INTERNATIONAL STANDARD

ISO 22055

First edition
2019-11

Switch and crossing rails

Rails pour appareils de voie

Reference number
ISO 22055:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 15, *Railway rails, rails fasteners, wheels and wheelsets*.

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

Switch and crossing rails

1 Scope

This document specifies switch and crossing rails that carry railway wheels as specified in ISO 5003. These are used in conjunction with flat bottom (vignole) railway rails. After switch and crossing rails are produced, in order to be ready for railway track use, secondary processing (forging, grinding and heat treatment etc.) is carried out. This document does not include secondary processing. Secondary processing is specified in other standards or through agreements between manufacturer and purchaser.

Sixteen pearlitic steel grades are specified, covering a hardness range of 200 HBW to 440 HBW, and include non-heat-treated carbon manganese steels, non-heat-treated alloy steels, heat-treated carbon manganese and heat-treated low alloy steels.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3887, *Steels — Determination of the depth of decarburization*

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

ISO 4968, *Steel — Macrographic examination by sulfur print (Baumann method)*

ISO 4969, *Steel — Etching method for macroscopic examination*

ISO 5003:2016, *Flat bottom (Vignole) railway rails 43 kg/m and above*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

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

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

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

3.1
heat
<liquid steel> melt tapped out of a converter or electric arc furnace which includes after continuous casting a given number of blooms relating to the weight of the heat and the extension of the mixing zone

Note 1 to entry: In the case of sequence casting the blooms belonging to the mixing zone should be clearly defined.

3.2
sequence
any number of *heats* (3.1), of the same steel grade, which undergo continuous casting in tundishes

Note 1 to entry: Tundishes can be used in parallel if the caster has many strands.

3.3
heat-treated rail
rail that has undergone accelerated cooling from austenitizing temperature during the metallurgical transformation period

3.4
rolling process
process between the blooms leaving the heating furnace and exiting the finishing pass

3.5
isothermal treatment process
process whereby blooms are held for a period of time at an elevated temperature for reducing the hydrogen content

Note 1 to entry: For maximum efficiency this is as near to (but below) the pearlite to austenite transformation temperature as is practically possible.

Note 2 to entry: This process is sometimes referred to as sub-critical diffusion annealing.

3.6
rail running surface
curved surface of the rail head

Note 1 to entry: It may also refer to any area between both gauge corners (transition points of the head inclination and the first head radius).

4 Information to be supplied by the purchaser

The purchaser shall provide the supplier with the following information at the time of enquiry or order:

a) the rail profile (by submitting a drawing);

b) the steel grade (see 7.2);

c) the non-metallic inclusion determination method and if applicable: the class “1” or “2” of rail (see Table 12);

d) the determination of the macrostructure (see 5.10);

e) the lengths of rail (see 6.1 and Table 3);

f) undrilled or drilled rail ends to take fish bolts, and location and dimensions of holes when required (see 6.1 and Table 3);

g) paint code requirements (see 9.4.4).

5 Test methods

5.1 Test items, testing frequency and test methods

Test items, sampling position, sampling numbers and test methods shall be as given in Table 1.

Table 1 — Testing frequency for acceptance testing

Test items	As-rolled rails	Heat-treated rails	Relevant subclause
Chemical composition	One per heat	One per heat	5.2
Hydrogen	One per heat (2 tests from first heat in sequence)	One per heat (2 tests from first heat in sequence)	5.3
Total oxygen	One per sequence[a]	One per sequence[a]	5.4
Tensile	One per heat[a,b,d]	One per heat[a,c]	5.5
Hardness	One per heat[a,b]	One per heat[a,c]	5.6
Microstructure	Not required for grades HR200, HR220, HR235 and HR260A One per 1 000 tonnes or part thereof for grades HR260B, HR310C and HR320[a,b]	One per 100 tonnes of heat-treated rail[a,c]	5.7
Decarburization	One per 1 000 tonnes or part thereof[a,b]	One per 500 tonnes or part thereof[a,c]	5.8
Nonmetallic inclusions	One per sequence[b]	One per sequence[b or c]	5.9
Macrostructure	One per 500 tonnes or part thereof[a,b]	One per 500 tonnes or part thereof[a,b or c]	5.10
Dimension	Whole length	Whole length	6.1
Straightness	Whole length	Whole length	6.2
Surface quality	Whole length	Whole length	7.9
Ultrasonic test	Whole length	Whole length	5.11

[a] Samples shall be taken at random. When different rail grades are cast in the same sequence, the samples shall be taken outside the mixing zone.

[b] Samples shall be cut after rolling.

[c] Samples shall be cut after heat-treating for heat-treated rails.

[d] One calculation per heat and one testing per 2 000 tonnes if agreed between purchaser and manufacturer.

5.2 Chemical composition

The chemical composition shall be determined on the liquid.

When the solid chemical composition is to be checked as a requirement of the purchaser, this shall be carried out at the position of the tensile test piece shown in Figure 1.

5.3 Hydrogen content

The hydrogen content of the liquid steel shall be measured by determining the pressure of hydrogen in the steel using an on-line immersion probe system or a method agreed between the purchaser and manufacturer.

At least two liquid samples shall be taken from the first heat of any sequence using a new tundish and one from each of the remaining heats and analysed for hydrogen content (see Table 1). The first sample from the first heat in a sequence shall be taken from the tundish at the time of the maximum hydrogen concentration.

When testing of rails is required rail samples shall be taken at the hot saw at a frequency of one per heat at random. However, on the first heat in a sequence, the rail sample shall be from the last part of a first bloom teemed on any strand. Hydrogen determination shall be carried out on samples taken from the centre of the rail head and determined by automatic machine.

5.4 Total oxygen content

The total oxygen content can be determined in the liquid or solid.

If the total oxygen content is determined from the solid rail head, the testing positions are shown in Figure 2.

5.5 Tensile test

Test samples shall be taken from the rail head as shown in Figure 1.

The tensile properties shall be determined in accordance with ISO 6892-1 by using a round tensile test piece with the dimensions as follows:

— diameter 10 mm;

— gauge length 50 mm.

In the case of dispute, the tensile test pieces shall be maintained at a temperature of 200 °C for 6 h before testing.

For as-rolled rails, the tensile strength and elongation may be determined as agreed between purchaser and manufacturer by a correlation to the chemical composition based on the statistical data analysis. The method to be applied is shown in ISO 5003:2016, Annex B.

5.6 Hardness

5.6.1 General requirements

Brinell hardness tests (HBW) shall be carried out in accordance with ISO 6506-1. The method used is at the discretion of the manufacturer.

In case of dispute, the test shall be done using HBW 2,5/187,5.

5.6.2 Surface hardness

The surface hardness shall be tested at position RS as shown in Figure 3.

The surface hardness shall be tested on the centre line of the rail head crown. 0,5 mm shall be removed from the running surface before a hardness impression is made. Surface quality shall be in accordance with ISO 6506-1.

5.6.3 Internal hardness

For heat-treated rails the internal hardness shall be tested in accordance with ISO 6506-1 at the testing positions shown in Figure 3.

The internal hardness of heat-treated rails of any steel grade shall be determined on a transverse specimen cut from the end of the rail. The specimen shall be ground or milled so that the transverse surfaces are parallel.

5.7 Microstructure

The microstructure testing position in the rail head shall be as shown in Figure 1 and shall be determined at a magnification of ×500.

5.8 Decarburization

Decarburisation depth shall be assessed by means of a hardness test using HBW 2,5/187,5 indentation. The test shall be performed at three points in the centre of the rail crown after minimal preparation of the rail head surface (less than 0,2 mm material removed). None of the hardness test results shall be more than 7 points lower than the minimum hardness of the specified grade (e.g. 253 HBW for 260 grade rail). If the test fails to meet the requirements, decarburization shall be measured at the same sample location metallographically.

As an alternative or in the case of dispute decarburisation depth shall be measured metallographically. The testing position in the surface of the rail head shall be as shown in Figure 4. The test shall measure the depth of closed ferrite network in accordance with ISO 3887. Photomicrographs showing examples of how to determine the depth of decarburization are shown in Figure 5.

5.9 Non-metallic inclusions

5.9.1 General requirements

Samples shall be taken from one of the last blooms of the last heat of the sequence. From each sample 2 specimens shall be tested.

The non-metallic inclusions testing position in the rail head is shown in Figure 6.

5.9.2 Testing methods

The test shall conform with the method shown in ISO 5003:2016, Annex C.

If agreed between purchaser and manufacturer [see Clause 4 c)], alternative methods may be used:

— ISO 4967:2013, Method A.

— ASTM E45, Method A.

5.10 Macrostructure

Macrostructure of transverse rail sections shall be tested in accordance with ISO 4969 or ISO 4968, as agreed between purchaser and manufacturer [information given by the purchaser in Clause 4 d)].

5.11 Ultrasonic test

5.11.1 Testing area

The minimum cross-sectional area examined by the ultrasonic technique shall be:

— at least 70 % of the head;

— at least 60 % of the web;

— and the area of the foot to be tested shall be as shown in Figure 7.

In the case of a web width exceeding 16,5 mm or an asymmetrical rail geometry, the area on the foot to be tested can be determined by agreement between the purchaser and the manufacturer.

By convention these areas are based on projecting the nominal crystal size of the probe. The head shall be tested from both sides and from the running surface.

5.11.2 Sensitivity requirements

The sensitivity levels of the automated equipment used shall be a minimum of 4 dB greater than the level required to detect the reference reflectors described in 5.11.3. A rail giving an echo referring to a possible defect shall be separated by means of an automatic trigger/alarm level combined with a marking and/or sorting system. For possible retesting, the test sensitivity shall be increased to 6 dB instead of 4 dB.

The system shall incorporate continuous monitoring of interface signals and, if present, backwall echo signals.

5.11.3 Calibration rails

There shall be a calibration rail for each profile to be tested ultrasonically. The positions of the artificial defects are given for the rail head, web and foot of the 60E1 profile (see Annex D in ISO 5003:2016) in Figures 8, 9 and 10 respectively. Calibration rails for other profiles with calibration defects similar to those in accordance with Figures 8, 9 and 10 for 60E1 shall be available.

Other methods of calibration may be used but these methods shall be equivalent to that described above.

6 Tolerances for dimension, length and weight

6.1 Dimension and length tolerance

The dimensions of the profile [see Clause 4 a)] which shall have certain tolerances are given in Table 2.

The cut length and shortened length of rails shall be agreed by the purchaser and manufacturer [see Clause 4 e)]. The tolerances for cutting, drilling and length shall be as given in Table 3. The chamfer angle of drilled holes shall be 45° and 0,8 mm to 2,0 mm in depth.

6.2 Straightness, surface flatness and twist

Flatness testing of the body shall be performed automatically.

Tolerances for straightness, surface flatness and twist shall meet the requirements given in Table 4.

If the rail shows evidence of twist, this shall be checked in accordance with Figure 11 by inserting feeler gauges between the base of the rail and the rail skid nearest the rail end with the rail being laid head up on an inspection bed. If the gap exceeds 2,5 mm the rail shall be rejected. For twist measurement the rail may not overhang the end skid by more than 2 000 mm.

Rotational twist in the end metre of the rail as measured by the gauge illustrated in Figure 12 shall not exceed 0,2°.

Rejected rails may be subject to only one roller re-straightening.

In cases of dispute on the results of the automatic technique, rail flatness shall be verified using a straight edge as shown in Table 4.

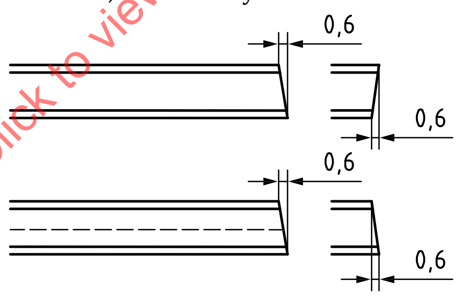
6.3 Weight

Rails shall be delivered in theoretical weight. The density of 7,85 g/cm^3 shall be applied to calculate the rail theoretical weight.

Table 2 — Tolerances for profile dimension

*Reference points (see ISO 5003:2016, Figure D.1)			Tolerances in mm	Gauge Figure number (see ISO 5003:2016, Annex G)
Height of rail	<165 mm ≥165 mm	*H	±0,7 ±0,8	G.3
Width of rail head		*WH	±0,5	G.4
Crown profile		*C	±0,6	G.5
Rail asymmetry		*AS	±1,2	G.6 and G.7
Height of fishing	<165 mm ≥165 mm	*HF	±0,5 ±0,6	G.8
Web thickness		*WT	±0,7	G.9
Width of rail foot		*WF	±1,0	G.10
Foot toe thickness		*TF	+0,75 −0,5	G.11
Foot base concavity			≤0,3	

Table 3 — Tolerances for cutting, drilling and length

	Dimensions in millimetres	Gauge Figure number (see ISO 5003: 2016, Annex G)
Squareness of ends	0,6 mm in any direction 	

[a] The given rail lengths apply for +20 °C. Measurements made at other temperatures are to be corrected to take into account expansion or contraction of the rail.

Table 3 *(continued)*

		Dimensions in millimetres	Gauge Figure number (see ISO 5003: 2016, Annex G)
Bolts	Diameter	±0,7	G.12
	Position Centring and positioning of the holes vertically and horizontally	The horizontal position of the holes is checked using a gauge as shown in ISO 5003:2016, Figure G.12 which has a stop designed to come into contact with the end of the rail and pins designed to enter the holes. The diameter of the pins for horizontal and vertical clearances is smaller than the diameter of the holes by: — 1,0 mm for holes ≤30 mm in diameter; — 1,4 mm for holes >30 mm in diameter. The distances between the centre lines of the pins and the stop are equal to the nominal distances from the centre line of the holes to the end of the rail. The gauge pins shall be able to enter the holes at the same time while the stop is touching the end of the rail. The vertical centring of the holes can be checked using a gauge as shown in ISO 5003:2016, Figure G.13. The side of the hole, left or right, is determined by proceeding from the side with the relief markings.	G.12, G.13
Length[a]	Rails drilled both ends ≤25 m	±6	
	Rails undrilled ≤25 m	±10	
	Rails undrilled or drilled one end >25 m	±1 mm/1 m	

[a] The given rail lengths apply for +20 °C. Measurements made at other temperatures are to be corrected to take into account expansion or contraction of the rail.

Table 4 — Straightness, surface flatness and twist tolerances

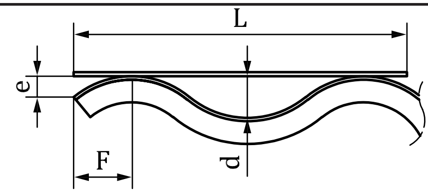
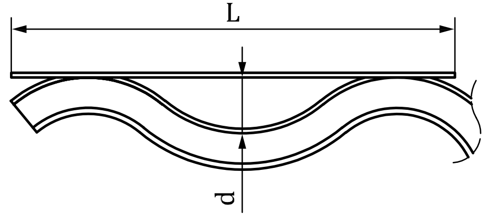
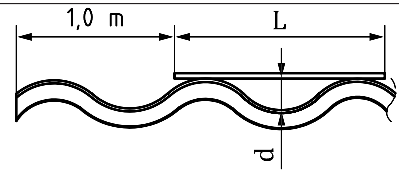
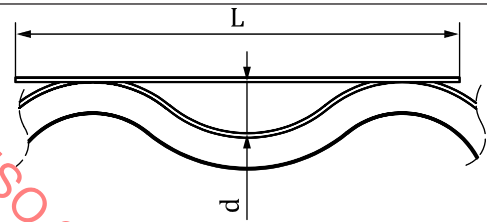
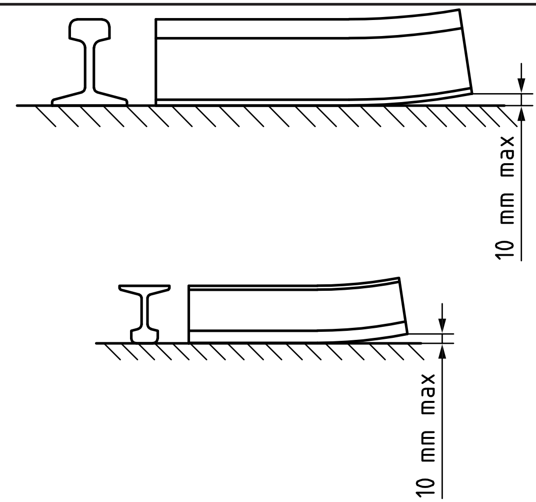
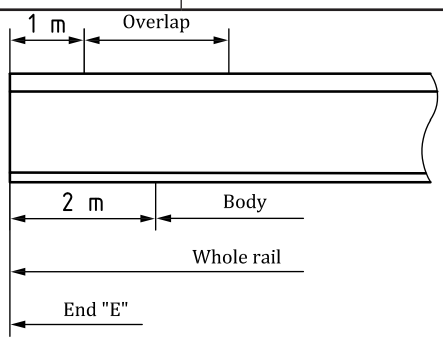
Location/Dimensional properties		d	L	
Ends[a,c,d]	End "E"	1,5 m		 If e > 0 F ≥ 0,6 m
	Vertical straightness-up (V[b])	≤0,5 mm	1,5 m	
	Vertical straightness-down (V)	and e ≤ 0,2 mm		
	Horizontal straightness (H[b])	≤0,7 mm	1,5 m	
Overlap[a,c,d]	Length of overlap	1,5 m		
	Vertical flatness (V)	≤0,4 mm	1,5 m[e]	
	Horizontal flatness (H)	≤0,6 mm	1,5 m[e]	
Body[a,c,d]	Vertical flatness (V)	≤0,4 mm	3 m[e]	
		and		
		≤0,4 mm	1,5 m[e]	
	Horizontal flatness (H)	≤0,6 mm	1,5 m[e]	

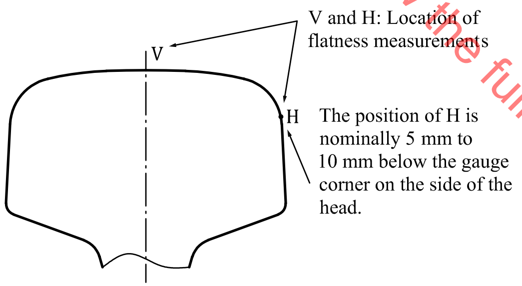
Table 4 *(continued)*

Location/Dimensional properties		d	L	
Sweep (whole rail)	Upsweep and downsweep	10 mm[f]		
Twist	Whole rail	Max. gap of 2,5 mm		See 6.2 and Figure 11
	End (1 m)	Max. rotational twist of 0,2° and max. relative twist of 0,003 5 × c		See 6.2 and Figure 12

a



b



c Automatic measurement equipment shall measure as much of the rail as possible but, at least the body. If the whole rail satisfies the body specifications, then measurement of end and overlap is not mandatory.

d Automatic measurement techniques are complex and are therefore difficult to define but the finished rail flatness shall be capable of being verified by straight edge as shown in the above drawings.

e 95 % of delivered rails shall be within limits specified, with 5 % of rails allowed outside the tolerances by 0,1 mm.

f The ends of the rails shall not be up more than 10 mm when the rail is on its foot or on its head when standing on an inspection bed.

7 Technical requirements

7.1 Manufacturing methods

7.1.1 Blooms made from basic oxygen steel or electric arc furnace steel that has been secondary refined including vacuum degassing, and continuously cast, shall be used for the manufacture of rails.

7.1.2 The manufacturer shall operate a procedure for the effective removal of scale during the rolling process.

7.1.3 The cross-sectional area of the rail shall not exceed one seventh that of the bloom from which the rail is rolled.

7.1.4 Rail straightening shall be by a two-stage roller straightening process which straightens the rail about its XX and YY axes as defined in the rail profiles. End deviations or a localized deviation on the rail may be corrected using pressing.

7.2 Chemical composition

7.2.1 General

The liquid chemical composition shall fulfil the requirements of Tables 5 and 6, and liquid residual elements shall fulfil the requirements of Table 7.

The content of nitrogen shall not exceed 90 × 10^{-4} % in the liquid for all steel grades.

Table 5 — Chemical composition of as-rolled (HR) rails (in mass %)

Steel grade	C	Si	Mn	P max.	S max.	Cr	Al_t max.	V
HR200	0,40–0,60	0,15–0,58	0,70–1,20	0,025	0,025	≤0,15	0,004	≤0,030
HR220	0,50–0,60	0,20–0,60	1,00–1,25	0,025	0,025	≤0,15	0,004	≤0,030
HR235	0,63–0,75	0,15–0,30	0,70–1,10	0,025	0,025	≤0,15	0,004	≤0,030
HR260A	0,62–0,80	0,15–0,58	0,70–1,20	0,025	0,025	≤0,15	0,004	≤0,030
HR260B	0,55–0,75	0,15–0,60	1,30–1,70	0,025	0,025	≤0,15	0,004	≤0,030
HR260C	0,40–0,60	0,20–0,45	1,20–1,60	0,025	0,025	0,40–0,65	0,004	≤0,060
HR260D	0,70–0,82	0,15–0,30	0,70–1,10	0,030	0,025	≤0,15	0,004	≤0,030
HR310C	0,72–0,82	0,50–0,80	0,70–1,05	0,025	0,025	0,30–0,50	0,004	0,04–0,12
HR320	0,60–0,80	0,50–1,10	0,80–1,20	0,020	0,025	0,80–1,20	0,004	≤0,18

Table 6 — Chemical composition of heat-treated (HT) rails (in mass %)

Steel grade	C	Si	Mn	P max.	S max.	Cr	Al_t max.	V
HT320	0,72–0,82	0,10–0,55	0,70–1,10	0,030	0,020	≤0,20	0,004	≤0,030
HT320A	0,65–0,76	0,10–0,58	0,70–1,20	0,025	0,025	≤0,15	0,004	≤0,030
HT330	0,72–0,82	0,10–0,65	0,80–1,20	0,030	0,020	≤0,25	0,004	≤0,030
HT350A	0,72–0,80	0,15–0,58	0,70–1,20	0,020	0,025	≤0,15	0,004	≤0,030
HT350B	0,72–0,80	0,15–0,58	0,70–1,20	0,020	0,025	0,15–0,30	0,004	≤0,030
HT370D	0,72–0,82	0,50–0,80	0,70–1,05	0,025	0,025	0,30–0,50	0,004	0,04–0,12
HT400	0,90–1,05	0,20–0,60	1,00–1,30	0,020	0,020	≤0,30	0,004	≤0,030

Table 7 — Maximum residual elements (in mass %)

Steel grade	Nb	Mo	Cu	Ni	Sn	Sb	Ti	Cu+10Sn	Others
HR200, HR220, HR235 HR260A, HR260B, HR260C, HR260D	0,01	0,02	0,15	0,10	0,030	0,020	0,025	0,35	Cr+Mo+Ni+Cu+V:0,35
HR310C, HT370D	0,04	0,02	0,15	0,10	0,030	0,020	0,025	0,35	Ni+Cu:0,20
HR320	0,01	0,02	0,15	0,10	0,030	0,020	0,025	0,35	Ni+Cu:0,16
HT320, HT320A, HT330 HT350B, HT400	0,04	0,02	0,15	0,10	0,030	0,020	0,025	0,35	Mo+Ni+Cu+V:0,20
HT350A	0,04	0,02	0,15	0,10	0,030	0,020	0,025	0,35	Cr+Mo+Ni+Cu+V :0,25

7.2.2 Solid chemical composition tolerances

The solid chemical composition tolerances shall conform to the requirements of Table 8.

Table 8 — Solid chemical composition tolerance on the upper and lower limits (in mass %)

Elements	Under (Minimum)	Over (Maximum)
C	0,02	0,02
Si	0,02	0,02
Mn	0,05	0,05
P	—	0,005
S	—	0,005
N	—	0,001
Cr[a]	0,03	0,03
V[b]	0,02	0,02

[a] This is suitable only for HR260C, HR310C, HR320, HT350B and HT370D.

[b] This is suitable only for HR310C and HT370D.

7.2.3 Hydrogen content

For all grades other than HT370D and HT400, the hydrogen contents of the liquid steel shall not exceed $2,5 \times 10^{-4}$ %, or the hydrogen contents of solid rails shall not exceed $2,0 \times 10^{-4}$ %. For the grades of HT370D and HT400, the hydrogen contents of the liquid steel or solid rails shall not exceed $1,7 \times 10^{-4}$ %.

If the hydrogen contents of the first samples of a first heat or the heat sample of a second or further heat do not conform with these requirements, then the blooms made before those samples are taken shall be slowly cooled or isothermally treated. This applies also to all blooms made before the hydrogen content eventually complies with these requirements; in these cases, all heats shall be tested in the rail form. In case of dispute, the hydrogen content shall be tested in the rail form.

If any test result after corrective treatment fails to meet these requirements the heat shall be rejected.

7.2.4 Total oxygen content

Total oxygen content of liquid steel or product rail shall not exceed 20×10^{-4} %.

7.3 Mechanical properties

The tensile strength, elongation and surface hardness of as-rolled and heat-treated rail shall meet the requirements as shown in Tables 9 and 10. The surface hardness shall not vary by more than 30 HBW on any individual rail.

The internal hardness of heat-treated rails shall meet the requirements as shown in Table 11.

Table 9 — Tensile strength, elongation and surface hardness of as-rolled (HR) rails

Steel grade	Tensile strength Rm (MPa)	Elongation A (%)	Surface hardness (HBW)
HR200	≥680	≥14	200–240
HR220	≥770	≥12	220–260
HR235	≥800	≥10	235–275
HR260A, HR260B, HR260C	≥880	≥10	260–300
HR260D	≥890	≥8	260–300
HR310C	≥980	≥9	310–350
HR320	≥1 080	≥9	320–360

Table 10 — Tensile strength, elongation and surface hardness of heat-treated (HT) rails

Steel grade	Tensile strength Rm (MPa)	Elongation A (%)	Surface hardness (HBW)
HT320	≥1 080	≥10	320–375
HT320A	≥1 080	≥10	320–380
HT330	≥1 130	≥10	330–390[a]
HT350A, HT350B	≥1 175	≥9	350–390[a]
HT370D	≥1 280	≥10	370–420[b]
HT400	≥1 280	≥9	400–440[c]

[a] If the hardness exceeds 390 HBW, the rail is acceptable provided the microstructure is confirmed to be pearlitic, and the hardness does not exceed 405 HBW.

[b] If the hardness exceeds 420 HBW, the rail is acceptable provided the microstructure is confirmed to be pearlitic, and the hardness does not exceed 435 HBW.

[c] If the hardness exceeds 440 HBW, the rail is acceptable provided the microstructure is confirmed to be pearlitic, and the hardness does not exceed 455 HBW.

Table 11 — Internal hardness of heat-treated (HT) rails

Steel grade	Internal hardness (HBW)			
	Point 1	Point 2	Point 3	Point 4
HT320, HT320A	≥321	≥311	≥301	≥321
HT330	≥331	≥321	≥311	≥331
HT350A, HT350B	≥340	≥331	≥321	≥340
HT370D	≥360	≥350	≥340	≥360
HT400	≥390	≥380	≥370	≥370

7.4 Microstructure

For HR200, HR220, HR235, HR260A, HR260B and HR260D, the microstructure shall be pearlitic, but grain boundary ferrite may occur. For other grades, the microstructure shall be fully pearlitic.

All grades including heat-treated grades, the microstructure shall contain no martensite, bainite or grain boundary cementite.

7.5 Decarburization

Where decarburisation is assessed metallographically, the depth of continuous ferrite networks as assessed according to ISO 3887 shall not exceed 0,5 mm measured on the rail head surface.

Where decarburisation is assessed by the hardness method, the minimum hardness measured at the centre of the rail crown shall not be more than 7 HBW below the minimum bulk hardness for the grade tested.

7.6 Nonmetallic inclusions

If the method shown in ISO 5003:2016, Annex C is applied, the total index K3 shall conform with:

— 10 < K3 ≤ 20 for a maximum of 5 % of samples;

— K3 ≤ 10 for a minimum of 95 % of samples.

For orders less than 5 000 tonnes, only one sample with a K3 greater than 10 and less than or equal to 20 is allowed.

If alternative methods are used (see 5.9), the following limits shall apply:

— If the method of ISO 4967 is applied, the non-metallic inclusions of rails shall conform with the requirements of Table 12 according to the information on the class applied as given by the purchaser [see Clause 4 c)].

Table 12 — Non-metallic inclusions assessment according to ISO 4967

Type	Class 1	Class 2
A	≤2,0	≤2,5
B	≤1,5	≤2,0
C	≤1,5	≤2,0
D	≤1,5	≤2,0

— In ASTM E45, Method A, each individual metallographic sample shall have a maximum average rating of 2 and a maximum individual rating of 3 for any inclusion type, thin or heavy.

7.7 Macrostructure

The transverse macrostructures of acid etch rail test pieces shall conform with the requirements specified in ISO 5003:2016, Annex H or Annex I.

7.8 Ultrasonic test

All rails shall be ultrasonically tested by a continuous process ensuring that the entire rail length and specified cross-sectional area are inspected. Rails giving signals exceeding the threshold in the rail using the increased sensitivity shall be rejected or cut back to remove the defective portion.

7.9 Surface quality

7.9.1 All rails shall be visually or automatically inspected on all faces for surface imperfections. All rails shall conform with the criteria defined in 7.9.2 to 7.9.5. Assessment and dressing of imperfections shall be in accordance with 7.9.6.

7.9.2 The rail surface shall be free of cracks, when assessed by visual inspection.

7.9.3 All protrusions on the running surface or the underside of the foot shall be dressed. Any protrusions affecting the fit of the fishplate at less than 1 m from the extremity of the delivered rail shall be dressed to shape.

7.9.4 The depth of hot marks and seams shall not exceed:

— 0,35 mm for the running surface;

— 0,5 mm for the rest of the rail.

In the case of longitudinal guide marks, there shall be a maximum of two, to the depth limits specified, at any point along the length of the rail but no more than one of these shall be on the rail running surface. Recurring guide marks along the same axis are accepted as a single guide mark.

The maximum width of guide marks shall be 4 mm. The width to depth ratio of allowable guide marks shall be a minimum 3:1.

In the case of hot formed marks originating from the vicinity of the mill rolls, those which are recurrent along the same axis, at a distance equal to the roll circumference, shall be accepted as a single mark and may be removed by dressing. On the running surface a maximum of three marks per 40 m is allowed. Statements concerning dressing are given in 7.9.6.

7.9.5 Cold marks are longitudinal or transverse cold formed scratches.

The discontinuity depth shall be not larger than:

— 0,3 mm for the rail running surface and underside of foot;

— 0,5 mm for the rest of rail.

7.9.6 If the imperfection depth cannot be measured it shall be investigated by depth proving, and subsequently dressed to the criteria below, using a rotary burr, lamellar flap tool or grinding belt, provided the rail microstructure is not affected by the operation and the work is contour blended.

The depth of dressing shall be not larger than:

— 0,35 mm for the rail running surface;

— 0,5 mm for the rest of rail.

No more than three defects within a length of 10 m of rail and, over the whole length a maximum of one defect per 10 m rail length shall be dressed or proved. After dressing profile tolerances shall be in accordance with Table 2 and flatness tolerances shall be in accordance with Table 4.

7.9.7 Any sign of surface microstructural damage resulting in martensite or bainite shall be dressed or the rail rejected.

8 Inspection requirements

8.1 Inspection and acceptance

The inspection and acceptance tests shall be the responsibility of the manufacturer.

8.2 Retest and justification

When the initial test results fail to conform with the requirements, retest and justification shall conform with the following requirements.

If any test result fails to meet the requirements, this rail should be rejected. Further tests shall be performed on samples from two other rails from the same heat. These samples should be representative of the cast and rolling batch and should be from separate caster strands. If the results of both retests are in accordance with the specification requirements, the remaining rails from this heat shall be accepted.

Should either retest fail to meet the specification requirements, then rails from this heat and batch shall be either rejected or re-heat treated depending on the specification.

Alternatively, rails from this heat and batch may be accepted on the basis that acceptable results are obtained by testing the individual rails to be supplied.

9 Identification

9.1 Branding

Brand marks shall be rolled in relief on one side and in the middle of the web of each rail at least once every 4 m. The brand marks on the rails shall be clearly legible and shall be 20 mm to 30 mm high, raised between 0,5 mm and 1,5 mm.

The brand marks shall include:

a) the identification of the mill;

b) the rail profile identification;

c) the steel grade;

d) the last two figures of the year of manufacture.

The order of the information given in a) to d) shall be given by the manufacturer.

9.2 Hot stamping

In addition to the branding requirements of 9.1 each rail shall be identified by a numerical and/or alphabetical code system, hot stamped on the non-branded side of the rail web by machine and each rail shall be hot stamped at least once every 10 m.

NOTE Subsequent cutting could result in more than one rail length having the same identity.

The figures and letters used shall be clearly legible and shall be 16 mm high. The stamped characters shall have a flat or radius face (1 mm to 1,5 mm wide) with bevels on each side. The letters and numbers shall be on a 10° angle from vertical and shall have rounded corners. The stamping shall be between 0,5 mm and 1,5 mm in depth along the centre of the web. The design shall be as shown in Figure 13.

The identification system employed shall be such as to enable the hot stamped marking to be collated with the:

a) number of the heat from which the rail has been rolled;

b) number of the strand and position of bloom within the strand;

c) position of the rail in the bloom (A, B ... Y).

9.3 Cold stamping

Cold stamping shall only be used on the cut face of the rail within the central portion of the head, at the request of the purchaser.

9.4 Other identification

9.4.1 As an alternative to 9.1 and 9.2, the brand marks or hot stamping on the web can also be agreed between manufacturer and purchaser.

9.4.2 In the event of identification marks having been removed, omitted or requiring alteration, re-identification of such marks shall be made by rotary burr or painting.

9.4.3 The rail shall not be delivered when no marks are present or marks cannot be clearly identified.

9.4.4 Painting of rail identification shall be agreed by purchaser and manufacturer [see Clause 4 g)].

10 Certificate

When specified in the purchase order or contract, a certificate shall be furnished, including:

a) the name of manufacturer;

b) the name of purchaser;

c) the rail profile(s);

d) the number of the contract;

e) the number of this document;

f) the steel grade(s);

g) quantity and length of the rail;

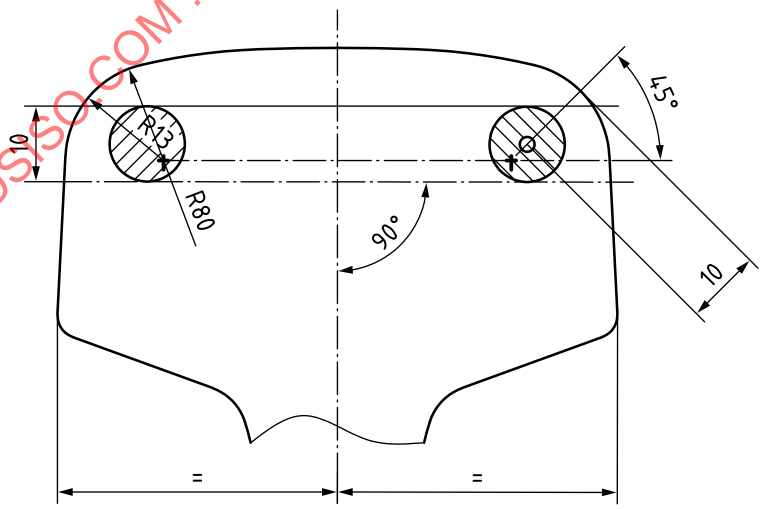
h) heat;

i) date of issue;

j) all the test results specified in 7.2 to 7.7.

The issue of a certificate according to this document confirms conformance with all technical requirements of this document.

Dimensions in millimetres



Key

✝ intersecting point of the *R*13 and *R*80 radii (60E1 section)

○ location at the centre of the tensile test piece

area to be checked for microstructure

Figure 1 — Location of tensile test piece and microstructure checks

Dimensions in millimetres

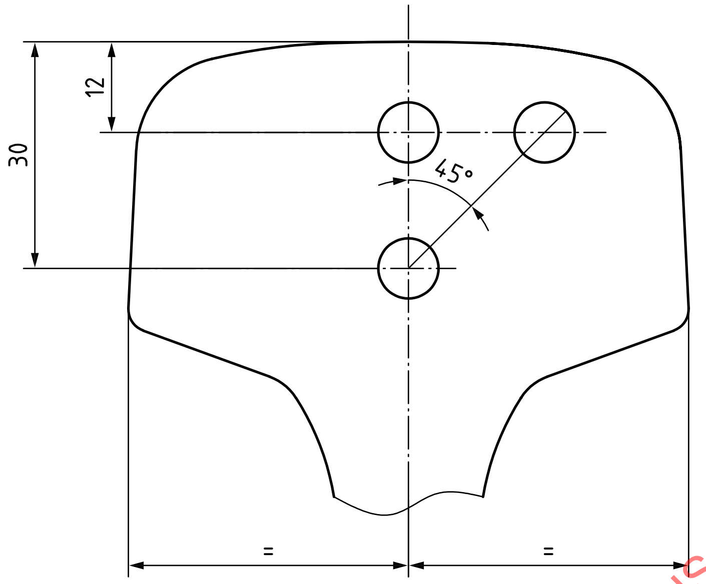
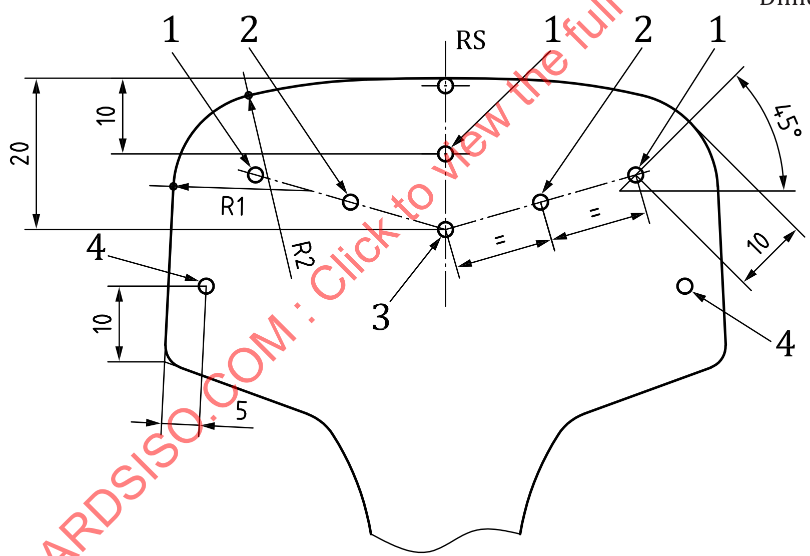


Figure 2 — Sampling positions in rail for total oxygen determination

Dimensions in millimetres

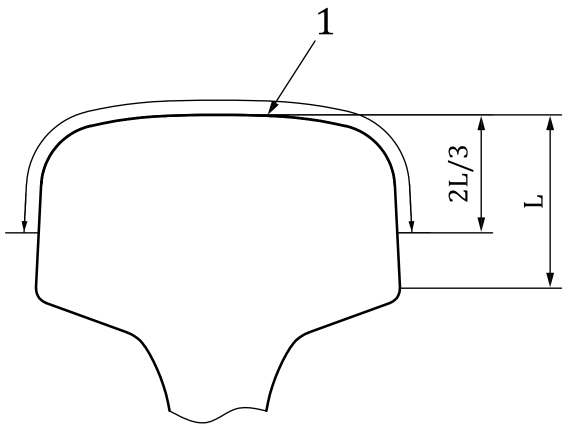


Key

1,2,3 and 4 location of hardness testing (see Table 11)

• exact intersection points of the radii

Figure 3 — Hardness testing positions

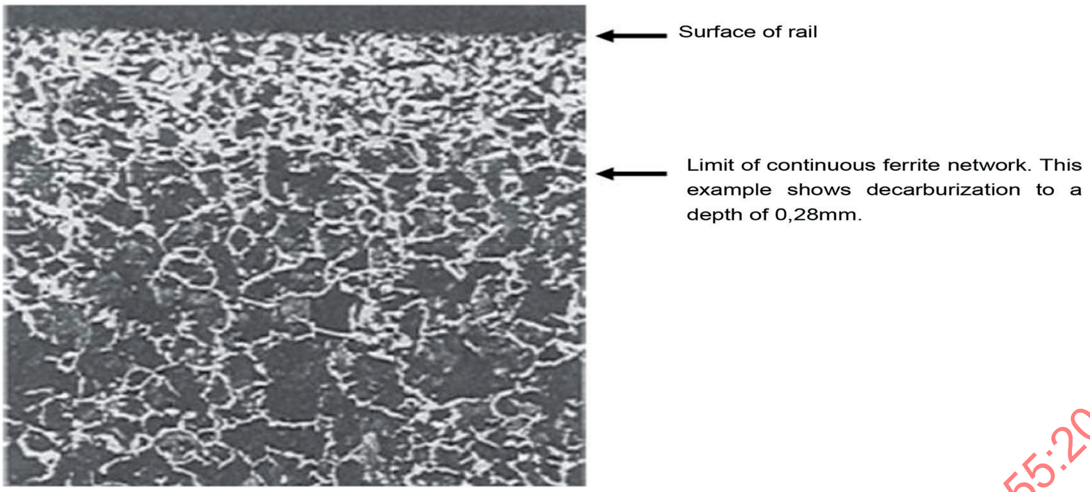


Key

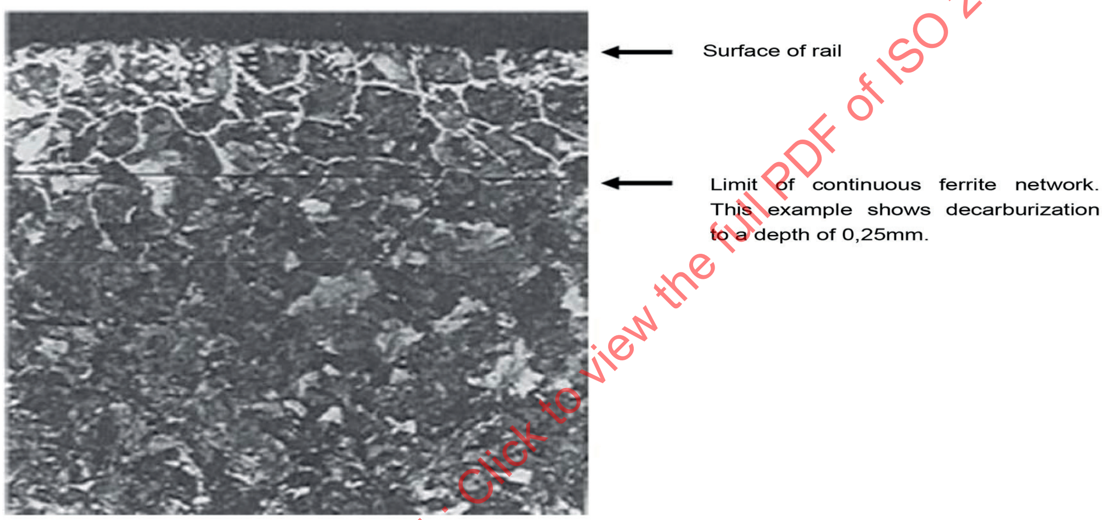
1 decarburization limits apply to this part of rail head.

L from railhead top to the transition point between the flat part of the side and the radius at the lower part of the rail head

Figure 4 — Range of extent of rail head surface for decarburization checks



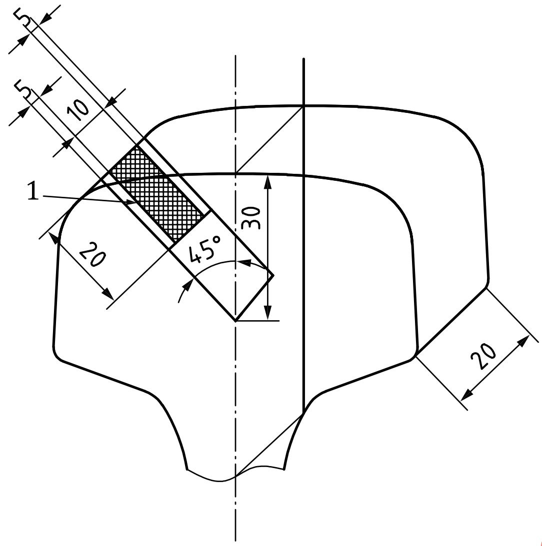
Grades HR200 and HR220



All grades other than HR200 and HR220

Figure 5 — Photomicrographs (×100) showing examples how to determine the depth of decarburization allowed on the rail wear surface

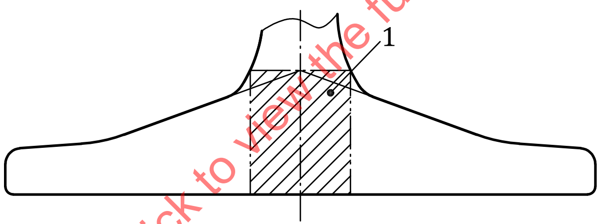
Dimensions in millimetres



Key

1 face to be examined

Figure 6 — Nonmetallic inclusions sampling position in rail head



Key

1 area to be tested

Figure 7 — Area to be tested in rail foot of 60E1 profile