SLOVENSKI STANDARD
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Železniške naprave - NDT na progi - 1. del: Zahteve za ultrazvočni pregled in merila za ovrednotenje

Railway applications - NDT on rails in track - Part 1: Requirements for ultrasonic inspection and evaluation principles

Bahnanwendungen - ZfP an Schienen im Gleis - Teil 1: Anforderungen für Ultraschall-Untersuchungen und Bewertungsgrundlagen

Applications ferroviaires - Infrastructure - Essais non destructifs sur les rails de voie - Partie 1: Exigences pour les principes d'évaluation et d'inspection par ultrasons

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Railway applications - Infrastructure - Non-destructive testing on rails in track - Part 1: Requirements for ultrasonic inspection and evaluation principles

Applications ferroviaires - Infrastructure - Essais non destructifs sur les rails de voie - Partie 1: Exigences pour les principes d'évaluation et d'inspection par ultrasons

Bahnanwendungen - Infrastruktur - Zerstörungsfreie Prüfung an Schienen im Gleis - Teil 1: Anforderungen an Ultraschallprüfungen und Bewertungsgrundlagen

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European foreword

This document (EN 16729-1:2016) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2016, and conflicting national standards shall be withdrawn at the latest by November 2016.

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2008/57/EC.

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

This series of European Standards EN 16729, *Railway applications — Infrastructure — Non-destructive testing on rails in track*, consists of:

— *Part 1: Requirements for ultrasonic inspection and evaluation principles*;

— *Part 2: Eddy current testing of rails in track* [planned];

— *Part 3: Requirements for identifying internal and surface rail defects* [planned];

— *Part 4: Qualification of personnel for non-destructive testing on rails* [planned].

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

Introduction

This European Standard represents the actual state of the art of automated ultrasonic testing of rails in track applied by European railway companies.

1 Scope

This European Standard applies to testing of rails installed in track for detecting internal discontinuities.

This part applies to testing equipment fitted to dedicated test vehicles or manually-propelled devices. This European Standard does not define the requirements for vehicle acceptance. This part of the standard does not apply to ultrasonic testing of rails in a production plant.

The European Standard specifies the requirements for testing principles and systems in order to produce comparable results with regard to location, type and size of discontinuities in rails. This European Standard is not aiming to give any guidelines for managing the result of ultrasonic rail testing.

This European Standard applies only to rail profiles meeting the requirements of EN 13674-1.

2 Normative references

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

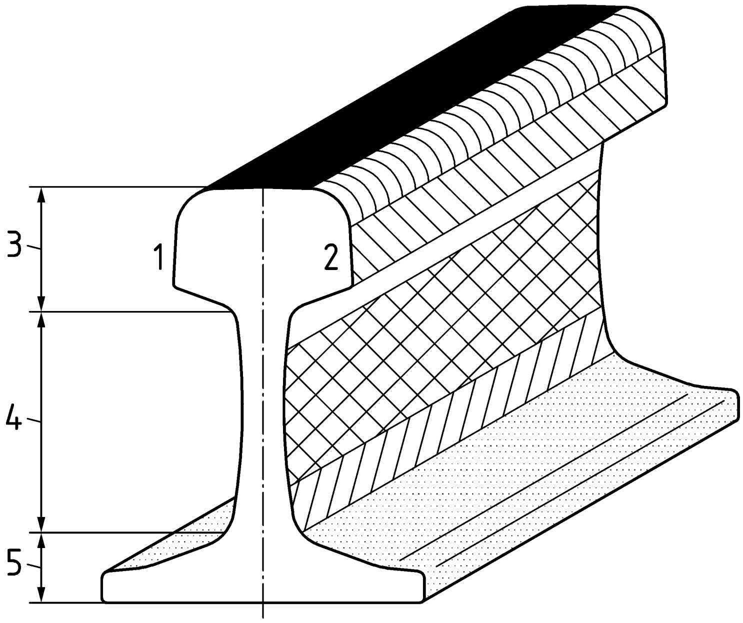
EN 1330-4, *Non-destructive testing - Terminology - Part 4: Terms used in ultrasonic testing*

EN 13674-1, *Railway applications - Track - Rail - Part 1: Vignole railway rails 46 kg/m and above*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1330-4 and the following apply.

3.1
parts of the rail
components that constitute the rail itself as shown in Figure 1



Key

1 field side
2 gauge corner side
3 rail head
4 rail web
5 rail foot

running surface
gauge corner area
rail head side area
rail head fillet radius area
rail web area
rail foot fillet radius area
rail foot area

Figure 1 — Parts of the rail

3.2
simulated reflector
artificial feature designed to represent a real defect of a known size, orientation and position

3.3
functional reflector
artificial feature designed to dynamically test an ultrasonic system at normal operation speed

4 Basics

4.1 General

In order to verify the performance of the automated ultrasonic systems for rail testing there shall be defined reference reflectors in a test track. These reference reflectors shall be recorded and reported at the normal operational speed of the test vehicle/system.

The reference rail in the test track shall be constructed from new rail to provide the correct head profile and running surface condition. Rails with corrosion on the running surface shall be cleaned to allow the transmission of ultrasound prior to any testing, for example using a powered steel wire brush.

A signal shown on the display of an ultrasonic instrument or system as a result of received ultrasonic pulse is called an indication. Evidence obtained by non-destructive testing.

In test systems according to this standard ultrasound at a frequency range of 2 MHz to 5 MHz is used.

A flat-bottomed hole (FBH) shall be machined using a twist drill at the appropriate diameter followed by a slot drill hole of the same diameter to the required depth to generate the flat end of the hole. Accuracy in diameter and depth shall be within 0,1 mm. Accuracy in angle shall be within 0,1°.

A side drilled hole (SDH) shall be machined using a twist drill at the appropriate diameter. Accuracy in diameter shall be within 0,1 mm. Accuracy in angle shall be within 0,1°.

An electrical discharge machined (EDM) notch shall be machined to the desired shape and orientation with an accuracy of 0,1 mm. Accuracy in angle shall be within 0,1°.

Due to wear of the rail, dimension might vary. If the rail is used for distance and sensitivity setting of Ultrasonic Testing (UT) inspection devices this needs to be taken into account.

4.2 Principle of ultrasonic testing in track

Ultrasonic waves transmitted into the rail will be reflected from the surfaces of the rail body. Fractures and other discontinuities within the rail, as well as the boundary of the rail will act as reflecting surfaces. By receiving, recording and interpreting the returned ultrasonic signals, it is possible to detect discontinuities within a rail installed in track before they present an unacceptable risk to the integrity and strength of the rail. Annex C gives examples of test areas in rails tested with test vehicles or manually propelled devices.

4.3 Ultrasonic testing speed and detection of discontinuities

Ultrasonic beams have a width which is determined by the size of the transducer and the frequency. All reflectors interact with the ultrasonic beam. The beam sweeps across the reflector when the vehicle and / or manually-propelled device travels along the track. Ultrasound will be reflected and detected by the transducer. All ultrasonic systems use a threshold level in a gate and the system will record a response when the reflection is above the threshold level. By controlling the gain in the ultrasonic system and the gate threshold level the number of responses for a given size of reflector can be defined.

A reflector can be sized by setting the system parameters so that a known number of responses are received from a known sized reference reflector. The relationship of the number of responses and the size of the reference reflector is known. This applies to all the reflectors in Annex A.

The maximum testing speed depends upon the rail profile (longitudinal and transverse), reflector size to be detected, the beam width, sampling frequency and the number of responses required for an indication to be recorded.

4.4 Simulation of internal reflectors in reference rails

Reference rails incorporating sets of reference reflectors selected from Annex A shall be created. In addition, reference rails incorporating sets of reference reflectors selected from Annex B may be created. They shall be installed in the left and right rails of a section of track if test vehicles are used. If only trolleys or manually-propelled devices are used the reference rails may be installed out-of-track. The length of the reference rails is not defined by this standard. When in track carrying traffic, the distance between the simulated reflectors and functional reflectors should be assessed by the Infrastructure Manager with consideration to the structural integrity of the rail. Reference reflectors shall be orientated to check probes scanning in both directions.

To prevent the influence of water and dirt on the ultrasonic responses, reference holes and notches shall be plugged with a synthetic compound.

Where the reference rails carry traffic the infrastructure manager shall carry out a risk assessment to determine if reinforcement of the reference reflectors is necessary (fishplates or similar) and determine the maintenance regime of the reference rails.

When several values are given for a certain quantity in Table 1, they are all mandatory. If a range is given for a quantity the user may chose a value within this range.

For example reflector No. 01 consists of three holes in a rail. All holes have a diameter of 6 mm. The distance from the running surface to the centre of the hole is 7 mm for the first hole and 10 mm and 20 mm for the second and third hole respectively. This leads to three holes in a rail for reflector No. 01.

No. 02 consists of four holes in a rail. Two holes for the forward direction and two holes for the backward direction. The distance from the running surface (see Figure A.2) can be chosen within a range of 10 mm to 20 mm. The holes per direction have a diameter of 5 mm and 10 mm respectively. This leads to four holes in a rail for reflector No. 02.

Table 1 — Artificial reflectors in reference rails (normative references)

No.	Figure, shown in Annex A	Type S/F[a]	Description	Dimensions mm
01	Figure A.1	F	Volumetric reflector in rail head	*a* = 7; 10; 20 *d* = 6
02	Figure A.2	S	Central transverse reflector (20°) in rail head	*a* = 10 to 20 *d* = 5;10
03	Figure A.3	S	Gauge transverse reflector (20°) in rail head	*a* = 10 to 20 *b* = 10 to 15 *d* = 5; 10
04	Figure A.4	S	Full width transverse reflector (20°) in rail head	*a* = 20 *d* = 3 *l* = 7
05	Figure A.5	S	Full width transverse reflector (35°) in rail head	*a* = 20 *d* = 3 *l* = 7
06	Figure A.6	S	Full width transverse reflector (53°) in rail head	*a* = 20 *d* = 3 *l* = 7
07	Figure A.7	F	Volumetric reflector gauge side of rail head	*a* = 25 *b* = 20; 25; 30; 36 *d* = 6 to 8
08	Figure A.8	F	Volumetric reflector field side of rail head	*a* = 25 *b* = 20; 25; 30; 36 *d* = 6 to 8
09	Figure A.9	S	Horizontal reflector in rail head	*a* = 20 *d* = 5; 8; 10
10	Figure A.10	S	Horizontal bolt hole slot	*l* = 5; 10
11	Figure A.11	S	Bolt hole slot, position A	*l* = 5; 10
12	Figure A.12	S	Bolt hole slot, position B	*l* = 5; 10

No.	Figure, shown in Annex A	Type S/F[a]	Description	Dimensions mm
13	Figure A.13	S	Bolt hole slot, position C	l = 5; 10
14	Figure A.14	S	Bolt hole slot, position D	l = 5; 10
15	Figure A.15	F	Volumetric reflector at head – web radius	d = 6
16	Figure A.16	F	Volumetric reflector mid – web	d = 6
17	Figure A.17	F	Volumetric reflector at foot – web radius	d = 6
18	Figure A.18	S	Head – web radius transverse reflector (35°)	d = 3 l = 10
19	Figure A.19	S	Foot – web radius transverse reflector (53°)	d = 3 l = 10
20	Figure A.20	S	Vertical longitudinal reflector (version 1)	a = 20 h = 10; 15; 20 l = 50 to 100
21	Figure A.21	S	Vertical longitudinal reflector (version 2)	a = 20 d = 5 l = 50 to 100
22	Figure A.22	S	Change in foot depth	c_1 = 5 c_2 = 10 l = 80 w = 30
23	Figure A.23	S	Rail foot notch 5 mm (version 1)	c = 5 r = 17
24	Figure A.24	S	Rail foot notch 10 mm (version 1)	c = 10 r = 22
25	Figure A.25	F	Multiple repeated reflector	a = 25 d = 6 10 holes within 2 000
26	Figure A.26	F	Resolution check reflector	a = 25 d = 6 l_1 = 8 l_2 = 9 l_3 = 11 l_4 = 13 l_5 = 16 l_6 = 21 l_7 = 26

[a] S = simulated reflector, *F* = functional reflector

Table 2 — Artificial reflectors in reference rails (informative references)

No.	Figure, shown in Annex B	Type S/F[a]	Description	Dimensions mm
27	Figure B.1	S	Simulated gauge corner reflector	*a* = 20 *b* = 20
28	Figure B.2	S	Horizontal reflector in rail head	*a* = 5 *b* = 25 *l* = 25
29	Figure B.3	S	Horizontal head – web reflector (mid rail)	*l* = 5
30	Figure B.4	S	Horizontal head – web reflector (rail end)	*l* = 15
31	Figure B.5	S	Vertical longitudinal reflector (version 3)	*a* = 40 *l* = 75
32	Figure B.6	S	Rail foot notch 5 mm (version 2)	*c* = 5 *r* = 35
33	Figure B.7	S	Rail foot notch 10 mm (version 2)	c = 10 *r* = 40

[a] S = simulated reflector, *F* = functional reflector

5 Detection of reference reflectors

The reference reflectors listed in Table 1 and Table 2 shall be detectable with the mandatory probe angles listed in Table 3 and Table 4.

Where the end of a drill hole is used as a reflector the hole bottom shall be machined flat (FBH – flat bottomed hole).

The ultrasonic probe angles listed in Table 3 and Table 4 are used in most ultrasonic test vehicles or manually propelled devices. The infrastructure manager shall define which probe angles are to be used. This will be dependent on what reflectors are to be detected.

All angled transducers shall be configured to scan in both directions (forward and backward). Reference reflectors shall be orientated to check probe scanning in both directions.

Table 3 — Reference reflectors (Table 1) to be detected with defined probe angles

No.	Reflector	Centreline of the rail head					Parallel within the gauge corner	Squinting in the direction of gauge corner
		0°	35° to 40°	50° to 60°	45° to 55° T[a]	65° to 70°	65° to 70°	65° to 70°
01	Volumetric reflector in rail head	M	O	O		M	M	O
02	Central transverse reflector (20°) in rail head					M		
03	Gauge transverse reflector (20°) in rail head					O	M	
04	Full width transverse reflector (20°) in rail head	O	O	O		M	M	
05	Full width transverse reflector (35°) in rail head	O	O	M		M	M	
06	Full width transverse reflector (53°) in rail head	O	M	O				
07	Volumetric reflector gauge side of rail head				O	O	M	
08	Volumetric reflector field side of rail head				O	O	M	
09	Horizontal reflector in rail head (version 1)	M						
10	Horizontal bolt hole slot	M						
11	Bolt hole slot position A	O	M	O		O		
12	Bolt hole slot position B	O	M					
13	Bolt hole slot position C	O	M	O		O		
14	Bolt hole slot position D	O	M					
15	Volumetric reflector at head – web radius	M	M	O				
16	Volumetric reflector mid – web	M	M					
17	Volumetric reflector at foot – web radius	O	M					
18	Head – web radius transverse reflector (35°)	O		M				
19	Foot – web radius transverse reflector (53°)		M					
20	Vertical longitudinal reflector (version 1)	O			M			