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Part 1: Vignole railway rails 46 kg/m and above

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

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Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Railway applications - Rail - Part 1: Vignole railway rails 46 kg/m and above

Applications ferroviaires - Rails - Partie 1 : Rails
Vignole de masse supérieure ou égale à 46 kg/m

Bahnanwendungen - Schienen - Teil 1: Vignolschienen
ab 46 kg/m

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 256.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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Contents

Page

European foreword.....	5
Introduction	6
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions	7
4 Information to be supplied by the purchaser	9
5 Steel grades	9
6 Profile drawings/properties/mass	10
7 Manufacture	11
7.1 Product integrity	11
7.2 Blooms.....	11
7.3 Rails.....	11
7.4 Identification	11
7.4.1 Branding.....	11
7.4.2 Hot stamping.....	12
7.4.3 Cold stamping.....	13
7.4.4 Other identification.....	13
8 Qualifying tests	13
8.1 Procedure.....	13
8.2 Fracture toughness (K_{IC}).....	13
8.2.1 Test pieces and test methods.....	13
8.2.2 Qualifying criteria.....	13
8.3 Fatigue crack growth rate	14
8.3.1 Test method	14
8.3.2 Test pieces	14
8.3.3 Number of tests and test conditions.....	14
8.3.4 Qualifying criteria.....	14
8.4 Fatigue test	15
8.4.1 Test method	15
8.4.2 Test pieces	15
8.4.3 Number of tests and test conditions.....	15
8.4.4 Qualifying criteria.....	15
8.5 Residual stress in rail foot	15
8.5.1 Test method	15
8.5.2 Test pieces	15
8.5.3 Measurements.....	15
8.5.4 Qualifying criteria.....	15
8.6 Treated rails.....	16
8.7 Segregation.....	16
8.8 Other qualifying requirements	16
9 Acceptance tests	16
9.1 Laboratory tests.....	16
9.1.1 General.....	16
9.1.2 Sampling and preparation of samples and test pieces	16
9.1.3 Chemical composition	16
9.1.4 Microstructure	21
9.1.5 Decarburisation.....	21

9.1.6	Oxide cleanness	22
9.1.7	Sulphur prints	22
9.1.8	Hardness	22
9.1.9	Tensile tests	23
9.1.10	Tensile strength and elongation	23
9.1.11	Retest procedures	24
9.2	Dimension tolerances	24
9.2.1	Profile	24
9.2.2	Straightness, surface flatness and twist	25
9.2.3	Cutting and drilling	29
9.3	Gauges	29
9.4	Inspection for internal quality and surface quality	29
9.4.1	Internal quality	29
9.4.2	Surface quality	32
9.4.3	Checking of automated testing equipment	34
Annex A (normative) Rail profiles		46
Annex B (normative) Standard test method for the determination of the plane strain fracture toughness (K_{IC}) of rails		71
B.1	Test methods	71
B.2	Test pieces	71
B.3	Number of tests	71
B.4	Test conditions	71
B.5	Analysis of test data	72
B.6	Reporting of results	72
Annex C (normative) Method for the determination of rail foot surface longitudinal residual stresses		78
C.1	Procedure	78
C.2	Strain gauges and their location	78
Annex D (normative) Limiting sulfur prints		81
Annex E (normative) Profile and drilling gauges		87
Annex F (normative) Microscopic examination of rail steels using standard diagrams to assess the content of non-metallic inclusions		100
F.1	General	100
F.1.1	Degree of purity	100
F.1.2	Standard diagram plate No. 1	100
F.2	Preparation of specimens	100
F.3	Structure and use of standard diagram plate No. 1	100
F.3.1	Use of diagram plate No. 1	100
F.3.2	Rating a single inclusion	101
F.3.3	Rating of very small inclusions	101
F.4	Test procedure	101
F.4.1	Magnification	101
F.4.2	Selection of inclusions	101

F.4.2.1 General.....	101
F.4.2.2 Rating of inclusions extending the diameter of observation	101
F.4.2.3 Rating of inclusions of different types and shapes	102
F.4.2.4 Rating of continuous and isolated inclusions	102
F.4.2.5 Area to be examined	102
F.5 Evaluation	102
F.5.1 General.....	102
F.5.1.1 Designation of inclusions	102
F.5.1.2 Recording of inclusions.....	102
F.5.2 Method of evaluation	102
F.5.3 Calculation procedure for evaluation using method K.....	102
Annex G (normative) Minimum requirements for the introduction of a new rail steel grade in EN 13674-1	105
G.1 Mechanical and metallurgical properties	105
G.2 Welding properties.....	105
G.3 Track testing.....	106
G.4 Documentation and request to CEN to introduce the new rail steel grade	106
Annex H (informative) Significant technical changes between this European Standard and the previous edition.....	107
Annex ZA (informative) Relationship between this European Standard and the essential requirements of EU Directive (EU) 2016/797 aimed to be covered.....	110
Bibliography	112

European foreword

This document (prEN 13674-1:2023) has been prepared by Technical Committee CEN/TC 256 “Railway Applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 13674-1:2011+A1:2017.

prEN 13674-1:2023 includes the following significant technical changes with respect to EN 13674-1:2011+A1:2017:

- The number of rail profiles is modified: 24 instead of 23;
- Introduction of a new steel grade: R335V;
- The minimum depth of stamping is reduced from 0,5 mm to 0,4 mm;
- 60E2 can be used as well as the 60E1 for the qualifying tests;
- The predictive equation is removed from the qualifying tests to the acceptance tests;
- Suppression of 02 as an element to be controlled and measured;
- Brinell hardness test conditions have been modified;
- New value for foot toe thickness;
- The rail transition references have been removed;
- A new normative annex “Minimum requirements for the introduction of a new rail steel grade in EN 13674-1” has been introduced.

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

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

Introduction

This Introduction provides an explanation of the concepts and reasoning considered for this standard.

Whenever possible this part of EN 13674 is performance based, recognizes the European Quality System standard EN ISO 9001 and requires manufacturers to offer the latest proven technology to consistently satisfy the demanding quality of the required product.

This part of EN 13674 has two major divisions:

- 1) qualifying tests;
- 2) acceptance tests.

The qualifying tests take into account performance requirements. They also include typical results from relevant acceptance tests.

The acceptance tests control those characteristics of the rail steel and rail that are of relevance to the production of high quality rails including heat treated rails and the demands of the railway.

To ensure the supply of high quality rails, some restrictions on production processes are considered.

The performance based standard applies to all procurements falling inside the requirements of the European Procurement Directive (93/38/EEC of 14th June 1993), taking into account safety implications and at the same time addressing modern production technology and the requirements of high-speed railways. As a result of the Directive it was recognized that there would be few opportunities (and these would have to be for transparent safety considerations) for derogation from the standard to operate between the user and the manufacturer.

The standard includes a prerequisite for all manufacturers to prove conformity against a set of qualifying test criteria. Qualifying tests include all "normal" acceptance test results plus new "type-casting" features such as fracture toughness, fatigue cracks growth rate, fatigue test and residual stress. To provide users with the necessary confidence, acceptance limits have been based on results from rail known to have performed well in demanding track installations.

The standard includes a quality assurance and inspection clause as part of product integrity.

In order that quality management systems are consistent across all manufacturers and that users have the best assurance for the consistency of required product quality on this safety critical component of the track, this rail standard recommends that the manufacturers' quality assurance systems are at least equivalent to the requirements of EN ISO 9001. The inclusion of this requirement also reduces the need to incorporate detailed method and calibration descriptions on items such as normal chemical composition determination and the need to define more extensive testing.

1 Scope

This document specifies Vignole railway rails of 46 kg/m and greater linear mass, for conventional and high speed railway track usage.

Pearlitic steel grades are specified covering a hardness range of 200 HBW to 440 HBW and include non heat treated non alloy steels, non heat treated alloy steels, and heat treated non alloy steels and heat treated alloy steels.

There are 24 rail profiles specified in this document.

Two classes of rail straightness are specified, differing in requirements for straightness, surface flatness and crown profile. Two classes of profile tolerances are specified.

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.

EN 10163-1:2004, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections - Part 1: General requirements*

CEN/TR 10261:2018, *Iron and steel - European standards for the determination of chemical composition*

EN ISO 6506-1:2014, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:2014)*

EN ISO 6892-1:2019, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2019)*

EN ISO 14284:2022, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition (ISO 14284:2022)*

EN ISO 80000-1:2022, *Quantities and units - Part 1: General (ISO 80000-1:2022)*

ISO 1099:2017, *Metallic materials - Fatigue testing - Axial force-controlled method*

ISO 4968:2022, *Steel - Macrographic examination by sulphur print (Baumann method)*

ISO 12108:2018, *Metallic materials - Fatigue testing - Fatigue crack growth method*

ASTM E399-22, *Standard test method for linear-elastic plane-strain fracture toughness of metallic materials*

3 Terms and definitions

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

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

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 bloom

refers to a semi product produced from a continuous casting machine with either a square, rectangular or circular section

3.2

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.

3.3

sequence

any number of heats, of the same steel grade, which undergo continuous casting in tundishes

Note 1 to entry: Tundishes may be used in parallel.

3.4

heat treated rail

rail that has undergone accelerated cooling from austenitizing temperature during the metallurgical transformation period

Note 1 to entry: The heat treatment can be carried out directly after rolling or following a separate reheating process to achieve the austenitization temperature.

3.5

rolling process

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

3.6

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 austenite to pearlite transformation temperature as is practically possible.

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

3.7

qualifying test

special test and criteria which are relevant to some aspects of the service performance of rails

Note 1 to entry: Acceptance tests also form part of the qualifying tests.

3.8

acceptance test

test carried out as part of the process and product control system, normally on a heat, sequence or tonnage basis

3.9

rail running surface

curved surface of the rail head. Area between both gauge corners (transition points of the head inclination and the first head radius)

3.10

units of measurement

for the purpose of determining conformance with the specification, numeric values are rounded according to the rules stipulated in EN ISO 80000-1:2022

4 Information to be supplied by the purchaser

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

- a) rail profile (see Annex A);
- b) steel grade (see Clause 5);
- c) profiles class, 'X' or 'Y' (see 9.2.1);
- d) straightness class 'A' or 'B' of rail as specified in 9.2.2;
- e) length(s) of rail (see Table 9);
- f) undrilled or drilled rail ends to take fish bolts, and location and dimensions of holes when required (see 9.2.3);
- g) any special treatment to be applied to bolt holes and corresponding special tolerances for bolt holes (see 9.2.3);
- h) cold stamping on the cut face (see 7.4.3);
- i) paint code requirements (see 7.4.4).

5 Steel grades

The applicable steel grades are given in Table 1. The hardness ranges of the steel grades shall conform to those given in Table 1.

For the steel grades in Table 1, the steel names and steel numbers were allocated in accordance with EN 10027-1 and EN 10027-2, respectively.

For inclusion of a new rail steel grade in this document, the supplier shall comply with the requirements of Annex G "Minimum requirements for the introduction of a new rail steel grade in EN 13674-1".

Table 1 — Steel grades

Steel grade ^a		Hardness range (HBW)	Description	Branding lines
Steel name	Steel number			
R200	1.0521	200 to 240	Non-alloy Non heat treated	No branding lines
R220	1.0524	220 to 260	Non-alloy Non heat treated	-----
R260	1.0623	260 to 300	Non-alloy Non heat treated	--- -----
R260Mn	1.0624	260 to 300	Non-alloy Mn Non heat treated	----- -----
R320Cr	1.0915	320 to 360	Alloy (Cr, Si) Non heat treated	----- ----- -----
R335V	1.0639	335 - 375	Alloy (V, Si) Non heat treated	----- ----- ---
R350HT	1.0631	350 to 390 ^b	Non-alloy Heat treated	--- ----- -----
R350LHT	1.0632	350 to 390 ^b	Non-alloy Heat treated	--- ----- ----- ---
R370CrHT	1.0992	370 to 410	Alloy Cr)) Heat treated	--- ----- ----- -----
R400HT	1.1254	400 to 440	Non-alloy Heat treated	----- ----- -----
^a See Table 5 a) and Table 5 b) for chemical composition/mechanical properties. ^b See Table 6 for hardness requirements.				

6 Profile drawings/properties/mass

Rail profiles, dimensions, properties and linear masses shall be in accordance with Annex A. The tolerances of certain dimensions shall be as given in Table 7. All other quantities are informative only.

NOTE Linear masses have been calculated based on the density of steel of 7,85 kg/dm³.

7 Manufacture

7.1 Product integrity

Rails shall be produced under a comprehensive system of factory production control which shall ensure confidence in the conformity of the finished product. The system shall address this document to ensure that the finished products consistently comply with requirements to achieve the product integrity necessary to provide assurance of product safety in track.

Manufacturers shall demonstrate continuing compliance, including documented evidence, with the factory production control system required.

NOTE Manufacturers having a factory production control system which complies with EN ISO 9001 are recognized as satisfying the minimum requirements specified by this clause.

7.2 Blooms

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

7.3 Rails

7.3.1 The manufacturer shall operate a procedure for the effective removal of scale during the manufacturing process.

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

7.3.3 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 shown in Annex A. End deviations or a localised deviation on the rail may be corrected using pressing.

NOTE Other mandatory processes are described in the relevant clauses within the document.

7.4 Identification

7.4.1 Branding

Brand marks shall be rolled in relief on one side and in the middle of the web (see Annex A) 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 25 mm high, raised between 0,6 mm and 1,3 mm.

The branding line(s) to denote grade shall be 50 mm in length for the long branding line and 25 mm in length for the short branding line.

The brand marks shall include:

- a) identification of the mill;
- b) steel grade as shown in Table 1;
- c) last two figures of the year of manufacture;
- d) rail profile identification as shown in Annex A.

EXAMPLES

ROLLING MILL _____ 07 60 E1

(60 E1 profile rail rolled 2007, non-alloy rail steel grade R260).

ROLLING MILL _____ 07 60 E1

(60 E1 profile rail rolled 2007, non-alloy heat treated rail steel grade R350HT).

NOTE The sequence of the branding marks is at the discretion of the manufacturer.

7.4.2 Hot stamping

In addition to the branding requirements of 7.4.1, 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.

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 0,4 mm and 1,5 mm in depth along the middle of the web as defined for the branding in annex A. The design shall be as shown in Figure 1.

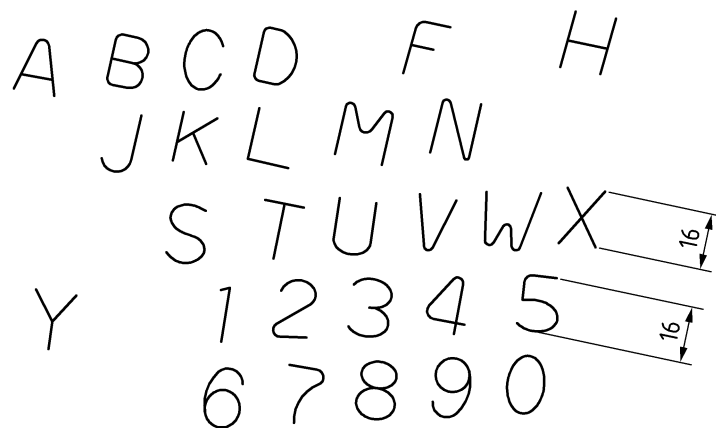


Figure 1 — Design of letters and numbers on a 10° angle for rail stamps

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).

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 other method agreed by the customer.

NOTE 1 A rail can display different indications of position of the rail in the bloom (A,B...Y) along its length.

NOTE 2 Subsequent cutting could result in more than one rail length having the same identity.

7.4.3 Cold stamping

Cold stamping may only be used on the cut face of the rail within the central portion of the head. Cold stamping at another position shall be agreed by the purchaser.

7.4.4 Other identification

The purchaser shall specify their requirements for any colour coding or special marking instructions and their position on the rail at the time of enquiry or order.

8 Qualifying tests

8.1 Procedure

8.1.1 The manufacturer shall describe any bloom slow cooling or isothermal treatment process used to demonstrate compliance with the requirements of 9.1.3.2.

8.1.2 All qualifying tests as specified in 8.2 to 8.8 shall be undertaken at least once every five years and as a result of any significant production process change for all grades.

The manufacturer shall only carry out testing on the 60E1/60E2 profile or the heaviest section produced.

All rail grades and profiles supplied shall conform to the qualifying criteria in accordance with 8.2 to 8.8.

The results for the grades to be supplied shall be provided at the time of tendering.

In the event of a manufacturer not having produced the rail grade prior to the tender enquiry he shall have the option of carrying out such tests on the first available sequence. When the qualifying criteria have been complied with, compliance with the standard is demonstrated and consequently the manufacturer is qualified.

8.1.3 The samples in accordance with 8.1.4 and 8.1.5 shall be removed from finished roller straightened rails. These samples shall not be subject to any further mechanical or thermal treatment (other than the treatment of ageing of the tensile test pieces as described in 9.1.9.2).

8.1.4 Test pieces for fracture toughness, fatigue crack growth rate and fatigue tests (see 8.2, 8.3 and 8.4 respectively) shall be taken from at least 3 sample rails taken at a minimum of 3 m from the cut ends of the rail. Sample rails shall be from different heats.

8.1.5 For residual stress tests (see 8.5), there shall be 6 sample rails and the test pieces shall be taken at least 3 m from each rail end. Sample rails shall be from at least 3 different heats.

8.1.6 All tests should be carried out by a laboratory that operates an approved and audited quality assurance system conforming to requirements at least equivalent to EN ISO 9001.

8.1.7 The purchaser shall have access to all test records, calibrations and calculations that contribute to the final results.

8.1.8 All test results shall be reported to the purchaser.

8.2 Fracture toughness (K_{Ic})

8.2.1 Test pieces and test methods

Tests shall be performed in accordance with Annex B.

8.2.2 Qualifying criteria

The value of K_{Ic} shall comply with Table 2.

Table 2 — Minimum single and minimum mean values of K_{Ic}

Steel grade	Minimum single value K_{Ic} (MPa m ^{1/2})	Minimum mean value K_{Ic} (MPa m ^{1/2})
R200 and R220	30	35
R260 and R260Mn	26	29
R320Cr	24	26
R335V	26	29
R350HT	30	32
R350LHT, R370CrHT, R400HT	26	29

NOTE In some circumstances K_Q^* values can be used for the purpose of qualification, see B.6.

8.3 Fatigue crack growth rate

8.3.1 Test method

Tests shall be carried out in accordance with the general requirements of ISO 12108:2018.

8.3.2 Test pieces

A three points bend, single edge notch test piece, of the dimensions and location within the rail shown in Figure 2 shall be used.

8.3.3 Number of tests and test conditions

A minimum of 3 tests from each sample rail shall be performed under the following conditions:

- test temperature shall be within the range +15 °C to +25 °C;
- $R = 0,5$ (R = minimum cyclic load/maximum cyclic load);
- 3 points bend test piece loading span shall be $4 W$ (see Figure 2);
- cyclic loading frequency shall be within the range 15 Hz to 40 Hz;
- environment: laboratory air.

8.3.4 Qualifying criteria

Fatigue crack growth rates (m/Gc) shall not exceed the values given in Table 3.

Table 3 — Fatigue crack growth rates

Steel grades	$\Delta K = 10 \text{ MPa m}^{1/2}$	$\Delta K = 13,5 \text{ MPa m}^{1/2}$
All grades	17 m/Gc	55 m/Gc

8.4 Fatigue test

8.4.1 Test method

Constant amplitude fatigue tests shall be carried out in accordance with ISO 1099:2017 or ISO 12106.

In case of testing carried out according to ISO 1099:2017, a minimum of 50 initial fatigue cycles under strain control shall be applied to define the load necessary to achieve the required strain.

8.4.2 Test pieces

The test pieces shall be machined from the sample rail as shown in Figure 3.

8.4.3 Number of tests and test conditions

A minimum of 3 test pieces shall be tested from each sample rail under the following conditions:

- test temperature shall be within the range + 15 °C to + 25 °C;
- control variable shall be axial strain amplitude of load;
- strain or load cycle shall be symmetrical about the initial, zero load.

R ratio to be used is -1.

8.4.4 Qualifying criteria

For an amplitude of total strain of 0,00135, the life of each specimen shall be greater than 5×10^6 cycles.

NOTE Life is defined as the number of cycles up to the complete separation of the specimen.

8.5 Residual stress in rail foot

8.5.1 Test method

The residual stresses in the rail foot shall be determined in accordance with Annex C.

8.5.2 Test pieces

Each of the 6 test pieces from the rail section shall be 1,00 -0/+0,10 m in length and shall be taken from rails as described in 8.1.3 and 8.1.5.

NOTE Only a small part of the test piece will be destroyed for the purpose of measuring residual stress; the remainder can be used for other qualifying approval tests.

8.5.3 Measurements

Longitudinal residual stress determinations shall be made on the rail foot of each of the 6 test pieces described in 8.5.2. The location of the measurements is shown in Figure C.1.

If data are available for straightness class A rails then class B rails of the same profile need not be tested.

8.5.4 Qualifying criteria

The maximum longitudinal residual stress in the foot shall be +250 MPa (tensile stresses) for all steel grades.

8.6 Treated rails

This clause only applies to heat treated rails.

For the longest length of rail produced by the manufacturer, a one metre length of rail shall be taken from each end and at 20 m intervals from one end of the rail. These shall be hardness tested (HBW) in accordance with EN ISO 6506-1:2014 along their length at 25 mm intervals on the centreline of the running surface after 0,5 mm has been ground away. The hardness results shall be no more than ± 15 HBW from the mean result obtained.

8.7 Segregation

Full section transverse test pieces shall be sulphur printed in accordance with ISO 4968:2022. For this purpose, rail sulphur prints shall be taken from each strand from the beginning of every heat, excluding the mixing zone, for three heats.

The samples shall be assessed and classified according to the limiting figures of Annex D. For the process to be accepted, all samples shall be classified as acceptable.

8.8 Other qualifying requirements

In addition to the results of the tests described in 8.2 to 8.8 inclusive the manufacturer shall provide a complete set of results for the acceptance tests described in 9.1. Samples for these tests shall be taken from the rails used for the qualifying tests as described in 8.1.3.

9 Acceptance tests

9.1 Laboratory tests

9.1.1 General

Laboratory tests shall be performed, during production, at frequencies as stipulated in Table 4. Results for each laboratory test shall comply with the limiting values shown in Table 5. Additional information and other acceptance tests not covered by Table 5 shall comply with the requirements of 9.1.3 to 9.1.9 inclusive. All rails supplied shall meet the requirements of Clause 9.

9.1.2 Sampling and preparation of samples and test pieces

Sampling and sample preparation for chemical analysis shall be carried out in accordance with EN ISO 14284:2022, unless otherwise specified in 9.1.3.

For sampling and test piece preparation for all other tests, see 9.1.4 to 9.1.9.

9.1.3 Chemical composition

9.1.3.1 General

The chemical composition of the liquid steel shall be determined for each heat. When the solid chemical composition is checked, this shall be carried out at the position of the tensile test piece. Liquid and solid chemical composition shall conform to the requirements of Table 5 a) and Table 5 b).

The choice of the suitable physical or chemical analytical method for the product analysis shall be at the discretion of the manufacturer. In cases of dispute, the analysis method shall be agreed taking into account the relevant existing European Standards. The available European Standards are given in CEN/TR 10261:2018.

Table 4 — Testing frequency

Test (on)	Relevant subclause	Steel grades	
		R200, R220, R260, R260Mn, R320Cr, R335V	R350HT, R350LHT, R370CrHT, R400HT
Chemical composition	9.1.3	One per heat	One per heat
Hydrogen	9.1.3.2	One per heat (2 tests from first heat in sequence)	One per heat (2 tests from first heat in sequence)
Microstructure	9.1.4	Not required for grades R200, R220 and R260 One per 1 000 tonnes or part thereof for grades R260Mn, R320Cr and R335V	One per 100 tonnes of heat treated rail ^{a,c}
Decarburisation	9.1.5	One per 1 000 tonnes or part thereof ^{a,b}	One per 500 tonnes of heat treated rail ^{a,c}
Oxide cleanness	9.1.6	One per sequence ^b	One per sequence ^b or ^c
Sulphur print	9.1.7	One per 500 tonnes or part thereof ^{a,b}	One per 500 tonnes or part thereof ^{a,b} or ^c
Hardness	9.1.8	One per heat ^{a,b}	One per 100 tonnes of heat treated rail ^{a,c}
Tensile	8.7 and 9.1.9	One calculation per heat and one test per 2 000 tonnes ^{a, b, d}	One test per 1 000 tonnes ^{a,c}
^a Samples shall be taken at random but only rails from blooms outside the mixing zone between heats when continuously cast in sequence. ^b Samples shall be cut after rolling. ^c Samples shall be cut from heat treated rails. ^d One test per heat when a predictive equation is not developed.			

Table 5 a) — Chemical composition and mechanical properties

Steel grade		% by mass									10 ⁻⁴ % (ppm) by mass max.	Tensile strength <i>R_m</i> min. MPa	Elonga- tion <i>A</i> min. %	Hardness of the rail running surface, centre line ^b HBW
Steel name	Sample	C	Si	Mn	P max.	S max.	Cr	Al max	V max	N max	H ^a			
R200	Liquid	0,40 to 0,60	0,15 to 0,58	0,70 to 1,20	0,035	0,035	≤ 0,15	0,004	0,030	0,009	3,0			
	Solid	0,38 to 0,62	0,13 to 0,60	0,65 to 1,25	0,040	0,040	≤ 0,15	0,004	0,030	0,010	3,0	680	14	200 to 240
R220	Liquid	0,50 to 0,60	0,20 to 0,60	1,00 to 1,25	0,025	0,025	≤ 0,15	0,004	0,030	0,009	3,0			
	Solid	0,48 to 0,62	0,18 to 0,62	0,95 to 1,30	0,030	0,030	≤ 0,15	0,004	0,030	0,010	3,0	770	12	220 to 260
R260	Liquid	0,62 to 0,80	0,15 to 0,58	0,70 to 1,20	0,025	0,025	≤ 0,15	0,004	0,030	0,009	2,5			
	Solid	0,60 to 0,82	0,13 to 0,60	0,65 to 1,25	0,030	0,030	≤ 0,15	0,004	0,030	0,010	2,5	880	10	260 to 300
R260Mn	Liquid	0,55 to 0,75	0,15 to 0,60	1,30 to 1,70	0,025	0,025	≤ 0,15	0,004	0,030	0,009	2,5			
	Solid	0,53 to 0,77	0,13 to 0,62	1,25 to 1,75	0,030	0,030	≤ 0,15	0,004	0,030	0,010	2,5	880	10	260 to 300
R320Cr	Liquid	0,60 to 0,80	0,50 to 1,10	0,80 to 1,20	0,020	0,025	0,80 to 1,20	0,004	0,18	0,009	2,5			
	Solid	0,58 to 0,82	0,48 to 1,12	0,75 to 1,25	0,025	0,030	0,75 to 1,25	0,004	0,20	0,010	2,5	1 080	9	320 to 360
R335V	Liquid	0,88 to 0,95	0,77 to 0,95	0,80 to 0,95	0,025	0,020	<0,10	0,004	0,05 to 0,14	0,007	2,5			

Steel grade		% by mass									10 ⁻⁴ % (ppm) by mass max.	Tensile strength <i>R_m</i> min. MPa	Elonga- tion <i>A</i> min. %	Hardness of the rail running surface, centre line ^b HBW
Steel name	Sample	C	Si	Mn	P max.	S max.	Cr	Al max	V max	N max	H ^a			
	Solid	0.86 to 0.97	0.75 to 0.97	0.75 to 1.00	0.030	0.025	<0.10	0.004	0.05 to 0.14	0.008	2.5	1150	8	335 to 375
R350HT	Liquid	0,72 to 0,80	0,15 to 0,58	0,70 to 1,20	0,020	0,025	≤ 0,15	0,004	0,030	0,009	2,5			
	Solid	0,70 to 0,82	0,13 to 0,60	0,65 to 1,25	0,025	0,030	≤ 0,15	0,004	0,030	0,010	2,5	1 175	9	350 to 390
R350LHT	Liquid	0,72 to 0,80	0,15 to 0,58	0,70 to 1,20	0,020	0,025	0.15 to 0,30	0,004	0,030	0,009	2,5			
	Solid	0,70 to 0,82	0,13 to 0,60	0,65 to 1,25	0,025	0,030	≤ 0,30	0,004	0,030	0,010	2,5	1 175	9	350 to 390
R370CrHT	Liquid	0,70 to 0,82	0,40 to 1,00	0,70 to 1,10	0,020	0,020	0,40 to 0,60	0,004	0,030	0,009	1,5			
	Solid	0,68 to 0,84	0,38 to 1,02	0,65 to 1,15	0,025	0,025	0,35 to 0,65	0,004	0,030	0,010	1,5	1.280	9	370 to 410
R400HT	Liquid	0,90 to 1,05	0,20 to 0,60	1,00 to 1,30	0,020	0,020	≤ 0,30	0,004	0,030	0,009	1,5			
	Solid	0,88 to 1,07	0,18 to 0,62	0,95 to 1,35	0,025	0,025	≤ 0,30	0,004	0,030	0,010	1,5	1.280	9	400 to 440
^a See 9.1.3.2. ^b See Figure 7.														

Table 5 b) — Maximum residual elements, % by mass

	Mo	Ni	Cu	Sn	Sb	Ti	Nb	Cu + 10 Sn	Others
R200, R220, R260, R260Mn	0,02	0,10	0,15	0,030	0,020	0,025	0,01	0,35	0,35 (Cr + Mo + Ni + Cu + V)
R320Cr, R335V	0,02	0,10	0,15	0,030	0,020	0,025	0,01	0,35	0,16 (Ni + Cu)
R350HT	0,02	0,10	0,15	0,030	0,020	0,025	0,04	0,35	0,25 (Cr + Mo + Ni + Cu + V)
R350LHT, R370CrHT, R400HT	0,02	0,10	0,15	0,030	0,020	0,025	0,04	0,35	0,20 (Mo + Ni + Cu + V)

9.1.3.2 Hydrogen

The hydrogen content of the liquid steel shall be measured by determining pressure of hydrogen in the steel using an on-line immersion probe system.

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 4). The first sample from the first heat in a sequence shall be taken from the tundish at the time of the maximum hydrogen concentration.

The heats shall be assessed for hydrogen content in accordance with Table 5 a).

If the hydrogen contents of the first samples of a first heat or the heat sample of a second or further heat do not comply with the requirements of Table 5 a) 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 the requirements in Table 5 a); in these cases, all heats shall be tested in the rail form, or the manufacturer shall calculate the hydrogen content with a documented model of hydrogen diffusion taking into account the time – temperature evolution of the blooms during the isothermal treatment process. In case of dispute, the hydrogen content shall be tested in the rail form.

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.

If any test result after corrective treatment fails to meet the requirements stated in Table 5 a) the heat shall be rejected.

9.1.4 Microstructure

9.1.4.1 General

Microstructures shall be determined at a magnification of x 500.

The microstructure shall be verified for R260Mn, R320Cr, R335V and heat treated rails in accordance with the requirements of Table 4.

The testing position in the rail head shall be as shown in Figure 4.

9.1.4.2 Grade R260Mn, R320Cr, R335V, R350HT, R350LHT, R370CrHT and R400HT

The microstructure shall be fully pearlitic with no martensite, bainite or grain boundary cementite. In the case of the grade R260Mn, grain boundary ferrite may occur. Nital etchant shall be used for the assessment of ferrite, martensite and bainite, Picrate etchant shall be used for the assessment of grain boundary cementite.

9.1.5 Decarburisation

The decarburisation depth shall be assessed by means of a hardness test at a frequency shown in Table 4. After a minimum of preparation of the rail surface without removing more than 0,2 mm of material from the surface a hardness test according to the method indicated in 9.1.8 shall be performed at three points. None of the results of hardness obtained shall be lower than the minimum value specified for the grade, reduced by 7 HBW (example: 253 HBW for grade R260).

Alternatively to the hardness test, or if there are any doubts regarding the conformity with the requirements on decarburization, metallographic investigations shall be carried out according to the manufacturer's decision or upon request of the purchaser.

Photomicrographs showing the depth of decarburisation allowed are shown in Figure 5.

Figure 6 defines the rail head surface for decarburisation checks.

No closed ferrite network shall be observed below 0,5 mm depth measured anywhere on the rail head surface.

9.1.6 Oxide cleanness

Samples shall be prepared and assessed in accordance with Annex F. Samples shall be taken from one of the last blooms of the last heat of the sequence but from each sample 2 specimens shall be tested. For orders less than 5 000 tonnes, only one sample with a K3 greater than 10 and less or equal than 20 is allowed.

The following limits shall apply.

Total index $10 < K3 \leq 20$ for a maximum of 5 % of samples;

$K3 \leq 10$ for a minimum of 95 % of samples.

The testing position in the rail head is shown in Figure 7.

9.1.7 Sulphur prints

Sulphur prints of transverse rail sections shall be prepared in accordance with ISO 4968:2022 at the frequency shown in Table 4.

All samples, including those intended for repeat test, shall be taken from outside the mixing zones of the heat. When part or all of an adjacent heat has been withdrawn due to non-conformance, tests shall be made in the mixing zones to determine the first conforming blooms.

The sulphur prints shall conform to the requirements of Annex D.

9.1.8 Hardness

Brinell hardness tests shall be carried out in accordance with EN ISO 6506-1:2014 at the frequency shown in Table 4. The choice of ball diameter shall be at the discretion of rail manufacturer, providing a force-diameter index of 30 is maintained.

The hardness values measured shall meet the requirements given in Table 6 for the relevant grade. The testing positions are shown in Figure 8.

For the steel grades R200, R220, R260, R260Mn and R320Cr the hardness shall only be tested for position RS.

In the case of the heat treated rails, the following shall apply:

$$HBW_2 > HBW_3 + 0,3 (HBW_1 - HBW_3)$$

where HBW_1 , HBW_2 and HBW_3 are the mean hardness values at position 1, 2 or 3 respectively. Also, the difference between any of the three positions shall be no more than 30 HBW.

The hardness on the centre line of the head crown shall not vary by more than 30 HBW on any individual rail.

0,5 mm shall be removed from the rail running surface before a hardness impression is made.

Table 6 — Hardness testing positions and requirements

Position	Rail Steel Grade							
	R200	R220	R260, R260Mn	R320Cr	R335V	R350HT, R350LHT	R370CrHT	R400HT
Hardness								
RS ^a	200 to 240	220 to 260	260 to 300	320 to 360	335 to 375	350 to 390 ^b	370 to 410 ^c	400 to 440 ^d
1	e	e	e	e	e	≥ 340 min	≥ 360	≥ 390
2						≥ 331 min	≥ 350	≥ 380
3						≥ 321 min	≥ 340	≥ 370
4						≥ 340 min	≥ 360	≥ 390
^a RS = Point on the centre line rail running surface.								
^b 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.								
^c If the hardness exceeds 410HBW, the rail is acceptable provided the microstructure is confirmed to be pearlitic, and the hardness does not exceed 425 HBW.								
^d If the hardness exceeds 440HBW, the rail is acceptable provided the microstructure is confirmed to be pearlitic, and the hardness does not exceed 455 HBW.								
^e Not relevant.								

9.1.9 Tensile tests

9.1.9.1 General

The tensile test shall be carried out with the test frequency specified in Table 4. Test samples from the rail shall be taken as given in Figure 4. Results obtained shall comply with the values given in Table 5 a).

9.1.9.2 Method of test

The manufacturer shall determine the tensile properties in accordance with EN ISO 6892-1:2019 using a proportional circular test piece of 10 mm diameter.

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

9.1.10 Tensile strength and elongation

Predictive equations relating chemical composition to tensile strength and elongation shall be calculated using multiple regression analysis for all non heat treated rails produced. The following procedure shall be carried out:

- development of a predictive equation;
- confirmation of the predictive equation;
- periodic updating of the predictive equation;
- corrective action.

Manufacturers shall calculate, using multiple regression analysis for all naturally hard steel grades produced, predictive equations relating chemical composition to tensile strength and elongation. Each manufacturer shall derive its own predictive equations.

The predictive equations shall be produced from a minimum number of 100 heats.

The equations shall be created by carrying out one valid tensile test per heat. Tensile tests shall be carried out in accordance with 9.1.9.

The predictive equations shall produce results which are within a scatter band governed by the following limits:

- tensile strength: 12,5 MPa (1 standard deviation);
- elongation: 1,0 % (1 standard deviation).

The results of the predictive equations shall be compared with experimentally determined tensile strength and elongation results as described in 9.1.9. This comparison will be achieved by carrying out one valid tensile test every 2 000 tonnes or at least every thirteen heat.

The experimental results shall be within plus or minus 25 MPa tensile strength and plus or minus 2 % elongation of those obtained from the predictive equations.

The results of the experimental tensile strength and elongation tests obtained from 8.7.3 shall be used to update the predictive equations. These results shall be accumulated and the equations updated annually. The updated equations shall be based on a minimum of the last 100 results.

If results from the predictive equations or the experimental results are outside the limits set in 8.7.2 and 8.7.3 then actions a), b) and c) and when necessary action d) shall be taken:

- a) manufacturer shall carry out an investigation;
- b) problem will be resolved by the manufacturer taking appropriate corrective action;
- c) manufacturer shall report the findings of a) and b) to the purchaser;
- d) if the problem cannot be resolved to the satisfaction of the purchaser, the manufacturer or potential manufacturer shall have failed the approval requirements as specified in 8.7.1. If the physical tests themselves are within the requirements of Table 5 a) the product is satisfactory

9.1.11 Retest procedures

If any test fails to meet the requirements of 9.1.3 to 9.1.9 (but excluding hydrogen) then two tests shall be performed on samples from rails in close proximity to the original. Should either retest fail then rails shall be progressively tested until acceptable material is found. The failed material shall be rejected or in the case of heat treated material re-treated and tested. For hydrogen testing refer to the 9.1.3.2.

If the results of an investigation under 8.7.5 or the qualification procedure, or the predictive equation indicate that certain rails are out of specification, then acceptance of such rails shall be based on experimental tensile test results. The minimum values in Table 5 a) shall apply in such cases.

9.2 Dimension tolerances

9.2.1 Profile

The nominal dimensions of the rail profile (see Annex A) and the actual dimensions anywhere on any rail shall not differ by more than the tolerances given in Table 7.

Table 7 — Profile tolerances

* Reference points (see Figure E.1)			Profile class (tolerances in mm)		Gauge, Figure number (see Annex E)
Location/property		Symbol	X	Y	
Height of rail ^a	< 165 mm	*H	± 0,5	+ 0,5 – 1,0	E.3
	≥ 165 mm		± 0,6	+ 0,6 – 1,1	
Crown profile		*C	+ 0,6 – 0,3	+ 0,6 – 0,3	E.4
– Class A straightness			± 0,6	± 0,6	
– Class B straightness					
Width of rail head		*WH	± 0,5	+ 0,6 – 0,5	E.5
Rail asymmetry		*As	± 1,2	± 1,2	E.6, E.7
Height of fishing	< 165 mm	*HF	± 0,5	± 0,5	E.8
	≥ 165 mm		± 0,6	± 0,6	
Web thickness		*WT	+ 1,0 – 0,5	+ 1,0 – 0,5	E.9
Width of rail foot		*WF	± 1,0	+ 1,5 – 1,0	E.10
Foot toe thickness		*TF	+ 0,8 – 0,5	+ 0,8 – 0,5	E.11
Foot base concavity			0,3 max.	0,3 max.	
^a The total height variation over any rail length shall not be greater than 1 mm for rails < 165 mm and 1,2 mm for rails ≥ 165 mm.					

9.2.2 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 8. Unless otherwise agreed, rails < 54 kg/m are delivered with class B tolerances.

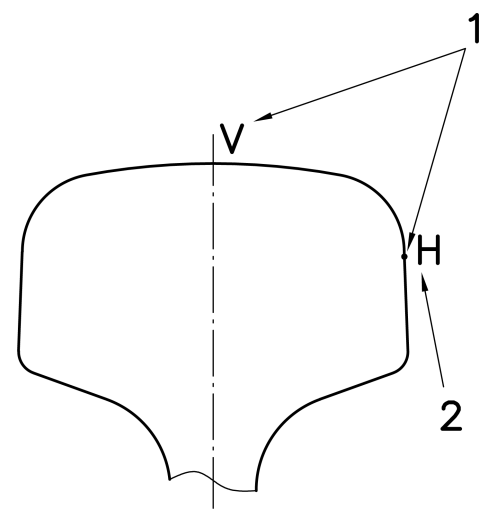
If the rail shows evidence of twist, this shall be checked in accordance with Figure 9 by inserting feeler gauges between the base of the rail and the rail skid nearest the rail end with the rail being laid head up on an inspection bed. If the gap exceeds 2,5 mm the rail shall be rejected.

Rotational twist in the end metre of the rail as measured by the gauge illustrated in Figure 10, shall not exceed 0,2°.

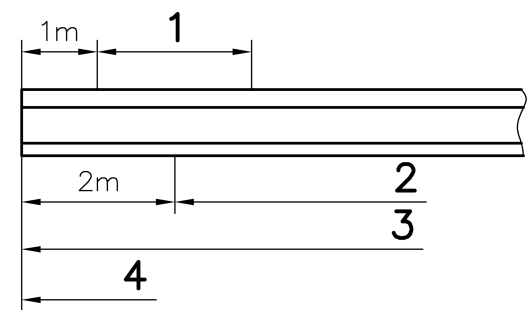
Rejected rails may be subject to only one roller re-straightening.

In cases of dispute on the results of the automatic technique, rail flatness shall be verified using a straight edge as shown in Table 8.

Table 8 — Straightness, surface flatness and twist tolerances



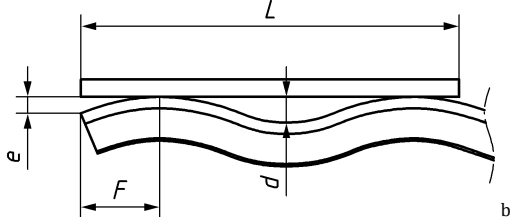
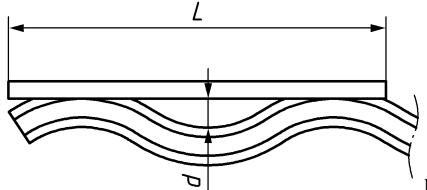
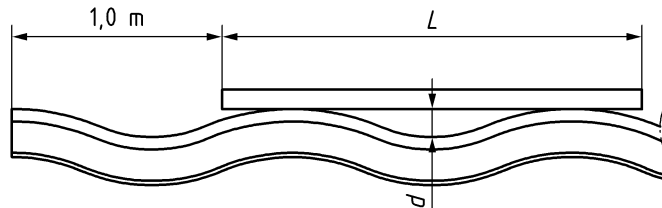
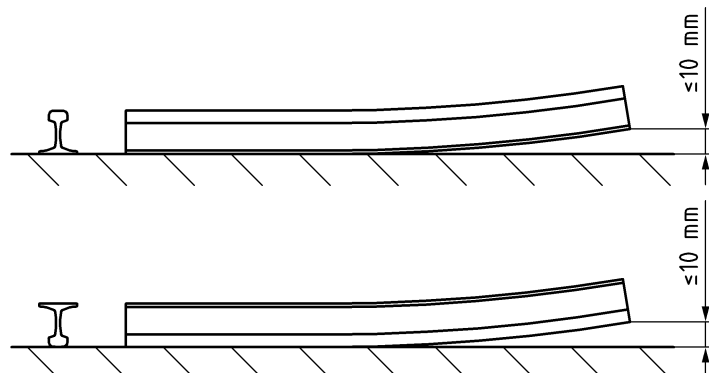
- Key**
- 1 *V* and *H*: Location of flatness measurements
 - 2 the position of *H* is nominally 5 mm to 10 mm below the gauge corner on the side of the head.



- Key**
- 1 overlap
 - 2 body
 - 3 whole rail
 - 4 end "E"

Location/Dimensional properties		Class B		Class A	
		<i>d</i>	<i>L</i>	<i>d</i>	<i>L</i>
BODY ^a	Vertical flatness <i>V</i>	≤ 0,4 mm	3 m ^c	≤ 0,3 mm	3 m ^c
		and		and	
	Horizontal flatness <i>H</i>	≤ 0,6 mm	1,5 m ^c	≤ 0,45 mm	1,5 m ^c

A side view diagram of a rail showing a wavy profile. A horizontal dimension line at the top is labeled 'L'. A vertical dimension line in the center is labeled 'd'. Two points on the profile are labeled 'a' and 'b'.

ENDS ^a	End “E”	1,5 m		2 m		 If $e > 0$ $F \geq 0,6$ m
	Vertical straightness	$\leq 0,5$ mm	1,5 m	$\leq 0,4$ mm	2 m	
		and		and		
		$e \leq 0,2$ mm		$e \leq 0,2$ mm ^f		
	Horizontal straightness	$\leq 0,7$ mm	1,5 m	$\leq 0,6$ mm	2 m	
		and		and		
				$\leq 0,4$ mm	1 m ^d	
	Length of overlap	1,5 m		2 m		
OVERLAP	Vertical flatness V	$\leq 0,4$ mm	1,5 m ^c	$\leq 0,3$ mm	2 m ^c	
	Horizontal flatness H	$\leq 0,6$ mm	1,5 m ^c	$\leq 0,6$ mm	2 m ^c	
SWEEP (whole rail)	Upsweep and downsweep	10 mm ^e		10 mm ^e		

prEN 13674-1:2023 (E)

TWIST	Whole rail	max. gap of 2,5 mm	(see also 9.2.2 and Figure 9)
	End (1 m)	Max. rotational twist of 0,2° and max. relative twist of 0,003 5 x c	(see also 9.2.2 and Figure 10)
^a 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. ^b 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. ^c 95 % of delivered rails shall be within limits specified, with 5 % of rails allowed outside the tolerances by 0,1 mm. ^d Reference <i>L</i> sliding over end E. ^e The ends of the rails shall not be up more than 10 mm when the rail is on its foot when standing on an inspection bed. ^f Dimension is measured under the 2 m straight edge only.			

9.2.3 Cutting and drilling

The size and location of drilled holes, the squareness of rail ends and rail lengths shall be within the tolerances given in Table 9.

Drilled holes and rail ends shall be deburred. For holes that are to be subject to special treatment, this treatment and the corresponding tolerances shall be specified (see Clause 4 g).

9.3 Gauges

The gauges required for manufacture are as shown in Annex E.

If other measurement techniques than those given in Annex E are used, only those in Annex E shall be used in case of dispute.

9.4 Inspection for internal quality and surface quality

9.4.1 Internal quality

9.4.1.1 All rails shall be ultrasonically tested by an automated process ensuring that the entire rail length and a specified cross-sectional area are inspected, leaving only a very small area untested. Untested ends shall be tested by an appropriate procedure or cropped off.

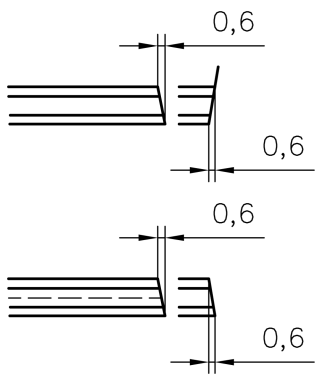
9.4.1.2 The minimum cross-sectional area examined by the ultrasonic technique shall be:

- at least 70 % of the head;
- at least 60 % of the web;
- the area of the foot specified in Figure 14.

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

Table 9 — Drilling and cutting tolerances

Number	Dimensional requirement	Tolerance
1	Drilling Diameter ≤ 30 mm > 30 mm Centring and positioning of the holes vertically and horizontally	$\pm 0,5$ mm $\pm 0,7$ mm The horizontal position of the holes is checked using a gauge as shown in Figure E.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 less than or equal to 30 mm in diameter; - 1,4 mm for holes greater than 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 Figure E.13. The side of the hole, left or right, is determined by proceeding from the side with the relief markings.

Number	Dimensional requirement	Tolerance
2	Squareness of ends	0,6 mm in any direction 
3	Length ^{a b} – both ends drilled ≤ 24 m > 24 m ≤ 40 m > 40 m to 60 m > 60m: – other (undrilled or one end drilled)	± 3 mm ± 4 mm +/-10 mm +/-20 mm ± 1 mm/per metre of rail For special purpose undrilled rails the length tolerance is ± 6 mm up to 24 m and ± 10 mm for > 24 m rail.
^a The given rail lengths apply for + 15 °C. Measurements made at other temperatures are to be corrected to take into account expansion or contraction of the rail. ^b These tolerances apply only for rails with fishplate holes, not for rails with handling holes.		

9.4.1.3 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 9.4.1.4. After calibration with the reference reflectors, the signal-to-noise ratio of the automated equipment shall be at least 10 dB. 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.

Rails giving signals exceeding the threshold in the rail using the increased sensitivity shall be rejected or cut back to remove the defective portion.

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

9.4.1.4 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 in Figures 11, 12 and 13 respectively. Calibration rails for other profiles with calibration defects similar to those in accordance with Figures 11, 12 and 13 for 60E1 shall be available.

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

9.4.2 Surface quality

9.4.2.1 Requirements

a) Hot marks, protrusions, seams and grooves

Protrusions on the rail running surface or the underside of the foot and any protrusions affecting the fit of the fishplate at less than 1 m from the extremity of the delivered rail are not permitted.

The depth of hot marks, seams and grooves, as defined in EN 10163-1:2004, shall not exceed:

- 0,35 mm for the rail running surface;
- 0,5 mm for the rest of the rail.

In the case of longitudinal grooves coming by example from guides, exceeding depth limits specified, there shall be a maximum of two at any point along the length of the rail but no more than one of these shall be on the rail running surface. Recurring grooves along the same axis are accepted as a single one.

The maximum width of grooves shall be 4 mm. The width to depth ratio of allowable grooves 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.

b) Cold marks

Cold marks are longitudinal or transverse cold formed scratches.

The discontinuity depth shall be not larger than:

- 0,30 mm for the rail running surface and the surface of the foot up to the connecting radius with the web.

- 0,5 mm for the rest of rail.

It is difficult, or impossible to detect in track fatigue cracks initiating and propagating from the underside of the foot; therefore all practicable efforts should be made to avoid cold transverse marks in this area.

c) Surface microstructural damage

Any sign of surface microstructural damage resulting in martensite or white phase shall be dressed or the rail rejected. The dressed area shall be proved by suitable hardness testing. The hardness shall not be more than 50 HBW greater than the surrounding material.

9.4.2.2 Inspection and dressing of surface imperfections and defects

a) General inspection

All rails shall be visually or automatically inspected on all faces for surface imperfections. All rails shall comply with the acceptance criteria specified at 9.4.2.1. Dressing of imperfections and defects shall be in accordance with 9.4.2.3.

b) Automated inspection

The rail shall be automatically inspected on the underside of the foot and on the head of the rail (running surface and sides) along its entire length.

The equipment used shall be able to detect artificial imperfections on the underside of the foot with sizes as shown in Table 10. For artificial imperfections, a tolerance of $\pm 0,1$ mm shall apply.

Table 10 — Dimensions of test imperfections, in mm

Depth	Length	Width
1,0	20	0,5
1,5	10	0,5

An edge loss for the automatic technique is permitted for the extreme 5 mm of the flat portion of the foot width at each side.

9.4.2.3 Dressing of surface imperfections and defects

Defects exceeding the limits specified in 9.4.2.1 a) and 9.4.2.1 b) shall be dressed. Any protrusions affecting the fit of the fishplate (see 9.4.2.1 a)) shall be dressed to shape.

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, providing 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, a mean of one defect per 10 m of rail over the whole length, shall be dressed. Hot formed marks originating from the vicinity of the mill rolls may be removed by dressing except those marks on the rail crown where a maximum of 3 per 40 m may be dressed. After dressing profile tolerances shall be in accordance with Table 7 and flatness tolerances shall be in accordance with Table 8.