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Railway applications — Rail Welding —

Part 1:
General requirements and test methods for rail welding

Applications ferroviaires — Soudage des rails —

Partie 1: Exigences de portée générale et méthodes d'essais pour le soudage des rails

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

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Foreword

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

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

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

This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 1, *Infrastructure*.

A list of all parts in the ISO 23300 series can be found on the ISO website.

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

Introduction

Rail welding is essential technology in the area of railway track for reducing noise and vibration on rail joints, improving ride comfort and reducing maintenance costs.

Since environments (e.g. geography, deployable resources and energy affairs) differ by regions and railway lines, rail welding methods have been developed to meet the needs and conditions of each environment. As a result, various rail welding methods, for example flash butt, gas pressure, aluminothermic and enclosed arc welding, exist.

Therefore, a general rail welding standard on an international level that covers conventional rail welding methods was deemed necessary. This document will contribute to the development of railways by ensuring the quality of welded joints in terms of enhancing reliability of train operation, improving the welding work efficiency and facilitating the introduction of new procedures.

This part of the ISO 23300 series covers the general requirements for rail welding and is used in conjunction with the subsequent parts which cover the specific requirement for each welding process such as flash butt welding, gas pressure welding, aluminothermic welding, and enclosed arc welding.

Railway applications — Rail Welding —

Part 1:
General requirements and test methods for rail welding

1 Scope

This document applies to the following rail welding processes:

— flash butt;

— gas pressure;

— aluminothermic;

— enclosed arc welding.

This document specifies the requirements on approval/homologation of welding processes, contractors/welders/inspectors, and acceptance of welded joints in factory/track.

In this document, 43kg/m–75kg/m new vignole rails of the same profiles and same steel grades are the subject of welding.

This document does not specify requirements and evaluation test methods specific to each welding process. These will be prescribed in the subsequent parts of the ISO 23300 series.

This document is restricted to butt welding for connecting rail ends.

This document does not cover the welding for construction of crossings, railway switches, signal bond installation or restoration of rails.

This document does not cover any safety regulations of welding operations.

In this document, qualifications of individuals and organisations for rail welding are not 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.

ISO 7500-1:2015, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force — measuring system*

3 Terms and definitions

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

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

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

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

3.1
acceptance in factory/track
acceptance inspection conducted from the viewpoint of quality control targeting welded joints which will be used in track

3.2
contractor
company approved by a railway authority to provide staff and machinery in order to execute the production of welds

3.3
finished condition
welded, trimmed, dressed and profile finished

3.4
fixed plant
stationary production line for flash butt welding of rails

3.5
heat affected zone
part of the unmelted base metal where metal structure, metallurgical properties, mechanical properties etc. are transformed due to heat input during welding process such as welding, post-weld heat treatment and flame cutting

3.6
inspector
an individual trained, qualified, approved and competent to carry out inspection of welds by observation and judgement, accompanied as appropriate by measurement and testing techniques

3.7
internal defect
any defect that is revealed by sectioning, or on a fracture face following bend, fatigue or drop hammer testing that is not identified as a surface defect

3.8
non-destructive testing (NDT)
application of technical methods to examine materials or components in ways that do not impair their future usefulness and serviceability, in order to detect, locate, measure and evaluate defects, to assess integrity, properties and composition, and to measure geometrical characteristics

3.9
operator
a person who is trained and competent to undertake the appropriate welding machine operation

3.10
post-weld heat treatment
application of heating and cooling control to a welded joint after welding

3.11
process supplier
company which provides a rail welding process which is approved by the railway authority to supply machines, consumables and tools for execution rail welds

3.12
production
butt welding work to connect rails for rail transport operation, whether performed in-factory or on-site

3.13
profile finishing
operation by which the rail head or relevant part of the rail head at the weld is returned to rail profile

Note 1 to entry: Operation can be carried out by grinding, milling, planing or any other suitable means.

3.14
railway authority
either the railway regulator or the owner of a railway infrastructure or the custodian with a delegated responsibility for a railway infrastructure

3.15
surface defect
any defect on the welded joint surface after normal finishing operations

3.16
training centre
organisation or centre responsible for training welders and which is approved by the railway authority, and in the case of aluminothermic welding the process supplier

3.17
welded joint
rail joints bonded by welding, which includes the weld metal and the heat affected zone

3.18
welder
a person who is trained and competent to undertake the appropriate welding process

4 Rail welding processes

The following processes are currently applied for butt welding connecting rail ends:

— Flash Butt Welding (FBW): Hot pressure welding process using electric current and axial force to produce rail joints (there are two types, fixed plant and mobile);

— Gas Pressure Welding (GPW): Hot pressure welding process using gas flame and axial force to produce rail joints;

— Aluminothermic Welding (ATW): Cast fusion weld process using aluminothermic reaction to generate liquid steel;

— Enclosed Arc Welding (EAW): Electric-arc welding process performed by surrounding rails with copper or ceramic block.

5 General process of rail welding

The rail welding process generally consists of the following stages:

— Preparatory stage: Including provision of information from the railway authority or delegated company and arrangement of conditions;

— Working stage: Including rail end preparation, alignment, step treatment, welding work and post-weld heat treatment;

— Finishing stage: Including profile finishing and weld identification;

— Verification/acceptance stage: Including inspections/tests classified in the following clauses.

NOTE Further details on each stage of each applied process will be prescribed in the subsequent parts of the ISO 23300 series.

6 Approval/homologation of welding processes

6.1 General

Initial approval/homologation tests shall be carried out for every application of each rail welding process. Approval/homologation tests are used to confirm the reliability of the welding process and do not reflect quality control in production. Approval/homologation tests shall be carried out for a particular rail profile and grade, using a specific welding machine or specific type of welding consumable material.

NOTE The series and sequence of tests for each welding method, together with the number of specimens for each test item, is specified in the subsequent parts of this document.

The specification requirements of each approval/homologation test shall be provided to the contractor from the railway authority before conducting the test.

6.2 Non-destructive testing (NDT)

NDT methods include:

— visual testing (VT);

— ultrasonic testing (UT);

— magnetic particle testing (MT);

— dye penetrant testing (PT).

After the VT, further appropriate NDT methods shall be applied in accordance with the relevant sections of this document used to inspect the welded joint in finished condition.

The NDT methods for sectioned and full-size samples are described in the subsequent parts of this document.

The NDT methods for sectioned and full-size samples are dependant upon the welding process being used.

6.3 Slow bend test

The slow bending test for rail welds is the only practical and efficient test method that can simply evaluate the joint performance of the welded joint on whether the load and the deflection satisfy the specified value. However, the original purpose of the test is to force failure of the welded joint and to observe existence or non-existence of weld defects on the fracture surface.

In this test, two loading modes are applied as appropriate; one with the rail head upwards in which tensile stress is applied to the rail bottom, and one with the rail head downward in which tensile stress is applied to the rail head. Each slow bending test shall also be continued until the load or deflection reaches the specified value or fracture occurs according to circumstances.

For applying the slow bending test in which tensile stress is applied to the rail bottom, the requirements and test method are given in Annex D.

For applying the slow bending test in which tensile stress is applied to the rail head, the requirements and test method are given in Annex E.

The practical predicted performance of the rail welded joint in service shall be preferable evaluated in conjunction with the non-destructive test and the bending fatigue test.

6.4 Past-the-post fatigue test

The straightness of the welded joint as in finished condition shall not affect execution of past-the-post fatigue test.

The test sample shall be subject to NDT which shall include VT and UT, MT or PT as appropriate. Only those samples that have been qualified by NDT can be used for the fatigue test.

The test shall be conducted in three or four points bending with the rail foot in tension. Both test types shall be considered as equal.

The requirements for the three-point bending test, and test method are given in Annex F.

The requirements for the four-point bending test, and test method are given in Annex G.

6.5 Macro examination

Macro examination is performed to investigate the presence or absence of an internal defect in the weld and to confirm that the appropriate heat input has been performed. The macro structures depend on each welding process.

6.6 Micro examination

Micro examination is performed to investigate the presence or absence of abnormal metallographic structure in the weld. The micro structures depend on each welding process.

6.7 Hardness test

A hardness test is performed to evaluate wear resistance and to confirm accordance with specification. The hardness values depend on each welding process.

6.8 Drop hammer test (optional)

A railway authority may demand a drop hammer test to assess the joint's performance. The drop hammer test is described in Annex H.

6.9 Recording of defects

The details of weld defects shall be recorded.

7 Acceptance in factory/track

7.1 General

Documentation and records relating to traceability shall be made available upon request by the railway authority. The contents of this chapter can also be applied to welds in service.

7.2 Weld inspection

Prior to any inspection the weld shall be completed and the traceability shall be identified. The weld shall be in the finished condition.

The joints welded in a fixed plant shall be inspected in the plant. Based on the inspection, the weld shall be deemed as accepted or rejected.

The joints welded on site shall be inspected on the railway track. Based on the inspection, the weld shall be deemed as accepted or rejected. This is applicable to; FBW using a mobile machine, GPW, ATW, EAW.

The equipment used for inspection shall be calibrated and meet the requirements of the equipment supplier and the railway authority.

The inspector shall be competent and meet the requirements of the railway authority.

A weld inspection report containing the result and details of the weld inspection shall be completed. When the inspection results do not comply with this document, the joints shall be treated as unqualified products.

7.3 Inspection reports

Items to be inspected for acceptance of rail welded joints may include:

a) straightness (See subclause 7.4);

b) NDT (VT shall be applied to find the surface defect about the welded joint. Other inspection items are optional which shall be defined by the railway authority. See Annex A, B, and C).

7.4 Straightness inspection

The straightness of the welded joint in finished condition shall be measured, vertically and horizontally over a 1 m span. The error of 1 m straight edge shall not exceed 0,05 mm.

The straightness shall be measured while the joint is at ambient temperature. In some specific cases (i.e. immediately following profiling, insufficient cooling times for site-made welds.), any measurement of alignment can be made while the weld is hot, and the effect of temperature on the weld shall be taken into consideration.

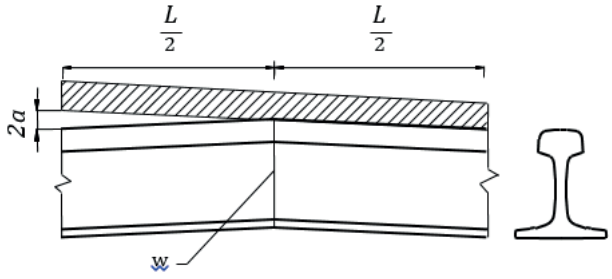
Straightness across the weld shall be measured as follows:

The vertical straightness of the running surface shall be measured along the longitudinal surface of the rail with the weld centrally referenced to datum points on the rail 500 mm either side of the weld. See Figure 1 a). This shall be confirmed by railway authority and contractor

The horizontal straightness of the weld at the running edge shall be measured on one or both faces at gauge measuring point below the running surface and referenced to datum points on the rail 500 mm either side of the weld. Tolerances widen gauge situation see Figure 1 b). Tolerances narrow gauge situation see Figure 1 c). The necessity of measurement on the field side is confirmed by the railway authority with the contractor.

The means of measuring the weld straightness as described above, shall be the choice of the contractor but in the case of any dispute a calibrated straight edge shall be used.

Acceptance criteria for straightness are determined by the railway authority. Examples of acceptance criteria for straightness are given in Annex I.



a) running surface straightness