SLOVENSKI STANDARD
SIST EN 1011-3:2001

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Varjenje - Priporočila za varjenje kovinskih materialov - 3. del: Obločno varjenje nerjavnih jekel

Welding - Recommendations for welding of metallic materials - Part 3: Arc welding of stainless steels

Schweißen - Empfehlungen zum Schweißen metallischer Werkstoffe - Teil 3: Lichtbogenschweißen von nichtrostenden Stählen

Soudage - Recommandations pour le soudage des matériaux métalliques - Partie 3: Soudage a l'arc des aciers inoxydables

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25.160.10	Varilni postopki in varjenje	Welding processes
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EUROPEAN STANDARD
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English version

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This European Standard was approved by CEN on 13 August 2000.

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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, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 121 "Welding", the secretariat of which is held by DS.

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of an identical text or by endorsement, at the latest by March 2001, and conflicting national standards shall be withdrawn at the latest by March 2001.

This European Standard 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(s).

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

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

This European Standard is composed of the following parts:

Part 1: General guidance for arc welding

Part 2: Arc welding of ferritic steels

Part 3: Arc welding of stainless steels

Part 4: Arc welding of aluminium and aluminium alloys

Annexes A, B, C and D are informative.

Introduction

This European Standard is being issued with several annexes in order that it may be extended to cover the different types of steel which will be produced to all the European steel standards for stainless steels.

When this standard is referenced for contractual purposes, the ordering authority should state the need for compliance with the standard and such other annexes as are appropriate.

This standard gives general guidance for the satisfactory production and control of welding and details the possible detrimental phenomena which may occur with advice on methods by which they may be avoided. It is generally applicable to all stainless steels and is appropriate regardless of the type of fabrication involved, although the application standard may have additional requirements. Permissible design stresses in welds, methods of testing and acceptance levels are not included because they depend on the service conditions of the fabrication. These details should be obtained from the design specification.

This Part of this European Standard contains additional details for fusion welding of stainless steels and should be read in conjunction with the general recommendations in EN 1011-1.

1 Scope

This European Standard gives general recommendations for the fusion welding of stainless steels. Specific details relevant to austenitic, austenitic-ferritic, ferritic and martensitic stainless steels are given in annexes A to D.

2 Normative references

This European Standard incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 288-2 Specification and approval of welding procedures for metallic materials – Part 2: Welding procedure specification for arc welding

EN 439 Welding consumables - Shielding gases for arc welding and cutting

EN 1600 Welding consumables - Covered electrodes for manual metal arc welding of stainless and heat resisting steels - Classification

EN 1011-1 Welding - Recommendations for welding of metallic materials – Part 1: General guidance for arc welding

EN 10088-1 Stainless steels - Part 1: List of stainless steels

EN 12072 Welding consumables - Wire electrodes, wires and rods for arc welding of stainless and heat resisting steels - Classification

EN 12073 Welding consumables - Tubular cored electrodes for metal arc welding with or without a gas shield of stainless and heat resisting steels - Classification

EN 25817 Arc-welded joints in steel - Guidance on quality levels for imperfections (ISO 5817 : 1992)

EN 29692 Metal-arc welding with covered electrode, gas-shielded metal-arc welding and gas welding - Joint preparations for steel (ISO 9692 : 1992)

EN ISO 8249 Welding – Determination of Ferrite Number (FN) in austenic and duplex ferritic-austenitic Cr-Ni stainless steel welds metals (ISO 8249:2000)

CR ISO 15608 Welding - Guidelines for a metallic material grouping system (ISO/TR 15608 : 2000)

3 Terms and definitions

For the purposes of this European Standard the following terms and definitions apply.

3.1
passive layer
a thin, transparent and tightly adherent film on the surface of stainless steels which protects them from corrosive attack.

3.2
stabilized/unstabilized
stabilized steels contain additions of strong carbide/nitride forming elements, (usually titanium or niobium), which limit the formation of chromium carbides/nitrides, allowing the stainless steel to retain its corrosion resistance, particularly around grain boundaries.

3.3
ferrite number (FN)
a number indicating magnetic attraction, relative to a series of reference samples and therefore, proportional to the ferro-magnetic phase content, approximately equal to ferrite (delta ferrite) content over the range 0 % to 10 % but more readily measured [EN ISO 8249].

3.4
consumable insert
a length of filler metal which is manufactured to conform with the shape and dimensions of the weld preparation and is melted to become an integral part of the joint during welding.

3.5
proof strength
where proof strength is referred to in this standard it refers to 0,2 % proof strength ($R_{p0,2\,\%}$).

4 Parent metal

This standard applies to stainless steels of the austenitic, ferritic, martensitic and austenitic/ferritic types, according to groups 8 to 10 of CR ISO 15608.

5 Storage and handling

When storing, handling or fabricating stainless steel, the environment shall be controlled to avoid permanent breakdown of the passive layer, which gives stainless steel its good corrosion resistance. Stainless steels shall be protected from contamination and surface damage during all stages of storage, fabrication and transportation.

Contact between stainless steels and other materials, e.g. carbon steels, copper, paints, dyes and tapes, which cause a breakdown of the passive layer or other detrimental effects should be avoided. When contact is not avoidable care should be taken that all residues are removed.

Racking for stainless steels shall be strongly built and shall be lined in a secure manner with materials that will not contaminate stainless steel, e.g. dry wood or stainless steel. Unlined or painted carbon steel racking shall not be used. Lifting grabs shall be made from or lined with a non-contaminating material.

Welding fixtures, earth clamps or manipulators shall be either manufactured from or lined with non-contaminating materials.

6 Welding consumables

Filler materials should be selected having regard to the parent metals and the particular application and shall comply with the relevant standards.

Where consumable inserts are used they shall correspond with the relevant filler metal composition.

7 Fabrication

7.1 General

Facilities for fabrication of stainless steels shall be segregated from other works and kept free of all possible contaminating materials such as lead, zinc, copper, copper alloys or carbon steels, etc.

Forming tools shall be cleaned thoroughly before use to avoid cross contamination. All lubricants used in the forming operations shall be removed from the workpiece.

Only tools dedicated to stainless steel shall be employed; this particularly applies to grinding wheels and wire brushes.

Welding heats up the parent metal which causes formation of oxide films both on the weld metal and on the surrounding areas of the weld. These oxides as well as slags produced by covered electrodes, flux cored wires and submerged arc welding, shall be removed if the weld is to be exposed to a corrosive medium or for other reasons (see clause 10).

When preparing fusion faces, oxidation, hardening and general contamination from thermal cutting processes should be eliminated by mechanically machining to a sufficient depth from the cut face. During shearing cracking can occur. These may also require to be removed prior to welding.

Where cut edges do not form fusion faces, care should be taken to ensure that the shearing or thermal cutting does not adversely affect the performance of the fabrication.

Hard stamping should be avoided, but when it has to be used attention is drawn to the danger of it being applied in highly stressed or corrosive areas and the purchaser should give guidance as to the location of such marks. Indentations used for marking in radiographic examination should be subject to similar precautions.

Welds which are to be inspected and approved should not be painted or otherwise treated until they have been accepted.

7.2 Weld details

Welding details shall be described in an appropriate Welding Procedure Specification (WPS) in accordance with EN 288-2.

Further details of weldability aspects are given in annexes A to D.

Acceptance criteria for misalignment of joints are given in EN 25817. For certain applications (for example the welding of pipework) and welding processes, closer tolerances may be necessary.

Where run-on/run off pieces are used these shall be manufactured from a grade of stainless steel compatible with that used for the fabrication and shall have a thickness and edge preparation similar to that used for the joint.

The removal of run-on/run off pieces shall be performed by a method which does not adversely affect the properties of the parent metal and weld deposit. Inspection should be carried out to demonstrate that both the parent material and weld deposit are free from unacceptable imperfections.

Where the weld has to be made from one side only, it may be necessary to protect the root side from atmospheric contamination to maintain the corrosion resistance of the joint. The root run of such welds is generally made using the TIG or plasma welding process.

7.3 Weld backing

Permanent backing shall consist of a compatible grade of stainless steel and should not be used where there is a risk of crevice corrosion.

When it is not appropriate to use part of the structure as backing material, the material to be used shall be as required by the design specification.

When using copper as a temporary backing material a groove shall be machined into the backing material in the fusion area. Care should be taken when welding as there is a risk of copper pick-up. This can be reduced by nickel or chromium plating of the copper backing material. When using high heat input, the copper backing may be water-cooled.

Backing material shall be free from contamination such as grease, moisture, oxide etc.

Where temporary or permanent backing is employed, the joint shall be arranged in such a way as to ensure that complete fusion of the parts to be joined is readily obtained.

When it is necessary to prevent oxidation on the reverse side of a weld, then purging using a suitable gas supply should normally be carried out. This is where a high purity gas or gas mixture, in accordance with EN 439, compatible with the parent and weld metal, is passed over the weld root. The purpose is to prevent contamination by the atmosphere, principally oxygen, which can lead to unacceptable imperfections in the weld and/or a reduction of corrosion resistance.

Where purging of the root area is to be carried out, the duration of purging prior to welding should be sufficient to ensure that the level of root oxidation is as required by the design specification. The prepurge time will depend principally on gas flow rate, volume to be purged and, to a lesser extent, purging gas density and injection point.

Where maximum allowable oxygen levels are specified in the contract, then it will be necessary to use an oxygen analyser of suitable sensitivity to measure the oxygen content of the exit gas. As a guideline it is suggested that ten volume changes be made before commencing welding.

Gas purging should be maintained for sufficient duration to ensure that the finished weld underside surface oxidation level is contractually acceptable.

8 Quality requirements of welds

Welded joints shall be free from imperfections that would impair the service performance of the construction. Acceptance levels shall be in accordance with the application standard where it exists. If no application standard exists acceptance levels shall be based on EN 25817.

Special quality requirements for stainless steels may be taken into account, such as appearance and corrosion resistance, and shall be specified in the contract.

9 Distortion

Distortion in a weldment results from non-uniform expansion and contraction of weld metal and adjacent parent metal during welding. In austenitic stainless steel this phenomenon is much more pronounced than in unalloyed steel due to a larger expansion coefficient and a lower thermal conductivity.

There are various practical ways of minimizing distortion such as:

- minimizing the weld metal volume;
- balanced (double sided) joint welding;
- reduced heat input;
- reduced numbers of weld layers;
- backstep welding;
- preset of the parts to be welded;
- jigs and mechanical restraints;
- tack welding;
- heat sinks.

Care should be taken that the methods chosen do not have a deleterious effect on the properties of the welds and the overall structure.

10 Post-weld cleaning

The corrosion resistance of stainless steel weldments is significantly affected by their surface condition. The degree of post weld cleaning necessary depends upon the weld quality requirements and should be as required by the design specification.

Post weld cleaning can be carried out by several processes, either separately or in combination, for example:

- **Brushing:** Dedicated wire brushes made with stainless steel bristles or other compatible material should be used. This technique cannot be used, in general, to remove adherent contaminants. Care should be taken when using mechanical rotary brushing as this may deform the surface giving microcrevices which will reduce corrosion resistance. It may be necessary to follow brushing with a pickling operation.

- **Blasting:** This technique is used for removal of adherant contaminants and also to give residual compressive stresses in the surface. Recommended blasting media include glass and stainless steel shot. These shall be free from iron or carbon steel contamination.

- **Grinding:** Dedicated iron free grinding discs, belts or wheels should be used. Excessive grinding should be avoided to prevent damage to the surface and thinning of the parent metal. The technique is used to remove heavy surface contaminants and to blend the weld smoothly into the parent metal.

- **Pickling:** Pickling removes surface oxides or surface layers of the steel by chemical reaction. An acid medium is used whose composition is dependent on the type of steel, pickling temperature and time. Careful removal of all pickling products needs to be carried out.

- **Electro-polishing:** This is used, generally, on nonstabilized stainless steels to give a smooth surface for optimum corrosion resistance.

For optimum corrosion resistance the most effective cleaning processes are pickling and electro-polishing, followed by a natural or induced passivation treatment.