



SLOVENSKI STANDARD
SIST EN 14730-1:2007
01-januar-2007

Številni postopki in varjenje železnih tirnic - Del 1: Odobritev postopkov
 CXC Vf]Hj j Uf]bY[Udcgfc_d_U

Railway applications - Track - Aluminothermic welding of rails - Part 1: Approval of
 welding processes

Bahnanwendungen - Oberbau - Aluminothermisches Schweißen von Schienen - Teil 1:
 Zulassung der Schweißverfahren

ITeH STANDARD PREVIEW

Applications ferroviaires - Soudage des rails par aluminothermie - Partie 1 : Approbation
 des procédés de soudage

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-60574961182e/sist-en-14730-1-2007>

Ta slovenski standard je istoveten z: EN 14730-1:2006

ICS:

25.160.10	Varilni postopki in varjenje	Welding processes
45.080	Via } železnice } železnice	Rails and railway components

SIST EN 14730-1:2007

en

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 14730-1:2007

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007>

ICS 25.160.10; 45.080

English Version

Railway applications - Track - Aluminothermic welding of rails - Part 1: Approval of welding processes

Applications ferroviaires - Soudage des rails par
aluminothermie - Partie 1 : Approbation des procédés de
soudage

Bahnanwendungen - Oberbau - Aluminothermisches
Schweißen von Schienen - Teil 1: Zulassung der
Schweißverfahren

This European Standard was approved by CEN on 12 June 2006.

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

This European Standard exists 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

[SIST EN 14730-1:2007](https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007)

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007>



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

Page

Foreword.....	4
Introduction	5
1 Scope.....	6
2 Normative references	6
3 Terms and definitions.....	6
4 Information to be supplied by the railway authority	7
5 Approval procedure	8
5.1 General.....	8
5.2 Process identification.....	8
5.3 General requirements	8
5.4 Initial compliance testing	9
5.5 Extension of initial compliance testing	10
5.6 Documents to be submitted with the request for approval	11
5.6.1 The process manual	11
5.6.2 Drawing with the required measurements.....	11
5.6.3 Chemical analysis ranges and tolerances.....	12
5.7 Preparation and allocation of test welds.....	12
6 Re-approval following process changes.....	13
7 Laboratory tests	16
7.1 Visual surface examination.....	16
7.1.1 As cast weld surface.....	16
7.1.2 Ground weld surface	16
7.1.3 Visible heat affected zone	17
7.2 Running surface hardness test	17
7.3 Slow bend test.....	18
7.4 Internal examination	18
7.4.1 Weld soundness.....	18
7.4.2 Fusion zone – shape and dimension	21
7.4.3 Microscopic examination	22
7.4.4 Heat softened zone width.....	22
7.5 Fatigue test	22
7.6 Chemical analysis	23
Annex A (informative) Steps in approval.....	25
Annex B (informative) Suggested sequence of laboratory tests	26
Annex C (normative) Ultrasonic testing procedure for aluminothermic welds in rail	27
C.1 A test of the head zone of the weld (non-planar defects)	27
C.2 A test of the head zone of the weld (planar defects).....	27
C.3 A test of the head and web zone of the weld (planar defects)	27
C.4 A test of the middle zone of the foot of the weld.....	27
C.5 A test of the ankle zone of the foot of the weld	27
C.6 A test of the toe zone of the foot of the weld	28
Annex D (normative) Procedure for FRY etching	29
Annex E (normative) Procedure for measurement of surface hardness	30
Annex F (normative) Procedure for slow bend test	31

Annex G (normative) Procedure for recording test weld fracture face defects	32
Annex H (normative) Ultrasonic inspection procedure on aluminothermic welds to be sectioned	34
H.1 Principle	34
H.2 Apparatus	34
H.3 Preparation of samples	34
H.4 Calibration	34
H.5 Testing.....	35
H.6 Reporting	35
Annex I (normative) Procedure for microscopic examination of the visible heat affected zone and fusion zone of welds	36
Annex J (normative) Procedure for measurement of the heat softened zone width	37
J.1 Measurement of hardness.....	37
J.2 Evaluation of hardness data	38
J.2.1 General.....	38
J.2.2 Mean hardness of parent rail	38
J.2.3 Measurement hardness line.....	38
J.2.4 Heat softened zone width measurement	39
J.2.5 Parent rail hardness variation	39
Annex K (normative) Fatigue test methods for aluminothermic welds.....	40
K.1 Scope.....	40
K.2 Test equipment.....	40
K.3 Calibration procedure.....	41
K.3.1 General.....	41
K.3.2 Test piece.....	41
K.3.3 Test piece preparation.....	41
K.3.4 Instrumentation.....	42
K.3.5 Procedure	42
K.4 Fatigue test method	45
K.4.1 General.....	45
K.4.2 Staircase testing method	45
K.4.3 Example of the data analysis of a fatigue strength determination by the staircase method	47
K.4.4 Past-the-post testing method	48
Annex L (informative) A–deviations.....	49

iTeH STANDARD PREVIEW
(standards.iteh.ai)

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46d9-855e-6639498f62c/sist-en-14730-1-2007>

Foreword

This document (EN 14730-1:2006) 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 February 2007, and conflicting national standards shall be withdrawn at the latest by February 2007.

The European Standard EN 14730 "*Railway applications – Track – Aluminothermic welding of rails*" is composed of two parts.

— Part 1: *Approval of welding processes*

— Part 2: *Qualification of aluminothermic welders, approval of contractors and acceptance of welds*

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

SIST EN 14730-1:2007

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007>

Introduction

This standard defines the approval procedure for aluminothermic welding processes for rail welding through laboratory tests of welds produced in a workshop. This laboratory approval will provide the railway authority with sufficient information for tests in the track if required.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN 14730-1:2007](https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007)

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007>

1 Scope

This standard defines the laboratory tests and requirements for approval of an aluminothermic welding process using welds produced in workshop conditions.

It applies to the joining of new, Vignole rails as described in EN 13674-1 of the same profile and steel grade.

Compliance with the requirements of this standard does not of itself ensure the suitability of a welding process for specific conditions of track and traffic.

The standard does not cover welds made between different rail sections, differently worn rails and different rail grades.

In addition to the definitive requirements this standard also requires the items detailed in Clause 4 to be documented. For compliance with this standard, it is important that both the definitive requirements and the documented items be satisfied.

2 Normative references

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

EN 473, *Non destructive testing – Qualification and certification of NDT personnel – General principles*

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

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

EN ISO 6507-1, *Metallic materials - Vickers hardness test - Part 1: Test method (ISO 6507-1:2005)*

EN ISO 7500-1:2004, *Metallic materials – Verification of static uniaxial testing machines – Part 1: Tension/compression testing machines – Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

3 Terms and definitions

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

3.1

fusion zone

area of the weld which has been in a liquid state and which is revealed by etching sections cut through the weld

3.2

visible heat-affected zone

HAZ

areas on either side of the fusion zone within which rail steel microstructure has been visibly modified by the heat of the welding process as revealed by FRY macro-etching

3.3**heat softened zone**

part of the HAZ characterised by a lower hardness

3.4**flashing**

flat fin of weld metal located on the rail surface adjacent to the weld collar caused by gaps between the mould and the rail

3.5**surface defect**

any defect visible on the weld surface after normal finishing operations

3.6**internal defect**

any defect that is revealed by sectioning or on a fracture face following bend or fatigue testing that has not already been identified as a surface defect

3.7**stress range**

stress range for the fatigue test is the maximum stress minus minimum stress

3.8**railway authority**

either the railway regulator or the owner of a railway infrastructure or the custodian with a delegated responsibility for a railway infrastructure

3.9**process supplier**

company which provides an approved aluminothermic welding process in accordance with this standard and which is approved by the railway authority to supply consumables and tools for the execution of aluminothermic welds

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 14730-1:2007

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-999999999999>

4 Information to be supplied by the railway authority

The following information shall be fully documented by the railway authority. For compliance with the standard both the definitive requirements specified throughout the standard and the following documented items shall be satisfied.

- a) Any limitations on the type of pre-heating.
- b) Maximum permissible numbers and/or dimensions of slag or sand inclusions on the as-cast weld surface.
- c) Any limitation on the weld collar geometry affected by riser removal (other than that on the ground rail head).
- d) The maximum size and number of pores to be permitted on the ground surfaces if the railway authority's requirements are more severe than those in 7.1.2.
- e) Any additional non-destructive testing requirements.
- f) Which of the width levels of visible heat affected zone is required (7.1.3).
- g) Which of the two formulae for minimum fracture load shall apply for R320Cr rail grade (7.3).

EN 14730-1:2006 (E)

- h) Any limit on the depth of the weld collar's edge (less than 2 mm) that may remain unfused to the rail surface.
- i) Which of the width levels of heat-softened zone is required (7.4.4).
- j) The fatigue requirement in terms of the mean and of the standard deviation of the fatigue strength for the staircase method of testing or the minimum value of upper stress in the rail foot for past the post testing (7.5.2).
- k) Which of the two hardness ranges for R260 rail grade specified in 7.2, Table 5 is required.

5 Approval procedure

5.1 General

An outline of the steps required for compliance to this standard is given in informative Annex A.

5.2 Process identification

The approval shall involve a single process identified by:

- a) The process name.
- b) A drawing of the pouring system.
- c) The characteristic geometry of the weld collar and riser configuration as given in 5.6.2 and Figure 1.
- d) The process manual in accordance with 5.6.1.

5.3 General requirements

The following general requirements shall be met.

- a) The process shall be capable of being carried out on track where the maximum can be 180 mm. It shall be capable of being carried out in track, at or near trackside or in a workshop.
- b) The aluminothermic welding portion shall be packed to avoid the risk of moisture contamination in proscribed storage conditions. The portion shall be identified by markings on the package.
- c) The mould shall be pre-fabricated for the rail profiles to be welded and be identified by markings on the package.
- d) The crucible shall be tapped automatically (automatic tapping) and shall have a device to limit spattering.
- e) Pre-heating shall comply with any limitations of the railway authority as specified in Clause 4 a). The pre-heating tools shall operate at temperatures down to 0 °C without the need for special precautions.
- f) The process shall not damage the rail.

5.4 Initial compliance testing

- a) For the purposes of approval the standard rail profiles (see EN 13674-1) shall be grouped as follows:

Table 1 — Rail profile groups

Group	Rail profiles
1	60E1, 60E2
2	54E1, 54E2, 54E3, 55E1, 56E1
3	46E1, 46E2, 46E3, 46E4, 49E1, 49E2, 49E3, 50E1, 50E2, 50E3, 50E4, 50E5, 50E6, 52E1
4	49E4

- b) Initial compliance with this standard shall be achieved by undertaking the tests specified in category 1 of Table 2 using either grade R220 or grade R260 rail of one profile in either group 1 or 2 of Table 1. Compliance with all the criteria specified and with the railway authority's documented requirements specified in Clause 4 shall be demonstrated. A test sequence is outlined in informative Annex B. A test specimen can be used for several different tests.

ITEH STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 14730-1:2007

<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007>

Table 2 — Testing scheme

Test	Section Reference	Number of Tests					
		Category 1 ^a	Category 2 ^b	Category 3 ^c			
				R200/R220/ R260/R260 Mn	R320Cr	R350HT	R350LH T
A Hardness Test	7.2	6	Nil	6	6	___6___	
B Surface Examination - Visual	7.1.1 7.1.2	All	All	All	All	___All___	
C Visible Heat Affected Zone	7.1.3	2	2	2	2	___2___	
D Slow Bend Test	7.3	6	2	2	6	___6___	
E Ultrasonic Inspection - Annex H	7.4.1.1	5	2	Nil	Nil	Nil	Nil
F Fatigue Test	7.5	n*	Nil	Nil	n*	Nil	n*
G Fusion Zone -Weld Soundness	7.4.1 7.3 7.5.3	5 (6) (n*)	2 (2) Nil	Nil (2) Nil	Nil (2) (n*)	Nil ___2___ Nil	Nil n*
H Fusion Zone - Shape and Dimensions	7.4.2	5	2	Nil	Nil	Nil	Nil
I Chemical Analysis	7.6	3	Nil	3	3	___3___	
J Heat Softened Zone - Hardness Distribution	7.4.4	2	2	2	2	___2___	
K Structure - Fusion Zone - Heat Affected Zone	7.4.3.3 7.4.3.2	1 1	Nil Nil	1 1	1 1	___1___ ___1___	
L Ultrasonic Inspection - Annex C	5.7 d)	All	All	All	All	All	All

NOTE 1 n* indicates the number of welds required for one staircase or past the post evaluation. Typically 10 test pieces will be required for a staircase and 3 for a past the post evaluation.

NOTE 2 ___X___ indicates that tests in one rail grade cover the other indicated grade

NOTE 3 () indicates weld soundness evaluation of the fracture face of the slow bend test or fatigue specimens

^a Category 1 Initial tests to be conducted using R220 or R260 grade rail and one profile from either of rail profile groups 1 or 2 (Table 1).

^b Category 2 Tests to be carried out on one profile from each of the remaining rail profile groups in order to extend approval to that group.

^c Category 3 Tests required extending approval to other rail grades. Tests on one rail profile cover all profile groups approved in categories 1 and 2.

5.5 Extension of initial compliance testing

Initial compliance can be extended as follows:

The relevant railway authority requirements defined in Clause 4 a) to k) shall be met for each of the items below:

- To other groups of rail profiles of Table 1 [subclause 5.4 a)] by the tests in category 2 of Table 2 [subclause 5.4 b)] to be conducted on one profile from each of the appropriate groups. Failure of any test shall cause non-compliance for the group of rail profiles being tested.
- To other rail grades by the tests in category 3 of Table 2 [subclause 5.4 b)]. Failure of any test shall cause non-compliance for that rail grade. Tests on one rail profile cover all profiles in categories 1 and 2.
- To process changes as prescribed by the limits and tests of Clause 6. Failure of the relevant tests of Table 3 shall cause non-compliance of the process change.

5.6 Documents to be submitted with the request for approval

When applying for approval, the following documents shall be submitted:

5.6.1 The process manual

The process supplier shall produce a manual identifying all the consumable materials and equipment used, as well as the operating method to be followed for all steps of welding. The approval procedure for laboratory tests will not include means of alignment or finishing operations. The manual shall specify the critical parameters of the welding process and their safe bounds, and shall include the following:

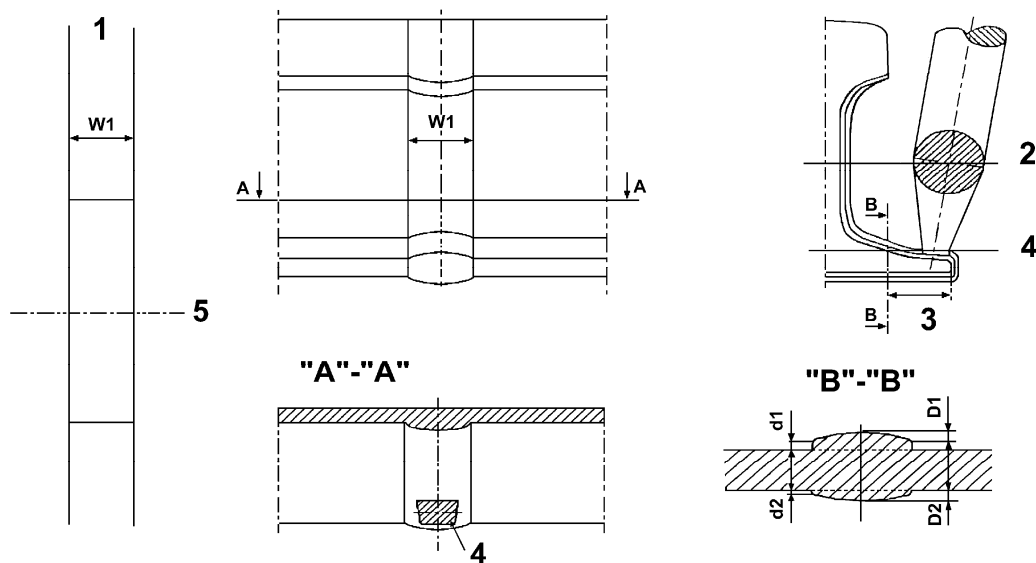
- a) number of people required carrying out the operations;
- b) diagram of equipment;
- c) portion for each rail grade and profile;
- d) rail end preparation requirements;
- e) nominal gap shall have a tolerance of ± 2 mm for a gap up to 30 mm and ± 3 mm for gaps above 30 mm and up to 50 mm and ± 5 mm for gaps above 50 mm;
- f) preheating details;
- g) range of ignition to tap times for the portion;
- h) critical process timings; [SIST EN 14730-1:2007](https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007)
- i) time (or temperature) before trains can pass; <https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007>
- j) safety information.

5.6.2 Drawing with the required measurements

A drawing, as illustrated in Figure 1, which provides the measurements listed below:

- a) weld collar width (W1). The development of the weld collar shall be fully dimensioned around the weld;
- b) maximum depth of collar at section B-B (D1 and D2);
- c) minimum depth of collar at section B-B (d1 and d2);
- d) riser cross section at foot;
- e) riser cross section at neutral axis;
- f) number of risers;
- g) position of risers.

The dimensions W, D and d and cross sectional areas of the risers shall be the nominal dimensions taken from the drawing of the pattern used to produce the moulds.



Key

- 1 Figure showing the width of the weld collar around the weld
- 2 Riser cross section on the neutral axis mm²
- 3 25 % of the foot width
- 4 Riser cross section at the foot mm
- 5 Longitudinal axis under the rail foot

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 14730-1:2007
<https://standards.iteh.ai/catalog/standards/sist/0cf25a54-48a2-46f9-855e-6639498f182e/sist-en-14730-1-2007>

Figure 1 — Dimensions taken from mould pattern

5.6.3 Chemical analysis ranges and tolerances

The chemical analysis ranges and tolerances according to 7.6.1.

5.7 Preparation and allocation of test welds

- a) Welds required for the tests shall be produced in accordance with the process manual (5.6.1) under the supervision of the approving authority recognised by the railway authority. Rails to be used for the production of test welds shall be new rails. Fifty percent of test welds shall be made with minimum gap and fifty percent at maximum gap.
- b) Welding gap shall be measured after weld alignment (peaking) on both sides of the rail head (or on the running surface), web mid point and both foot tips. The maximum gap is the maximum at any of the above points and minimum the minimum of any of the above points.
- c) The weld gap for all welds made for Table 2 tests shall be within the specified range. In the case of the welds required for test H in category 1 of Table 2, three welds shall be produced at the minimum gap and two at the maximum, and for category 2 of Table 2, one weld at the maximum gap and one weld at the minimum gap. Measurements shall be made to an accuracy of ± 0,5 mm.
- d) All welds shall be tested ultrasonically using the procedure given in Annex C and the results recorded.

- e) With the exception of the welds made for test H, as many as possible of the welds that show an ultrasonic response shall be allocated to test as follows:
- Response from web or foot – slow bend test (test D);
 - Response from head – weld soundness test (test G)
- Otherwise welds shall be allocated to tests randomly.
- f) The number of each test shall be in accordance with the appropriate parts of Tables 2 and 3. The process supplier shall determine the order of testing.
- g) Where tests fail to meet the required test criteria as a result of a defect (or defects) in the rail, re-tests shall be made on a one-to-one basis.

6 Re-approval following process changes

6.1 Changes to the following criteria require approval.

6.1.1 Any geometric parameters given in 5.6.2:

- a) weld collar width (W);
- b) collar depth (D);
- c) collar depth (d);
- d) riser cross-section – in foot;
- e) riser cross-section – in neutral axis;
- f) riser configuration – position;
- g) riser configuration – numbers.

A revised drawing shall be submitted.

6.1.2 Crucible system

- Any changes in the chemical nature of the main component of the refractory;
- Internal crucible geometry changes outside the range covered by the tolerances shown on the suppliers drawing.

6.1.3 Tapping system

- Any changes in the chemical nature of the main component of the refractory of the tapping system body;
- Any changes in the geometry of the tapping system body outside the suppliers drawing;
- All changes to the releasing mechanism.

6.1.4 Pre-heating system

- Any change in the equipment or critical parameters;