers with stroke of 105 mm and 150 mm

The standard height of buffer heads shall be 340 mm, i.e. 170 mm on either side of the centre line of the housing.

Buffer heads shall be convex and the radius of curvature of their spherical working surfaces shall be (2 750 ± 100) mm.

The standard width of the buffer head of standard gauge wagons (distance between centre line of buffers 1 750 mm) shall be as specified in Table 6.

Table 6 — Standard widths of buffer heads

Value Δ	Corresponding standard width
Δ ≤ 400 mm	450 mm
400 mm < Δ ≤ 550 mm	550 mm

The minimum width of buffer heads on wagons accepted for traffic between the European standard gauge network and the Spanish broad gauge network (distance between centre line of buffer 1 850 mm) shall be 100 mm more than the width calculated in accordance with Annex I and Table 6.

The minimum width of buffer heads on wagons accepted for traffic between the European standard gauge network and the Finnish network (distance between centre line of buffer 1 790 mm) shall be 40 mm more than the width calculated in accordance with Annex I and Table 6.

NOTE This clause will be modified, when EN 16839 is published.

6.2.3.3 Buffers with stroke of 110 mm

The standard height of buffer heads shall be 360 mm, i.e. 180 mm on either side of the centre line of the housing.

Buffer heads shall be convex and the radius of curvature of their spherical working surface shall be equal to (1 500 ± 100) mm.

6.3 Type and series tests

The quantity of series test shall be at minimum one or as agreed in the technical specification for a batch comprising less than 40 component parts.

Table 7 summarizes all the type and series tests to be carried out.

Table 7 — Type and series tests

Nature of tests and controls			Quantity of type test	Quantity of serial test
Part	**Parameter to control**	**Criteria**		
Complete housing	Mechanical characteristics	According to 5.4 and Annex B	1	–
	Dynamic characteristics	If requested by the technical specification: after tests according to Annex E, no crack shall have appeared. This shall be confirmed by a non-destructive testing	1	–
All components	Dimensions - aspect ratio	According to the drawing dimensions	1	2,5 % per batch
	Static Characteristics	According to 5.5.2 and Annex D	1	2,5 % per batch
	Chemical analysis	According to EN 10204 and EN 10168; The results shall conform to the standard associated with the material	1 certificate per production batch and per supplier	
	Painting - Protection	According to the drawing and customer specifications	1	1 % per batch
Base, Plunger or Plate or raw material from which these components are produced, respectively	Marking	Each part shall be marked for traceability	1	100 %
	Hardness of cast parts	On 1 test piece according to EN ISO 6507-1 to -4: — inside for type test, — on the surface for serial tests; The results shall be in conformity with the standard associated to the material	1	2,5 % per batch
	Hardness of the plate	On 1 test piece according to EN ISO 6507-1 to -4; The results shall be in conformity with 6.2.1.2	1	2,5 % per batch
	Surface quality - Roughness	According to 6.2.1.3	1	2,5 % per batch
	Tensile test	On 1 test piece taken from the longitudinal part of the component; According to EN ISO 6892-1; The results shall conform to the standard associated with the material	1	1 per production batch

Nature of tests and controls			Quantity of type test	Quantity of serial test
Part	**Parameter to control**	**Criteria**		
Base, Plunger or Plate or raw material from which these components are produced, respectively *(continued)*	Fracture toughness at 20 °C	On 3 test pieces taken from the longitudinal part of the component; According to EN ISO 148-1 to -3; The results shall conform to the standard associated with the material With exception of cast and crashworthy buffers, the minimum value shall be 20 J. For crashworthy buffers the minimum value shall be 3,5 J	1	1 per production batch
	Fracture toughness at −20 °C	Tests to be done only if requested by the technical specification or the standard associated with the material: On three test pieces taken from the longitudinal part of the component; According to EN ISO 148-1 to -3; The results shall conform to the technical specification or the standard associated with the material	1	1 per production batch

In case of modification of the design or the material of a housing already approved, the type tests are not necessary if it can be demonstrated (by calculation, simulation…) that this new design has the same or higher safety level than the one approved.

7 Crashworthy buffers

7.1 On wagons

Crashworthy buffers shall comply with the provisions of Annex J and those given below. The requirements on wagons are defined in EN 12663 (all parts).

Crashworthy buffers shall fulfil all requirements of Clause 5 and Clause 6.

The envelope of these buffers shall be in accordance with Annex K.

NOTE Annex A is not applicable for crashworthy buffers.

7.2 On other vehicles

For energy absorbing components, EN 15227 is applicable instead of Annex J.

NOTE Annex A is not applicable for crashworthy buffers.

Annex A
(normative)

Maximum space envelope of buffer

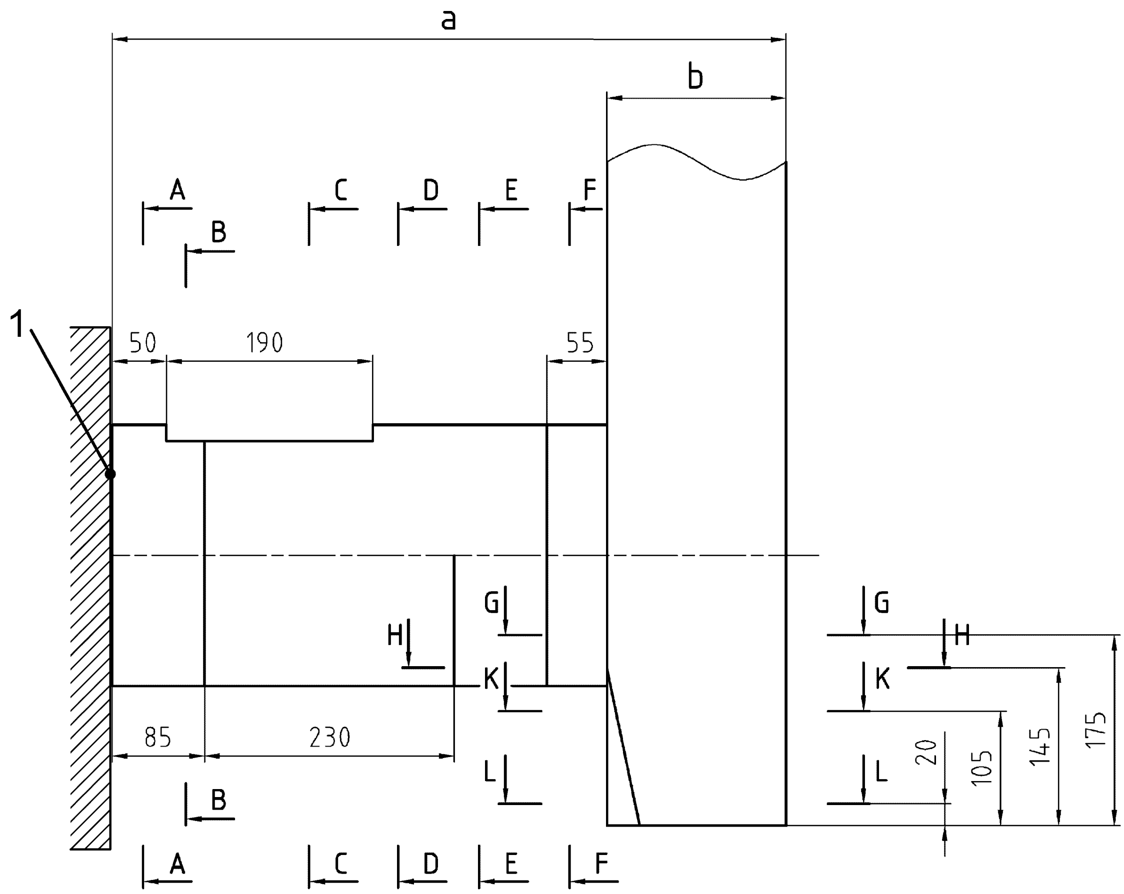
A.1 Requirements for space envelope of buffer

A.1.1 Buffers for freight wagons

Any parts of the buffer including the working position shall be within the maximum space envelope as indicated in Figure A.1.

NOTE UIC 535–2 and UIC 527–1 give the background of the requirements of this Annex A.

Dimensions in millimetres



Key

		Stroke 105 mm	Stroke 150 mm
1	headstock/buffer plate		
a	total length of buffer in uncompressed condition	620 mm	665 mm
b	space envelope of the buffer plate (thickness of the buffer plate including buffer hub)	165 mm	210 mm

NOTE For the cross sections A – A to L – L see Figures A.2 to A.8.

Figure A.1 — Dimension of the maximum space envelope of buffer – Side view

Dimensions in millimetres

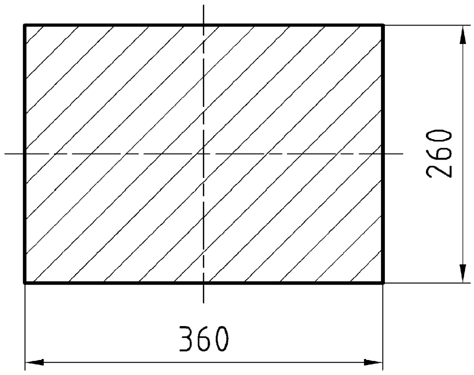


Figure A.2 — Cross section A – A

Dimensions in millimetres

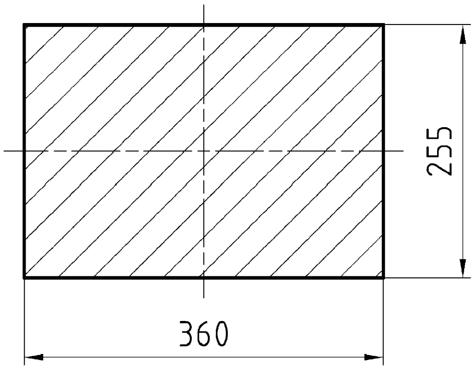


Figure A.3 — Cross section B – B

Dimensions in millimetres

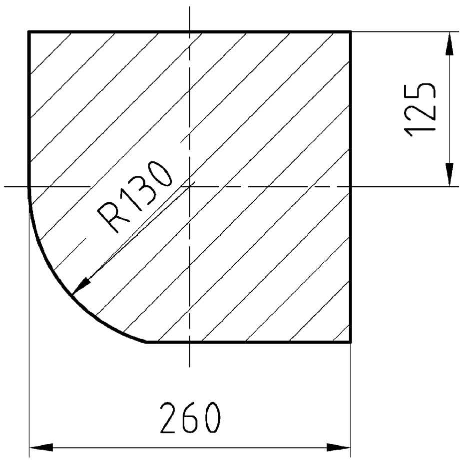


Figure A.4 — Cross section C – C

Dimensions in millimetres

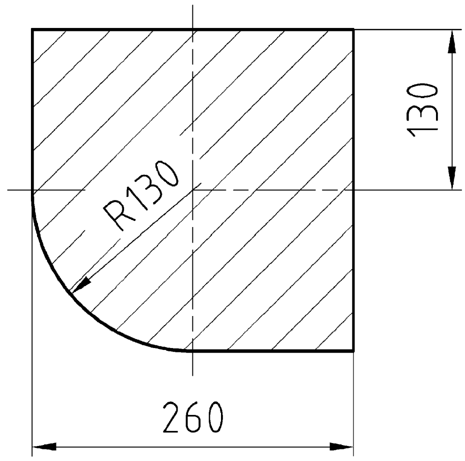


Figure A.5 — Cross section D – D

Dimensions in millimetres

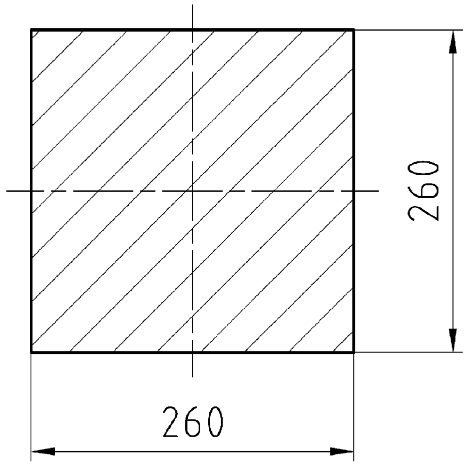


Figure A.6 — Cross section E – E

Dimensions in millimetres

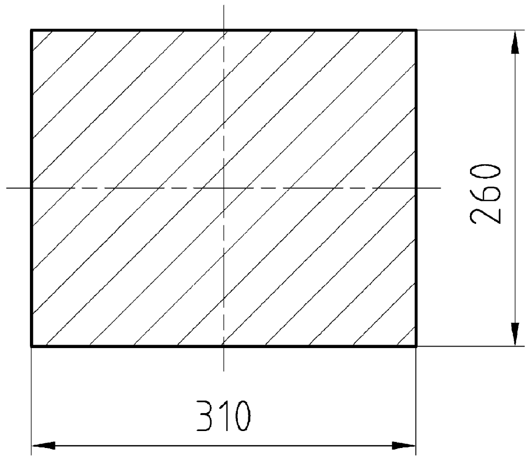
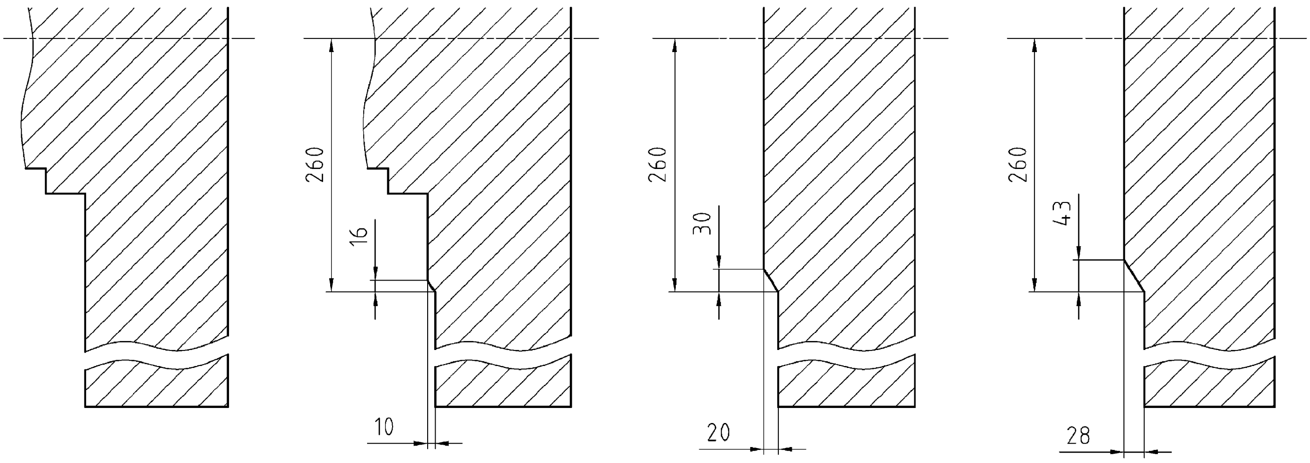


Figure A.7 — Cross section F – F

Dimensions in millimetres



a) G – G **b) H – H** **c) K – K** **d) L – L**

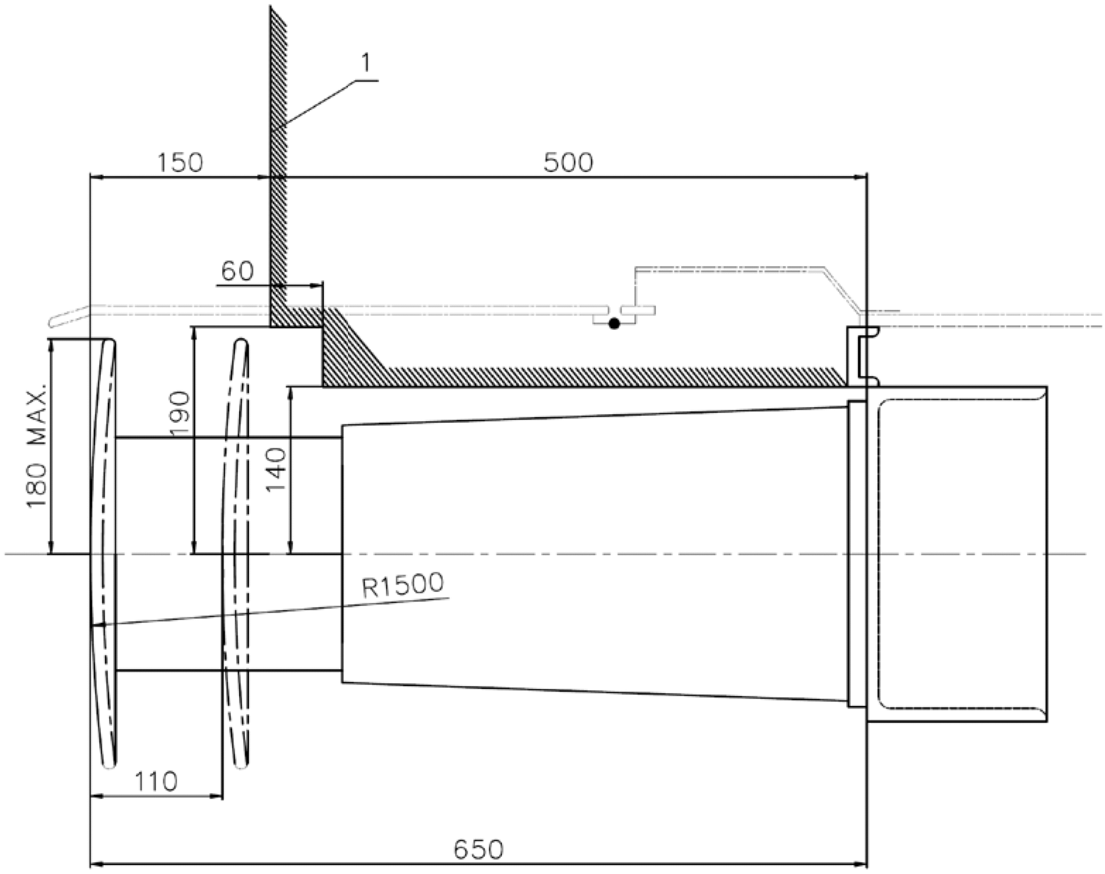
Figure A.8 — Dimension of the buffer: Cross sections G – G, H – H, K – K and L – L

A.1.2 Buffers for coaches

No part of the buffer may project within the space above the buffer as indicated in Figure A.9.

Figure A.9 is not applicable for crashworthy buffers.

Dimensions in millimetres



Key

1 end wall

Figure A.9 — Dimension of the maximum space envelope of buffer for coaches – Side view

A.2 Notes on the definition of envelopes for overall dimensions of Buffers for freight wagons

A.2.1 General

The maximum envelope for side buffers of freight wagons shall comprise:

— the diameter of the main body of the buffer (Ø 260 mm);

— the buffer housing and its base plate;

— the buffer heads.

The values specified above have been supplemented to take account of:

a) automatic couplers and locking release gear for as long as buffers are maintained during the screw coupler-automatic coupler transition period; this concerns:

   1) locking release handles;

   2) sliding handle;

   3) the coupler head itself.

b) adjacent equipment other than the automatic coupler and its control gear.

A.2.2 Study relating to definition of the envelope

A.2.2.1 Main body of buffer

A.2.2.1.1 General

As the Ø 260 mm maximum dimension for the diameter of the buffer was found to be too great a constraint, a square cross section of 260 mm × 260 mm has been taken instead, except in the case of the following cross-sections:

A.2.2.1.2 Cross section C – C

This cross section (see Figure A.1 and Figure A.4) has a dual limit:

a) The lower left-hand quarter has a radius of *R* 130 mm.

   This limit is imposed by the locking release handle (left) of the automatic coupler in the “coupling impossible” position.

   The study was conducted under the following conditions:

   1) the handle placed in “coupling impossible” position on left side;

   2) all manufacturing tolerances taken from the most unfavourable angle, and at 60 % of their absolute values;

   3) buffer centre line positioned at 880 mm (875 mm + 5 mm) from the wagon centre line.

   4) the handle (left) is at a tangent to the diameter of 260 mm as specified in A.2.2.1.1.

b) The upper half is limited to 125 mm.

   This space is taken up by the mounting of locking gear for the swinging ends of certain types of high-sided open wagon.

A.2.2.1.3 Cross section D – D

The same limit (see Figure A.1 and Figure A.5) as in the case of cross section C – C is applicable to the lower left-hand quarter.

A.2.2.1.4 Cross section E – E

No limit for this section (see Figure A.1 and Figure A.6).

A.2.2.1.5 Cross section F – F

The width of this section (see Figure A.1 and Figure A.7) is increased to 310 mm to allow a device to prevent the head from rotating to be fitted.

A.2.2.2 Base plate

A.2.2.2.1 General

Overall dimensions of the base plate shall be less or equal than (360 mm x 260 mm) as specified in A.2.2.2.2.

In addition to the maximum thickness for the plate, the envelope includes the space required for fitting or removal of fastening nuts. This envelope is limited to 85 mm (see Figure A.1).

A.2.2.2.2 Cross section A – A

360 mm × 260 mm with a maximum thickness of 50 mm (see Figure A.1 and Figure A.2).

A.2.2.2.3 Cross section B – B

The upper half (see Figure A.1 and Figure A.3) is limited to 125 mm instead of 130 mm.

The same remark as for cross section C – C referred to in A.2.2.1.2 above.

A.2.2.3 Head

The limits stipulated in 6.2 of this document are used in the envelope with respect to:

— outer gauge;

— clearance space prescribed in the Technical Unity, taking a measurement of 200 mm from the centre line of the vehicle to cover space taken up by screw coupling fitments;

— lower limit.

Where the thickness and compression stroke of the head are concerned, the following dimensions were taken as a basis:

— a head with a uniform thickness of 60 mm;

— a compression of 25 mm for compatibility with operating handle (left) of the automatic coupler.

The space required for movement of this lever is shown in cross sections H – H, K – K and L – L in Figure A.8; an additional compression of 80 mm to obtain the 105 mm stroke with the head defined in A.1.1 (dimension 165 mm and cross section G – G (see Figure A.1 and Figure A.8)).

Annex B
(normative)

Mechanical characteristics of buffers – Test methods

B.1 General

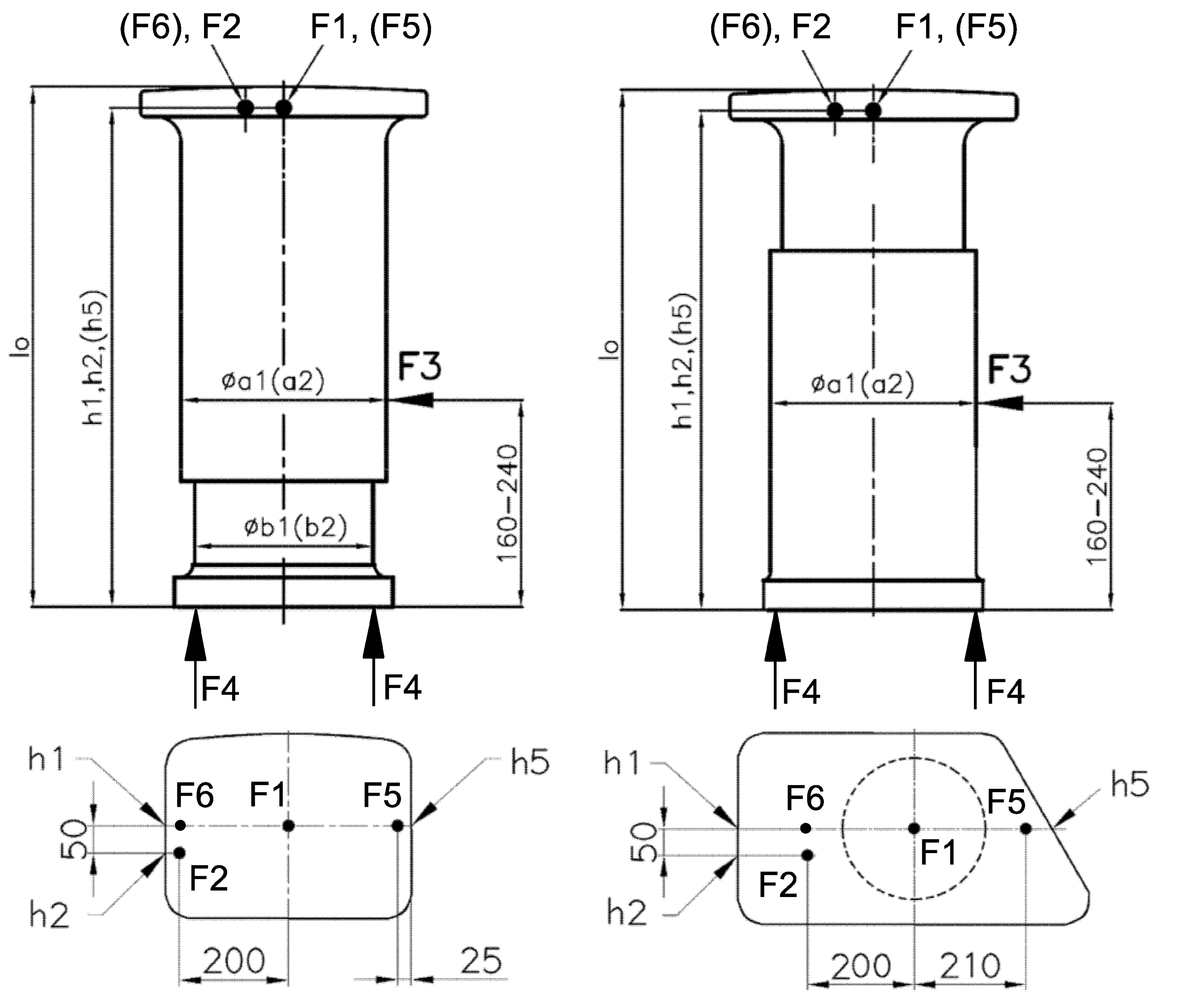
Before conducting the tests, the non-metallic inserts (if any) shall be removed from the buffer plates.

Table 4 defines the test forces (F1 to F6) and Figure B.1 gives the location of measurement (*a*1, *a*2, *b*1, *b*2, *l*0, *h*1, *h*2 and *h*5).

B.2 Test methodology

B.2.1 General

Dimensions in millimetres



NOTE Buffer plate not drawn to scale and rotated.

Figure B.1 — Location of measurement

B.2.2 Force F1

The test shall be conducted on a press, the buffer to be tested being placed between the plates and the press.

B.2.3 Force F2

The test shall be conducted on a press, a wedge-shaped plate being placed between the lower plate of the press and the base plate of the buffer so that the upper plate of the press can exert force F2 on the buffer head at the application point shown in Figure 4.

This test can also be carried out by positioning the buffer directly on the lower plate of the press and applying force F2 parallel to the centre line of the buffer.

For both cases, in order to keep the force contact point at the defined position, a ball and socket joint may be used. In this case, the socket surface area is a maximum of 900 mm^2.

B.2.4 Force F3

The force shall be applied by means of a V-shaped (120°) of at least 50 mm thick tool on the main body of the buffer (housing or plunger) as shown in Figure B.2.

When it is not possible to apply F3 at 200 mm above flange, force F3 shall be applied within the range 160 mm to 240 mm above flange level with simultaneous force adjustment (and constant moment).

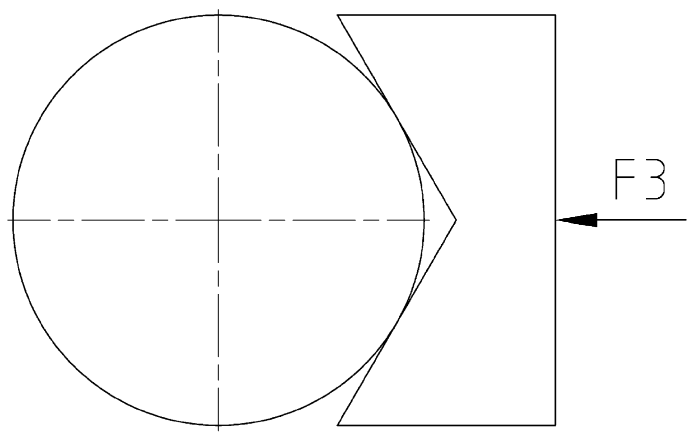


Figure B.2 — Tool for application of force F3

B.2.5 Force F4

This test shall be carried out on a press, with a frame consisting of four rectangular supports being placed between the lower plate of the press and the base-plate of the buffer.

B.2.6 Force F5

The test shall be conducted on a press, a wedge-shaped plate being placed between the lower plate of the press and the base plate of the buffer so that the upper plate of the press can exert force F5 on the buffer head at the application point shown in Figure 4.

This test can also be carried out by positioning the buffer directly on the lower plate of the press and applying force F5 parallel to the centre line of the buffer.

For both cases, in order to keep the force contact point at the defined position, a ball and socket joint may be used. In this case, the socket surface area is a maximum of 900 mm^2.

B.2.7 Force F6

When a life-cycle test of the single buffer housing is requested by the technical specification, it shall be carried out according to the following conditions:

— force F6 pulsating from 50 kN to 250 kN;

— attached, 200 mm off-centre of the buffer head;

— load changes: 300 000;

— load change frequency: max 4 Hz.

B.3 Test documentation

An example for the documentation of test results is shown in Table B.1.

Table B.1 — Measurement protocol (example)

Loading sequence	l_0 mm	h_1 mm	h_2 mm	H_5 mm	Øa_1 mm	Øa_2 mm	Øb_1 mm	Øb_2 mm	Deflection flange
Initial state									
after F1 = kN									
after F4 = kN									
after F3 = kN									
after F2 = kN									
after F5 = kN									
after F6 = kN									

NOTE The measurement protocol is given without values for forces. The range of proof loads are given in Table 4.

Annex C
(normative)

Requirements for elastic systems

C.1 Rubber elastomer or other elastomer elastic systems

C.1.1 General

This clause concerns rubber elastomer or other elastomer elastic systems in which inserts may be present.

C.1.2 Metal inserts

Unless otherwise specified, minimum steel grade is S235JR according to EN 10025-2.

Surface state, dimensions and rust protection are made according to the technical specification.

C.1.3 Constituents of rubber elastomer and/or other elastomer systems

Composition, characteristics and process are made according to the technical specification and to the specifications according to Table C.1.

The approval values in Table C.1 are the average values of the tests done during the type test (Table C.2).

Table C.1 — Characteristics of the constituents

Characteristics	Results	Tests for rubber elastomer	Tests for others
Hardness *IRHD* according to ISO 48	D_i = approval initial hardness D_p = piece hardness D_a = after ageing 7 days at a temperature of 70 °C $D_p = D_i \pm 5$ *IRHD* $\Delta D = \lvert D_a - D_p \rvert \leq 5\,IRHD$	X	–
Shore hardness *D* according to EN ISO 868	D_i = approval initial hardness D_p = piece hardness $D_p = D_i \pm 5$ shore	–	X
Tensile strength *R* according to ISO 37	R_i = approval value R_p = piece value R_a = after ageing 7 d at a temperature of 70 °C $R_p = R_i \pm 0{,}15\,R_i$	X	–

Characteristics	**Results**	**Tests for rubber elastomer**	**Tests for others**
	$\frac{\Delta R}{R_p} = \frac{\lvert R_a - R_p \rvert}{R_p} \leq 0{,}2$		
Elongation at fracture *A* according to ISO 37	A_i = approval value A_p = piece value A_a = after ageing 7 d at a temperature of 70 °C $A_p = A_i \pm 0{,}15\ A_i$ $\frac{\Delta A}{A_p} = \frac{\lvert A_a - A_p \rvert}{A_p} \leq 0{,}3$	X	–
200 % Elongation modulus *M* according to ISO 37	M_i = approval value M_p = piece value M_a = after ageing 7 d at a temperature of 70 °C $M_p = M_i \pm 0{,}15\ M_i$ $\frac{\Delta M}{M_p} = \frac{\lvert M_a - M_p \rvert}{M_p} \leq 0{,}2$	X	–
Compression set after 25 % compression for 24 h at 70 °C according to ISO 815-1	*DRC* ≤ 30 %	X	–
Compression set after 25 % compression for 24 h at 50 °C according to ISO 815-1	*DRC* ≤ 30 %	–	X
Compression set after 25 % compression for 24 h at - 30°C, after stabilizing for 3 min at - 30 °C measured according to ISO 815-2 at ambient temperature	*DRC* ≤ 55 %	X	X
Static Characteristics after ageing 7 d at 70 °C according to ISO 188	F_i = approval initial value of preset force F_p = piece value After ageing $F_p = F_i \pm 8$ %	X	–
Static Characteristics after ageing 7 d at 50 °C according to ISO 188	F_i = approval initial value of preset force F_p = piece value After ageing $F_p = F_i \pm 8$ %	–	X

C.1.4 Static characteristics of the sets

Test shall be carried out according to Annex D, on the elastic system with or without housing.

For series tests, the maximum static absorbed and stored capacity deviations are ± 20 % compared to the type test, with the respect of the values of Table 4.

C.1.5 Dynamic characteristics of the sets

To be carried out according to Annex E.

C.1.6 Bonding

If applicable, test procedures or requirements shall be defined.

C.1.7 Marking

Unless otherwise specified, the following markings shall be applied, if possible on a lateral surface:

— supplier’s stamp;

— batch number or serial number or month and the last two digits of the manufacturing year.

— marking of the material in according to EN ISO 11469, if applicable.

C.1.8 Inspection and tests

The number of the type or series tests shall be in accordance with Table C.2.

The quantity of series tests shall be minimum one or agreed in the technical specification for a batch comprising less than 40 component parts.

Table C.2 — Nature of inspections and tests

Nature of inspections and tests (if applicable)	**Type test**		**Series test**	
	Level	**Number of tests**	**Level**	**Number of tests**
Spring element: without ageing				
Dimensions	M	2	M	2,5 % per batch
Bonding	M	2	M	2,5 % per batch
Hardness *IRHD* / Shore *D*	M	2	M	2,5 % per batch
Tests (*R*, *A*, *M*)	M	2	M	1 per batch
Compression set (25 %, 50°C/70°C)	M	2		
Compression set (25 %, −30°C)	M	2		
Spring element: after ageing				
Dimensions	M	2	O	2,5 %
Bonding	M	2	O	2,5 % per batch
Hardness *IRHD* / Shore *D*	M	2	O	2,5 % per batch
Tests (*R*, *A*, *M*)	M	2	O	1 per batch
Compression set (25 %, 50°C/70°C)	M	2		
Compression set (25 %, −30°C)	M	2		
Metals:				
Dimensions	M	1	M	5 per batch
Chemical composition	M	1	M	1 per cast
Spring set:				
Dimensions	M	1	M	2,5 % per batch
Static test (Annex D)	M	1	M	1 per batch
Endurance test (Annex F)			O	
Life cycle test (Annex G)	M	1		
Spring set after ageing:				
Static test after 7 d at 70 °C or 50 °C (Annex D)	M	1	O	
Endurance testing under service load (Annex F)	O	1	O	
Key: M: mandatory test O: optional				

C.2 Friction spring/ring spring

C.2.1 Manufacturer's marks

— Rings shall be marked as specified in the technical specification.

— In the absence of a technical specification, the rings shall show the year of manufacture.

— However, when rings are manufactured by rolling, these marks may be replaced by a circular line or groove marked during the rolling process on a curved surface, the shape and position of which will indicate the above information in a conventional code.

C.2.2 Flexibility test

C.2.2.1 Requirements for flexibility test

— After tests the rings should show no breaks, defects, signs of cracking or abrasions.

— The height H_1 (see Figure F.1) shall be within tolerances specified in the drawing.

— During the initial cycle of operations the load deflection ratio shall comply with the specifications of the graph shown on the drawing, allowing for the tolerances provided.

— After 20 compression and release cycles, the new loads recorded, in proportion to the deflection shall comply with the specifications of the graph shown in the drawing, allowing for the tolerances provided.

— After 20 compression and release cycles, the new loads recorded, in proportion to the deflection, shall remain within the same tolerance.

C.2.2.2 Carrying out of the flexibility test

— The flexibility test shall be carried out as follows: the slightly greased rings are stacked in such a way as to form a spring as used in service.

— The stack thus formed is tested as indicated below on a test bench equipped with a chart recording device. The test bench shall be checked at least once a year by an independent body.

— The spring is compressed three times up to the maximum stroke as shown on the drawing and the load maintained, each time, for 1 min up to this stroke.

— The semi-static diagram is recorded. It shall comply with the specifications of the drawing, with allowance for the tolerances.

— The spring is compressed 20 times to the maximum stroke indicated on the drawing and the load maintained, each time, for 30 s, at this maximum stroke.

— The semi-static diagram is recorded. It shall comply with the specifications of the drawing, with allowance for the tolerances.

C.2.2.3 Number of tests

Each batch when submitted shall be subjected to inspections and tests of type and number indicated in Table C.3.

Table C.3 — Number of flexibility tests per batch of springs

Batch size	Number of tests
up to 50	1
51 to 150	2
151 to 300	3
301 to 500	4
501 to 1 000	5

C.2.3 Endurance test

— The test shall use a normally lubricated spring mounted in a buffer case or similar device.

— After the endurance tests the rings shall show no breaks, defects, signs of cracking or abrasions.

— The flexibility test, repeated on the assembled spring after the endurance test, shall give results which comply with the specifications given in the drawing.

— During and after the endurance test, energy absorption shall remain within the limits laid down in the drawing.

— The load frequency shall be chosen in such a way that the temperature of the rings does not exceed 60 °C.

— To ensure that the quality meets the required standards, the test shall be carried out with 5 000 loadings at 85 % of the nominal stored energy.

— When this test has been completed, the value for the absorption load shall not exceed the specified limits.

— This test is only carried out if specifically stated in the contract or appended documents.

C.2.4 Static characteristics for friction spring/ring spring

Test shall be carried out according to Annex D, on elastic system with or without housing.

For serial tests, the maximum static absorbed and stored capacity deviations are ± 20 % compared to the type test, with the respect of the values of Table 4.

C.2.5 Dynamic characteristics for friction spring/ring spring

To be carried out in accordance to Annex E.

C.3 Hydrodynamic or hydrostatic systems

C.3.1 General

Because the elastic system is integral to hydrodynamic or hydrostatic systems their characteristics shall be tested on the capsule.

Because most characteristics of capsules are tested with the buffer, only the following characteristics are measured on the capsule alone.

All parts included in capsules shall be meet an approved control program before assembly on the basis.

C.3.2 Absorbing energy medium

The term “medium” means flowable elastomer, oil, gas or their combination.

The quality of absorbing energy medium shall be tested according to Table C.4.

Table C.4 — Characteristics of absorbing energy medium

Characteristics	Results	Tests for			Type test	Series test (one per batch)
		flowable elastomer	oil	gas		
Properties determined in simple shear condition:	Newtonian viscosity $\eta_0 = (\Psi \pm Y)$	X	–	–	X	X
Properties measured in the following condition on rheometer with plate-plate sensor system: f = 10 Hz; τ = 30 Pa, f = 1 Hz; τ = 30 Pa, f = 0,1 Hz; τ = 30 Pa	complex dynamic viscosity: $\eta^* = (\Psi \pm Y)$ complex modulus: $G^* = (\Psi \pm Y)$	X	–	–	X	X
Density at 15 °C	$\rho = (\Psi \pm Y)$ [g/cm³]	X	X	–	X	X
Kinematic viscosity at 40 °C	$(\Psi \pm Y)$ [cst]	–	X	–	X	X
Kinematic viscosity at 100 °C	$(\Psi \pm Y)$ [cst]	–	X	–	X	X
Viscosity index	$(\Psi \pm Y)$	–	X	–	X	X
Pour point	$(\Psi \pm Y)$ [°C]	–	X	–	X	X
Key: f frequency τ shear stress						
Ψ is the value obtained during the type test. Y is the tolerance in percent [%] and should be defined in the technical specification.						

C.3.3 Static tests of capsules

After assembly and fill up process each capsule shall be subject to static tests, in order to verify the absorbing medium quality and correctness of assembly process.

If the result is in the tolerance of the approved capsule, the capsule passes through the static tests and it may be released for installation in buffers. The results of static tests shall be recorded and archived in the form of a stroke-force diagram.

C.4 Combined elastic systems

When different elastic systems are combined, each elastic system shall conform to the relevant requirements in C.1 to C.3, except for the combined performance.

Annex D
(normative)

Testing of static characteristics of buffers

D.1 Test principle

The test consists of the determination of stroke-force diagram during the compression of the constituent. This test is carried out on a complete buffer system consisting of the elastic system to be tested and a housing conforming to this European Standard.

D.2 Test procedure

For rubber elastomer and rubber systems, tests shall be carried out at least 72 h after assembly.

Test temperature shall be between 15 °C and 25 °C.

The compression phase shall be followed immediately by the decompression phase, and the maximum displacement speed of the plunger in both directions shall be less or equal 0,05 m/s. When fully released, the buffer shall be found to be in the same condition as initially.

Three cycles up to the maximum stroke according to Table 5 are made. The tests shall be arranged in such a way that the elastic system will not be exposed to unacceptable thermal loads.

For this reason, time periods between two complete cycles are permitted but they shall not exceed 10 min.

A stroke-force diagram is recorded during the three cycles, all curves shall be included in the tolerance defined in 5.5.2.

An additional test for hydrodynamic or hydrostatic systems shall be carried out to ensure that the buffer reaction remains virtually constant for 10 min with compressive values of 30 mm, 60 mm and 100 mm respectively.

D.3 Measurements

Measurements are the following:

— stroke of the plunger;

— force.

Parameters are recorded on a force-stroke diagram. Stored energy W_{es} and absorbed energy W_{as} are calculated with the diagram. The speed of the cycle and temperature during the test are also recorded.

Annex E
(normative)

Dynamic testing

E.1 Dynamic testing of buffer

E.1.1 General

The measuring values:

— impact speed;

— buffer load;

— buffer travel;

— acceleration

shall be determined by reference to Table E.2.

The test wagons could be of the following types "Type 1 wagon" [30] or "Type 2 wagon" [30] with the main characteristic given in Table E.1.

Table E.1 — Standard high-sided open wagon

Characteristic	**Type 1 wagon**			**Type 2 wagon**		
Length over buffers	14,040 m			15,740 m		
Length of underframe	12,800 m			14,500 m		
Minimum inside length of floor	12,710 m			14,490 m		
Minimum inside width of floor	2,760 m			2,720 m		
Floor area	approximately 35 m^2			approximately 39,4 m^2		
Capacity	approximately 71 m^3			approximately 82,5 m^3		
Distance between bogie pivots	9,00 m			10,700 m		
Wheelset load	20 t			22,5 t		
Maximum tare	22 t			25 t		
Length of load or distance between supports	3 m	5 m	9 m	3 m	5 m	10,7 m
Loads resting on 2 supports	26 t	30 t	80 t - tare	26 t	30 t	90 t - tare
Uniformly-distributed loads	23 t	27 t	39 t	23 t	27 t	39 t

At least one of the standard high-sided open wagons used as a test wagon should correspond to the buffing wagon as per [30], 3.1. It should be fitted with partitions and reinforced as shown in [34] and loaded with ballast (UIC-ballast: grain size: 31,5 mm to 63 mm; weight per unit volume: 2 900 kg/m^3 to 3 150 kg/m^3).

Table E.2 — Characteristics and requirements with regard to both the test set-up and measuring and technical assessment

	Impact speed v_a km/h	**Buffer force** F_P kN	**Buffer stroke** s_P mm	**Acceleration** m/s²	**Strain** ‰
Transmission/ frequency behaviour of the measuring chain		a	a	a	a
Position of sensor/location of measuring points	Immediately before buffing impact of impact wagon upon stationary wagon	Pressure gauge mounted on the buffer head or between base plate of buffer and headstock/ frame end of test wagon	Two displacement transducers per buffer (above and below the buffer between the base plate and the buffer head)	Centre of test wagon body, where possible at or beneath the centre of the loading area	In keeping with specific plan of measuring points
Maximum value of measured variable	20 km/h	2 000 kN (force per buffer – dynamic)	160 mm	200 m/s²	3 ‰
Mean measuring precision	±1 %	±5 %	±2 %	±2,5 %	±2,5 %
Limiting frequency for filtering [b]	unfiltered	$f \geq 100$ Hz [c]	$f \geq 100$ Hz [c]	$f = 32/40$ Hz	unfiltered
Observations	In specific studies also additional measurement of the speed of the impacted wagon after the buffing impact	Static calibration of the pressure gauge in keeping with equipment mounted on the test wagon (initial tension)	RMS-formation in the case of the electrical measuring signals from the two displacement transducers per buffer	Influence upon the measuring signal from natural oscillation of the fastening component is to be ruled out	The specific characteristics of the strain gauge in use shall be indicated in the test report

[a] Transmission of measuring signals up to a frequency of 1 000 Hz in the case of a drop in amplitude of 1 dB max.

[b] Filtering is basically to be carried out with low-pass filters the Butterworth characteristics and an edge steepness of ≥ 24 dB/octave (4th other and 3 dB in the case of the limiting frequency); the edge steepness shall be indicated in the test report.

[c] Filtering of the buffer force and buffer stroke shall, however, be synchronized; the filter frequency shall be indicated in the test report.

The location where acceleration is to be measured shall be along the longitudinal axis of the underframe, at the centre of the wagon.

For each test, a test wagon at a standstill with brakes off, shall be subjected to an impact from another test wagon on a straight, level track.

Table E.2 and Table E.3 define the appropriate dynamic tests for each buffer category, setting out the wagon type, mass on rails and buffer type for each test wagon used.

E.1.2 Temperature effects

Dynamic tests shall be carried out at a test object temperature of between 10 °C and 25 °C.

Under extreme temperature of - 25 °C and + 50 °C, the characteristics shall not vary more than 20 % from those recorded at ambient temperature.

For buffers used in the temperature range – 40 °C to + 35 °C, buffer under extreme temperature of – 40 °C after releasing of load should return to initial position in short time.

E.2 Dynamic characteristics of 105 mm stroke buffer

E.2.1 Test programme

Test series N°1 (see Table E.3), designed to assess protection of the load, is obligatory.

Test series N°2 (if stipulated in Table E.3) and N°3 designed to assess protection of the wagon structure, are also obligatory.

Test series N°4 and N°5, designed to check that the buffers undergoing testing are compatible with existing Category A buffers, are recommended in cases where the buffers being tested are equipped with a new type of resilient system.

Table E.3 — Wagons – Buffers with a stroke of 105 mm, Definition of dynamic tests

	Category A			Categories B and C		
Test wagons	**Buffing wagon**		**Impacted wagon**	**Buffing wagon**		**Impacted wagon**
Test N°1	2-axle wagon 20 t buffers tested	→	Bogie wagon 80 t buffers tested	2-axle wagon 40 t buffers tested	→	Bogie wagon 80 t buffers tested
Test N°2	2-axle wagon 40 t buffers tested	→	2-axle wagon 40 t buffers tested	Nil		
Test N°3	Bogie wagon 90 t [a] buffers tested	→	Bogie wagon 80 t buffers tested	Bogie wagon 90 t [a] buffers tested	→	Bogie wagon 80 t buffers tested
Test N°4	2-axle wagon 20 t Category A buffer (existing type)	→	Bogie wagon 80 t buffers tested	2-axle wagon 20 t Category A buffer (existing type)	→	Bogie wagon 80 t buffers tested
Test N°5	Bogie wagon 90 t [a] Category A buffer (existing type)	→	Bogie wagon 80 t buffers tested	Bogie wagon 90 t [a] Category A buffer (existing type)	→	Bogie wagon 80 t buffers tested

NOTE

$$\lambda = \sqrt{\frac{\frac{m_1 \times m}{m_1 + m}}{\frac{m_1 \times M}{m_1 + M}}}$$

where

λ is the conversion factor,

m_1 is the stationary wagon mass,

m is the buffing wagon mass of the present type,

M is the buffing wagon mass for testing.

EXAMPLE With m = 90 t, M = 80 t and m_1 = 80 t: λ = 1,03.

[a] A 90 t buffing wagon may be substituted by a 80 t wagon. In this case, the buffing speed shall be increased by a factor λ = 1,03 (impact energy conservation).

In conformity with the conditions contained in E.1.1, each test wagon should be identified by its type, mass on rails and buffer type fitted.

E.2.2 Category A

During the tests defined in Table E.3 the following characteristics shall be obtained.

— **Test N°1:**

With a buffing speed of 7 km/h, no acceleration shall exceed 4,0 g.

With a buffing speed of 9 km/h, no acceleration shall exceed 6,0 g.

— **Test N°2:**

With a maximum end-of-stroke force of 1 000 kN and a buffing speed of 12 km/h or over, the stored energy W_e shall be at least 25 kJ and the absorbed energy W_a shall equal at least 0,6 W_e.

— **Test N°3:**

With a maximum end-of-stroke force of 1 500 kN, the stored energy W_e shall be at least 30 kJ and the absorbed energy W_a shall equal at least 0,6 W_e.

With a buffing speed of 9 km/h, the buffer force shall not exceed 1 000 kN.

— **Test N°4:**

With a buffing speed of 7 km/h, no acceleration shall exceed 4,0 g.

With a buffing speed of 9 km/h, no acceleration shall exceed 6,0 g.

— **Test N°5:**

With a maximum end-of-stroke force of 1 500 kN, the stored energy W_e shall be at least 30 kJ and the absorbed energy W_a shall equal at least 0,6 W_e.

With a buffing speed of 9 km/h, the buffer force shall not exceed 1 000 kN.

E.2.3 Category B

During the tests defined in Table E.3 the following characteristics shall be obtained.

— **Test N°1:**

With a buffing speed of 7 km/h, no acceleration shall exceed 4,0 g.

With a buffing speed of 9 km/h, no acceleration shall exceed 5,0 g.

— **Test N°3:**

With a maximum end-of-stroke force of 1 500 kN, the stored energy W_e shall be at least 50 kJ and the absorbed energy W_a shall equal at least 0,6 W_e.

With a buffing speed of 10 km/h, the buffer force shall not exceed 1 000 kN.

However for test N°3, it is recommended that the end-of-stroke force shall not exceed 1 300 kN.

— **Test N°4:**

With a buffing speed of 7 km/h, no acceleration shall exceed 4,0 g.

With a buffing speed of 9 km/h, no acceleration shall exceed 5,0 g.

— **Test N°5:**

With a maximum end-of-stroke force of 1 500 kN, the stored energy W_e shall be at least 50 kJ and the absorbed energy W_a shall equal at least 0,6 W_e.

With a buffing speed of 10 km/h, the buffer force shall not exceed 1 000 kN.

E.2.4 Category C

During the tests defined in Table E.3 the following characteristics shall be obtained.

— **Test N°1:**

With a buffing speed of 7 km/h, no acceleration shall exceed 3,0 *g*.

With a buffing speed of 9 km/h, no acceleration shall exceed 4,0 *g*.

— **Test N°3:**

With a maximum end-of-stroke force of 1 300 kN, the stored energy W_e shall be at least 70 kJ and the absorbed energy W_a shall equal at least 0,6 W_e.

With a buffing speed of 10 km/h, the buffer force shall not exceed 1 000 kN.

However for Test N°3, it is recommended that the end-of-stroke force shall not exceed 1 000 kN.

— **Test N°4:**

With a buffing speed of 7 km/h, no acceleration shall exceed 3,5 *g*.

With a buffing speed of 9 km/h, no acceleration shall exceed 4,5 *g*.

— **Test N°5:**

With a maximum end-of-stroke force of 1 300 kN, the stored energy W_e shall be at least 70 kJ and the absorbed energy W_a shall equal at least 0,6 W_e.

With a buffing speed of 10 km/h, the buffer force shall not exceed 1 000 kN.

E.2.5 Comments on the test conditions

a) Filtering at 32/40 Hz is specially intended to examine the behaviour of the wagon, its fittings, the commodities loaded, etc.

   The dynamic characteristic thus recorded gives a more exhaustive idea of the dynamic phenomena which occur in the course of an impact between wagons (see also [31]).

b) The accelerations specified for Categories A, B and C should be taken as limit values not to be exceeded with a view to improving the protection of the vehicle.

c) The maximum values specified for the accelerations measured during Test N°1 and Test N°4 include the tolerance ranges of the measuring equipment.

d) From the point of view of the protection of the load, it is advisable to bring down the upper limit values for accelerations for Test N°1 and Test N°4. This applies particularly to recent buffer designs.

E.3 Dynamic characteristics of 150 mm stroke buffer

E.3.1 General

The minimum characteristics with which the “L” buffers shall comply are laid down in Table E.4 and shall be demonstrated by testing. Tests N°1 to N°5 in Table E.4 are obligatory.

— Test N°1 is designed to assess the protection of the load during an impact of two wagons which are both fitted with Group “L” buffers.

— Test N°3 is designed to assess the protection of the vehicle structure during an impact of two wagons which are both fitted with Group “L” buffers.

— Test N°4 is designed to assess the protection of the load during an impact, where the moving wagon is fitted with the test buffers and the stationary wagon with a Category A buffers according to this document.

— Test N°5 is designed to assess the protection of the vehicle during an impact, where the moving wagon is fitted with the test buffers and the stationary wagon with a Category A buffers according to this document.

Table E.4 — Definition of dynamic tests

	Test wagon						**Speed** km/h	**Acceleration** g		**Force** kN
	Buffing wagon			**Stationary wagon**				**filtered at/for**		**unfiltered**
Test N°	40 t, bogie wagon	90 t, bogie wagon [a]	Buffers to be tested	80 t, bogie wagon	Buffer Category A	Buffer to be tested		Hz	150 mm	150 mm
1	X	—	X	X	—	X	10	32/40	2,4	—
2	None									
3	—	X	X	X	—	X	12	32/40	—	1 000
4	X		X	X	X	—	10	32/40	2,0	—
5	—	X	X	X	X	—	12	32/40	—	1 200

[a] A 90 t buffing wagon may be substituted by a 80 t wagon. In this case, the buffing speed shall be increased by a factor λ = 1,03 (impact energy conservation).

The spring system shall be able to withstand standard stress equivalent to a buffer load of ≥ 2 000 kN without damaging or restricting its function.

The energy absorbed by the spring system shall be at least 60 % of the storage capacity (W_e). The dynamic storage capacity shall be the value determined during Test N°3 (Table E.4).

E.3.2 Comments on test conditions

Filtering at 32/40 Hz is designed particularly to study the behaviour of the wagon, of its fittings and loads, etc. The dynamic characteristic recorded in this way gives the most exhaustive indication of the dynamic phenomena which occurs during buffing between wagons (see also [31]).

The maximum values shown for the accelerations measured during Tests N°1 and N°4 includes the ranges of tolerance of the measuring instruments.

E.4 Dynamic characteristics of 110 mm stroke buffer

Dynamic characteristics of 110 mm stroke buffers shall be obtained as indicated in Table E.5.

Compliance with the dynamic characteristics shall be demonstrated through impacts between a bogie wagon (mass 80 t) with rubber buffers Type A and a coach (mass approximately 45 t) fitted with the buffers to be tested.

Table E.5 — Dynamic characteristics of 110 mm stroke buffers

	Buffer with 110 mm stroke with conventional springs	**Buffer with 110 mm stroke with hydrodynamic and hydrostatic springs**
Impact speed		at least 10 km/h
Compressive force	≤ 1 000 kN	≤ 750 kN
Recorded stroke		≤ 95 % of maximum stroke
Stored energy (W_e)	≥ 10 kJ	≥ 25 kJ
Absorbed energy (W_a) [kJ]	≥ 0,6 W_e	≥ 0,8 W_e

The dynamic tests shall be carried out in an ambient temperature of between 10 °C and 25 °C.

At extreme temperatures of - 40 °C and + 50 °C, the buffer characteristics shall not differ by more than 20 % from those recorded in an ambient temperature of between 10 °C and 25 °C. Additionally, buffers with stroke of 110 mm with hydrodynamic and hydrostatic springs shall be subjected to specific endurance and buffing tests:

— Buffing tests at a buffing speed of 10 km/h;

— Endurance test under alternate stresses.

The conditions for these tests are given in G.2.

Annex F
(normative)

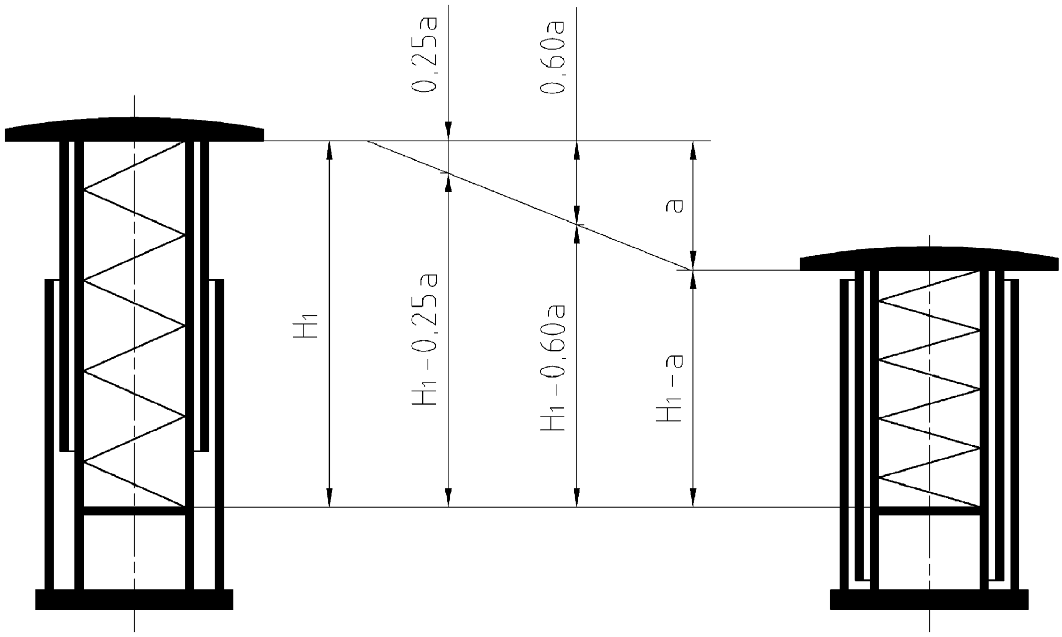
Endurance testing under service load for elastic system

F.1 Aim of the test

The aim of this test is to verify the fatigue performance of the product when functioning under short stroke conditions (behaviour in curves and S-curves and during braking).

F.2 Test principle

Test the elastic system with 10 000 compressive cycles between heights (H_1 – 0,25 a) and (H_1 – 0,60 a) (Figure F.1).



Key

a	nominal buffer stroke
H_1	preset height of the elastic system in a buffer without stress
(H_1 – a)	height of the elastic system at the end of the buffer stroke

Figure F.1 — Definition of heights

At the end of this test, a new stroke-force diagram is plotted.

F.3 Test results to be obtained

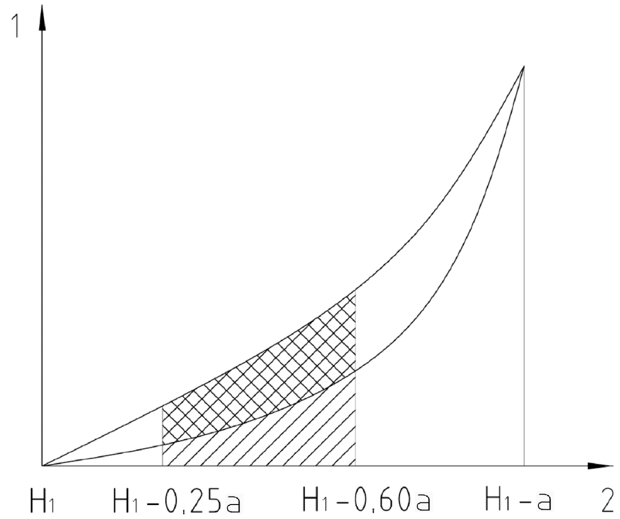
The functioning of the buffer is considered to be acceptable if the deviations relative to the initial static characteristics measured between (H_1 – 0,25 a) and (H_1 – 0,60 a) do not exceed:

— ± 20 % for the force;

— ± 10 % for the stroke;

— ± 20 % for the energies W_e and W_a, see Figure F.2.

In addition, neither degradation of the elastic system nor loss of oil (hydrodynamic system) or gas shall be noted during or at the end of the endurance test under service load.



Key

1 force

2 stroke

H_1 height of elastic system

a stroke of elastic system

(hatched) stored energy W_e

(hatched) absorbed energy W_a

Figure F.2 — Representation of the stored energy

F.4Test procedure

F.4.1 Endurance test assembly

The elastic system is placed in an assembly that ensures it can be guided and kept at the installation height in a buffer of its category (H_1). Guidance can be ensured either by means of a central pin or by external guides. In addition, the assembly shall be fitted with a device for centring the elastic system relative to the guides. During the tests, the relative travel of the elastic system shall not cause any contact with the guide pins.

The guiding device shall allow the device under test to be easily ventilated.

F.4.2 Preliminary static test

With elastic system being kept flanged in its assembly at height H_1 for a minimum of 72 h, the stroke-force diagram is plotted under the conditions of D.2.

The stored energy W_e and absorbed energy W_a between (H_1 – 0,25 a) and (H_1 – 0,60 a) are then measured.

F.4.3 Endurance test

For the endurance test, the elastic system is subjected in a press to 10 000 compression cycles between [(H_1 – 0,25 a) ± 2] mm and [(H_1 – 0,60 a) ± 2] mm at a rate of (4 ± 2) cycles/min.

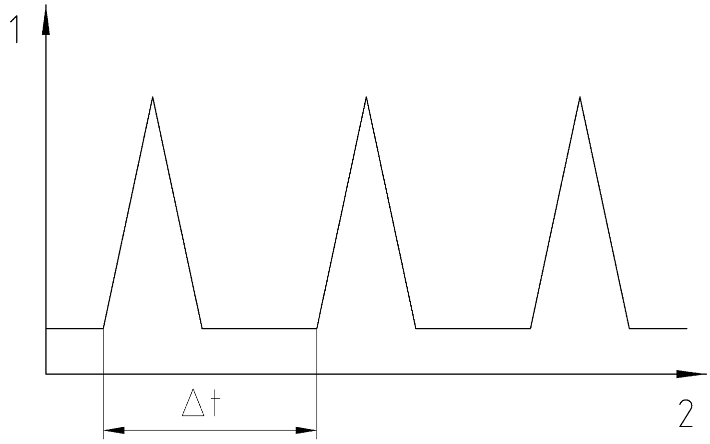
Each cycle comprises:

— compression;

— decompression;

— a rest period.

Compression and decompression are at a constant speed of between 10 mm/s and 20 mm/s (Figure F.3). The maximum temperature of the elastic system during the test shall be defined by agreement with the supplier. This maximum permissible value shall not be less than 40 °C. If necessary, ventilation can be used.



Key

1 compression/decompression, in mm

2 time, in s

Δt period

Figure F.3 — Endurance test under service load

F.4.4 Final static test

The elastic system is subjected to the following operations:

— detachment of the system and rest for (24 ± 4) h;

— replacing of the elastic system in its assembly or buffer housing, flanged at height H_1, for (24 ± 4) h;

— execution of the static compression test and measurement of the energies W_e and W_a [(H_1 - 0,25 a) ± 2] mm and [(H_1 – 0,60 a) ± 2] mm.

The forces, strokes and energies recorded before and after the endurance test are compared.

Annex G
(normative)

Endurance testing under buffing load for life-cycle simulation

G.1 Endurance tests for elastic systems for wagons

G.1.1 Aim of the test

The dynamic tests specified in the following clauses are certification tests and not acceptance tests as part of the quality control process.

G.1.2 Test principle

The test consists of subjecting an elastic system to 13 200 compression cycles repeated at three stroke levels and afterwards verifying that its static characteristics are maintained.

G.1.3 Test results to be obtained

The stored energy (W_e) shall be at least equal to 80 % of the value measured under the same conditions during the static compression test carried out before the three endurance test cycles.

The absorbed energy (W_a) shall be at least equal to 80 % of the corresponding value measured before the three cycles of the endurance test (under the same conditions).

G.1.4 Test procedure

G.1.4.1 Assembly for the endurance test

The elastic system shall be placed in a guided assembly or in a housing.

G.1.4.2 Preliminary static test

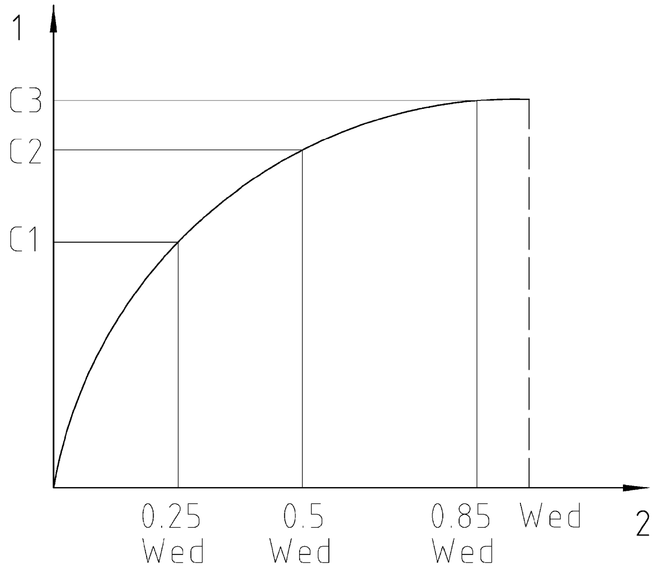
With the elastic system being kept flanged in its test assembly at height H_1 for a minimum of 72 h, the stroke - force diagram is plotted under the conditions of D.2.

The stored energy W_{es} and absorbed energy W_{as} are then measured.

G.1.4.3 Type test for spring systems by endurance test

For the test with repeated compressions on a press, the sequence of operations shall be as follows:

On the basis of the dynamic stroke-force diagrams obtained during the buffing tests at increasing speed (see Annex E), shall be plotted the stored energy against the stroke in a diagram (see Figure G.1).



Key

1 stroke [mm]

2 stored energy [kJ]

Figure G.1 — Determination of the buffer strokes for endurance test

From this derive the strokes C_1, C_2 and C_3 corresponding to 0,25 W_{ed}, 0,50 W_{ed}, 0,85 W_{ed} respectively, W_{ed} being the minimum specified value of the stored energy for the buffer categories, i.e.:

— 30 kJ for Category A buffers;

— 50 kJ for Category B buffers;

— 70 kJ for Category C buffers.

For buffers with 105 mm stroke, proceed in accordance with Test N°3 of Table E.3.

For buffers with 150 mm stroke, proceed in accordance with Test N°3 of Table E.4.

Test equipment for the endurance tests is:

— wagon impact test or,

— pendulum test stand or,

— drop hammer or,

— installation simulating an impact ramp or,

— test bench following the recommended values where the 200 tests at C_3 level are impact tests as proposed in the first four bullets.

The elastic system is subjected on endurance test equipment to the following continuous test programme:

Three sequences each consisting of 3 000 cycles at C_1 followed by 1 200 cycles at C_2 and then 200 cycles at C_3 are performed. Alternatively, the three blocks at C_3 level could be done at the beginning of the test in one sequence or use a random distribution of cycles in respect of the total number of cycles at each level.

The total number of test cycles is 13 200.

The maximum external temperature of the elastic system during the test shall be defined in the technical specification. This maximum permissible temperature cannot be less than 40 °C. If necessary, a ventilation system can be used. As a guide, the following values are recommended:

— stroke C_1: 1 cycle per 60 s;

— stroke C_2: 1 cycle per 90 s;

— stroke C_3: 1 cycle per 120 s.

Each cycle comprises:

— compression;

— decompression;

— a rest period.

G.1.4.4 Final static test

The elastic system is subject to the following operations:

— carrying out the static test after a rest period of at least 24 h;

— execution of the static compression test and measurement of the energies W_{es} and W_{as}.

W_{es} is then compared to the stored energy recorded before the endurance test.

G.1.4.5 Additional test for elastic elements including tightness elements

An additional test is required for spring elements for which the elastic force is mainly related to the compression speed and which are fitted with tightness elements.

For the examination of the behaviour of the tightness elements, it is necessary to carry out, in addition to the main cycle to be repeated three times, the following cycle, which shall also be repeated three times:

$15\,000 \cdot 0{,}25\, f_D$ (f_D = maximum elasticity stroke of the element in the mounted condition);

$15\,000 \cdot 0{,}10\, f_D$.

It is permissible to use a second spring element for these tests.

These tests shall be carried out on a press; the test speed shall be between 0,05 m/s to 0,3 m/s.

Before and after each series of three cycles, the dimension of the cylinder and piston, as well as those of the tightness elements, shall be measured. The wear noted shall not adversely affect the operation.

G.1.5 Delivery of elastic systems

Characteristics to be verified for the delivery of elastic systems shall be stated in the technical specification.

G.2 Endurance tests for elastic systems for coaches

G.2.1 General

These tests shall be carried out only on hydrodynamic and hydrostatic buffers.

The aim of the tests described below is to ascertain the extent to which buffers are able to withstand the overall range of compressions occurring in service conditions over a logged distance of approximately 1 million kilometres.

These tests shall be carried out on two buffers or on two complete spring damper systems.

The following repeated load patterns have been established for the tests to be carried out on each of the buffers:

— 15 repeated buffing impacts between a wagon weighing 80 t and a coach weighing 45 t,

— tests under alternating loads,

— 15 repeated buffing impacts between a wagon weighing 80 t and a coach weighing 45 t.

G.2.2 Tests under alternating loads

The buffer to be examined shall be subjected to the following loads given in Table G.1 or Table G.2 depending of the type of the elastic system, on a suitable test bench.

Table G.1 — Hydrodynamic buffers

Buffer stroke mm	**Number of cycles** (compression expansion)
10	16 000
30	6 000
50	800
75	30

Table G.2 — Hydrostatic buffers

Buffer stroke mm	**Number of cycles** (compression expansion)
15	27 000
40	3 000
55	450
75	10

This load aggregate shall be repeated 30 times.

The speed of buffer depression and return shall be constant at 3 mm/s. The pulsation rate may be adapted in the case of elements overheating to an unacceptable degree.

Maximum permissible overheating levels shall be stated in the technical specification.

G.2.3 Repeated buffing tests

The buffers tested shall be subject to 15 buffing impacts at a speed of 10 km/h before and after carrying out the tests described in G.2.2. The tests shall be performed in accordance with 5.5.3 as far as the vehicles and conditions are concerned. The coach may be replaced by a wagon with the same mass or the tests carried out using test devices to simulate equivalent conditions.

All the beginning and at the end of the tests, a stroke-force diagram shall be drawn up and the W_e and W_a absorbed capacity in static mode and dynamic mode duly determined.

No unacceptable overheating shall occur in the spring systems during buffing tests.

G.2.4 Conditions to be observed

Once the tests are completed, the component parts of the buffers shall be examined.

Any changes affecting the component parts shall not lead to unacceptable differences in their dimensions or endanger the working of the parts concerned.

No cracks shall have occurred.

Small losses of oil, gas or elastomer are permissible. The buffer shall be considered to be working satisfactorily when the differences in relation to initial static and dynamic characteristics do not exceed the following values:

— ± 20 % for force;

— ± 10 % for stroke;

— ± 20 % for W_e and W_a energy.

However, the maximum values laid down in Table 5 shall not be exceeded.

Annex H
(informative)

Guidelines for buffer head materials

H.1 Example of test program requirements for verification of buffer head materials

Table H.1 gives an example of a test program and requirements for verification of the buffer head materials.

Table H.1 — Verification of buffer head materials

Requirements under test	Proof of compliance
General requirements for buffer head materials	Operating trials Prior to approval of buffer head materials, trials in service over a period of at least one year shall be performed and documented in a report. All studies and trials carried out shall be documented in a concise report together with a declaration of conformity.
Roughness value of the surface condition of buffer heads	Documentation in a report on measured roughness and hardness values.
Compatibility of buffer head materials	Proof of compliance shall be provided by theoretical studies or tests where necessary. Study report and information on other materials studied; a declaration of conformity shall be provided. In the case of non-metallic materials, a product description and a materials data sheet shall be provided. Details of proof to be provided.
Function of buffer head materials [a] Friction tests — temperature + 50 °C — normal force: in steps 100 kN, 150 kN and 250 kN without changing the buffer heads — transverse movement: ± 50 mm — 1 cycle: 1 000 — opposite material: same material, steel, all materials contained in Annex F. Impact test — temperature: - 40 °C and + 50 °C — buffing test 90 t against 80 t at 12 km/h using Category A buffers. Alternatively, the test can be carried out on a pendulum rig in equivalent conditions. — opposite buffer head: Same material and steel. If results are ambiguous,	Friction and impact tests performed on buffer heads shall not generate any shelling, cracks or delaminating with tempering colours. A sliding motion over the surface of the buffer head with a small smooth object shall not result in any stick/slip movements, because this would indicate the presence of unacceptable sharp-edged surface damage. For metallic materials, proof of compliance via the characteristic values in the EN Standards shall be provided for the metals concerned. For non-metallic materials, proof of compliance shall be provided via the characteristic values and in rig tests (friction tests and impact tests in the given temperature ranges). Documentation of the studies in test reports.

Requirements under test	Proof of compliance
supplementary tests shall be performed with other buffer head materials contained in I.2	
Strength of buffer head materials Test "durable strength" The buffer head material under study (with the usual grease, oils and cleaning chemicals applied) is in each case subjected in the open to UV rays and other weather conditions for a period of several weeks.	By means of known characteristic values or appropriate tests. Documentation in study and/or test reports.
Running safety Running tests: passenger vehicles Running tests shall be performed with the vehicles and operating conditions considered for application of the buffer head materials under test. Measurement of transverse buffer displacement; wheel/rail forces Pushing tests: wagons In accordance with the conditions in the relevant EN. Tests with opposite buffers from the same material and tests against steel buffers and (possibly) other approved materials from Annex F. The results (permissible longitudinal compressive force) shall be contrasted to a comparative test with the same combination of vehicles equipped with conventional steel buffer heads.	Computer simulations, tests or other means. For wagons, replace running tests by comparative propelling tests in accordance with the relevant EN. A long 2-axle wagon shall be provided as test vehicle. Documentation in study and/or test reports.
Safety test in the presence of material transitions on the buffer head surface	Computer simulations and photographs of respective positions. Study report.
[a] This text is copied from UIC 527–1 but test conditions are not sufficiently defined and shall be stated in the technical specification.	

H.2 Buffer head materials

Table H.2 contains a selection of existing buffer head materials.

Table H.2 — List of selection of existing buffer head materials

Material designation Number	Standard	Buffer head hardened	These material designation number are used among others by following railway undertakings
S355J2+N	EN 10025 (all parts)		FS, SBB, DB
EN-GJS-600–3, EN-JS1060	EN 1563		DB, ÖBB, SBB, SNCB, SNCF
EN-GJS-400–15, EN-JS1030	EN 1563		SBB
GS-52, 1.0552	EN 10293	> 450 HV30	DB
C35	EN 10083–2	> 450 HV30	DB
S355J2+N	EN 10025 (all parts)	(390 to 460) HV30	DB
G25CrMo4V, 1.7218	EN 10083–1		SBB
25CrMo4	EN 10083–3	> 450 HV30	SNCF
42CrMo4	EN 10083–3	> 450 HV30	AAE
34Cr4V, 1.7033	EN 10083–1		SBB
PA 6 G + liquid lubricant			DB, ÖBB, SBB
PA 6 G + solid lubricant			DB, SBB
E 300–520 M equivalent to GE 320	EN 10293	165–215 HBS (see [27])	SNCF
L35GSM	[28]	> 500 HV30	PKP SA
35SG	EN 10083–1 [29]	> 500 HV30	PKP SA

Annex I
(normative)

Calculation of the width of buffer heads

I.1 General

I.1.1 Introduction

This calculation applies to:

— curve transitions of 150 m curves,

— S-curves of 150 m with an intermediate straight of 6 m and sheer S-curves with a radius of 190 m without intermediate straight section.

NOTE Additional information on track geometry is contained in EN 13803 (all parts). The applicable formulae which are shown are based on UIC 527–1.

I.1.2 Comments on the preparation of the formulae in this annex

These formulae are the result of studies to:

a) define a method of calculating the width of buffer heads so that the overlap of the buffers of any two vehicles running on a given track circuit is not less than that of the buffers of two so-called “basic” vehicles running under the same conditions;

b) draw up, subsequently, regulations for the layout of S-curves which, in relation to the track gauge and the radii of the curves, shall determine the length of straight track required to comply with the buffer head dimensions defined above.

I.1.3 Track

— Sheer S-curve with a radius of 190 m without intermediate straight section - Track gauge: 1,458 m;

— S-curve with a radius of 150 m with intermediate straight section of 6,79 m - Track gauge: 1,470 m.

I.1.4 Vehicle

a) Minimum horizontal overlap of 25 mm of two buffer heads in contact, with vehicles running on tracks, as defined in I.1;

b) These conditions led a so-called “basic” vehicle to be adopted, with the following characteristics:

1) Distance between end axles or bogie pivots: 12 m;
2) Distance between the buffer face and the end axles or bogie pivot: 3 m;
3) Internal clearance of the vehicle: 5 mm;
4) Wheelset clearance on a track 1 470 mm wide: 30 mm.

I.2 Data used in the calculation

$$F = \frac{an_a + n_a^2}{300\,000} \tag{I.1}$$

$$k = \frac{n_a + a}{a} \quad \text{for bogie vehicles.} \tag{I.2}$$

$$k = \frac{2n_a + a}{a} \quad \text{for all other vehicles.} \tag{I.3}$$

where

- *a* is the distance, in mm, between end wheelsets or bogie pivots of the vehicle concerned;
- n_a is the overhang, in mm, of the buffer face in relation to the end wheelsets or bogie pivot;
- *k* is the coefficient of displacement of vehicle.

NOTE *F* is the geometrical overthrow named dg_a in EN 15273–1.

I.3 Calculation

The half-width $\frac{\Delta}{2}$ of the buffer heads shall not be less than:

$$\frac{\Delta_1}{2} = 30k + 130 - \frac{p^2}{1\,200\,000} \quad \text{when } F \leq 150 \text{ and } (a + n_a) \leq 15\,000 \tag{I.4}$$

$$\frac{\Delta_2}{2} = F + 30k - 20 - \frac{p^2}{1\,200\,000} \quad \text{when } F \geq 150 \text{ and } n_a \geq 3\,000 \tag{I.5}$$

when $(a + n_a) > 15\,000$ and $n_a < 3\,000$:

$$\frac{\Delta_3}{2} = \frac{\Delta_1}{2} + \frac{(a + n_a - 15\,000)^2}{300\,000\left(\frac{a}{n_a} - 4\right)} = \frac{\Delta_2}{2} + \frac{(3\,000 - n_a)^2\left(\frac{a}{n_a} + 1\right)}{60\,000\left(\frac{a}{n_a} - 4\right)} \tag{I.6}$$

where

- *p* is the bogie wheelbase (*P* = 0 for 2-axle vehicles);

NOTE 1 If the calculated half width of the buffer head does not infringe the defined internal limit, the calculation methodology is valid for the vehicle specification given in Table I.1.

Table I.1 — Vehicle specification and valid methodology

No	Type of vehicle	Additional conditions	Formulae	Calculation with multibody simulation	Drawing
1	Vehicles equipped with symmetric buffers	the own play of the vehicle is only influenced by the design of the running gear (no own play due to the centre pivot)	Yes	Yes	Yes
2	Other wagons and on track machines		No	Yes	Yes
3	Locomotives equipped with symmetric buffers Or with asymmetric buffers that do not infringe the internal limit by calculation with the formulae	has restoring force on car body by lateral displacement on the bogie due to secondary springs is equipped with yaw bump stop	Yes	Yes	Yes
4	Other locomotives		No	Yes	Yes
5	For coaches equipped with asymmetric buffers	that do not infringe the internal limit by calculation with the formula	Yes	Yes	Yes
6	For coaches equipped with asymmetric buffers	which infringe the internal limit by calculation with the formula	No	Yes	Yes

NOTE 2 When the demonstration of buffer overlap is carried out on type of vehicles “No 1” and “No 3” and its combination with other vehicles, $j1$ = 5 mm can be used for all vehicles.

a) Drawing methodology:

The demonstration of the absence of buffer locking risk for a vehicle shall be realized in the followed configurations for the two tracks defined in I.1.3:

1) the vehicle coupled to one of the same type;

2) the vehicle coupled with the basic vehicle defined in the body of the standard, this vehicle being equipped with buffers with 400 mm width and 340 mm height:

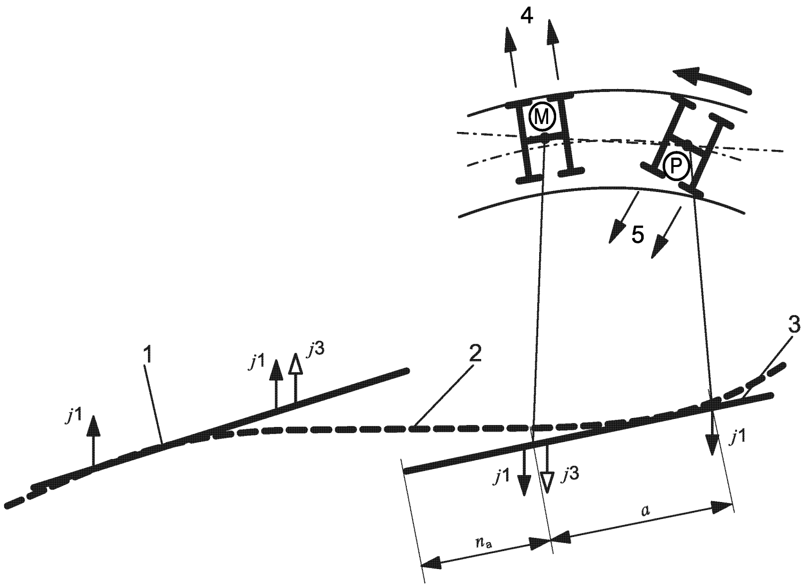
3) the vehicle coupled with a vehicle according to the technical specification.

The position of the vehicles shall fulfil these assumptions.

NOTE 3 The position of the vehicle (coefficient of displacement) is in conformity with the formulae above.

4) Bogie vehicles:

$$k = \frac{n_a + a}{a} \quad (I.2)$$



Key

1 vehicle 1

2 intermediate straight

3 vehicle 2

4 wheel sets 30 mm outside from the centre line of the track

5 first wheel sets 30 mm inside from the centre line of the track, second wheel set 30 mm outside

*j*1 is the assumed internal lateral displacement of the vehicle

*j*3 is the assumed wheelset clearance in a track

a is the distance, in mm, between bogie pivots of the vehicle concerned

n_a is the overhang, in mm, of the buffer face in relation to bogie pivot

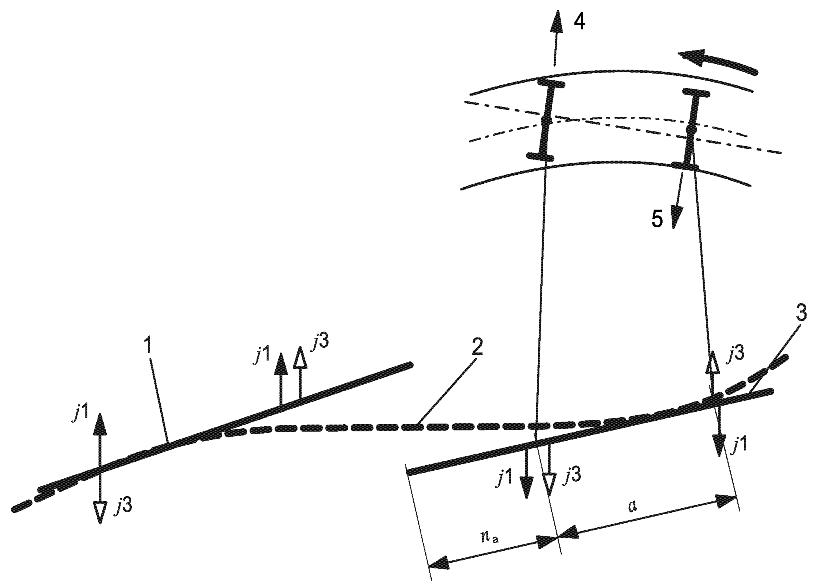
M is the powered bogie

P is the non powered bogie

Figure I.1 — The position of the bogie vehicles in the track

5) Other vehicles (non bogie vehicles):

$$k = \frac{2n_a + a}{a} \quad (I.3)$$



Key

1 vehicle 1

2 intermediate straight

3 vehicle 2

4 wheel sets 30 mm outside from the centre line of the track

5 wheel sets 30 mm inside from the centre line of the track

*j*1 the assumed internal lateral displacement of the vehicle

*j*3 the assumed wheelset clearance in a track

a is the distance, in mm, between end wheel sets of the vehicle concerned

n_a is the overhang, in mm, of the buffer face in relation to the end wheel sets

Figure I.2 — The position of the other vehicles (non bogie vehicles) in the track

Assumed wheelset clearance in a track (*j*3) and the assumed internal lateral displacement of the vehicle (*j*1) depend on the vehicle design.

The demonstration of the absence of buffer locking risk for a vehicle should be made in a track configuration defined in the technical specification.

b) Simulation methodology:

The demonstration of the absence of overlapping risk for a vehicle shall be made with a Multibody Software for the following configurations for the 2 tracks defined in I.1.3:

1) the vehicle coupled to one of the same type;

2) the vehicle coupled to the basic vehicle defined in I.1.4, this vehicle being equipped with buffers with 350 mm width and 340 mm height;

3) in operating conditions (to be defined).

Annex J
(normative)

Crashworthy buffers for tank wagons

J.1 Requirements on crashworthy buffers

J.1.1 Objectives

Crashworthy buffers for wagons subjected to dangerous goods regulation shall be designed to fulfil the following objectives:

— the crashworthy buffer shall not be triggered when buffed with a loaded tank wagon at a speed of less or equal 12 km/h;

— the total energy that can be absorbed through elastic and plastic deformation of the buffer shall be greater than or equal 400 kJ for new wagons or greater than or equal 250 kJ for refitted wagons;

— the energy absorption of up to 250 kJ or 400 kJ shall not lead to any plastic deformation of the tank body.

NOTE Requirements on wagons subjected to dangerous goods regulation are given in RID, 6.8.4, TE22.

J.1.2 Additional requirements

a) The force to trigger the plastic deformation shall be greater than 1 500 kN in static and dynamic mode;

b) the mean force of the plastic deformation of the crashworthy buffer shall be less or equal 2 200 kN in order to limit the deceleration and to avoid climbing;

c) a plastic deformation indicator device shall be fitted as an integral part of the buffer. This device shall:

   1) remain clearly visible throughout the service life of the buffer;

   2) respond to any plastic deformation of the buffer of greater or equal than 10 mm;

d) crashworthy buffers shall be identified with a letter “X” placed alongside the buffer category code (e.g. “AX”, “BX” or “CX”).

J.2 Test procedure for crashworthy buffers

In order to obtain a general acceptance for a crashworthy buffer (to be put into service freely), the following test procedure shall be performed with crashworthy buffers with a temperature between 10 °C and 25 °C:

a) It shall be shown in an impact test with two crashworthy buffers that they are not triggered when impacted at a speed of 12 km/h.

   The configuration of the vehicles in this test should be based on those described in EN 12663-2, test conditions for buffing tests. The impact test vehicle (80 t filled with ballast and equipped with standard buffers) shall comply with EN 12663-2. The stationary vehicle shall be a four-axle tank wagon filled to at least 95 % of the tank capacity with water. If the mass of this vehicle deviates from the target value of 90 t, the impact speed in the test shall be modified so that the same kinetic energy of a 90 t mass vehicle with a speed of 12 km/h will occur.

b) A further dynamic test shall be done with the two crashworthy buffers tested under J.2 a).

The test shall be done with two wagons or on a test bench at an impact speed of 5 m/s to 15 m/s. The speed shall be chosen in order to achieve at least 75 % of the plastic-deformation nominal stroke. The force signal is measured at a sampling rate according to EN 12663-2. The force which causes the plastic deformation of the crashworthy buffer shall be measured with a sampling rate of at least 1 000 Hz and shall be more than 1 500 kN.

If the required energy absorption per buffer of 400 kJ or 250 kJ is not obtained for the two tested buffers, additional tests according to J.2 c) shall be done.

c) A quasi-static test shall be done with an additional crashworthy buffer over the complete nominal deformation stroke (both elastic and plastic) at a speed of maximum 5 mm/s. The force progression is measured depending on the deformation stroke which builds up the absorbed energies. The force which triggers plastic deformation shall be greater than 1 500 kN.

The energy absorption capacity of the crashworthy buffer as calculated from the results of the dynamic test shall be:

$W_d \geq 400$ kJ for wagons built after 1st January 2005;

NOTE 1 For wagons built before the 1st January 2005, the minimum value of W_d is 250 kJ.

when using the following formula:

$$W_d = W_s + \overline{F_d} \cdot s_p \tag{J.1}$$

where:

W_d is the total energy absorption capacity

W_s is the energy absorption capacity of the nominal elastic stroke from Test J.2 a)

$\overline{F_d}$ is the mean force from the plastic stroke from Test J.2 b).

s_p is the total plastic deformation stroke from Test J.2 c)

NOTE 2 For this calculation, when the end of the elastic stroke cannot be clearly determined from the test result, it is considered that the plastic stroke starts at the end of the nominal elastic stroke.

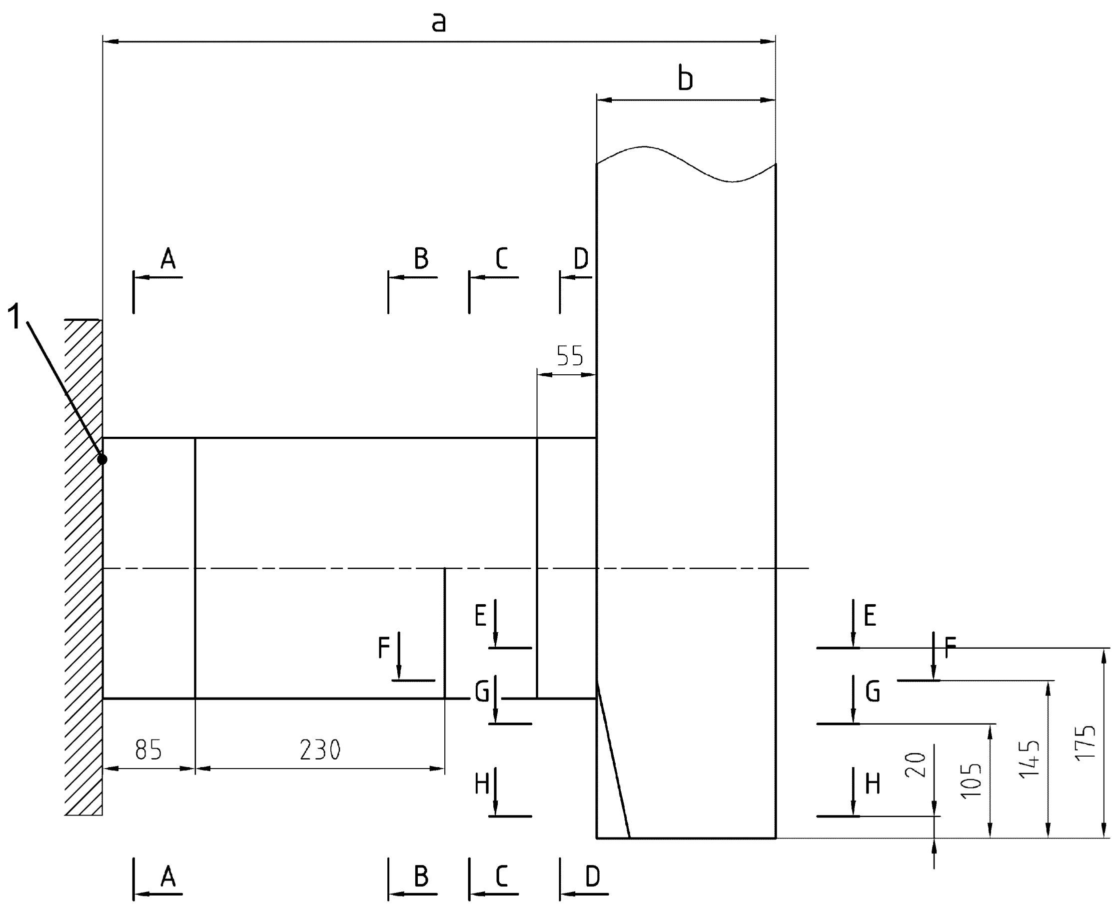
Annex K
(normative)

Maximum space envelope of crashworthy buffers

Figure K.1 shows the dimension of the maximum space of the buffers and Figures K.2 to K.6 show the according cross sections.

This maximum space envelope is for the buffer before any plastic deformation.

Dimensions in millimetres



Key

1 headstock/buffer plate

		Stroke 105 mm [mm]	Stroke 150 mm [mm]
a	total length of buffer in uncompressed condition	620	665
b	space envelope of the buffer plate (thickness of the buffer plate including buffer hub)	165	210

NOTE For the cross sections A – A to H – H see Figures K.2 to K.6.

Figure K.1 — Dimension of the maximum space of the buffer

Dimensions in millimetres

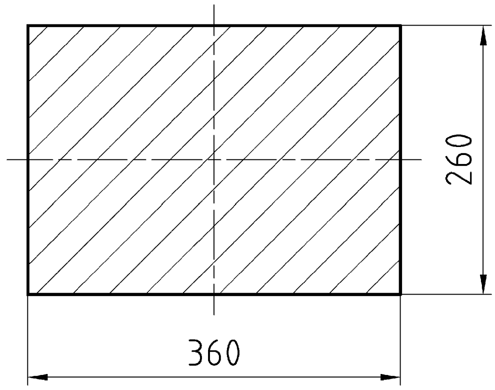


Figure K.2 — Cross section A – A

Dimensions in millimetres

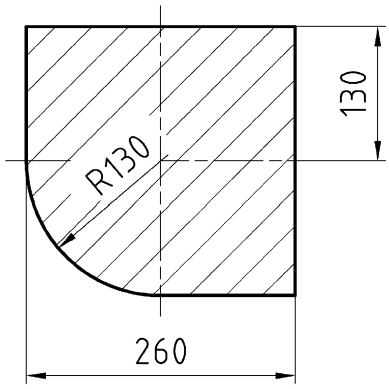


Figure K.3 — Cross section B – B

Dimensions in millimetres

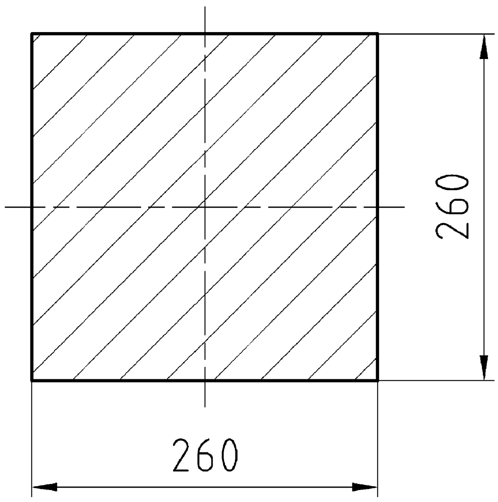


Figure K.4 — Cross section C – C

Dimensions in millimetres

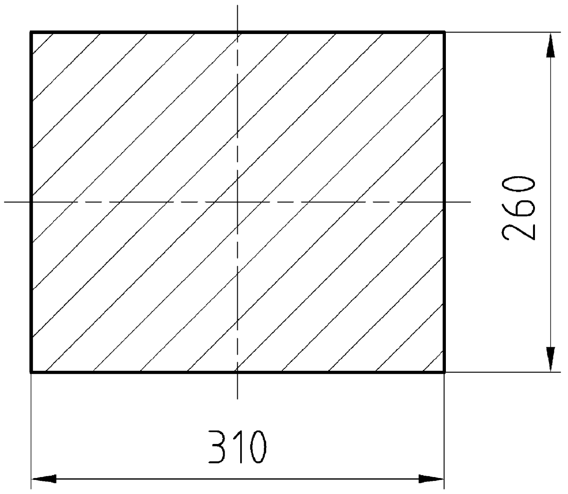
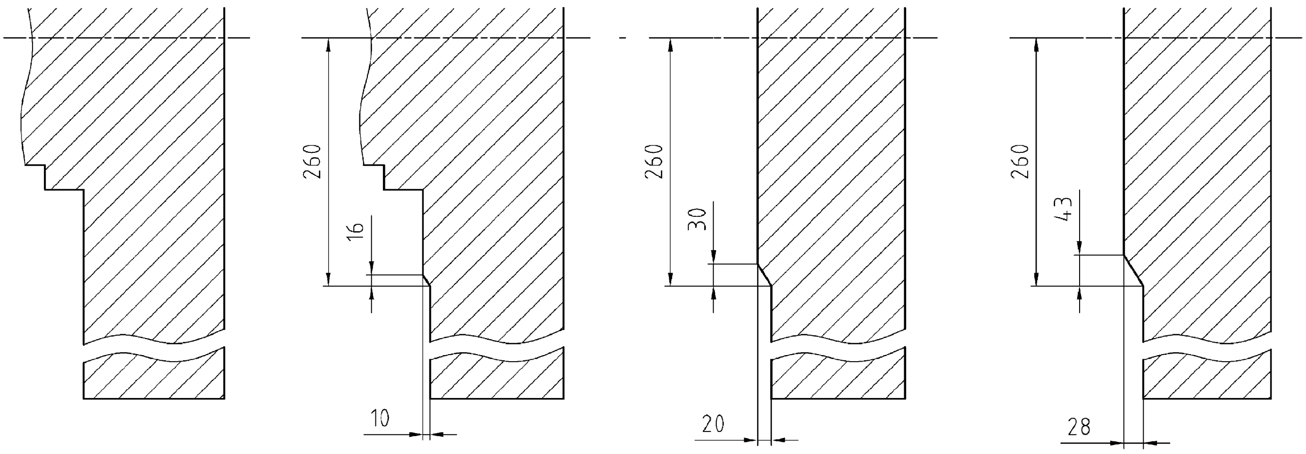


Figure K.5 — Cross section D – D

Dimensions in millimetres



a) E – E **b) F – F** **c) G – G** **d) H – H**

Figure K.6 — Dimension of the buffer: Cross section E – E, F – F, G – G and H – H

For new development of crashworthy buffers with high absorption energy, a bigger diameter for a crashworthy buffer tube may be used. Therefore the cross section A - A may be square with the measurements (360 mm × 360 mm), cross section B - B with $R = 180$ mm and the dimensions (360 mm × 180 mm) instead of (260 mm × 130 mm), cross section C - C with the measurements (360 mm × 360 mm) and cross section D - D also with the measurements (360 mm × 360 mm).

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the Directive 2008/57/EC[1)].

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 for Freight wagons and Table ZA.2 for Locomotives and Passenger Rolling Stock confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

1) This Directive 2008/57/EC adopted on 17 June 2008 is a recast of the previous Directives 96/48/EC ‘Interoperability of the trans-European high-speed rail system’ and 2001/16/EC ‘Interoperability of the trans-European conventional rail system’ and revisions thereof by 2004/50/EC ‘Corrigendum to Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system’.

Table ZA.1 — Correspondence between this European Standard, the Commission Regulation concerning the technical specification for interoperability relating to the subsystem 'rolling stock – freight wagons' of the rail system in the European Union and repealing Commission Decision 2006/861/EC, as amended by Commission Regulation (EU) 2015/924 (published in the Official Journal L 150, 17.06.2015, p.10); and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable.	4 Characterization of the subsystem 4.2 Functional and technical specifications of the subsystem 4.2.2 Structures and mechanical parts 4.2.2.1 Mechanical interface § 4.2.2.1.1 End coupling § 4.2.2.1.2 Inner coupling Appendix C Additional optional conditions 1. Manual coupling system Appendix D Standards or normative documents referred to in this TSI Additional optional conditions for units Manual coupling system	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.5 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.2 Reliability and availability	The EN is referenced in Appendix C of the TSI. The TSI refers to EN 15551:2009, sub-clause 6.2.3.1. The revision EN 15551:2009+A1:2010 is not implemented by the TSI.

Table ZA.2 — Correspondence between this European Standard, the Commission regulation (EU) No 1302/2014 of 18 November 2014 concerning the technical specification for interoperability relating to the 'rolling stock locomotives and passenger rolling stock' of the rail system in the European Union (published in the Official Journal L 356, 12.12.2014, p.228) and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
Clauses 1 to 6 inclusive Annexes A to H inclusive	4 Characteristics of the Rolling stock subsystem 4.2 Functional and technical specification of the sub-system 4.2.2 Structure and mechanical parts 4.2.2.2 Mechanical interfaces § 4.2.2.2.1 General and definitions § 4.2.2.2.2 Inner coupling § 4.2.2.2.3 End coupling § 4.2.2.2.4 Rescue coupling 5 Interoperability constituents 5.3 Interoperability constituent specification § 5.3.2 Manual end coupling Appendix A Buffers and screw coupling system A.1 Buffers A.3 Interaction of draw and buffing gear Appendix J Technical specifications referred to in this TSI J-1 Standards or normative documents Index 67	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.5 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §1 2.4.2 Reliability and availability	The TSI cites the UIC type of manual end coupling described in this EN as an Interoperability Constituent. The TSI also cites the EN as a means of achieving the requirements for a UIC-type manual end coupling. The reference in Appendix J of the TSI to the EN refers to the 2009 version; the updated text in this version remains valid.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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[1] EN 1563, *Founding — Spheroidal graphite cast irons*

[2] EN 10025-1, *Hot rolled products of structural steels — Part 1: General technical delivery conditions*

[3] EN 10025-3, *Hot rolled products of structural steels — Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

[4] EN 10025-4, *Hot rolled products of structural steels — Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels*

[5] EN 10025-5, *Hot rolled products of structural steels — Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*

[6] EN 10025-6, *Hot rolled products of structural steels — Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

[7] EN 10083 (all parts), *Steels for quenching and tempering*

[8] EN 10293, *Steel castings — Steel castings for general engineering uses*

[9] EN 13803 (all parts)[2)], *Railway applications — Track — Track alignment design parameters — Track gauges 1 435 mm and wider*

[10] EN 15085-1, *Railway applications — Welding of railway vehicles and components — Part 1: General*

[11] EN 15085-2, , *Railway applications — Welding of railway vehicles and components — Part 2: Quality requirements and certification of welding manufacturer*

[12] EN 15085-3, *Railway applications — Welding of railway vehicles and components — Part 3: Design requirements*

[13] EN 15085-4, *Railway applications — Welding of railway vehicles and components — Part 4: Production requirements*

[14] EN 15273-1, *Railway applications — Gauges — Part 1: General — Common rules for infrastructure and rolling stock*

[15] EN 15839, *Railway applications — Testing for the acceptance of running characteristics of railway vehicles — Freight wagons — Testing of running safety under longitudinal compressive forces*

[16] prEN 16839, *Railway applications — Rolling stock — Head stock layout*

[17] UIC 526-1:1998, *Wagons — Buffers with a stroke of 105 mm*

[18] UIC 526-3:1998, *Wagons — Buffers with a stroke of 130 mm and 150 mm*

2) EN 13803-1 and -2 will be merged into EN 13803, *Railway applications — Track — Track alignment design parameters — Track gauges 1 435 mm and wider*.

[19] UIC 527-1:2005, *Coaches, vans and wagons — Dimensions of buffer heads — Track layout on S-curves*

[20] UIC 528:2007, *Buffer gear for coaches*

[21] UIC 535-2:2005, *Standardisation and positioning on wagons of steps, end platforms, gangways, handrails, tow hooks, automatic coupler (AC), automatic draw-on coupling and brake valve controls on the UIC member RUs and OSJD member Rus*

[22] UIC 571-2:2001, *Standard wagons — Ordinary bogie wagons — Characteristics*

[23] UIC 573:2005, *Technical conditions for the construction of tank wagons*

[24] UIC 827-1:1990, *Technical specification for the supply of elastomer components for buffers*

[25] UIC 827-2:1981, *Technical specification for the supply of steel rings for buffer springs*

[26] UIC 840-2:1981, *Technical specification for the supply of steel castings for tractive and trailing stock*

[27] NF F10-102:1998, *Railway rolling stock — Buffers for freight rolling stock — Envelopes and component parts*

[28] PN-H-83160:1988, *Abrasive wear resistant cast steel — Grades*

[29] PN-H-84030:1989, *Structural alloy steel — Toughening and surface hardening steel — Grades*[3)]

[30] REPORT E.R.R.I. B12/RP 17, *Programme of tests to be carried out on wagons with steel underframe and body structure (suitable for being fitted with the automatic buffing and draw coupler) and on their cast steel frame bogies (8th edition)*[4)]

[31] REPORT E.R.R.I. B36/RP 24, Guidelines for the execution of impact tests with wagons (with side buffers or with automatic coupler) [4)]

[32] REPORT E.R.R.I. B36/RP 30, Reduction of acceleration during buffing impacts [4)]

[33] REPORT E.R.R.I. B36/RP 32, Characteristics of the buffing and draw gear of wagons to ensure the safe running of long vehicles in small radius curves [4)]

[34] ERRI drawing M0003-081, *Buffer stop wagon* [4)]

[35] RID, *Convention concerning International Carriage by Rail (COTIF) — Appendix C – Regulations concerning the International Carriage of Dangerous Goods by Rail (RID, 2015)*[5)]

3) Replaced by EN 10083-1.

4) To be purchased from Editions Techniques Ferroviaires (ETF), 16 rue Jean Rey, F-75015 Paris, France.

5) Source: download at the internet at: www.otif.org.

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