UDC 669.14.018.29.018.821 : 620.1 August 1993

Structural steels with improved atmospheric corrosion resistance

Technical delivery conditions
English version of DIN EN 10 155

DIN
EN 10 155

Wetterfeste Baustähle; technische Lieferbedingungen

European Standard EN 10 155 : 1993 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by ECISS/TC 10.

The responsible German body involved in its preparation was the *Normenausschuß Eisen und Stahl* (Steel and Iron Standards Committee), Technical Committee *Stähle für den Stahlbau*. The present standard specifies requirements for flat and long products with improved atmospheric corrosion resistance. Such products had not been covered in any DIN Standards, but had been dealt with in *Stahl-Eisen-Werkstoffblatt* (Iron and steel materials sheet) 087, issued by the *Verein Deutscher Eisenhüttenleute* (Society of German Ferrous Metallurgists). In comparison with that document, the present standard specifies nine (as opposed to three) steel grades, these having a higher phosphorus content (with the symbol WP, cf. table 2) or, for grade S355W, belonging to quality group J0 or K2 (with a minimum impact energy of 27 J at 0 °C and 40 J at −20 °C, respectively).

For the most part, all other requirements, including mechanical properties, reflect those specified for unalloyed structural steel in EN 10 025. The designation has been brought into line with that specified in EN 10 027 Parts 1 and 2 and the ECISS Information circular IC 10.

The DIN Standards corresponding to the standards and other documents referred to in clause 2 of the EN are as follows:

prEN 10 052	DIN 17 014 Part 1
EN 10 204	DIN 50 049
ECISS Information circular IC 10	DIN V 17 006 Part 100
EURONORM 19	DIN 1025 Part 5
EURONORM 24	DIN 1025 Part 1
EURONORM 48	DIN EN 10 048*)
EURONORM 53	DIN 1025 Parts 2 to 4
EURONORM 54	DIN 1026
EURONORM 55	DIN EN 10 055*)
EURONORM 56	DIN EN 10 056 Part 2*) and DIN 1028
EURONORM 57	DIN EN 10 056 Part 2*) and DIN 1029
EURONORM 58	DIN 1017 Part 1
EURONORM 59	DIN 1014 Part 1
EURONORM 60	DIN 1013 Part 1
EURONORM 91	DIN 59 200
EURONORM 103	DIN 50 601

*) At present at the stage of draft.

Continued overleaf.
EN comprises 33 pages.

Standards referred to

(and not included in **Normative references**)

DIN 1013 Part 1	Hot rolled round steel for general applications; dimensions and tolerances
DIN 1014 Part 1	Hot rolled square steel for general applications; dimensions and tolerances
DIN 1017 Part 1	Hot rolled steel flats for general applications; dimensions, tolerances and mass
DIN 1025 Part 1	Steel sections; hot rolled I beams; dimensions, mass, limit deviations and static values
DIN 1025 Part 2	Steel sections; hot rolled H beams (IPB and IP series); dimensions, mass, limit deviations and static values
DIN 1025 Part 3	Hot rolled light duty H beams (IPBl series); dimensions, mass, limit deviations and static values
DIN 1025 Part 4	Hot rolled heavy duty H beams (IPBv series); dimensions, mass, limit deviations and static values
DIN 1025 Part 5	Hot rolled I beams of medium flange width (IPE series); dimensions, mass, limit deviations and static values
DIN 1026	Steel sections; hot rolled round-edged channel sections; dimensions, mass, limit deviations and static values
DIN 1028	Steel sections; hot rolled round-edged equal angles; dimensions, mass, limit deviations and static values
DIN 1029	Steel sections; hot rolled round-edged unequal angles; dimensions, mass, limit deviations and static values
DIN V 17 006 Part 100	Designation systems for steel; additional symbols for steel names
DIN 17 014 Part 1	Heat treatment of ferrous materials; terminology
DIN 50 049	Inspection documents for the delivery of metallic products
DIN 50 601	Determination of grain size of ferrite or austenite in ferrous materials by metallographic methods
DIN 59 200	Hot rolled wide steel flats; dimensions and tolerances on size, form and mass
DIN EN 10 048*)	Hot rolled uncoated narrow strip; dimensions and tolerances
DIN EN 10 055*)	Hot rolled round-edged tee sections; tolerances on shape and dimensions
DIN EN 10 056 Part 2*)	Hot rolled equal and unequal leg angles; tolerances on shape and dimensions

International Patent Classification

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EN 10 155

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Descriptors: Iron and steel products, hot rolled products, structural steels, corrosion resistant steels, atmospheric corrosion, grades, quality, chemical composition, dimensions, delivery conditions, tests, inspection, marking.

English version

Structural steels with improved atmospheric corrosion resistance

Technical delivery conditions

Aciers de construction à résistance améliorée à la corrosion atmosphérique; conditions techniques de livraison

Wetterfeste Baustähle; technische Lieferbedingungen

This European Standard was approved by CEN on 1993-06-21.

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

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 10 155 : 1993 E

Contents list

Foreword

This European Standard has been drawn up by ECISS/TC 10 "Structural steel - qualities" whose secretariat is held by NNI.

This European Standard replaces EURONORM 155-80 "Weathering steels for structural purposes - Quality standard".

ECISS/TC 10 met 26 and 27 September 1991 in Brussels and agreed on the text for circulation for formal vote within CEN. The following countries were represented at that meeting: Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Sweden and United Kingdom.

This standard was approved by CEN as a European Standard.

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 December 1993, and conflicting national standards shall be withdrawn at the latest by December 1993.

In accordance with the CEN/CENELEC Internal Regulations, following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

1.1 This European Standard specifies requirements for long products and flat products of hot-rolled steels with improved atmospheric corrosion resistance (alloyed special steel according to EN 10020) in the grades and qualities given in tables 3 (chemical composition), 5 and 6 (mechanical properties) in the usual delivery condition as given in 7.2.

The thicknesses in which products of the steel grades and qualities specified in this European Standard may be supplied are given in table 2. The application of this standard to greater thicknesses shall be agreed at the time of the enquiry and order.
Option 1.

The steels specified in this European Standard are intended for use in welded, bolted and riveted components which shall have enhanced resistance to atmospheric corrosion, for service at ambient temperatures (subject to the restrictions described in 7.5.1).

They are not intended to be heat treated except products delivered in the delivery condition N. Stress relief annealing is permitted. Products delivered in the N condition may be normalized and hot formed after delivery (see clause 3).

1.2 This European Standard does not apply to structural steels for use in the applications referred to in 1.1 for which specific EURONORMS exist or European Standards dealing with steels for general structural applications are being prepared:
- non-alloy structural steels - (see EN 10025);
- steels for simple pressure vessels - (see EN 10207);
- non-alloy steel sheet and strip for pressure purposes - (see EN 10028 part 1 - 3);
- reinforcing bars (not for prestressing) - (see prEN 10080) [1];
- weldable fine grain structural steel - (see EN 10113 part 1 - 3);
- hot finished structural hollow sections - (see EN 10210-1).

2 Normative references

This European Standard incorporates by dated or 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.

2.1 *General standards*

EN 10020 Definition and classification of grades of steel

1) Draft is under discussion.

EN 10021	General technical delivery requirements for steel and iron products
EN 10025	Hot-rolled products of non-alloy structural steels -- Technical delivery conditions
EN 10027-1	Designation systems for steel -- Part 1: Steel names, principal symbols
EN 10027-2	Designation systems for steels -- Part 2: Numerical system
prEN 10052 [1]	Vocabulary of heat treatment terms for ferrous products
EN 10079	Definition of steel products
EN 10163	Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections -- Part 1: General requirements Part 2: Plate and wide flats Part 3: Sections
EN 10164	Steel products with improved deformation properties perpendicular to the surface of the product -- Technical delivery conditions
EN 10204	Metallic products -- Types of inspection documents
EURONORM 168 (1986) [2]	Iron and steel products -- Inspection documents -- Contents
ECISS IC 10	Designation systems for steel -- Additional symbols for steel names

2.2 *Standards on dimensions and tolerances*

EN 10029	Hot-rolled steel plates 3 mm thick or above -- Tolerances on dimensions, shape and mass
EN 10051	Continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels -- Tolerances on dimensions and shape
prEN 10034 [1]	Structural steel I and H sections -- Tolerances on shape and dimensions
prEN 10056-2 [1]	Structural steel equal and unequal leg angles -- Part 2: Tolerances on shape and dimensions
EURONORM 19 (1957) [2]	IPE beams: parallel-flanged beams
EURONORM 24 (1962) [2]	Standard beams and channel sections -- Tolerances
EURONORM 48 (1984) [2]	Specification for hot-rolled narrow steel strip -- Tolerances on dimensions, shape and mass
EURONORM 53 (1962) [2]	Wide-flanged beams with parallel flanges
EURONORM 54 (1980) [2]	Small hot-rolled steel channels
EURONORM 55 (1980) [2]	Hot-rolled equal flange tees with radiused root and toes in steel

1) Draft is under discussion.
2) Until these EURONORMS are transformed into European Standards, they can either be implemented or reference made to the corresponding national standards, the list of which is given in Annex D to this European Standard.

EURONORM 56 (1977) [2] [3]	Hot-rolled equal angles (with radiused root and toes)
EURONORM 57 (1978) [2] [3]	Hot-rolled unequal angles (with radiused root and toes)
EURONORM 58 (1978) [2]	Hot-rolled flats for general purposes
EURONORM 59 (1978) [2]	Hot-rolled square bars for general purposes
EURONORM 60 (1977) [2]	Hot-rolled round bars for general purposes
EURONORM 91 (1981) [2]	Hot-rolled wide flats -- Tolerances on dimensions, shape and mass

2.3 *Standards on testing*

EN 10002-1	Metallic materials -- Tensile testing -- Part 1: method of test (at ambient temperature)
EN 10045-1	Metallic materials -- Charpy impact test -- Part 1: Test method
EURONORM 18 (1979) [2]	Selection and preparation of samples and test pieces for steel and iron and steel products
EURONORM 103 (1971) [2]	Microscopic determination of the ferritic and austenitic grain size of steel
ISO 2566/1 (1984)	Steel -- Conversion of elongation values -- Part 1: Carbon and low alloy steels

3 Definitions

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

3.1 Alloy special steel as defined in EN 10020,

3.2 Heat treatment terms as defined in prEN 10052,

3.3 Long products and flat products (plate, sheet, narrow strip, wide strip and wide flats) as defined in EN 10079.

3.4 **Normalizing rolling**: a rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing.
The abbreviated form of this delivery condition is N.

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2) Until these EURONORMS are transformed into European Standards, they can either be implemented or reference made to the corresponding national standards, the list of which is given in Annex D to this European Standard.

3) EURONORM 56 and 57 are added because they contain the nominal dimensions.

NOTE: In international publications for both the normalizing rolling, as well as the thermomechanical rolling, the expression "controlled rolling" may be found. However in view of the different applicability of the products a distinction of the terms is necessary.

3.5 **Steel with improved atmospheric corrosion resistance:** a steel in which a certain number of alloying elements, such as P, Cu, Cr, Ni, Mo, ... have been added in order to increase its resistance to atmospheric corrosion, by forming an auto-protective oxide layer on the base metal under the influence of weather conditions.

NOTE 1: Steel with improved atmospheric corrosion resistance is often called weathering steel.
NOTE 2: Additional information for the use of steel with improved atmospheric corrosion resistance is given in Annex B.

4 Information to be supplied by the purchaser

4.1 *General*

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) details of the product form and relevant quantities;

b) reference to this European Standard;

c) nominal dimensions and tolerances (see 5.1);

d) the grade and quality of steel (see tables 3, 5 and 6);

e) whether products have to be submitted to inspection and testing and if inspection and testing is required which type of inspection and which inspection document is required (see 8.1.2);

Where no specific choice is made by the purchaser concerning points a, b, c and d the supplier shall refer back to the purchaser.

4.2 *Options*

A number of options are specified in clause 11. In the event that the purchaser does not indicate his wish to implement any of these options, the supplier shall supply in accordance with the basic specification.

5 Dimensions, mass and tolerances

5.1 *Dimensions and tolerances*

Dimensions and tolerances shall be in accordance with the relevant European Standards and EURONORMS (see 2.2).

5.2 *Mass of steel*

The calculated mass shall be determined using a volumetric mass of 7,85 kg/dm^3.

6 Classification of grades and qualities; designation

6.1 *Classification of grades and qualities*

This European Standard specifies the steel grades S235 and S355 (see table 5, which differ in their mechanical properties.

These steel grades may be supplied in qualities J0, J2, and K2. Products of grade S355 with quality J2 and K2 are subdivided into two qualities J2G1, J2G2, K2G1 and K2G2 (see 7.2). The qualities differ in weldability and specified impact values (see also 7.5.1).

Grade S355 is subdivided into the classes W and WP, which differ mainly in their carbon and phosphorus contents (see table 3) and availability (see table 2).

6.2 *Designation*

6.2.1 For the steel grades covered by this European Standard the steel names are allocated in accordance with EN 10027-1 and ECISS IC 10; the steel numbers are allocated in accordance with EN 10027-2.

NOTE: For a list of corresponding former designations and the former designations from EURONORM 155 (1980) see Annex E, table E.1.

6.2.2 The designation shall consist of:

- the number of this European Standard (EN 10155);
- the symbol S;
- the indication of the minimum specified yield strength for thickness ≤ 16 mm expressed in N/mm^2;
- the quality designation (see 6.1) in respect to the weldability and specified impact values;
- the letter W indicating that the steel has an improved atmospheric corrosion resistance;
- the letter P for the class with a greater phosphorus content (only in the case of grade S355);
- if applicable, the indication "+N" when the products shall be delivered in the condition N (see 3.4 and table 1).

EXAMPLE: Steel EN 10155-S355J0W

7 Technical requirements

7.1 *Steel manufacturing process*

7.1.1 The steel manufacturing process shall be at the manufacturer's option. If specified at the time of the enquiry and order the steel manufacturing process shall be reported to the purchaser.
Option 2.

7.1.2 The method of deoxidation shall be as given in table 3.

7.1.3 The deoxidation methods are indicated as follows:

FN Rimming steel not permitted
FF Fully killed steel containing nitrogen binding elements in amounts sufficient to bind the available nitrogen (for example min. 0,020 % Al). If other elements are used they shall be reported in the inspection document.

7.2 *Delivery conditions*

7.2.1 General

If an inspection document is required (see 8.1.2) and products are ordered and delivered in the condition N this shall be indicated in the document.

7.2.2 Flat products

7.2.2.1 Unless otherwise agreed flat products of qualities J0 shall be supplied in a delivery condition at the manufacturers discretion (see 7.4.1).
Option 10.

7.2.2.2 Flat products of qualities J2, J2G1 and K2G1 shall be supplied normalized or in an equivalent condition obtained by normalizing rolling as defined in 3.4.

7.2.2.3 Flat products of qualities J2G2 and K2G2 shall be supplied in a delivery condition at the manufacturers discretion.

7.2.3 Long products

7.2.3.1 Unless otherwise agreed long products of the qualities J0, J2, J2G1 and K2G1 shall be supplied in a delivery condition at the manufacturers discretion.
Option 14.

7.2.3.2 Long products of qualities J2G2 and K2G2 shall be supplied in a delivery condition at the manufacturers discretion.

7.2.4 The delivery conditions are summarized in table 1.

Table 1: Delivery conditions.

Grades and qualities	Delivery condition	
	Flat products	Long products
S235J0W	Optional [1]	Optional [1]
S235J2W	N	Optional [1]
S355J0WP	Optional [1]	Optional [1]
S355J2WP	N	Optional [1]
S355J0W	Optional [1]	Optional [1]
S355J2G1W	N	Optional [1]
S355J2G2W	Discretion manufacturer [2]	Discretion manufacturer [2]
S355K2G1W	N	Optional [1]
S355K2G2W	Discretion manufacturer [2]	Discretion manufacturer [2]

1) Unless otherwise agreed at the time of the enquiry and order delivery condition at the manufacturers discretion.
2) Delivery condition at the manufacturers discretion.

7.3 *Chemical composition*

7.3.1 The chemical composition determined by ladle analysis shall comply with the values of table 3.

7.3.2 The permissible deviations of the product analysis from the specified limits of the ladle analysis are specified in table 4. The product analysis shall be carried out only when specified at the time of the enquiry and order.
Option 3.

7.3.3 For the grade S355 a carbon equivalent value of max. 0,52 % and for grade S235 a carbon equivalent value of max. 0,44 % for all thicknesses can be agreed at the time of the enquiry and order to be determined on the ladle analysis using the following formula:

$$CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

When a maximum carbon equivalent value has been agreed the content of the elements in the carbon equivalent value formula shall be reported in the inspection document.
Option 4.

7.4 *Mechanical properties*

7.4.1 General

7.4.1.1 Under the inspection and testing conditions as specified in clause 8 and in the delivery condition as specified in 7.2 the mechanical properties shall comply with the relevant requirements of tables 5, 6 and 7.

7.4.1.2 For products ordered and supplied in the normalized or normalized rolled condition the mechanical properties shall comply with tables 5, 6 and 7 in the delivered condition as well as after normalizing by heat treatment after delivery.

NOTE: Stress relief annealing at more than 580 °C or for over 1 hour may lead to a deterioration of the mechanical properties. If the purchaser intends to stress relief anneal the products at higher temperatures or for longer times the minimum values of the mechanical properties after such a treatment should be agreed at the time of the enquiry and order.

7.4.1.3 For flat products the nominal thickness applies. For long products of irregular section the nominal thickness of that part from which the samples are taken applies (see Annex A).

7.4.1.4 For flat products of quality J2, J2G1 and K2G1 supplied as-rolled for normalizing by the purchaser the samples shall be normalized. The values from the normalized samples shall comply with this European Standard.

NOTE: The results of these tests do not represent the properties of the supplied products but indicate the properties which may be achieved after correct normalizing.

7.4.2 Tensile test

The values of the tensile test shall be verified for shapes, sections, bars, hot-rolled strip and wide flats of widths < 600 mm by means of longitudinal test pieces; for sheet and plate, wide strip and wide flats of width ≥ 600 mm transverse test pieces shall be used.

7.4.3 Impact test

7.4.3.1 If the nominal product thickness is not sufficient for the preparation of full size impact test pieces, test pieces of smaller width shall be taken (see 8.6.3.3) and the applicable values shall be taken from figure 1.
Impact tests are not required for nominal thickness < 6 mm.

7.4.3.2 For products of quality J2, J2G1, J2G2, K2G1 and K2G2 with nominal thickness < 6 mm the ferritic grain size shall be ≥ 6, verified

by the method as described in EURONORM 103, if specified at the time of enquiry and order.
Option 5.

7.4.3.3 When aluminium is used as the grain refining element, the grain size requirement shall be deemed to be fulfilled if on ladle analysis the aluminium content is not less than 0,020 % total aluminium or alternatively, 0,015 % acid soluble aluminium. In this case verification of the grain size is not required.

7.4.3.4 The impact properties of steel grade S355 class WP products are verified by test only when specified at the time of the enquiry and order.
Option 6.

7.5 *Technological properties*

7.5.1 Weldability

7.5.1.1 The steels specified in this European Standard do not have unlimited suitability for the various welding processes, since the behaviour of a steel during and after welding depends not only on the material but also on the dimensions and shape and on the manufacturing and service conditions of the components.

7.5.1.2 The weldability increases for each grade from quality J0 to K2.

7.5.1.3 In Annex C more information on weldability may be found.

7.5.2 Hot forming

Only products ordered and supplied in the normalized or normalized rolled condition shall comply with the requirements of tables 5, 6 and 7 if hot forming is carried out after delivery (see 7.4.1).

7.5.3 Flangeability

If specified at the time of the enquiry and order, plate, sheet, strip and wide flats with a nominal thickness $\leq$ 20 mm shall be suitable for flanging without cracking with the minimum bend radii given in table 7. The grades and qualities to which this applies are given in table 7.
Option 11.

7.6 *Surface finish*

7.6.1 Strip

The surface condition should not impair an application appropriate to the steel grade if adequate processing of the strip is applied.

7.6.2 Plates, wide flats and sections

EN 10163 part 1 - 3 applies for the permissible surface discontinuities and for the repair of surface defects by grinding and/or welding.

8 Inspection and testing

8.1 *General*

8.1.1 The products can be supplied with inspection and testing with respect to their compliance with the requirements of this European Standard.

8.1.2 If inspection and testing is required the purchaser shall specify at the time of enquiry and order:
- the type of inspection and testing (specific or non-specific) (see EN 10021);
- the type of the inspection document (see 8.10).

See 4.1 e and option 7.

8.1.3 Specific inspection and testing shall be carried out according to the requirements of 8.2 to 8.9.

8.1.4 Unless otherwise agreed at the time of the enquiry and order inspection of surface condition and dimensions shall be carried out by the manufacturer.
Option 8.

8.2 *Specific inspection and testing*

8.2.1 If an inspection document for specific inspection and testing is required the following shall be carried out:
- for all products the tensile test;
- for all products of quality J0, J2, J2G1, J2G2, K2G1 and K2G2 of the steel grade S235 and S355 class W the impact test.

8.2.2 At the time of enquiry and order for all products of steel grade S355 from class WP the impact test (see 7.4.3.4) can be agreed.
Option 6.

8.3 *Sampling*

The verification of the mechanical properties shall be carried out by cast.

8.4 *Test units*

8.4.1 The test unit shall contain products of the same form and grade and of the same thickness range as specified in table 5 for the yield strength and shall be 40 t or part thereof.

8.4.2 If agreed at the time of the enquiry and order for flat products of quality J2, J2G1, J2G2, K2G1 and K2G2 the impact test only or

the impact test and the tensile test shall be carried out on each parent plate or coil.
Option 12.

8.5 *Verification of chemical composition*

8.5.1 For ladle analysis determined for each cast, the values reported by the manufacturer shall apply.

8.5.2 Product analysis shall be carried out if agreed at the time of the enquiry and order. The purchaser shall specify the number of samples and the elements to be determined.
Option 3.

8.6 *Mechanical tests*

8.6.1 Number of samples

The following samples shall be taken from one sample product of each test unit:

- one sample for tensile testing (see 8.2.1),
- one sample sufficient for one set of six impact test pieces for quality J0, J2, J2G1, J2G2, K2G1 and K2G2 of steel grade S235 and S355 class W and if required for steel grade S355 class WP (see 8.2.1 and 8.2.2).

8.6.2 Position of samples (see Annex A)

8.6.2.1 The samples shall be taken from the thickest product in the test unit except for flat products of quality J2, J2G1, J2G2, K2G1 and K2G2, for which the samples are taken from any product of the test unit.

8.6.2.2 For plates, sheet, wide strip and wide flats the samples shall be taken so that the axes of the test pieces are approximately midway between the edge and centre line of the products.

For wide strip the sample shall be taken at an adequate distance from the end of the coil.

For narrow strip (< 600 mm wide) the sample shall be at an adequate distance from the end and at one third of the width.

8.6.2.3 For long products EURONORM 18 applies (see Annex A).

8.6.3 Selection and preparation of test pieces

8.6.3.1 General

The requirements of EURONORM 18 shall apply (see Annex A).

8.6.3.2 Tensile test pieces

The requirements of EN 10002-1 as appropriate shall apply.

Test pieces may be non-proportional but in cases of dispute proportional test pieces having a gauge length $L_o = 5.65\sqrt{S_o}$ shall be used (see 8.7.2.1).

For flat products with a nominal thickness < 3 mm the test pieces shall always have a gauge length L_o = 80 mm and a width of 20 mm (test piece 2 EN 10002-1).

For bars, round test pieces are commonly used but other forms are not prohibited (see EN 10002-1).

8.6.3.3 Impact test pieces

Impact V-notch test pieces shall be cut parallel to the principal direction of rolling. The test pieces shall be machined and prepared in accordance with EN 10045-1. In addition the following requirements apply:

a) for nominal thicknesses > 12 mm, standard 10 mm x 10 mm test pieces shall be machined in such a way that one side is not further away than 2 mm from a rolled surface;
b) for nominal thicknesses ≤ 12 mm, when test pieces with reduced widths are used, the minimum width shall be ≥ 5 mm.

8.6.3.4 Chemical analysis samples

The preparation of samples for product analysis shall be in accordance with EURONORM 18.

8.7 *Test methods*

8.7.1 Chemical analysis

For the determination of the chemical composition the corresponding European Standards and EURONORMS (see footnote 2 of clause 2) shall apply in cases of dispute.

8.7.2 Mechanical tests

Mechanical tests shall be carried out in the temperature range between 10° C and 35° C, except where a specific temperature is specified for impact tests.

8.7.2.1 Tensile tests

The tensile test shall be carried out in accordance with EN 10002-1.

For the specified yield strength in table 5 the upper yield strength (R_{eH}) shall be determined.
If a yield phenomenon is not present, the 0,2 % proof strength ($R_{p0,2}$) or the $R_{t0,5}$ shall be determined; in cases of dispute the 0.2 % proof strength ($R_{p0,2}$) shall be determined.

If a non-proportional test piece is used for products with a thickness ≥ 3 mm the percentage elongation value obtained shall be converted to the

value for a gauge length $L_o = 5.65\sqrt{S_o}$ using the conversion tables given in ISO 2566/1.

8.7.2.2 Impact tests

The impact test shall be carried out in accordance with EN 10045-1.

The average value of the three test results shall meet the specified requirement. One individual value may be below the minimum average value specified, provided that it is not less than 70 % of that value.
Three additional test pieces shall be taken from the same sample in accordance with 8.6.1 and tested in any one of the following cases:

- if the average of three impact values is lower than the minimum average value specified;
- if the average value meets the specified requirement, but two individual values are lower than the minimum average value specified;
- if any one value is lower than 70 % of the minimum average value specified.

The average value of the six tests shall be not less than the minimum average value specified. Not more than two of the individual values may be lower than the minimum average value specified and not more than one may be lower than 70 % of this value.

8.8 *Retests and resubmission for testing*

EN 10021 shall apply in respect of all retests and resubmission for testing.

In the case of strip retests on a rejected coil shall be carried out after the cutting of an additional longitudinal section of sufficient length to remove the coil end effect with a maximum of 20 m.

8.9 *Internal defects*

EN 10021 shall apply for testing for internal defects.

8.10 *Inspection documents*

If agreed and specified at the time of the enquiry and order one of the documents specified in EN 10204 shall be supplied. In these documents the information groups A, B and Z and the code numbers C01-C03, C10-C13, C40-C43 and C71-C92 according to EURONORM 168 shall be included.
See 4.1 e and option 7.

9 Marking for flat and long products

9.1 Unless otherwise agreed at the time of the enquiry and order, products shall be marked by painting, stamping, durable adhesive labels or attached tags with the following:

- the grade, indicated by its abridged designation (e.g. S235J0W);
- a number by which the cast can be identified;
- the manufacturers name or trademark.

Option 9.

9.2 Marking shall be at a position close to one end of each product or on the end cut face at the manufacturers discretion.

9.3 It is permissible for light products to be supplied in securely tied bundles. In this case the marking shall be on a label attached to the bundle or on the top product of the bundle.

10 Complaints after delivery

EN 10021 shall apply in respect of complaints after delivery and their processing.

11 Options (see 4.2)

11.1 *All products*

1) Whether greater thicknesses are required (see 1.1).

2) Whether the steel manufacturing process should be indicated (see 7.1.1).

3) Whether product analysis should be carried out and if so the number of samples and the elements to be determined (see 7.3.2 and 8.5.2).

4) Whether for grade S355 a carbon equivalent value of max. 0,52 % and for grade S235 a carbon equivalent value of max. 0,44 % is required (see 7.3.3).

5) For products of quality J2, J2G1, J2G2, K2G1 and K2G2 with nominal thickness < 6 mm whether the grain size should be verified (see 7.4.3.2).

6) Whether the impact properties of products of steel grade S355 class WP should be verified by test (see 7.4.3.4, 8.2.2 and table 6).

7) Whether products should be submitted to inspection and testing and if inspection and testing is required which type and which inspection document is required (see 4.1 e and 8.1.2).

8) Whether the purchaser wishes to carry out inspection of dimensions and surface condition at the manufacturers works (see 8.1.4).

9) Whether specific marking is required (see 9.1).

11.2 *Flat products*

10) Whether the delivery condition N is required for quality J0 (see 7.2.2.1).

11) Whether sheet, plate, strip and wide flats with a nominal thickness ≤ 20 mm are suitable for flanging without cracking (see 7.5.3).

12) For flat products of quality J2, J2G1, J2G2, K2G1 and K2G2 each parent plate or coil: whether the impact test only or the impact test and the tensile test shall be carried out (see 8.4.2).

13) For flat products of nominal thickness > 30 mm a round test piece may be used for the tensile test (see figure A.3).

11.3 *Long products*

14) Whether for the qualities J0, J2, J2G1 and K2G1 the delivery condition N is required (see 7.2.3.1).

Table 2: Product forms for the different steel grades depending on their thickness

Designation		Flat products		Long products	
		Nominal thickness		Sections Shapes	Bars
		mm		Nominal thickness or diameter mm	
According EN 10027-1 and ECISS IC 10	According EN 10027-2	≤ 12	≤ 100	≤ 40	≤ 100
S235J0W	1.8958		x	x	x
S235J2W	1.8961		x	x	x
S355J0WP	1.8945	x		x	
S355J2WP	1.8946	x		x	
S355J0W	1.8959		x	x	x
S355J2G1W	1.8963		x	x	x
S355J2G2W	1.8965		x	x	x
S355K2G1W	1.8966		x	x	x
S355K2G2W	1.8967		x	x	x

Table 3: Chemical composition of the ladle analysis

Designation		Method of deoxi-dation	C % max.	Si % max.	Mn %	P %	S % max.	N % max.	Addition of nitrogen binding elements [1]	Cr %	Cu %	Others
According EN 10027-1 and ECISS IC 10	According EN 10027-2											
S235J0W	1.8958	FN	0,13	0,40	0,20 - 0,60	max. 0,040	0,040	0,009 [2][5]	-	0,40 - 0,80	0,25 - 0,55	[3]
S235J2W	1.8961	FF					0,035	-	yes			
S355J0WP	1.8945	FN	0,12	0,75	max. 1,0	0,06 - 0,15	0,040	0,009 [5]	-	0,30 - 1,25	0,25 - 0,55	[3]
S355J2WP	1.8946	FF					0,035	-	yes			
S355J0W	1.8959	FN	0,16	0,50	0,50 - 1,50	max. 0,040	0,040	0,009 [2][5]	-	0,40 - 0,80	0,25 - 0,55	[3][4]
S355J2G1W	1.8963	FF				max. 0,035	0,035	-	yes			
S355J2G2W	1.8965	FF				max. 0,035	0,035	-	yes			
S355K2G1W	1.8966	FF				max. 0,035	0,035	-	yes			
S355K2G2W	1.8967	FF				max. 0,035	0,035	-	yes			

1) The steels shall contain at least one of the following elements: Al total ≥ 0,020 %, Nb: 0,015 - 0,060 %, V: 0,02 - 0,12 %, Ti: 0,02 - 0,10 %. If these elements are used in combination, at least one of them shall be present with the minimum content indicated.

2) It is permissible to exceed the specified values provided that for each increase of 0,001 % N the P max. content will be reduced by 0,005 %; the N content of the ladle analysis, however, shall not be more than 0,012 %.

3) The steels may show a Ni content of max. 0,65 %.

4) The steels may contain max. 0,30 % Mo and max. 0,15 % Zr.

5) The max. value for nitrogen does not apply if the chemical composition shows a minimum total Al content of 0,020 % or if sufficient other N binding elements are present. The N binding elements shall be mentioned in the inspection document.

Table 4: Permissible deviations of the product analysis from the specified limits of the ladle analysis in accordance with table 3

Element	Permissible maximum content in the ladle analysis %	Permissible deviation of the product analysis from specified limits for the ladle analysis [1] %
C	≤ 0,16	+ 0,03
Si	≤ 0,75	+ 0,05
Mn	≤ 0,60 > 0,60	± 0,05 ± 0,10
P	≤ 0,040 > 0,040	+ 0,005 ± 0,01
S	≤ 0,040	+ 0,005
N	≤ 0,012	+ 0,001
Cr	≤ 0,80 > 0,80	± 0,05 ± 0,10
Cu	≤ 0,55	± 0,05
Ni	≤ 0,65	+ 0,05
Mo	≤ 0,30	+ 0,05
Zr	≤ 0,15	+ 0,02
Nb	≤ 0,060	± 0,005
V	≤ 0,15	+ 0,02 - 0,01
Ti	≤ 0,10	+ 0,02 - 0,01

1) ± means that in one cast the deviation may occur over the upper value or under the lower value of the specified range in table 3 but not both at the same time.

Table 5: Mechanical properties for flat and long products [1]

Designation		Minimum yield strength R_{eH} [1] N/mm²					Tensile strength R_m [1] N/mm²		Position of test pieces [1]	Minimum percentage elongation at fracture [1] %					
		Nominal thickness mm					Nominal thickness mm			L_o = 80 mm Nominal thickness mm			$L_o = 5{,}65\sqrt{S_o}$ Nominal thickness mm		
According EN 10027-1 and ECISS IC 10	According EN 10027-2	≤ 16	> 16 ≤ 40	> 40 ≤ 63	> 63 ≤ 80	> 80 ≤ 100	< 3	≥ 3 ≤ 100		> 1,5 ≤ 2	> 2 ≤ 2,5	> 2,5 < 3	≥ 3 ≤ 40	> 40 ≤ 63	> 63 ≤ 100
S235J0W	1.8958	235	225	215	215	215	360 - 510	340 - 470	l	19	20	21	26	25	24
S235J2W	1.8961								t	17	18	19	24	23	22
S355J0WP	1.8945	355	345 [2]	-	-	-	510 - 680	490 - 630	l	16	17	18	22	-	-
S355J2WP	1.8946								t	14	15	16	20	-	-
S355J0W	1.8959	355	345	335	325	315	510 - 680	490 - 630	l	16	17	18	22	21	20
S355J2G1W	1.8963														
S355J2G2W	1.8965														
S355K2G1W	1.8966														
S355K2G2W	1.8967								t	14	15	16	20	19	18

1) The values in the table apply to longitudinal test pieces (l) for the tensile test. For plate, strip and wide flats with widths ≥ 600 mm transverse test pieces (t) are applicable.
2) This value applies only in respect to shapes, sections and bars (see table 2).

Table 6: Mechanical properties -- impact strength KV longitudinal for flat and long products [1]

Designation		Temperature	Minimum energy [1]
According EN 10027-1 and ECISS IC 10	According EN 10027-2	°C	J
S235J0W	1.8958	0	27
S235J2W	1.8961	- 20	27
S355J0WP [2]	1.8945	0	27
S355J2WP [2]	1.8946	- 20	27
S355J0W	1.8959	0	27
S355J2G1W	1.8963	- 20	27
S355J2G2W	1.8965	- 20	27
S355K2G1W	1.8966	- 20	40
S355K2G2W	1.8967	- 20	40

1) For substandard test pieces figure 1 applies.
2) The impact values shall be verified if agreed at the time of the enquiry and order. Option 6.

Table 7: Minimum value of the bend radius for cold flanging of flat products

Designation		Bending direction [1]	Minimum recommended inside bend radius for nominal thicknesses mm												
According EN 10027-1 and ECISS IC 10	According EN 10027-2		> 1,5 ≤ 2,5	> 2,5 ≤ 3	> 3 ≤ 4	> 4 ≤ 5	> 5 ≤ 6	> 6 ≤ 7	> 7 ≤ 8	> 8 ≤ 10	> 10 ≤ 12	> 12 ≤ 14	> 14 ≤ 16	> 16 ≤ 18	> 18 ≤ 20
S235J0W	1.8958	t	2,5	3	5	6	8	10	12	16	20	25	28	36	40
S235J2W	1.8961	l	2,5	3	6	8	10	12	16	20	25	28	32	40	45
S355J0W	1.8959	t	4	5	6	8	10	12	16	20	25	32	36	45	50
S355J2G1W	1.8963														
S355J2G2W	1.8965														
S355K2G1W	1.8966														
S355K2G2W	1.8967	l	4	5	8	10	12	16	20	25	32	36	40	50	63

1) t: transverse to the rolling direction.
l: parallel to the rolling direction.

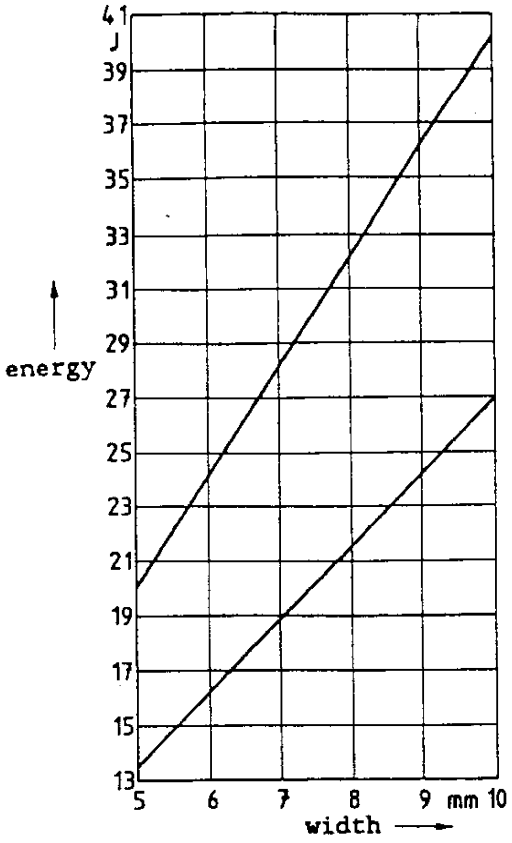
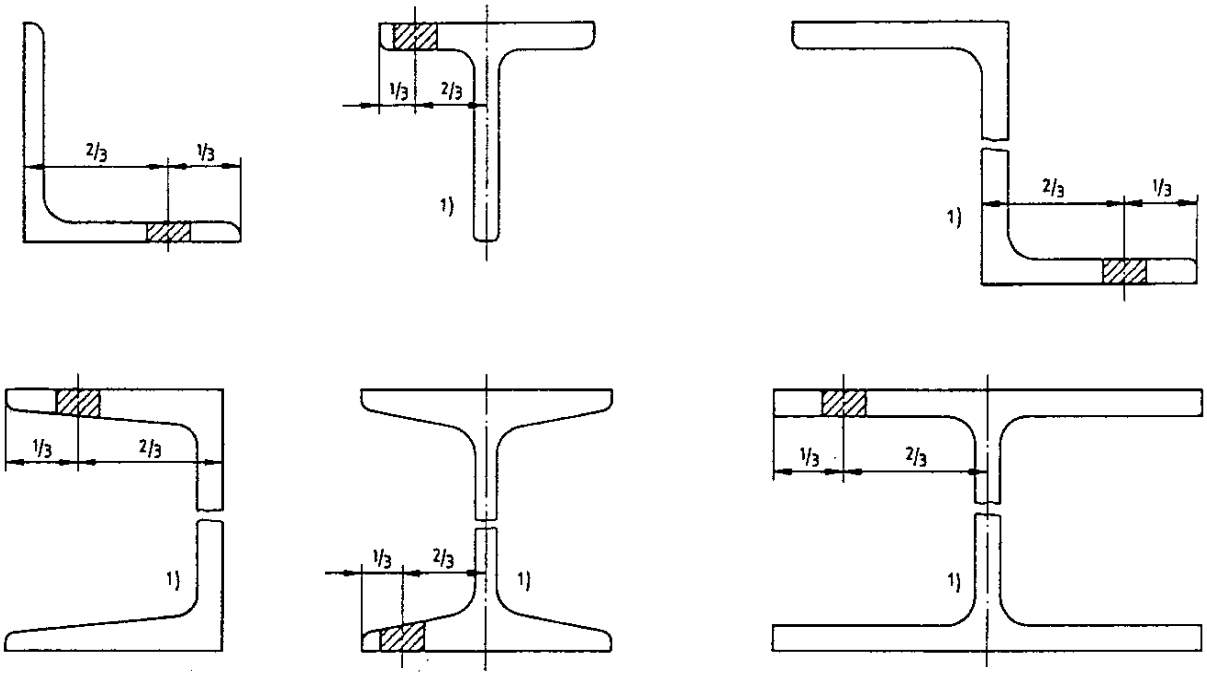


Figure 1: Minimum impact energy values (J) for impact test pieces with a width between 5 mm and 10 mm.

Annex A
(Normative)

Location of samples and test pieces (see EURONORM 18)

The following three categories of products are covered:
-- beams, channels, angles, T sections and Z sections (figure A.1);
-- bars (figure A.2);
-- flat products (figure A.3).

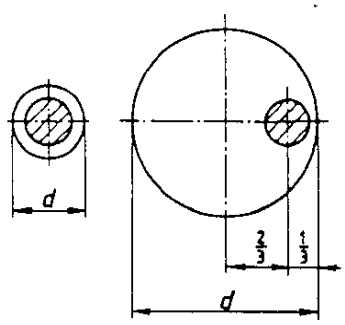
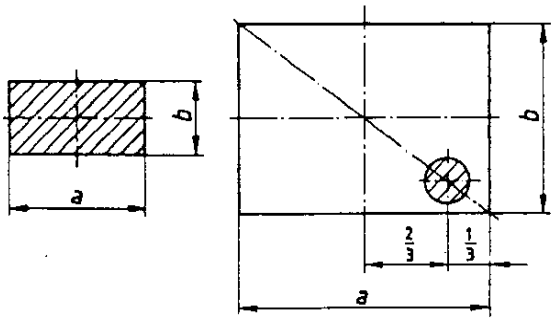
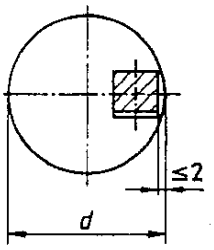
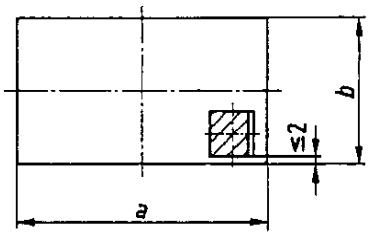


location of samples [2)]

1) By agreement, the sample can be taken from the web, at a quarter of the total height.
2) Test pieces are taken from the sample as indicated in figure A.3. For sections with inclined flanges, machining of the inclined surface is permitted in order to make it parallel to the other surface.

Figure A.1 -- Beams, channels, angles, T sections and Z sections

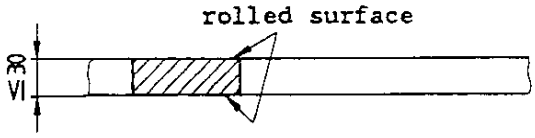
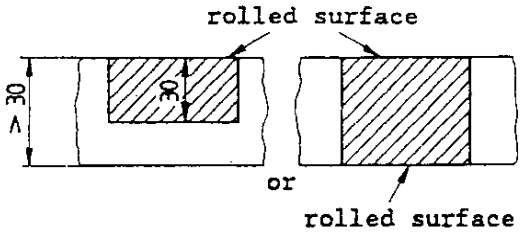
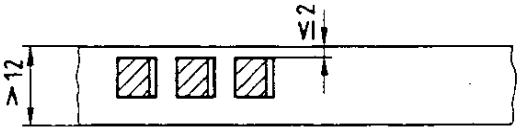
Dimensions in mm

Type of steel	Type of test	Products with round cross-section	Products with rectangular cross-section
Structural steels	Tensile	$d \leq 25$ [1] $d > 25$ [2] 	$b \leq 25$ [1] $b > 25$ [2] 
	Impact [3]	$d \geq 16$ 	$b \geq 12$ 

1) For products with small dimensions (d or $b \leq 25$ mm) the test piece, if possible, consists of an unmachined full section of the product.
2) For products of diameter or thickness ≤ 40 mm the manufacturer may either apply:
   - the rules specified for products of diameter or thickness ≤ 25 mm, or
   - take the test piece at a location nearer the centre than indicated in the figure.
3) For products of round cross-section, the axis of the notch is approximately a diameter; for products with rectangular cross-section, the axis of the notch is perpendicular to the greatest rolled surface.

Figure A.2: Bars

Dimensions in mm

Type of test	Thickness of product	Orientation of the test pieces for widths of		Distance of the test piece from the rolled surface
		< 600	≥ 600	
Tensile [1]	≤ 30	longitudinal	transverse	
	> 30			
Impact [2]	> 12	longitudinal	longitudinal	

1) In case of doubt or dispute. for products of thickness greater than or equal to 3 mm use proportional test pieces of gauge length $L_o = 5.65 \sqrt{S_o}$. For normal testing, for reasons of economy, test pieces of a constant measuring length may be used provided the result obtained for elongation after breaking is converted by a recognized formula (see, for example, ISO 2566 - Conversion of elongation values).
For products of thickness greater than 30 mm a round test piece may be used if agreed between the parties.
Option 13.
2) The axis of the notch shall be perpendicular to the surface of the product.

Figure A.3: Flat products

Annex B
(informative)

Additional information for the use of steel with improved atmospheric corrosion resistance

The corrosion inhibiting effect of the auto-protective oxide layer relates to the nature of its constituents and to the particular distribution and concentration of alloying elements in it. The resistance to atmospheric corrosion resistance depends on weather condition having a succession of dry and wet periods for the forming of the auto-protective oxide layer of the base metal. The protection afforded depends on the environmental and other conditions prevailing at the site of the structure.

Provisions should be made in the design and the fabrication of the structure for the auto-protective oxide layer on the surface to form and regenerate itself unimpeded. It is the responsibility of the designer to include corrosion of unprotected steels in his calculation and, as far as is necessary, to compensate for this by increasing the thickness of the product.

A conventional surface protection is recommended when the content of particular chemical substances in the air is significant and absolutely necessary where the structure is in contact with water for long periods, is permanently exposed to moisture, or is to be used in a marine atmosphere. Before painting the products should be descaled. Under comparable conditions, the susceptibility to corrosion of steel with improved atmospheric corrosion resistance under painting is less than that for conventional structural steels.

The surfaces of structures which are not exposed to the elements but may be subject to the build-up of condensation, should be appropriately ventilated. Otherwise a suitable surface protection is necessary. The extent to which these factors depend on the prevailing climatic conditions in the widest sense and on the details of the structure do not permit any generally valid statements on the corrosion process. The user should therefore consult the manufacturer of the steel regarding the suitability of the products for each individual application.

Annex C
(informative)

Notes on fabrication

C.1 Weldability

If filler metal without improved atmospheric corrosion resistance is used ensure that the weld itself is weather resistant.

Before welding, any surface layer which has already been formed should be removed to a distance of 10 mm to 20 mm from the joint edges.

Special precautions should be taken when welding steel grades S355J0WP and S355J2WP with a high phosphorus content.

With increasing product thickness, increasing strength level and increasing carbon equivalent value the occurrence of cold cracking in the welded zone forms the main risk. Cold cracking is caused by the following factors in combination:

- the amount of diffusible hydrogen in the weld metal;
- a brittle structure of the heat affected zone;
- significant tensile strength concentrations in the welded joint.

When using recommendations as laid down, for example in ECSC IC 2 [1]) or any relevant national standard, the recommended welding conditions and the various welding ranges of the steel grades can be determined depending on the product thickness, the applied welding energy, the design requirements, the electrode efficiency, the welding process and the weld metal properties.

C.2 Riveting and bolting

In case of assembling by riveting and bolting, precautions should be taken with regard to the choice of rivets and bolts to be used for assemblies in order to prevent the start of the corrosion process.

1) Will be transformed into EN 1011 "Recommendations for arc welding of ferritic steels".

Annex D
(informative)

List of national standards which correspond to EURONORMS referenced

Until the following EURONORMS are transformed into European Standards, they may be either implemented or reference made to the corresponding national standards as listed in table D.1.

Table D.1: EURONORMS with corresponding national standards

EURONORM	Corresponding national standard in				
	Germany	France	United Kingdom	Spain	Italy
18	–	NF A 03-111	BS 4360	UNE 36-300 UNE 36-400	UNI-EU 18
19	DIN 1025 T5	NF A 45-205	–	UNE 36-526	UNI 5398
24	DIN 1025 T1 DIN 1026	NF A 45-210	BS 4	UNE 36-521 UNE 36-522	UNI 5679 UNI 5680
48	DIN 1016	NF A 46-100	BS 1449	UNE 36-553	UNI 6685
53	DIN 1025 T2 DIN 1025 T3 DIN 1025 T4	NF A 45-201	BS 4	UNE 36-527 UNE 36-528 UNE 36-529	UNI 5397
54	DIN 1026	NF A 45-007	BS 4	UNE 36-525	UNI-EU 54
55	DIN 1024	NF A 45-008 [1)]	BS 4	UNE 36-533	UNI-EU 55
56	DIN 1028	NF A 45-009 [1)]	BS 4848	UNE 36-531	UNI-EU 56
57	DIN 1029	NF A 45-010 [1)]	BS 4848	UNE 36-532	UNI-EU 57
58	DIN 1017 T1	NF A 45-005 [1)]	BS 4360	UNE 36-543	UNI-EU 58
59	DIN 1014 T1	NF A 45-004 [1)]	BS 4360	UNE 36-542	UNI-EU 59
60	DIN 1013 T1	NF A 45-003 [1)]	BS 4360	UNE 36-541	UNI-EU 60
91	DIN 59200	NF A 46-012	BS 4360	–	UNI-EU 91
103	DIN 50601	NF A 04-102	BS 4490	UNE 7-280	–
168	–	NF A 03-116	BS 4360	UNE 36-800	UNI-EU 168
ECCS IC 2	SEW 088	NF A 36-000	BS 5135	–	–

[1)] NF A 45 001 and NF A 45 101 shall be added for the tolerances.

(continued)

Table D.1 (concluded): EURONORMS with corresponding national standards

EURONORM	Corresponding national standard in				
	Belgium	Portugal	Sweden	Austria	Norway
18	NBN A 03-001	NP-2451	SS 11 01 20 SS 11 01 05	–	NS 10 005 NS 10 006
19	NBN 533	NP-2116	SS 21 27 40	M 3262	–
24	NBN 632-01	–	SS 21 27 25 SS 21 27 35	M 3261	NS 911
48	–	–	–	DIN 1016	–
53	NBN 633	NP-2117	SS 21 27 50 SS 21 27 51 SS 21 27 52	–	NS 1907 NS 1908
54	NBN A 24-204	NP-338	–	M 3260	–
55	NBN A 24-205	NP-337	SS 21 27 20	–	NS 1905
56	NBN A 24-201	NP-335	SS 21 27 11	M 3246	NS 1903
57	NBN A 24-202	NP-336	SS 21 27 12	M 3247	NS 1904
58	NBN A 34-201	–	SS 21 21 50	M 3230	NS 1902
59	NBN A 34-202	NP-333 + 334	SS 21 27 25	M 3226	NS 1901
60	NBN A 34-203	NP-331	SS 21 25 02	M 3221	NS 1900
91	NBN A 43-301	–	SS 21 21 50	M 3231	–
103	NBN A 14-101	NP-1787	–	–	–
168	–	–	SS 11 00 12	–	–
ECCS IC 2	–	–	SS 06 40 25	–	–

Annex E
(informative)

List of corresponding former designations

Table E.1: List of corresponding former designations

According EN 10027-1 and ECISS-IC 10	According EN 10027-2	Equivalent former designation			
		According EU 155-80	France	United Kingdom	Germany
S235J0W	**1.8958**	Fe 360 C Kl	E 24 W 3	–	–
S235J2W	**1.8961**	Fe 360 D Kl	E 24 W 4	–	WTSt 37-3
S355J0WP	**1.8945**	Fe 510 C 1 Kl	E 36 WA 3	WR 50 A	–
S355J2WP	**1.8946**	Fe 510 D 1 Kl	E 36 WA 4	–	–
S355J0W	**1.8959**	Fe 510 C 2 Kl	E 36 WB 3	WR 50 B	–
S355J2G1W	**1.8963**	Fe 510 D 2 Kl	E 36 WB 4	WR 50 C	WTSt 52-3
S355J2G2W	**1.8965**	–	–	–	–
S355K2G1W	**1.8966**	–	–	–	–
S355K2G2W	**1.8967**	–	–	–	–