FE159360 ISSN 0335-3931

European standard
French standard

NF EN 13262+A1
January 2009

Classification index: **F 01-135**

ICS: 45.040

Railway applications

Wheelsets and bogies

Wheels — Product requirements

F : Applications ferroviaires — Essieux montés et bogies — Roues — Prescriptions pour le produit
D : Bahnanwendungen — Radsätze und Drehgestelle — Räder — Produktanforderungen

French standard approved

by decision of the Director General of AFNOR on December 10, 2008 taking effect on January 10, 2009.

Replaces the approved standard NF EN 13262, dated October 2004.

Correspondence

The European standard EN 13262:2004+A1:2008 has the status of French standard.

Analysis

This document specifies the characteristics of railway wheels for use on European networks.

It applies to solid wheels which are made from vacuum degassed steel, forged and laminated with a treated rim, which have already been used significantly in commercial conditions on a European network, or which have satisfied a technical approval procedure according to NF EN 13979-1 intended to validate their design.

The technical approval process is not part of this document.

This document falls within the scope the EC Directive 96/48 (see Annex ZA) and Directive 2001/16, amended by EC Directive 2004/50 (see Annex ZB).

Descriptors

Technical International Thesaurus: railway equipment, railway rolling stock, vehicle wheels, steels, chemical composition, tension tests, hardness tests, fatigue tests, surface condition, qualification, inspection, sampling, corrosion prevention, marking.

Modifications

With respect to the replaced document, limited revision regarding the following main points: modification of the Foreword, the scope, Article 2, Annex E, paragraphs 3.2.5.4, 3.4.2.4.2, A.3, F.4.2, F.5.1, the bibliography and addition of Annex ZB.

Corrections

Published and distributed by Association Française de Normalisation (AFNOR — French standard institute) — 11, rue Francis de Pressensé — 93571 La Plaine Saint-Denis Cedex — Tel.: + 33 (0)1 41 62 80 00 — Fax: + 33 (0)1 49 17 90 00 — www.afnor.org

National foreword

References to French standards

The correspondence between the standards figuring in the clause "Normative references" and the identical French standards is as follows:

EN 10002-1 : NF EN 10002-1 (classification index: A 03-001)

EN 10045-1 : NF EN 10045-1 (classification index: A 03-011)

EN ISO 6506-1 : NF EN ISO 6506-1 (classification index: A 03-152-1)

ISO 1101 : NF EN ISO 1101 (classification index: E 04-552)

ISO 14284 : NF EN ISO 14284 (classification index: A 06-375)

The correspondence between the standards figuring in the clause "Normative references" and French standards having the same scope, but which are not identical, is as follows:

ISO 6933 : NF F 01-141

The other standards mentioned in the clause "Normative references" that do not have any correspondence in the collection of French standards are as follows (they may be obtained from AFNOR):

ISO 4967

ISO 5948

ISO/TR 9769

ASTM E 399.90

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13262:2004+A1

November 2008

ICS 45.040; 45.060.01

Supersedes EN 13262:2004

English Version

Railway applications - Wheelsets and bogies - Wheels - Product requirements

Applications ferroviaires - Essieux montés et bogies - Roues - Prescriptions pour le produit

Bahnanwendungen - Radsätze und Drehgestelle - Räder - Produktanforderungen

This European Standard was approved by CEN on 18 March 2003 and includes Amendment 1 approved by CEN on 23 September 2008.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

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Ref. No. EN 13262:2004+A1:2008: E

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Foreword

This document (EN 13262:2004+A1:2008) 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 May 2009 and conflicting national standards shall be withdrawn at the latest by May 2009.

This document includes Amendment 1 approved by CEN on 2008-09-23.

This document supersedes EN 13262:2004.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] 〈A1〉.

[A1] 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 support Essential Requirements of EU Directive 96/48 and EU Directive 2001/16, as modified by EU Directive 2004/50 of 29 April 2004. 〈A1〉

[A1] For relationships with EU Directives, see informative Annexes ZA and ZB, which are integral parts of this document. 〈A1〉

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

Introduction

Normative documents which have been used until now in Europe for the wheel delivery (UIC leaflets, national standards) had for the main purpose, a complete definition of the delivery procedures and the wheel characteristics that were to be measured.

Product qualification was sometimes mentioned, but the procedures and the characteristics that had to be verified for the qualification were not given.

This standard addresses these requirements by:

a) definition of all the wheel characteristics. These are either verified during the qualification or delivery of the product (see clause 3);
b) definition of the qualification procedures (see informative annex E);
c) definition of the delivery conditions (see informative annex F). Here, a choice is given to the supplier of either:

- a traditional delivery procedure with a control by batch sampling as in existing documents (see F.4), or

- a delivery procedure using quality assurance concepts (see F.5).

The standard defines the wheel product qualification, the technical approval procedure is not within the scope of this standard.

1 Scope

This European Standard specifies the characteristics of railway wheels for use on European networks.

[A1] Four steel grades, ER6, ER7, ER8 and ER9 are defined in this standard; for European freight wagon interoperability purposes only grades ER6, ER7 and ER8 are applicable.

NOTE 1 Grade ER6 is not normally fit for the duty of application to freight wagons; it is normally applied in low axleload situations. [A1]

[A1] Certain characteristics are defined according to a category 1 or a category 2. Category 1 is generally chosen when the train speed is higher than 200 km/h. Freight vehicles running at speeds lower than 200 km/h generally use wheels of Category 2. [A1]

These categories can sometimes be subdivided, depending upon the characteristics.

This standard is applicable to solid forged and rolled wheels which are made from vacuum degassed steel and have a chilled rim. They are to have already been used in commercial conditions on a European network in a significant quantity, or to have satisfied a technical approval procedure according to EN 13979-1 for their design.

[A1] NOTE 2 [A1] The definition of other wheels may be found in other documents, such as UIC leaflets or ISO standards.

[A1] NOTE 3 [A1] The technical approval procedure is not within the scope of this standard.

[A1] NOTE 4 [A1] Rim-chilled" describes heat treatment of the rim, the aim of which is to harden the rim and to create compressive residual stresses in the rim.

2 Normative references

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

EN 10002-1*, Metallic materials - Tensile testing - Part 1: Method of test at ambient temperature*

EN 10045-1, *Metallic materials - Charpy impact test - Part 1: Test method*

EN ISO 6506-1, [A1] *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:2005)* [A1]

[A1] *Deleted text* [A1]

ISO 1101, [A1] *Geometrical Product Specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out* [A1]

ISO 4967:1998, *Steel - Determination of content of non-metallic inclusions - Micrographic method using standard diagrams*

ISO 5948:1994, *Railway rolling stock material - Ultrasonic acceptance testing*

ISO 6933:1986, *Railway rolling stock material - Magnetic particle acceptance testing*

ISO/TR 9769[1)], *Steel and iron - Review of available methods of analysis*

[A1] ISO 14284:1996, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition* [A1]

[A1] ASTM E399.90:1997 [A1], *Standard test method for plane-strain fracture toughness of metallic materials*

1) See also CR 10261:1995

3 Product definition

3.1 Chemical composition

3.1.1 Values to be achieved

The maximum percentages of the various specified elements are given in Table 1.

Table 1 — Maximum percentages of the various specified elements

	Maximum content in % [a]										
Steel grade	C	Si	Mn	P[b]	S[bc]	Cr	Cu	Mo	Ni	V	Cr + Mo + Ni
ER6	0,48	0,40	0,75	0.020	0,015	0,30	0,30	0,08	0,30	0,06	0,50
ER7	0,52	0,40	0,80	0,020	0,015	0,30	0,30	0,08	0,30	0,06	0,50
ER8	0,56	0,40	0,80	0,020	0,015	0,30	0,30	0,08	0,30	0,06	0,50
ER9	0,60	0,40	0,80	0,020	0,015	0,30	0,30	0,08	0,30	0,06	0,50

[a] For special applications, variations within the maximum limit of these values may be agreed.

[b] A maximum phosphorus content of 0,025% may be agreed at the time of enquiry and the order.

[c] A minimum sulfur content may be agreed at the time of enquiry and the order according to the steelmaking process in order to safeguard against hydrogen cracking.

3.1.2 Location of the sample

The sample for determining the chemical composition shall be taken 15 mm below the tread at its nominal diameter.

3.1.3 Chemical analysis

This chemical composition analysis shall be performed according to the methods and requirements described in ISO/TR 9769.

3.2 Mechanical characteristics

3.2.1 Tensile test characteristics

3.2.1.1 Values to be achieved

Rim and web characteristics are given in Table 2.

Table 2 — Rim and web characteristics of the wheels

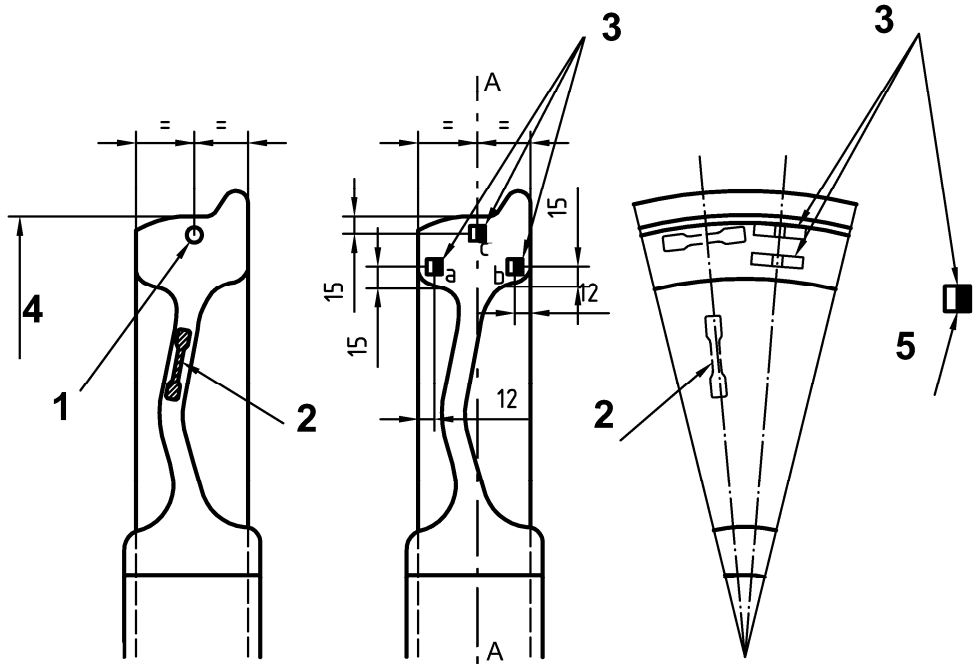
Steel grade	Rim			Web	
	R_{eH} (N/mm^2) [a]	R_m (N/mm^2)	A_5%	R_m reduction (N/mm^2) [b]	A_5%
ER6	≥ 500	780/900	≥ 15	≥ 100	≥ 16
ER7	≥ 520	820/940	≥ 14	≥ 110	≥ 16
ER8	≥ 540	860/980	≥ 13	≥ 120	≥ 16
ER9	≥ 580	900/1050	≥ 12	≥ 130	≥ 14

[a] If no distinctive yield strength is present, the proof stress $R_{p0,2}$ shall be determined.

[b] Reduction of tensile strength as compared to tensile strength of the rim on the same wheel

3.2.1.2 Location of test pieces

The test pieces shall be taken from the rim and the web of the wheel. Their positions are indicated in figure 1.



Key

1 Tensile test piece
2 Tensile test piece
3 Impact test piece
4 Nominal diameter
5 Notch

Figure 1 — Location of test pieces

3.2.1.3 Test method

The test shall be carried out in accordance with EN 10002-1. The test piece diameter shall be at least 10 mm in the parallel length and the gauge length shall be 5 times the diameter. If the test piece cannot be taken from the web, a smaller diameter shall be agreed between the customer and the supplier.

3.2.2 Hardness characteristics in the rim

3.2.2.1 Values to be achieved

The minimum Brinell hardness values applicable to the whole wear zone of the rim shall be equal to or greater than the values given in Table 3. These values are to be achieved up to a maximum depth of 35 mm under the tread, even if the wear depth is greater than 35 mm.

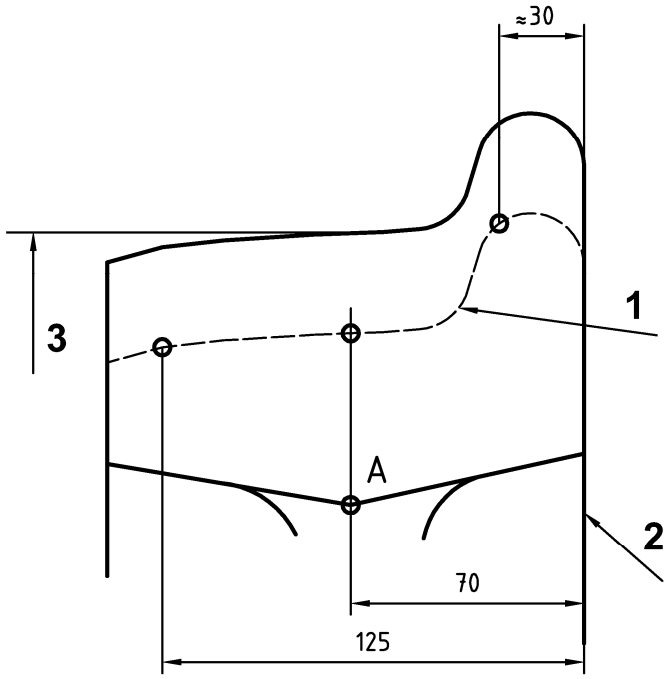
In the rim-web transition (point A in Figure 2), hardness values should be at least 10 points less than the wear limit values.

Table 3 — Values to be achieved for hardness characteristics in the rim

	Minimum Brinell hardness value	
Steel grade	**Category 1**	**Category 2**
ER6	-	225
ER7	245	235
ER8	245	245
ER9	-	255

3.2.2.2 Location of readings

Four readings are carried out on a radial section of the rim as shown in Figure 2.



Key

1 Limit of wear or last turning diameter (according to customer's requirements)
2 Inside surface of finished wheel
3 Nominal diameter

Figure 2 — Readings taken on a radial section of the rim

3.2.2.3 Test method

The test shall be performed in accordance with EN ISO 6506-1. The ball diameter is 5 mm.

3.2.3 Impact test characteristics

3.2.3.1 Values to be achieved

They are shown in Table 4. For each temperature, they represent the average value and the minimum value for the three test pieces defined in 3.2.3.2. At +20°C, U-notch specimens shall be used. At -20°C, V-notch specimens shall be used.

Table 4 — Values to be achieved for impact test characteristics

Steel grade	KU (in joules) at + 20°C		KV (in joules) at - 20°C	
	Average values	Minimum values	Average values	Minimum values
ER6	≥17	≥12	≥12	≥ 8
ER7	≥17	≥12	≥10	≥7
ER8	≥17	≥12	≥10	≥ 5
ER9	≥13	≥ 9	≥ 8	≥ 5

3.2.3.2 Location of the test pieces

The positions of the three test pieces are indicated in Figure 1. The bottom notch axis shall be parallel to the A-A axis of Figure 1.

3.2.3.3 Test method

The test shall be performed in accordance with EN 10045-1.

3.2.4 Fatigue characteristics

3.2.4.1 Values to be achieved

Independent of the steel grade, the web shall withstand the stress variation $\Delta\sigma$ given by Table 5 during 10^7 cycles without any crack initiation, with a probability of 99,7%.

Table 5 — Values to be achieved for fatigue characteristics

State of delivery of the web	$\Delta\sigma$ N/mm^2
Machined	450
As rolled	315

NOTE The aim of these characteristics is to guarantee that product characteristics are higher than those used for the definition of permissible stresses for the fatigue design of the web.

As there are many approximations in a fatigue calculation, it is not realistic to distinguish between the four steel grades.

3.2.4.2 Test pieces for fatigue test

Test pieces shall consist of wheels as delivered. Their surface appearances are those defined in 3.6.

3.2.4.3 Test method

The test method shall allow bending stresses to be created in a web section.

The tests to demonstrate the fatigue properties shall be performed in such a manner that statistical evaluation to assess the results can be applied.

The tests are monitored by measuring the radial stresses that exist in the crack initiation area.

An example of the method is given in the informative annex B.

3.2.5 Toughness characteristic of the rim

3.2.5.1 General

This characteristic need only be verified on tread braked wheels (service brake or parking brake), for category 1 or category 2.

3.2.5.2 Values to be achieved

For wheels of steel grade ER6, the average value obtained from six test pieces shall be greater than or equal to 100 $N/mm^2\sqrt{m}$, and no single value shall be less than 80 $N/mm^2\sqrt{m}$.

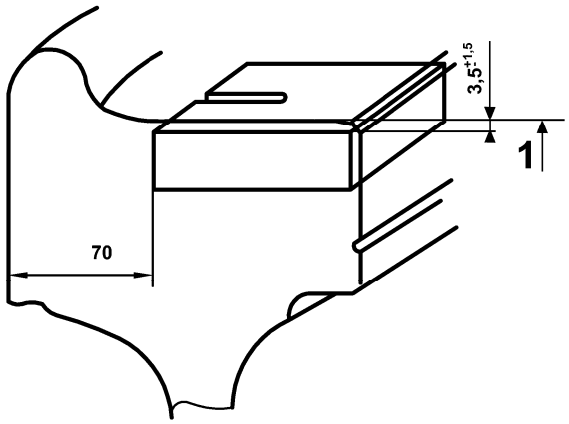
For wheels of steel grade ER7, the average value obtained from six test pieces shall be greater than or equal to 80 $N/mm^2\sqrt{m}$, and no single value shall be less than 70 $N/mm^2\sqrt{m}$.

For wheels of other steel grades, the values to be achieved are to be agreed between the customer and the supplier.

3.2.5.3 Location of test pieces

Six test pieces shall be taken from the rim as indicated in Figure 3.

The test pieces shall be evenly distributed around the rim.



Key

1 Nominal diameter

Figure 3 — Test pieces taken from the rim

3.2.5.4 Test method

The test shall be performed according to ASTM E399.90.

The particular conditions which shall be used are as follows:

- compact tensile test pieces: 30 mm thick (CT 30), with chevron notch with aperture angle of 90° (Figure 4 of [A1] ASTM E399.90:1997 [A1]);

- temperature during the test to be between +15 °C and +25 °C;

- measurement of the crack displacement of the test piece (Figure 3 of [A1] ASTM E399.90:1997 [A1]);

- rate of increase of stress intensity $\Delta K/s$ should be within the range from 0,55 $N/mm^2 \sqrt{m}/s$ to 1 $N/mm^2 \sqrt{m}/s$ (8.3 of [A1] ASTM E399.90:1997 [A1]).

The value of the toughness to be considered is the value K_Q which is calculated from the value of the load F_Q from the load-displacement record.

3.3 Heat treatment homogeneity

3.3.1 Values to be achieved

For category 1 wheels, the hardness values which are measured on the rim shall be no greater than 30 HB.

3.3.2 Test pieces

The hardness measurement shall be undertaken at three points equally distributed on the outside surface of the rim. The impressions shall be made on the same diameter in the area located as defined in Figure 8.

3.3.3 Test method

The test shall be performed according to EN ISO 6506-1. The ball diameter is 10 mm.

3.4 Material cleanliness

3.4.1 Micrographic cleanliness

3.4.1.1 Level to be achieved

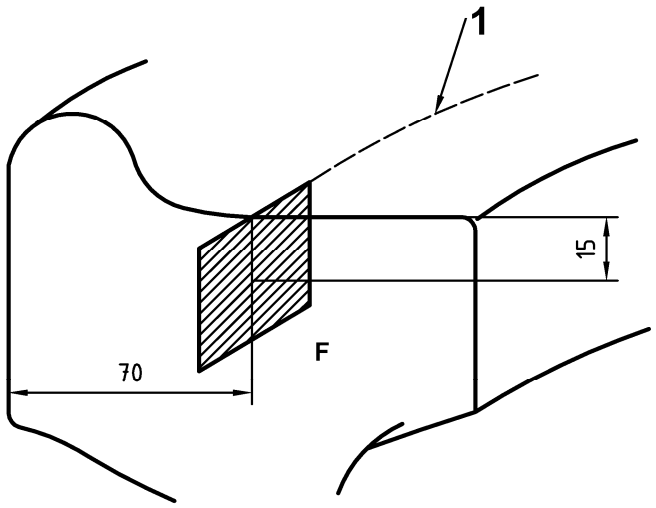
It shall be measured by micrographic examination as defined in 3.4.1.2. The values to be achieved are given in Table 6.

Table 6 — Level to be achieved for micrographic examination

Type of inclusions	Category 1		Category 2	
	Thick series (maximum)	Thin series (maximum)	Thick series (maximum)	Thin series (maximum)
A (Sulfur)	1,5	1,5	1,5	2
B (Aluminate)	1	1,5	1,5	2
C (Silicate)	1	1,5	1,5	2
D (Globular oxide)	1	1,5	1,5	2
B + C + D	2	3	3	4

3.4.1.2 Location of the micrographic sample

The examination field is situated in the shaded area of Figure 4. Its centre "F" is situated 15 mm below the tread.



Key

1 Nominal rolling circle

Figure 4 — Location of the micrographic sample

3.4.1.3 Test method

Determination of the level of cleanliness shall be made in accordance with the requirements of ISO 4967:1998, method "A".

3.4.2 Internal integrity

3.4.2.1 General

Internal integrity shall be defined from ultrasonic examination. Standard defects are flat-bottom holes with different diameters.

3.4.2.2 Level to be achieved

3.4.2.2.1 Rim

The rims shall have no internal defects which give echo magnitudes higher than or equal to those obtained for a standard defect situated at the same depth. The diameter of this standard defect is given in Table 7.

Table 7 — Diameter of standard defect

	Category 1	Category 2	
Diameter of the standard defect (mm)	1	2	3

There shall be no attenuation of the back echo greater than or equal to 4 dB during axial examination.

3.4.2.2.2 Web

The web shall not have:

- more than 10 echoes with magnitudes greater than or equal to those obtained for standard defects of ø 3 mm;
- echoes with magnitudes greater than or equal to those obtained for standard defects of ø 5 mm.

The distance between two acceptable defects shall be at least 50 mm.

3.4.2.2.3 Hub

The hub shall not have:

- more than 3 echoes with magnitudes greater than or equal to those obtained for standard defects of ø 3 mm;
- echoes with magnitudes greater than or equal to those obtained for standard defects of ø 5 mm.

The distance between two acceptable defects shall be at least 50 mm.

For one circumferential examination, no attenuation of the back echo equal to or greater than 6 dB is permitted.

3.4.2.3 Test piece

Examination shall be made of the complete wheel, after heat treatment, either before machining or in the finish machined condition, before corrosion protection is applied.

3.4.2.4 Methods of examination

3.4.2.4.1 General

The general conditions for ultrasonic examination are given by ISO 5948 in accordance with the following special conditions:

3.4.2.4.2 Rim

The rim examination shall be made according to the D_1 and D_2 methods of Table 1 of ISO 5948:1994.

Defect estimation shall be made by comparison to artificial defects in the standard rim described by Figures 1 and 2 of [A1] ISO 5948:1994 [A1].

3.4.2.4.3 Web

The web examination shall be made from its two faces. The direction of the examination is perpendicular to the surface.

Defect estimation shall be made by comparison to artificial defects in a standard web.

The web is defined as the part of the wheel between the two diameters where "*m*" and "*n*" are defined in Figure 7.

The thickness "*e*" of the web is defined as:

$$e = \frac{m+n}{2}$$

The location of the artificial defects is given as a function of "*e*". They shall be at least 100 mm apart in a cicumferential orientation.

- $e \leq 10$ mm

  - one 3 mm diameter flat bottom hole located 5 mm below the inner surface of the web
  - one 5 mm diameter flat bottom hole located 5 mm below the inner surface of the web

- 10 mm $< e \leq 20$ mm

  - two 3 mm diameter flat bottom holes located 5 mm and (e - 5) mm below the inner surface of the web

  - two 5 mm diameter flat bottom holes located 5 mm and (e - 5) mm below the inner surface of the web

- $e > 20$ mm

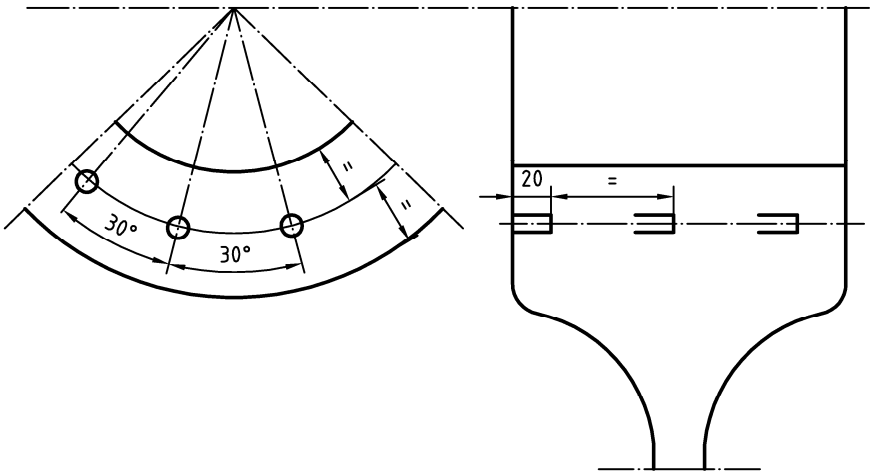
  - three 3 mm diameter flat bottom holes located 5 mm, $\left(\frac{e}{2}\right)$ mm and (e - 5) mm below the inner surface of the web

  - three 5 mm diameter flat bottom holes located 5 mm, , $\left(\frac{e}{2}\right)$ mm and (e - 5) mm below the inner surface of the web

3.4.2.5 Hub

The hub examination shall to be made from its two faces. The direction of the examination shall be perpendicular to the surface.

Defect estimation shall be made by comparison to artificial defects in the standard hub described by Figure 5.



NOTE Calibration references are:

- three 3 mm diameter holes located at different depths

- three 5 mm diameter holes located at different depths

spaced as shown in the figure above.

Figure 5 — Standard hub for ultrasonic examination

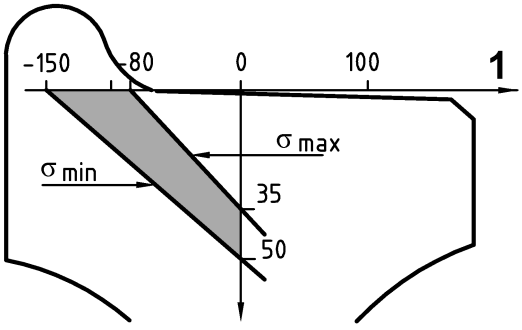
3.5 Residual stresses

3.5.1 General

Wheel heat treatment shall induce a compressive circumferential residual stress field inside the rim.

3.5.2 Values to be achieved

The level of compressive circumferential stresses measured near the surface of the tread shall be in the range 80 N/mm^2 to 150 N/mm^2. These stresses shall be equal to zero at a depth of between 35 mm and 50 mm. The stress distribution is shown in Figure 6 below the rolling contact line.



Key

1 Circumferential stress in N/mm^2

Figure 6 — Range in variation of circumferential stress values

3.5.3 Test piece

The test piece shall be the complete wheel after heat treatment.

3.5.4 Measurement methods

Measurement methods should estimate the variation of circumferential stresses located deep under the tread. This method shall be agreed between the supplier and the customer.

Annex C (informative) gives a method for this measurement as an example. For this method, Figure 6 shall be applied.

Annex D (informative) gives another method that is non-destructive. For this method, the values to be achieved are not those defined by Figure 6. It shall be demonstrated that the values to be achieved with this method give the same stress distribution as those defined in Figure 6.

3.6 Surface characteristics

3.6.1 Surface appearance

3.6.1.1 Characteristics to be achieved

According to their use, wheels may be fully or part machined. Their surface shall not show any marks other than those at the positions stipulated in this standard.

The parts that remain "as forged" and/or "as rolled" shall be shot-blasted, perfectly dressed and smoothly blended into the machined areas.

The average surface roughness (Ra) of areas of "finished" or "ready for assembly" wheels are given in Table 8.

Table 8 — Surface roughness (Ra) of wheels in the state of delivery

Area of the wheel	State of delivery[a]	Roughness Ra (µm)	
		Category 1	Category 2
Bore	Finished	≤ 12,5	
	Ready for assembly[b]	0,8 to 3,2	
Web and hub	Finished[c]	≤ 3,2	≤ 12,5
Rim tread	Finished	≤ 6,3	≤ 12,5[d]
Rim faces	Finished	≤ 6,3	≤ 12,5[d]

[a] See F.2.

[b] If the wheel has to be fitted on a hollow axle, other values may be required for the purpose of the in-service ultrasonic inspection.

[c] If defined in the order, this area of the wheel may remain unmachined, provided the tolerances indicated in this table are achieved.

[d] ≤ 6,3 if required for a standard defect of 2 mm (see 3.4.2).

3.6.1.2 Measurement method

The roughness of the wheel surfaces (Ra) in the state of delivery indicated in Table 8 shall be inspected by comparison with the roughness specimen or measured with a profile meter on the plane surface

3.6.2 Surface integrity

3.6.2.1 General

The surface integrity shall be determined by a magnetic particle test.

3.6.2.2 Level to be achieved

The maximum trace length of permissible surface breaking defects are as follows, unless otherwise defined in the order:

- 2 mm on machined faces,

- 6 mm on black faces, either forged or rolled.

3.6.2.3 Test piece

Examination shall be made on the complete wheel after heat treatment, in the finished or part finished machined condition before corrosion protection is applied.

3.6.2.4 Methods of inspection

The general requirements for the magnetic particle test are defined in ISO 6933, except that:

- the level of the surface magnetic induction shall be greater than or equal to 4 mT,
- the level of the lighting energy of ultra-violet light shall be greater than or equal to15 W/m².

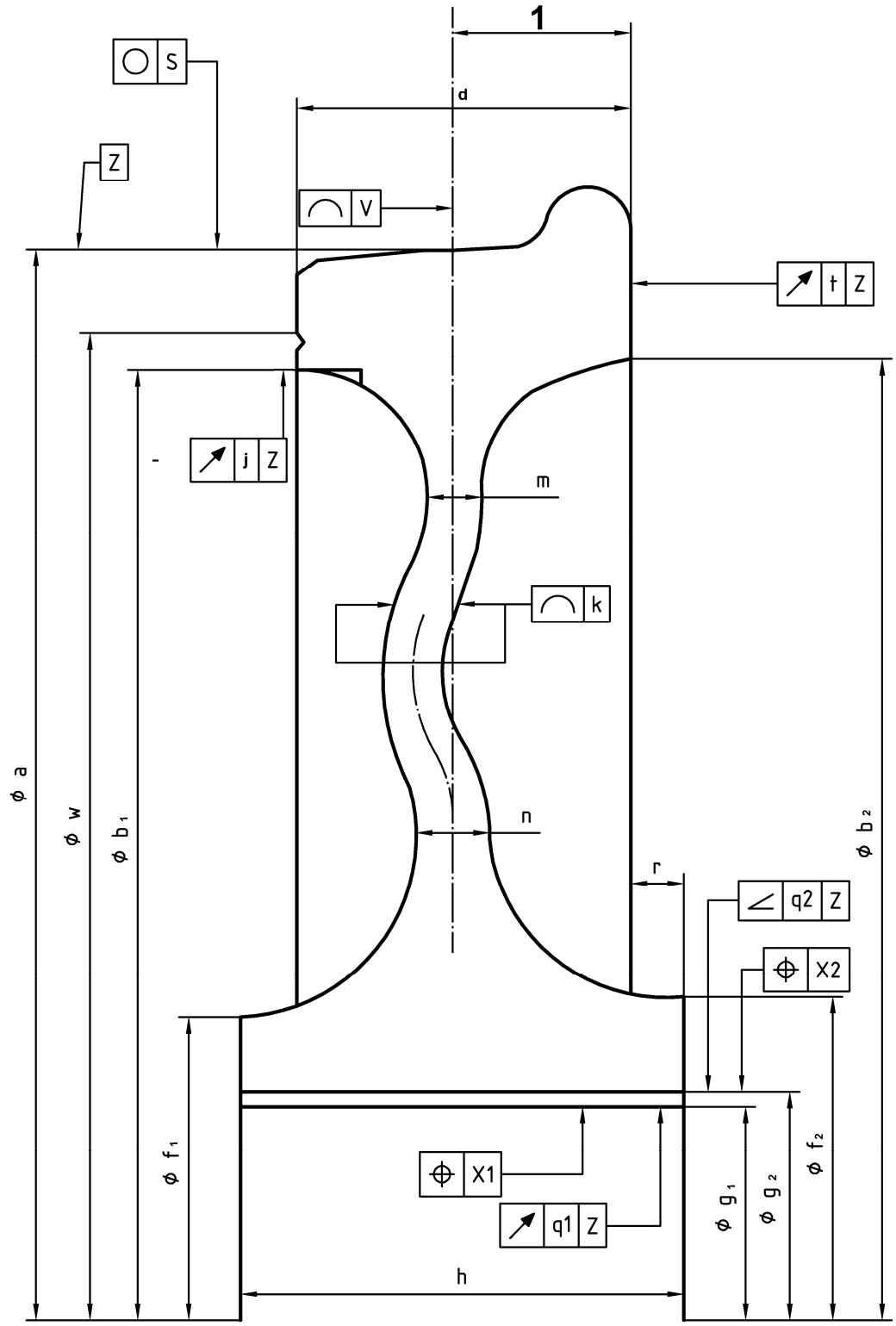
The magnetisation method to be used is indicated in Figure C of ISO 6933:1986.

The apparatus used shall scan the entire wheel surface and be able to detect the defects whatever their orientation.

3.7 Geometric tolerances

The geometry and dimensions of wheels are to be defined by a drawing included with the order.

The geometric tolerances shall comply with those in Table 9. The meaning of the symbols is defined in Figure 7.



Key

1 Dimension defined by the drawing

Figure 7 — Symbols

Table 9 — Geometric tolerances

Dimensions in millimetres

Tolerances						
Designation		Symbols (see Figure 7)		Values Cat. 1	Values Cat. 2	
		Dimensional	Geometrical[a]		Unmachined	Machined
Rim	External diameter	a		0 / +4 [b]		0 / +4 [b]
	Internal diameter (outer)	b_1		0 / -2		0 / -4
	Internal diameter (inner)	b_2		0 / -2	0 / -6	0 / -4
	Width	d		± 1		± 1
	Tread profile[e]		V	≤ 0,1		≤ 0,2
	Circularity of the tread		S	≤ 0,1		≤ 0,2
	Total run out in axial direction		T	≤ 0,2		≤ 0,3
	Total run out in radial direction		J	≤ 0,2		≤ 0,2
	Diameter of the groove (i.e. wear line)	W		0 / +2		0 / +2
Hub	External diameter (outer)	f_1		0 / +2	0 / +10	0 / +5
	External diameter (inner)	f_2		0 / +2	0 / +10	0 / +5
	Internal diameter of the bore: . "finished" [c]	g_1		0 / -2		0 / -2
	.. "finished ready" for assembly [c]	g_2		In accordance with the drawing or a standard to guarantee the interference fit		
	Cylindricity of internal diameter of the bore: - "finished" [c] - "finished ready for assembly" [c]		x_1 x_2	≤ 0,1 ≤ 0,02 [d]		≤ 0,2 ≤ 0,02 [d]
	Length	h		0 / +2 [b]		0 / +2 [b]
	Hub to wheel overhang	r		0 / +2 [b]		0 / +2 [b]
	Total run out of the diameter of the bore: - "finished" [c] - "finished ready for assembly" [c]		q_1 q_2	≤ 0,2 ≤ 0,1		≤ 0,2 ≤ 0,1
Web	Position for the web at the connection with the rim and the hub		k	≤ 4	≤ 8	≤ 8
	Thickness at the connection with the rim	m		+2 / 0	+8 / 0	+5 / 0
	Thickness at the connection with the hub	n		+2 / 0	+10 / 0	+5 / 0

[a] See ISO 1101

[b] For tractive stock other values may be necessary depending on the wheelset assembly process

[c] See F.2 for terms related to bore of the hub

[d] Any slight taper within the permitted tolerance shall be such that the "larger" diameter is at the axle entry end of the bore on assembly of the wheel on the axle

[e] From the top of the flange as far as the external chamfer

3.8 Static imbalance

The maximum static imbalance of a finished wheel in the delivery condition is defined in Table 10.

The means and methods of measurement shall be defined between the customer and the supplier.

Table 10 — Maximum static imbalance of the finished wheels in the delivery or ready for assembly state

For vehicles running at speed *v* km/h	Static imbalance g . m	Symbol
$v \leq 120$	≤ 125	E3
$120 < v \leq 200$	≤ 75	E2
$200 < v \leq 250$	≤ 50	E1
$v > 250$	≤ 25	E0

3.9 Protection against corrosion

Protection shall be provided:

- on all fully machined surfaces, with the exception of the surface of the rims
- on the unmachined web and unmachined hub of other wheels.

3.10 Manufacturer's marking

Each wheel shall be identified, as a minimum, with the following marks:

- manufacturer's mark;
- cast number;
- steel grade;
- month and two last figures of the year of production;
- position of residual imbalance and its symbol (see 3.8);
- serial number after heat treatment.

These may be applied to the hub-web fillet or as defined by the customer. These marks shall be stamped, except for imbalance marks which may be made by other means. Stamps with sharp edges are not allowed.

Annex A
(normative)

Control of the hydrogen content in the steel for solid wheels at the melting stage

As no European Standard covers this subject, this document specifies the requirements for this control.

A.1 Sampling

In order to meet the specified requirements, samples are taken from the molten bath using one of the following 4 methods:
:

- copper mould;
- silica dip tubes;
- quartz bubbling tube (translucent quartz is prohibited because of its hygroscopic ability);
- immersion probe method (carrier gas method with thermal conductivity detector).

A.2 Analysis methods

Two methods only are accepted:

- vacuum extraction in a temperature range of 650 °C to 1050 °C;
- injecting a carrier gas into the liquid steel at 650 °C ± 20°C. The resulting diffused gas containing hydrogen is recovered for re-circulation and analysis..

A.3 Precautions

See 6.5 of [A1] ISO 14284:1996 [A1].

NOTE The operators should be specifically trained for performing this analysis.

Annex B
(informative)

Example of test method for the determination of fatigue characteristics

B.1 Test piece

The test piece is the wheel itself.

B.2 Test rig

The principle of the test rig is shown in Figure B.1:

- the wheel is fitted on a simulated axle which is fixed to a face plate,

- forces are applied to the rim by a hydraulic actuator,

- the wheel remains fixed.

B.3 Test monitoring

The actuator is controlled by monitoring forces that are calibrated against the radial stresses that are measured in the area where the crack initiates.

The maximum and minimum forces applied are symmetrical about a mean load of 0 Newton.

B.4 Analysis of results

The Bastenaire method according to NF A 03-405 may be used.

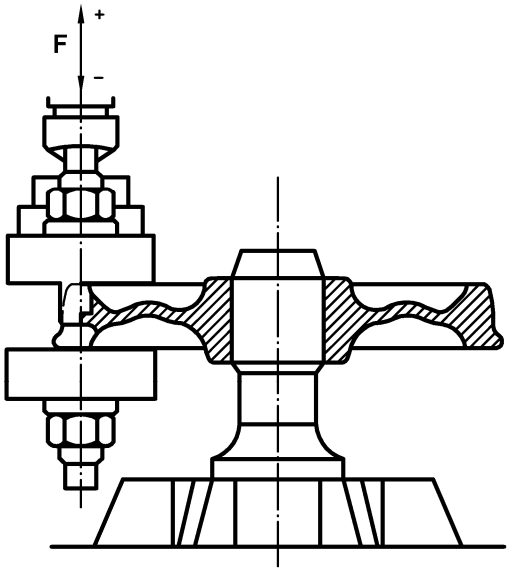


Figure B. 1 — Functional diagram

Annex C
(informative)

Strain gauge method for determining the variations of circumferential residual stresses located deep under the tread (Destructive method)

C.1 Principle of the method

The method comprises cutting operations leading to the progressive relief of residual stresses present in the rim.

The change in the state of residual stresses resulting from each cutting operation is evaluated at the surface by measuring local deformation using strain gauges.

The change in state inside the rim is obtained by a linear extrapolation of the state evaluated at the surface.

The evaluation is performed for one radial cross section only because, from experience, it is known that the heat treatment induces effectively a uniform circular state of residual stress.

C.2 Procedure

C.2.1 Fitting of a rim cross section with strain gauges prior to wheel cutting (Figure C.1)

Strain gauges are glued following:

- the circumferential and axial directions,
  . at point 1 of the tread located in the plane of symmetry of the web-rim connection,

- the circumferential and radial directions,
  . at points 2E of the external side and 2I of the internal side of the rim,
  . at points 3E (external) and 3I (internal) of the web-fillet.

C.2.2 Execution of cutting (Figure C.2)

Cutting operations are performed following a procedure that will not induce residual stresses (except on the small thickness of the cutting areas).

Three cutting operations shall be performed in the following order:

a) extraction of a rim section of length equal to at least twice the rim width (operation 1 - Figure C.2a),

b) cutting along a plane parallel to the axle, located at the start of the web-rim connection (operation 2 – Figure C.2b),

c) cutting along a plane parallel to the axle crossing the rim (operation 3 - Figure C.2c). This cutting process will only be performed if the thickness of the rim is greater than 30 mm.

C.2.3 Operations to be performed during cutting

-1 Measuring the strains of the gauges after cutting operation n°1.

- 2 Recording the exact profile of the radial cross-section on one of the ends of the rim section.

- 3 Gluing gauge 4 (Figure C.2b).

- 4 Measuring the strains of gauges 1 and 4 after cutting operation n°2.

  - Measuring the thicknesses h_1 and h_2 (Figure C.2b).

- 5 Gluing gauge 5 (Figure C.2c).

4 - Measuring the strains of gauges 1 and 5 after cutting operation n°3.

  - Measuring the thicknesses h_1 and h_2 (Figure C.2c).

C.3 Calculation of the variation of the circumferential residual stress located deep under the tread

The variation of the circumferential stresses σ^i_j resulting from each cutting operation "i" at measurement point "j" is calculated using the following formula :

$$\sigma^{i}_{j} = -\frac{E}{1-\upsilon^2}\left[e_{cir}{}_{j}^{\,i} + \upsilon e_{\perp}{}_{j}^{\,i} \right]$$

where

E = 210,000 MPa

$$\upsilon = 0{,}28$$

$$e_{cir}{}_{j}^{\,i} = circumferentialmeasuredstrain$$

$$e_{\perp}{}_{j}^{\,i} = axial(orradial)measuredstrain$$

C.3.1 - Calculation of the variation of the circumferential stress created by cutting operation n°1

Calculate stresses $\sigma^1{}_1$, $\sigma^1{}_{2E}$, $\sigma^1{}_{2I}$, $\sigma^1{}_{3E}$, and $\sigma^1{}_{3I}$

Stress values at points 2 and 3 (Figure C.3a) are given by the following formulae:

$$\sigma^1_2 = \frac{a}{a=b}\sigma^1_{2I} + \frac{b}{a+b}\sigma^1_{2E}$$

$$\sigma_3^1 = \frac{c}{c+d}\sigma_{3I}^1 + \frac{d}{c+d}\sigma_{3E}^1$$

The radial variation of the stress is represented by the straight line passing through the ordinates corresponding to points 1 and 3 in the stress diagram in relation to the distance between point and tread.

The representation of the calculated stress (Figure C.3a) at point 2 shall be located on this straight line at 20 N/mm^2.

C.3.2 Calculation of the variation of the circumferential stress created by cutting operation n°2

Calculate stresses $\sigma^2{}_1$ and, $\sigma^2{}_4$ then the stress at point A (Figure C.2b) using the following formula:

$$\sigma_A^2 = \frac{-(2h_1 + h_2)S_1\sigma_1^2 + h_2 S_2 \sigma_4^2}{S_1(h_1 + h_2)}$$

The radial variation of the stress is represented by the straight line passing through the ordinates corresponding to points 1 and A in the stress diagram in relation to the distance between point and tread (Figure C.3b).

C.3.3 Calculation of the variation of the circumferential stress created by cutting operation n°3

Calculate stresses $\sigma^3{}_1$ and, $\sigma^3{}_5$ then the stress at point A (Figure C.2c) using the following formula:

$$\sigma_B^3 = -\frac{(2h_1 + h_2)}{h_1 + h_2}\sigma_1^3 + \frac{(h_2)^2}{h_1(h_1 + h_2)}\sigma_5^3$$

The radial variation of the stress is represented by the straight line passing through the ordinates corresponding to points 1 and B in the stress diagram in relation to the distance between point and tread (Figure C.3c).

C.3.4 Final diagram representing the variation of the circumferential stress located deep under the tread

Determine stress values: $\sigma^1{}_B$ and $\sigma^2{}_B$ using the Figure C.3a and Figure C.3b diagrams.

The value of the circumferential residual stress σ_1 at point 1 is equal to the algebraic sum of the measured values of the stresses after each cutting process:

$$\sigma_1 = \sigma_1^1 + \sigma_1^2 + \sigma_1^3$$

Similarly, the σ_B value at point B is equal to:

$$\sigma_B = \sigma_B^1 + \sigma_B^2 + \sigma_B^3$$

The final diagram of the variation of the deep circumferential stress is represented by the straight line passing through the ordinates σ_1 and σ_B corresponding to points 1 and B in the stress diagram in relation to the distance between point and tread (Figure C.3d).

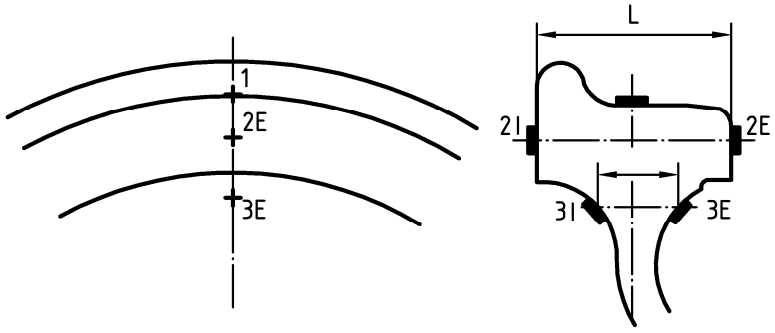


Figure C.1 — Fitting with strain gauges

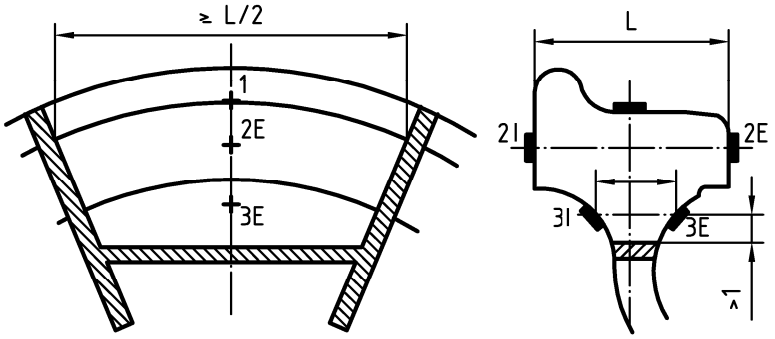


Figure C.2 a) — Cutting operation - operation no. 1

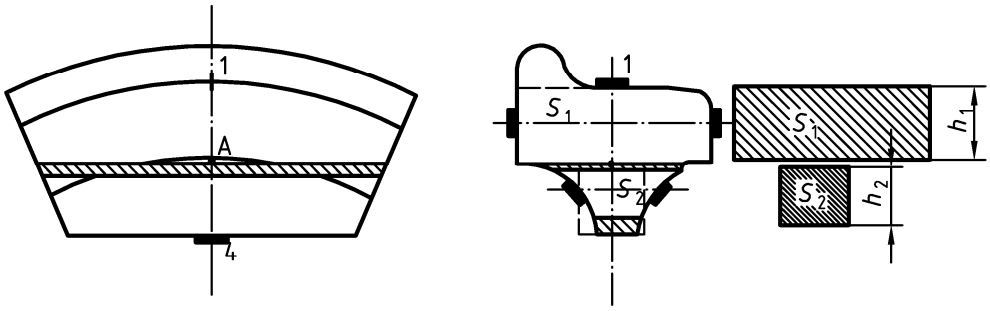


Figure C.2 b) — Cutting operation - operation no. 2

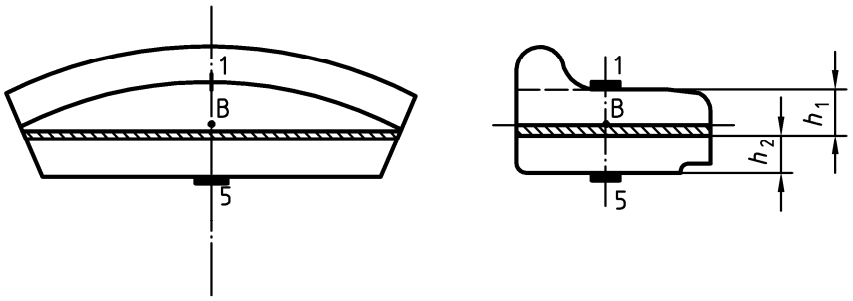
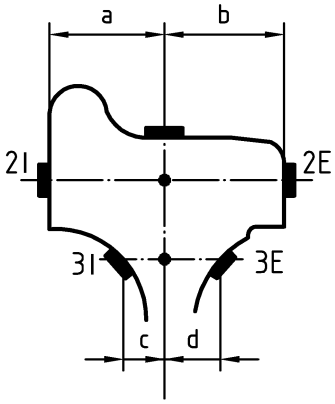


Figure C.2 c) — Cutting operation - operation no. 3



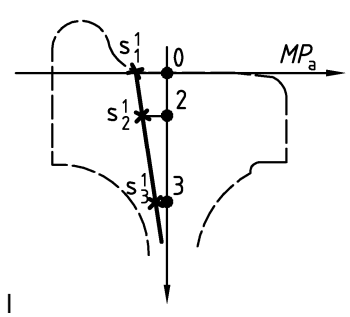


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Figure C.3 a)

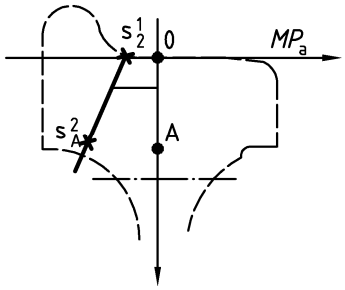


Figure C.3 b)

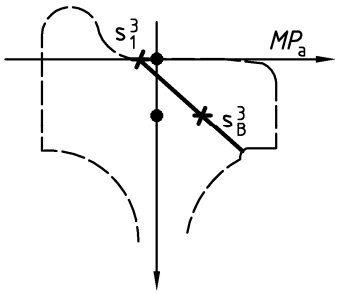


Figure C.3 c)

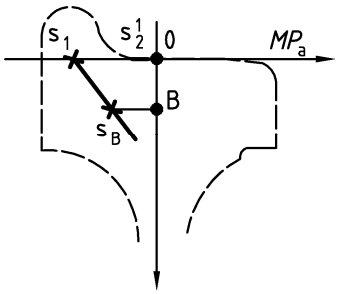


Figure C.3 d)

Figure C.3 — Determination of variation of circumferential residual stress located deep under the tread

Annex D
(informative)

Ultrasonic method for determining the residual stresses in the rim (non-destructive method)

D.1 Introduction

To ensure confidence in new solid wheels, the residual stress distribution of every wheel shall be controlled. The methods for measuring the circumferential stresses under the tread as specified in 3.5.4 shall be the subject of an agreement.

D.2 Method of measurement

The residual stresses across the outer rim of new solid wheels are measured by an ultrasonic velocity measuring method. With this method, the acousto-elastic effect is utilised which describes the influence of elastic elongation on the dispersing velocity of ultrasonic waves.

The distribution of residual stresses across the volume of the wheel rim of new solid wheels is evaluated by using the double diffraction index. The relative difference of propagation time of two transverse waves, one spreading in the radial direction, the other in the circumferential direction, is directly proportional to the difference of the main stresses existing in these two directions.

$$\sigma_{cir} - \sigma_{rad} = k \frac{\left(t_{rad} - t_{cir}\right)}{t_{cir}}$$

where

σ_{cir}, σ_{rad} are the principal stresses in the circumferential and radial directions,

t_{rad}, t_{cir} are the propagation times of the transverse waves in the radial and circumferential directions,

k is the acousto-elastic coefficient.

The measured results at one measuring point represent the mean value of the difference of principal stresses, acting in the volume of the sound field of one measuring point.

Although these results take into account the radial stresses, previous measurements have shown that the radial stress in the volume of the rim was sufficiently low and the measurements with this method can be regarded as representative of circumferential stresses and be used to verify the requirements of 3.5.

For the qualitative determination of residual stresses with ultrasonic waves, knowledge of the acousto-elastic coefficient of the material is required.

Several measuring points, radially distributed across the wheel rim, should be chosen to obtain a 'stress profile'.

The influence of the texture of the material on the measured results has to be taken into account. However, this influence has not been proven for forged and rolled wheels.

D.3 Evaluation of results

The maximum measured stress value near the tread shall be compressive.

The stress profile obtained shall not deviate more than ± 100 N/mm^2 of the mean stress value.

The depth of the point where the stress profile reaches zero shall be in line with the requirements of 3.5.2.

Annex E
(informative)

Product qualification

CEN/TC 256 considers that the following clauses represent the best means of assessing conformity of a range of products to this standard. However, a quality system other than the one specified in EN ISO 9001 may be applied.

E.1 General

A wheel shall be qualified before being used on a European network.

This clause specifies the requirements and procedures to be applied for product qualification.

Qualification of a wheel is directly linked to the supplier and a wheel can only be qualified if the supplier meets the requirements specified in E.2.

These requirements and procedures apply only to wheels for which the design has already been approved:

- either by previous use on European networks,

- or by a recognized technical approval procedure[2)]

The requirements are to be applied in the following cases:

- any wheel from a new supplier;

- any non-qualified wheel from a supplier, when its geomery is appreciably different to qualified wheels from this supplier (shape and thickness of web, diameter etc.),;

- any change in the manufacturing process of a qualified wheel from a supplier.

E.2 Requirements

E.2.1 Requirements to be met by the supplier

E.2.1.1 General

Where manufacture of a wheel involves more than one supplier, the following requirements shall be met by all concerned.

E.2.1.2 Quality organization

The supplier shall operate a quality assurance system conforming to EN ISO 9001.

---

2) See [A1] EN 13979-1 [A1].

E.2.1.3 Staff qualification

Staff trained in non-destructive testing shall be qualified in accordance with EN 473.

E.2.1.4 Equipment

The equipment used by the supplier for manufacture, control and monitoring shall allow the requirements of this standard to be met.

An automatic process shall be used for ultrasonic examination of the rim.

E.2.2 Requirements to be met by the product

The product shall meet the product requirements specified in clause 3.

Traceability of each wheel shall be established after its heat treatment.

E.3 Qualification procedure

E.3.1 General

The qualification procedure for the product comprises four successive stages:

- provision of documents by the supplier;

- evaluation of the manufacturing equipment and production processes;

- laboratory tests;

- service experience of wheels.

After the third stage, temporary qualification certification is given in order to allow in-service experience of the wheels to be gained.

E.3.2 Documentation required

When a request for qualification is submitted, the supplier shall provide a file comprising:

- a description of the products that are the subject of the request;

- a description of the company stating:

    - company size (number of employees, defining the proportion between production, control and quality assurance),

    - annual production of all the products;

    - a list of all the means of production and control;

- data about the company organization, with the relevant organization charts;

- a description of the manufacturing processes with explanations of the different stages of manufacture;

- data about raw materials with the list of suppliers;

- results of tests on the products that are the subject of the request;

- qualification certificates if the product has been previously qualified.

If a file has already been provided by a supplier for the qualification of a different wheel, the file to be provided by this supplier for the qualification of a new wheel shall include only data specific to this new wheel or new to the company.

E.3.3 Evaluation of the manufacturing plant and of the production processes

This evaluation comprises:

- an inspection of the manufacturing plant and examination of the production processes;

- an inspection of the raw material manufacturing plant and examination of its production processes;

- auditing of the data provided by the supplier to confirm whether the requirements of E.2.1 have been fully met;

- auditing of the information provided in the documents referred to in E.3.2.

At the end of this stage, a report shall be produced. It shall identify all the production processes including those of the raw material which are essential for product quality for which qualification is requested. It shall give an assurance that the evaluation satisfies the requirements of E.2.1 for the qualification procedure to continue.

E.3.4 Laboratory tests

All characteristics defined in clause 3, except fatigue characteristics, shall be proven for two wheels taken from one production process.

The fatigue characteristics shall be verified:

- when the maximum radial stresses, calculated with the method defined by EN 13979-1 "Wheels – Technical approval" are between 50 % and 100 % of the fatigue limits;

- if the roughness values of the surfaces are greater than those indicated in Table 8;

- if the production process is appreciably different from that used for wheels qualified for the European networks.

In order to ensure that the fatigue characteristics defined in 3.2.4.1 are achieved, it shall be verified on two wheels using the test method described in 3.2.4.3, but without statistical evaluation, that for a radial stress level equal to that given in Table E.1 and due to an external symmetrical loading there is no no fatigue crack initiation after 10^7 cycles.

Table E.1 — Level of radial stress

Symmetrical loading	Unmachined web	Machined web
Radial stress for verification	$\pm$ 168 N/mm^2	$\pm$ 240 N/mm^2

For better identification of the product to be qualified, there may be a need for further tests (metallographic, etc.) to be conducted at this stage, in addition to those mentioned in clause 3. The results of these tests have no influence on the final decision on qualification.

A report shall be produced at the end of this stage describing the test piece, the tests carried out and the results obtained. It shall specify whether or not the wheels tested are in compliance with the requirements.

If the outcome is satisfactory, a provisional qualification certificate may be issued.

E.3.5 Testing of wheels

E.3.5.1 Extended production inspection

After provisional qualification, the first batches of an industrial production of the product to be qualified shall be subjected to extended inspection according to the "qualification" column of Table F.1. Each batch shall comprise wheels from the same melting charge and shall have been heat treated under the same conditions. Each batch shall comprise at least 24 wheels.

E.3.5.2 Operational testing

The first wheels supplied on the basis of a provisional qualification shall be specially monitored in service. For this purpose, a programme shall be agreed upon between the supplier and the customer. It shall comprise:

- definition of the number of wheels to be monitored;

- description of the intermediate and final inspections;

- time period for the testing.

E.3.5.3 Results of operational testing

The product shall be deemed as qualified at the earliest 2 years after the first wheel has entered service provided that the acceptance tests defined in the "qualification" column of Table F.1 have not resulted in any repeated problems. The number of wheels supplied according to the "qualification" column of Table F.1 is limited to 1000 wheels or 10 batches.

A new report shall be produced. It shall contain as a minimum:

- the number of wheels and batches;

- the results of the operational testing;

- the number of wheels rejected during the tests and the reasons for the rejection.

E.4 Qualification certificate

E.4.1 Condition of validity

The certificate of qualification shall specify the limits of validity at least for:

- the steel grades;

- the wheel diameters;

- the web thicknesses and shapes.

E.4.2 Modification and extension

At the request of the supplier, the scope of the certification validity may be modified or extended if:

- other products are to be considered;

- the main parameters have been modified (manufacturing processes, quality organization, etc.).

E.4.3 Transference

In the case of a change in ownership, an existing qualification may, if requested, be transferred to another company if the relevant content and conditions prior to the qualification have not been modified.

E.4.4 Lapsed certification

If, for 2 years, there is no production of the qualified products that are the subject of the certification, the wheels of the first batch of the new production shall be supplied according to the "qualification" column of Table F.1.

E.4.5 Cancellation

If the customer registers significant defects in the product, the parts of the qualification procedure concerned shall be repeated.

If the supplier has not ensured that important conditions of the qualification were met, it may be cancelled.

E.5 Qualification file

A qualification file shall be prepared for each qualified product. It shall contain the following documents:

- the application request from the supplier;

- the documents provided by the supplier (see E.3.2);

- the assessment reports (see E.3.3);

- the laboratory test reports (see E.3.4);

- the utilization report (see E.3.5);

- the qualification certificate (see E.4).

Annex F
(informative)

Product delivery

CEN/TC 256 considers that the following clauses represent the best means of assessing conformity of the products delivered to this standard.

F.1 General

The customer shall define the following in the order:

- the geometry and the dimensions of the wheel (drawings);

- the category of the wheel (see 1);

- the maximum phosphorus content and the minimum and maximum contents of the other elements if necessary (see Table 1);

- the braking mode of the wheel, tread brake, disc brake type etc. (see 3.2.5);

- the diameter of standard defects for internal integrity of the rims of category 2 (see Table 7);

- the type of corrosion protection (see 3.9);

- the identification location (see 3.10);

- whether the nominal diameter of the rolling circle needs to be marked;

- the delivery condition (see F.2).

In the offer, the supplier shall make a proposal for the fabrication quality supervision of the products:

- either by batch control as described in F.4.1,

- or by a quality plan approved by the customer, as indicated in F.5.

The customer and the supplier shall agree on the following points:

- test piece diameter (see 3.2.1.3);

- measurement methods (see 3.5.4, 3.8, F.4.3);

- surface integrity inspection (see Table F.1, note 6 and F.4.4);

- imbalance (see F.4).

F.2 Delivery condition

The wheels shall be delivered in one of the following conditions:

- **unmachined** (as-forged or as-rolled condition) where the wheel has not been machined except for what the manufacturer has to do to make the wheel compatible with the requirements of this standard;

- **rough-machined**, (requested by the customer) where the wheel has been machined and requires subsequent machining;

- **semi-finished**, where the wheel, except for the bore, is finish machined in some parts, but other parts require final machining

- **finished**, where the wheel has undergone final machining (all parts apart from the bore);

- **finished, ready for assembly**, where all parts of the wheels including the bore are in the final machined state for assembly.

F.3 Controls on each wheel

Whether the fabrication quality supervision is made with controls by batch sampling (see F.4), or with a quality plan (see F.5), controls are required to ensure that the special characteristics, which are defined in clause 3, are obtained. These controls shall be made on each delivered wheel and are:

- internal integrity of the rims (see 3.4.2),

- surface integrity (see 3.6.2 or F.4.4),

- imbalance (se 3.8),

- tread diameter, bore diameter and rim profile (see 3.7).

F.4 Batch control

F.4.1 Controls

The nature and number of controls are defined in the "delivery" column of Table F.1; a batch comprises wheels from the same cast and heat treated under the same conditions.

Table F.1 — Type and number of controls to be carried out

Characteristics to be verified	Number of wheels per batch to control			Subclause reference
	Qualification (see E.3.5)	Delivery (see F.4)		
Maximum size of the batch	≤ 100	≤ 250	> 250	
- Chemical composition	1	1	1	3.1
- Hydrogen content	[a]	[a]	[a]	[b]
- Tensile characteristics				
in the rim	1	1	2	3.2.1
in the web	1	1	2	3.2.1
- Hardness on rim parts	1	1	2	3.2.2
- Hardness on rim (homogeneity)	100%	100%	100%	F.4.2
- Impact tests	1	1	2	3.2.3
- Toughness [3)]	1	1	1	3.2.5
- Heat treatment homogeneity	10% [d]	-	-	3.3
- Inclusion cleanliness	1	1	2	3.4.1
- Internal integrity				
Rim	100%	100%	100%	3.4.2
hub	100%	-	-	3.4.2
web	20% [e]	-	-	3.4.2
- Residual stresses trends	1	1	2	[l]
- State of surface	100%	100%	100%	3.6.1
- Surface integrity	100%	100% [f]	100% [f]	3.6.2
- Geometry and dimensions	100% [g]	100% [g]	100% [g]	
- Static imbalance	100%	100%	100%	3.8
- Complementary tests	[h]	-	-	E.2.3

[a] One analysis by cast. Sampling shall make it possible to ensure that the content measured is representative of the maximum hydrogen content of the cast.
[b] The hydrogen content is determined according to the methods described in annex A (normative). It has to be < 2 ppm for wheels of category 1 and < 2,5 ppm for wheels of category 2.
[c] Only tread braked wheels.
[d] Only category 1 wheels.
[e] The rejection of one wheel in a batch will require verification of the whole batch.
[f] By agreement between customer and the supplier, visual inspection as defined in F.4.4 may replace magnetoscopy inspection.
[g] Tread diameter, bore diameter, rim profile
[h] To be defined according to test laboratory results (see E.3.4)
[l] E.3.5 for qualification and F.4.3 for delivery

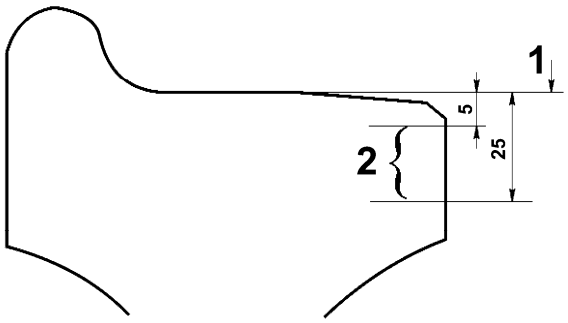
F.4.2 Homogeneity of batches by measurement of the hardness of the rim

The measurement of the Brinell hardness (10 mm diameter ball) shall be checked on the rim of each wheel, after heat treatment.

The test will be undertaken in accordance with the requirements of [A1] EN ISO 6506-1 [A1] on the flat surface opposite to the flange. The impression shall be located as shown in Figure F.1.

The extreme hardness values of the rims of wheels from the same batch shall not exceed 30 HB. Brinell hardness impressions may be left on the surface.

This test may be carried out before machining.



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Key

1 Nominal diameter of the rolling circle

2 Area for measurement of Brinel hardness

Figure F.1 — Impression

F.4.3 Orientation of residual stresses on rim chilled wheels

The existence of compressive stresses shall be verified by measuring the reduction in the distnce between 2 marks, 100 mm apart, marked in the middle of the rim thickness on the opposite side to the flange after a radial cut has been made from the top of the flange to the bore halfway between the two marks.

After the internal stresses are relieved, the distance between the 2 marks shall reduce by a value ≥ 1 mm.

Other methods may be used by agreement between the customer and the supplier.

F.4.4 Visual examination

The visual examination shall be made under normal conditions of vision

The acceptability criteria shall be established on the basis of the reference images used by agreement between the customer and the supplier.

F.5 Quality plan

F.5.1 General

In the case of quality control by a quality plan (according to the definition in [A1] EN ISO 9001 [A1]) of the products to be delivered, it shall be established by the supplier and shall be agreed with customer.

This quality plan shall refer to the quality manual of the supplier; it shall contain specific elements for the product.

F.5.2 Purpose

This plan shall be drawn up with the offer with the objective of:

- describing the processes and quality control of the producer in order to achieve the required quality of the product to be delivered. The reasons for their selection shall be given.

- the quality plan shall provide, at least, the same confidence as that from batch control.

This quality plan shall define the controls that are made during the manufacturing process and those for product delivery. These controls may be collated in the control plan of the fabrication process.

F.5.3 Application of the quality plan

Any modification to the quality plan shall only be made with the agreement of the customer.

If a non-conformity is discovered by the customer on the products delivered, the applicable clauses of the quality plan shall be discussed and if the result is unsatisfactory the quality plan can be cancelled.

In this case, the controls and tests defined by the "control by sampling of batches" mode shall be applied in their entirety until a new agreement is reached between the customer and the supplier.

F.6 Allowable rectification

With the exception of tread surfaces and bore, surface defects may be eliminated by fine-grained grinding with gradual transition within the dimensional, geometrical and finished surface tolerances.

All rectifications shall be in accordance with the conditions given in 3.6.2.

Elimination of residual imbalance is authorized by eccentric machining of the fillet between the web and the rim on the flange side. The thickness of metal removed shall not exceed 4 mm. The resultant surface shall be carefully blended into the adjacent material. If damping equipment is fitted in the area, the balancing area shall be agreed upon between the customer and the supplier.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives.

This European Standard has been prepared under a mandate given to CEN by the European Community and the European Free Trade Association and supports essential requirements of EU Directive.

- Council Directive 96/48/EC of 23 July 1996 on the interoperability of the trans-European high-speed rail system[3)]

Compliance with this European Standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

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

3) Official Journal of the European Communities No. L 235/6 of 17 September 1996

Table ZA.1 — Correspondence between this European Standard and the EU Directive

Clauses/subclauses/ of this European Standard	Clauses/subclauses of the STI on Rolling stock	Corresponding text, annexes/subclauses of Directive 96/48/EC	Comments
Clause 3 - Product definition 3.2 Mechanical characteristics	Clause 4 – Characteristics of the subsystem 4.2.10 Wheel/rail contact Point d *Characterization connected to wear criterion* 5.4 Wheels	Chapter II – Interoperability technical specifications Article 5 - § 3-e and § 3-f Article 10 - § 2 Annex III – Essential requirements 1 - General requirements 1.1 Safety – points 1.1.2 and 1.1.3 2 – Requirements specific to each subsystem 2.4 Rolling stock 2.4.2 Reliability and availability 2.4.3 Technical compatibility	Contact between the wheels and the rails has an effect on the ride and stability of railway vehicles. The geometrical characteristics of the wheels condition the rolling stability which shall be guaranteed in the new and worn states and this in a range of permitted limit tolerances for each of these characteristics. In order to guarantee rolling stability over time, the materials for the wheels shall meet the criteria specified in EN 13262
Annex E – Product qualification E.2 Requirements E.3 Qualification procedure	Annex D – Clause 2 Table 1 – 4.2.10.d Annex E – Clause 2 Table 2 – 4.2.10 d		
Annex F – Product supply F.4 Control by sampling of batches F.5 Quality plan	Annex D – Clause 2 Table 1 – 4.2.10.d Annex E – Clause 2 Table 2 – 4.2.10 d		

Annex ZB
(informative)

A1 Relationship between this European Standard and the Essential Requirements of EU Directive 2001/16/EC of the European Parliament and of the Council of 19 March 2001 on the interoperability of the trans-European conventional rail system, as modified by EU Directive 2004/50/EC of 29 April 2004

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 New Approach Directive 2001/16/EC, as amended by Directive 2004/50/EC.

Once this standard is cited in the Official Journal of the European Communities 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 ZB.1 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.

Table ZB.1 – Correspondence between this European Standard and Directive 2001/16/EC

Clause/ sub-clauses of this European Standard	**Chapter/§/points and annexes of the CR TSI Rolling Stock WAG dated July 2006 and published in the Official Journal on 8 December 2006**	**Corresponding text, annexes / § of the Directive2001/16/EC**
The whole standard is applicable	Clauses 4 - Characterisation of the subsystem §4.2.3.4.1 Functional and technical specifications of the sub system, Vehicle track interaction and gauging, General §4.2.4.1.2.5 Energy limits	Annex III, Essential Requirements, General Requirements – Clauses 1.1.1, 1.1.2, 1.1.3 Safety – Clause 1.2 Reliability and availability – Clauses 1.4.4, 1.4.5 Environmental protection. – Clause 1.5 Technical compatibility
	Clause 5 - Interoperability constituents §5.3.2 List of constituents, Vehicle track interaction §5.4.2 Constituents performances and specifications, Vehicle track interaction	Requirements Specific to Control and command and signalling Subsystem – Clause 2.3.2 Requirements Specific to Rolling stock Subsystem – Clause 2.4.2 Reliability and availability – Clause 2.4.3 §3 Technical compatibility
	Clause 6 – Assessment of conformity and/or suitability for use of the constituents and verification of the subsystem §6.1.3.2: Specification for assessment of IC's, Vehicle track interaction and gauging Annex E: Vehicle track interaction and gauging, wheelset dimensions and tolerances for standard gauge Annex L: Vehicle track interaction and gauging, wheels Annex Q: Assessment procedures, interoperability constituents Annex Y: Constituents, bogies and running gear	

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. 〈A1〉

Bibliography

[1] EN 473, *Non-destructive testing - Qualification and certification of NDT personnel - General principles*.

[2] EN 13979-1, *Railway applications - Wheelsets and bogies - Monobloc wheels - Technical approval procedure - Part 1: Forged and rolled wheels*

[3] ▌A1⟩ EN ISO 9001 ⟨A1▐, *Quality management systems – Requirements (ISO 9001:2000)*

[4] ▌A1⟩ EN ISO 9000:2005, *Quality management systems - Fundamentals and vocabulary (ISO 9000:2005)* ⟨A1▐