

Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions

The European Standard EN 10164:1993 has the status of a
British Standard

UDC 669.14.018.29:620.1

Cooperating organizations

The European Committee for Standardization (CEN), under whose supervision this European Standard was prepared, comprises the national standards organizations of the following countries:

Austria	Oesterreichisches Normungsinstitut
Belgium	Institut belge de normalisation
Denmark	Dansk Standardiseringsraad
Finland	Suomen Standardisoimisliito, r.y.
France	Association française de normalisation
Germany	Deutsches Institut für Normung e.V.
Greece	Hellenic Organization for Standardization
Iceland	Technological Institute of Iceland
Ireland	National Standards Authority of Ireland
Italy	Ente Nazionale Italiano di Unificazione
Luxembourg	Inspection du Travail et des Mines
Netherlands	Nederlands Normalisatie-instituut
Norway	Norges Standardiseringsforbund
Portugal	Instituto Português da Qualidade
Spain	Asociación Española de Normalización y Certificación
Sweden	Standardiseringskommissionen i Sverige
Switzerland	Association suisse de normalisation
United Kingdom	British Standards Institution

This British Standard, having been prepared under the direction of the Iron and Steel Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 August 1993

© BSI 02-1999

The following BSI references relate to the work on this standard:
Committee reference ISM/12
Draft for comment 91/35824 DC

ISBN 0 580 21371 4

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Cooperating organizations	Inside front cover
National foreword	ii
Foreword	2
Text of EN 10164	3
National annex NA (informative) Committees responsible	Inside back cover
National annex NB (informative) Cross-references	Inside back cover

National foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Policy Committee and is the English language version of EN 10164:1993 *Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions*, published by the European Committee for Standardization (CEN).

It supersedes BS 6780:1986 which is withdrawn.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, page i and ii, the EN title page, pages 2 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

UDC 669.14.018.29:620.1

Descriptors: Metal products

English version

Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions

Aciers de construction avec caractéristiques de
déformation améliorées dans le sens
perpendiculaire à la surface du produit —
Conditions techniques de livraison

Stahlerzeugnisse mit verbesserten
Verformungseigenschaften senkrecht zur
Erzeugnisoberfläche — Technische
Lieferbedingungen

This European Standard was approved by CEN on 1993-06-20. 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

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 164 (1983) Steel flat products with specified through thickness properties — Technical conditions of delivery

The paragraphs concerning flat products of this document were originally drawn up as Euronorm 164 under the European Coal and Steel Community. With the formation of ECISS and the establishment of the ECISS work programme TC 10 was asked to prepare this document for eventual publication as a European 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 in that meeting: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Sweden, and United Kingdom.

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.

This standard was approved and in accordance with the CEN/CENELEC Internal Regulations, the 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

Contents

	Page
Foreword	2
Introduction	3
1 Scope	3
2 Normative references	3
3 Information to be supplied by the purchaser	3
3.1 General	3
3.2 Options	3
4 Designation	3
5 Requirements	4
5.1 Reduction of area	4
5.2 Ultrasonic testing	4
6 Testing	4
6.1 Test units	4
6.2 Selection of samples and number of test pieces	4
6.3 Selection and preparation of test pieces	5
6.4 Test method and testing procedure	7
6.5 Retesting	7
6.6 Invalidation of tests	7
7 Complaints after delivery	7
8 Marking	7
9 Options	7
Annex A (informative) List of national standards or specifications which correspond with EURONORMS referenced	8
Figure 1 — Position of sample for sections	5
Figure 2 — Type and preparation of test pieces with two extension pieces for product thickness t , $15 \text{ mm} \leq t \leq 100 \text{ mm}$	6
Figure 3 — Type and preparation test pieces without extension pieces for product thickness t , $20 \text{ mm} < t \leq 100 \text{ mm}$	6
Figure 4 — Type and preparation of test pieces without extension piece for product thickness t , $100 \text{ mm} < t \leq 250 \text{ mm}$	7
Table 1 — Quality classes and minimum values for the reduction of area	4
Table 2 — Test units for sheet, plate and coil	4
Table A.1 — EURONORMS with corresponding national standards or specifications	8

Introduction

Steel plates, strip, wide flats and sections as normally manufactured have deformation properties perpendicular to the surface (through thickness) which are different from those obtained in the surface direction. This anisotropy of the properties may lead to difficulties in welded structures, for instance lamellar tearing.

It is, however, possible to improve the through thickness properties by using additional steelmaking procedures.

Through thickness properties are characterized in this standard by specified values for reduction of area in a through thickness tensile test.

There is no direct relationship between these values and the integrity of structures, because the risk of lamellar tearing is also basically influenced by the type of structure, weld design and welding procedure. The minimum values for reduction of area in this standard cannot therefore by themselves be regarded as ensuring safety against occurrence of lamellar tearing.

However the reduction of area is a good general guide to lamellar tear resistance i.e. the risk of lamellar tearing decreases with increased reduction of area in the through thickness tensile test.

1 Scope

This European Standard specifies through thickness properties and associated test methods for steel plates, strip, wide flats and sections.

This European Standard may be applied as a supplement to all product standards for plate, strip, wide flats and sections of killed steels, except stainless steels. It covers products having a thickness between 15 mm and 250 mm inclusive of steels with a specified minimum upper yield strength R_{eH} or proof strength $R_{p0.2} \leq 500 \text{ N/mm}^2$ for which improved through thickness properties are required.

The application of this European Standard to other product thicknesses and other steel types shall be the subject of agreement at the time of the enquiry and order.

Option 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.

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test (at ambient temperature)*.

EN 10021, *General technical delivery requirements for steel and iron products*.

EURONORM 160 (1985), *Ultrasonic testing of steel plate of thickness $\geq 6 \text{ mm}$ (reflection method)*¹⁾.

EURONORM 186 (1987), *Ultrasonic testing of broad flanged beams with parallel flanges and IPE beams*¹⁾.

3 Information to be supplied by the purchaser

3.1 General

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

- a) the designation of the steel (according to the relevant product standard);
- b) the designation of the quality class (see Table 1).

Where no specific choice is made by the purchaser the supplier shall refer back to the purchaser.

3.2 Options

A number of options is specified in clause 8. 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.

4 Designation

Products with requirements for improved deformation properties perpendicular to the surface of the product shall be designated as follows:

- the designation of the steel (according to the relevant product standard);
- the number of this European Standard (EN 10164);
- the designation of the quality class (according to Table 1).

¹⁾ 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 A to this European Standard.

Example: steel according to EN 10113-2 of the grade S355N with requirements for improved deformation properties perpendicular to the surface of the product according to EN 10164 of class Z25,

Steel EN 10113-2 S355N + EN 10164 – Z25.

5 Requirements

5.1 Reduction of area

Table 1 gives minimum values for reduction of area for the specified quality classes.

NOTE Reduction of area (Z) is defined in EN 10002-1:1990 as:

$$\left(\frac{S_o - S_u}{S_o} \right) 100$$

where:

S_o is the original cross-sectional area of the parallel length;

S_u is the minimum cross-sectional area after fracture.

The purchaser shall select one of the quality classes at the time of enquiry and order.

For plates, strip and wide flats the minimum values for reduction of area apply to the whole product.

For sections the minimum values for reduction of area apply to either the flange or the web depending on where the samples are taken (see 6.2.3).

Table 1 — Quality classes and minimum values for the reduction of area

Quality class	Reduction of area in %	
	Minimum average value of three tests	Minimum individual value
Z15	15	10
Z25	25	15
Z35	35	25

5.2 Ultrasonic testing

Flat products shall be submitted to an ultrasonic examination in accordance with the requirements of EURONORM 160-85. Sections shall be submitted to an ultrasonic examination in accordance with the requirements of EURONORM 186-87.

Unless otherwise agreed at the time of the enquiry and order plates and wide flats shall meet the requirements of class A in accordance with EURONORM 160-85, sections shall meet the requirements of class 22 in accordance with EURONORM 186-87 Table 2.

Option 2.

NOTE Application of the normal ultrasonic techniques does not give information about susceptibility to lamellar tearing.

6 Testing

6.1 Test units

Each consignment shall be subdivided into test units in accordance with 6.1.1 to 6.1.3.

6.1.1 Sheet, plate and coil

The test units for sheet, plate and coil of the quality classes Z15, Z25 and Z35 based on the sulfur content of the ladle analysis are given in Table 2.

Table 2 — Test units for sheet, plate and coil

Quality class	Test unit for $S > 0,005 \%^a$		Test unit for $S \leq 0,005 \%^a$
	Parent plate or coil ^b	Max. 40 t ^c	Cast ^d
Z15	if agreed	× ^e	×
Z25	×	—	× ^e
Z35	×	—	× ^e

^a Ladle analysis.

^b Coil applies to wide strip, narrow strip and slit strip.

^c Or part thereof of products of the same cast with the same heat treatment.

^d Products with the same heat treatment.

^e Unless otherwise agreed at the time of enquiry and order. Option 3.

6.1.2 Wide flats

The test unit for wide flats shall consist of products from the same cast having been subjected to the same heat treatment with a total mass of max. 10 t for products of nominal thickness ≤ 25 mm and max. 20 t for products of nominal thickness > 25 mm.

6.1.3 Sections

The test unit for sections shall consist of products from the same cast having been subjected to the same heat treatment with a total mass of max. 40 t or part thereof.

6.2 Selection of samples and number of test pieces

6.2.1 For each test unit according to 6.1 one sample sufficient to enable six test pieces to be machined shall be taken.

6.2.2 For flat products according to 6.1.1 and 6.1.2 the sample shall be taken from one end of the product. These samples shall be taken for ingot cast material on the longitudinal axis of the product and for continuously cast material they may be taken at the manufacturer's discretion either on the longitudinal axis of the product or from approximately midway between the edge and the longitudinal axis of the products.

6.2.3 For sections the sample shall be taken from one end of the product. The sampling position shall be the flange unless otherwise agreed at the time of the enquiry and order. The location of the sample is indicated in Figure 1.

Option 4.

6.2.4 Only three tensile test pieces shall be machined from the sample, the remaining pieces being kept in reserve in the event that supplementary testing is required (see **6.4.2.1** to **6.4.2.3**).

6.3 Selection and preparation of test pieces

6.3.1 From the sample obtained in accordance with **6.2**, three full thickness specimens shall be taken. The cross-section of each specimen shall be sufficient to permit the removal of any resultant heat affected or work hardened zone during machining of the final test pieces. The balance of the sample shall be kept in reserve in the event that additional tests are required.

6.3.2 From the specimens obtained in accordance with **6.3.1** test pieces with or without extension pieces shall be prepared in accordance with the procedures given in **6.3.2.1** and **6.3.2.2**, as appropriate.

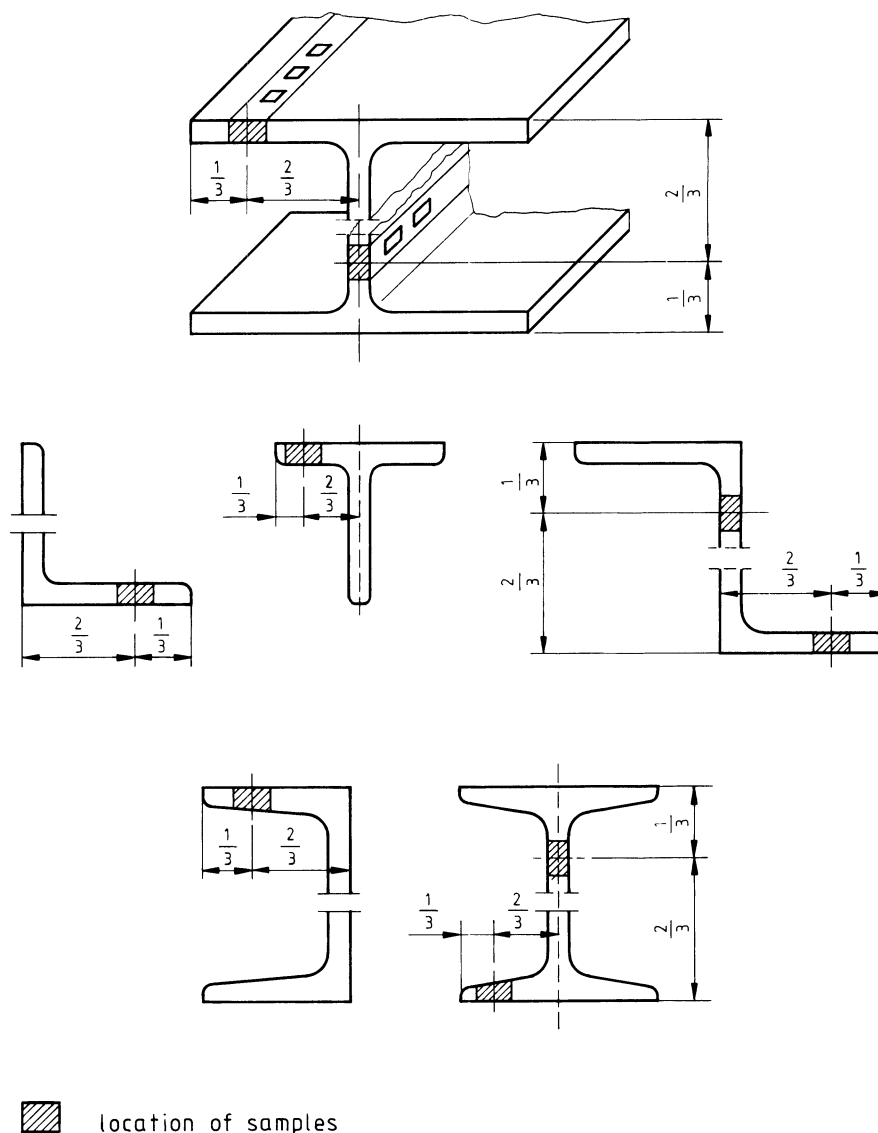


Figure 1 — Position of sample for sections

Extension pieces are:

- mandatory for $15 \text{ mm} \leq t \leq 20 \text{ mm}$, where t is the product thickness;
- optional for $20 \text{ mm} < t \leq 100 \text{ mm}$, where t is the product thickness;
- not acceptable for $t < 100 \text{ mm}$, where t is the product thickness.

The axis of the test pieces shall be perpendicular to the surface.

6.3.2.1 Test piece with extension pieces (see Figure 2)

Prior to any welding taking place all rust, scale and grease shall be removed from the contact surfaces of the specimen.

- a) Extension pieces are welded to both surfaces of the specimen using friction welding, or another suitable method, in such a way as to ensure a minimum heat affected zone.

For specimens from sections with non-parallel surfaces, one surface shall be machined parallel to the other. In the case of I beams with tapered flanges the inside surface shall always be machined.

- b) The test piece shall have the following diameter, d_0 :

$d_0 = 6 \text{ mm}$ or 10 mm for $15 \text{ mm} \leq t \leq 25 \text{ mm}$, where t is the product thickness;

$d_0 = 10 \text{ mm}$ for $25 \text{ mm} < t \leq 100 \text{ mm}$, where t is the product thickness.

- c) The parallel length, L_c , of the test piece shall be at least $1,5 d_0$ and shall not exceed 100 mm . The heat affected zone shall be outside L_c .

6.3.2.2 Test pieces without extension pieces (see Figure 3 and Figure 4)

- a) The test piece shall have the following diameter, d_0 :

$d_0 = 6 \text{ mm}$ for $20 \text{ mm} < t \leq 40 \text{ mm}$, where t is the product thickness;

$d_0 = 10 \text{ mm}$ for $40 \text{ mm} < t \leq 250 \text{ mm}$, where t is the product thickness.

- b) The parallel length, L_c , of the test piece shall be at least $1,5 d_0$ and shall not exceed 100 mm .

- c) For products $\leq 100 \text{ mm}$ the total length, L_t , of the test piece shall be equal to the full product thickness, t .

- d) For products $> 100 \text{ mm}$ and $\leq 250 \text{ mm}$ the total length, L_t , of the test piece shall be such that L_c contains the $1/4$ thickness position of the product.

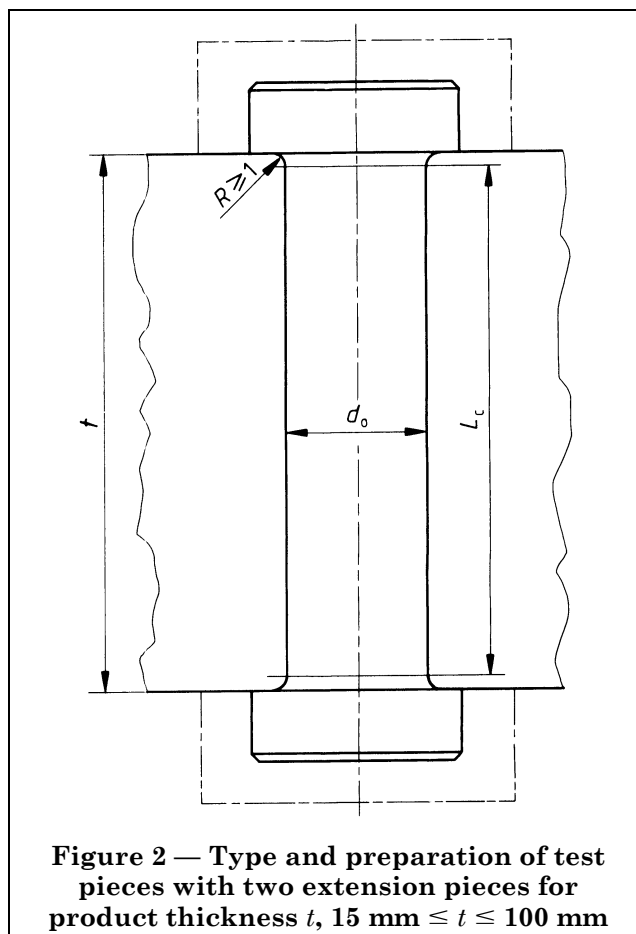


Figure 2 — Type and preparation of test pieces with two extension pieces for product thickness t , $15 \text{ mm} \leq t \leq 100 \text{ mm}$

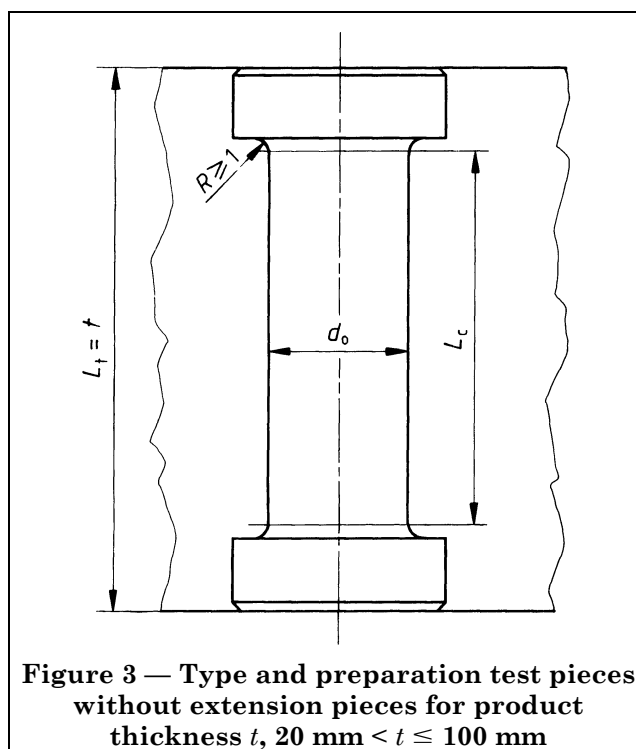
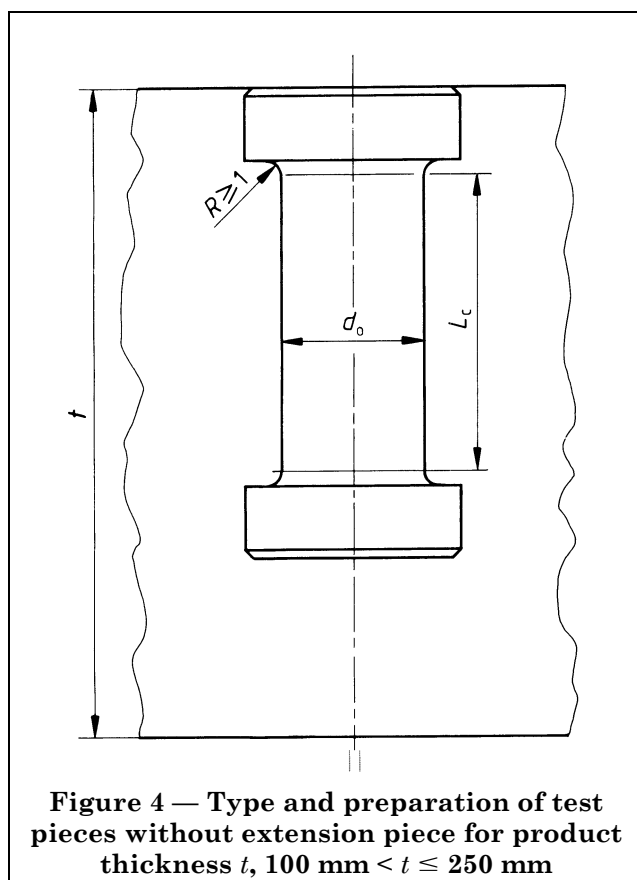


Figure 3 — Type and preparation test pieces without extension pieces for product thickness t , $20 \text{ mm} < t \leq 100 \text{ mm}$



6.4 Test method and testing procedure

6.4.1 The tensile test shall be carried out in accordance with EN 10002-1 and the reduction of area shall be determined in accordance with EN 10002-1. The assessment of results is based on a sequential method (as defined in EN 10021). The results from three test pieces according to **6.2.4** shall comply with the values specified in Table 1 for the ordered quality class.

6.4.2.1 The average value of a set of three test pieces shall meet the specified requirement. One individual value may be below the specified minimum value for the average of three test pieces, provided that it is not less than the specified minimum individual value.

6.4.2.2 If the conditions under **6.4.2.1** are not satisfied then an additional set of three test pieces shall be taken from the same sample and tested. To consider the test unit as conforming, after testing the second set, the following conditions shall be satisfied simultaneously:

- i) the average value of six tests shall be equal to or greater than the specified minimum average value;

- ii) not more than two of six individual values may be lower than the specified minimum average value;

- iii) not more than one of six individual values may be lower than the specified minimum individual value.

6.4.2.3 If these conditions are not satisfied, the sample product is rejected and retests are carried out on the remainder of the test unit, if applicable (see **6.5**).

6.5 Retesting

Except in cases where the test unit is the parent plate or the coil (**6.1.1**) a new set of three tests shall be carried out on each of two different products from the remainder of the test unit, those two series of tests shall meet the requirements. In this case **6.4.2.2** and **6.4.2.3** no longer apply.

If one of these retests does not meet the requirements of this European Standard, the remainder of the test unit shall be retested product by product.

Each product on which the tests do not meet the requirements shall be rejected.

6.6 Invalidation of tests

The requirements of EN 10021 shall apply with the addition that a fracture in the weld or in the heat affected zone is also a reason for invalidation.

7 Complaints after delivery

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

8 Marking

The product shall be marked according to the relevant product standard or specification with the addition of the quality class (see **5.1**).

Example: S355N + Z15

9 Options

- 1) Whether other product thicknesses and steel types are applicable (see clause 1).
- 2) Whether ultrasonic tested plates and wide flats shall meet the requirements other than class A in accordance with EURONORM 160-85 and sections shall meet the requirements other than class 22 in accordance with EURONORM 186-87 Table 2 (see **5.2**).
- 3) Whether different test units shall be agreed for the flat products indicated in Table 2 by footnote 5 (see Table 2, footnote 5).
- 4) Whether the sampling position shall be from another position than the flange (see **6.2.3**).

Annex A (informative)
List of national standards or specifications which correspond with
EURONORMS referenced

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

Table A.1 — EURONORMS with corresponding national standards or specifications

EURONORM	Corresponding national standard in				
	Germany	France	United Kingdom	Spain	Italy
160	SEL 072-77	NF A 04-305	BS 5996	—	UNI-EU 160
186	—	NF A 04-306	—	—	—

National annex NA (informative)
Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the Iron and Steel Standards Policy Committee (ISM/-) to Technical Committee ISM/12 upon which the following bodies were represented:

BEAMA Ltd.
British Constructional Steelwork Association Ltd.
British Railways Board
British Steel Industry
Department of Transport
Institution of Structural Engineers
Lloyd's Register of Shipping
National Association of Steel Stockholders
Railway Industry Association of Great Britain
Society of Motor Manufacturers and Traders Ltd.
Steel Construction Institute
Welding Institute

National annex NB (informative)
Cross-references

The British Standards corresponding to the European Standards referred to in the text are identical in number and title with those given in clause 2.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI.

This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

If permission is granted, the terms may include royalty payments or a licensing agreement. Details and advice can be obtained from the Copyright Manager. Tel: 020 8996 7070.