INTERNATIONAL STANDARD

ISO 4951-1

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High yield strength steel bars and sections —

Part 1: General delivery requirements

Barres et profilés en acier à haute limite d'élasticité —

Partie 1: Conditions générales de livraison

Reference number
ISO 4951-1:2001(E)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 4951 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4951-1 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 3, *Steels for structural purposes*.

This first edition of ISO 4951-1, together with ISO 4951-2 and ISO 4951-3, cancels and replaces ISO 4951:1979, the content of which has been revised and augmented.

ISO 4951 consists of the following parts, under the general title *High yield strength steel bars and sections*:

— *Part 1: General delivery requirements*

— *Part 2: Delivery conditions for normalized, normalized rolled and as-rolled steels*

— *Part 3: Delivery conditions for thermomechanically-rolled steels*

Annex A of this part of ISO 4951 is for information only.

High yield strength steel bars and sections —

Part 1:
General delivery requirements

1 Scope

This part of ISO 4951 specifies the requirements for the general delivery conditions of hot-rolled bars and sections, in high yield strength steels for use in bolted, riveted or welded structures[1)].

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 4951. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 4951 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 148:1983, *Steel — Charpy impact test (V-notch).*

ISO 377:1997, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing.*

ISO 404:1992, *Steel and steel products — General technical delivery requirements.*

ISO 2566-1:1984, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels.*

ISO 4951-2:2001, *High yield strength steel bars and sections — Part 2: Delivery conditions for normalized, normalized rolled and as-rolled steels.*

ISO 4951-3:2001, *High yield strength steel bars and sections — Part 3: Delivery conditions for thermo-mechanically-rolled steels.*

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature.*

ISO 6929:1987, *Steel products — Definition and classification.*

ISO 10474:1991, *Steel and steel products — Inspection documents.*

ISO 14284:1996, *Steel and iron — Sampling and preparation af samples for the determination of chemical composition*.

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis.*

1) Compared with mild steels, these steels may require special precautions for welding. See the guide *Welding and weldability of C-Mn micro-alloy steels*, published by subcommission IX-G of the International Institute of Welding (document IIS/IIW 843-84).

3 Terms and definitions

For the purposes of this part of ISO 4951, the definitions of the terms "bars" and "sections", given in ISO 6929:1987 and the following terms and definitions apply.

3.1
as-rolled steel
steel without any special rolling and/or heat treatment condition

3.2
normalized steel
steel obtained by a normalizing treatment, i.e. heat treatment consisting of austenitizing followed by air cooling

3.3
normalized rolled steel
steel obtained by normalizing rolling

3.4
normalizing rolling
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

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
thermomechanical rolling
rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition with certain properties which cannot be achieved or repeated by heat treatment alone

NOTE 1 Subsequent heating above 580 °C may lower the strength values. If temperatures above 580 °C are needed reference should be made to the supplier.

NOTE 2 Thermomechanical rolling leading to the delivery condition "thermomechanically rolled" can include processes with an increasing cooling rate with or without tempering, including self-tempering but excluding direct quenching or quenching and tempering

3.6
thermomechanically rolled steel
steel obtained by thermomechanical rolling

4 General requirements

4.1 Steelmaking method

Unless otherwise agreed at the time of enquiry and order, the steelmaking method is left to the discretion of the manufacturer.

4.2 Deoxidation process

The steels shall be made to a fine-grain practice.

4.3 Delivery condition

4.3.1 Normalized steel

The delivery condition for normalized steel for bars and sections as defined in clause 3 is given in ISO 4951-2.

4.3.2 Thermomechanically rolled steel

The delivery condition for thermomechanically rolled steel for bars and sections as defined in clause 3 is given in ISO 4951-3.

4.4 Surface condition

4.4.1 Surface appearance

The products shall have a smooth surface consistent with the rolling process used; they shall not show any defects which may prejudice processing or their appropriate application.

4.4.2 Removal of discontinuities

Surface discontinuities may be removed by the manufacturer, before despatch, by means of grinding, provided that the depression does not extend below the rolled surface by more than:

— 0,8 mm for material of thickness $<$ 10 mm;

— 1,6 mm for material of thickness 10 mm to 50 mm;

— 3 mm for material of thickness $>$ 50 mm.

4.4.3 Repairs by welding

Unless otherwise specified, discontinuities that are greater in depth than limits specified in 4.4.2 may be removed and weld metal deposited subject to the following conditions.

a) The reduction of thickness of the material resulting from the removal of discontinuities prior to welding shall not exceed 20 % of the nominal thickness at the location of the discontinuity.

b) All welding shall be performed by competent welders using welding electrodes appropriate for the grade being repaired and shall follow welding procedures approved by the purchaser.

c) For materials supplied in the normalized condition, it shall be specifically agreed with the purchaser whether repair welding is to be carried out prior to the heat treatment.

If agreed at the time of the order, the sites of repair welds shall be carefully recorded and pointed out to the purchaser.

5 Technical requirements

5.1 Chemical composition

5.1.1 Ladle analysis

The chemical composition determined by ladle analysis shall comply with the values given in Table 1 of ISO 4951-2:2001 or ISO 4951-3:2001.

5.1.2 Product analysis

If requested by the purchaser at the time of enquiry and order, a product analysis shall be carried out.

Table 1 gives the permissible deviations of the product analysis from the specified limits of the ladle analysis given in Table 1 of ISO 4951-2:2001 or ISO 4951-3:2001.

Table 1 — Permissible deviations for the product analysis in relation to the specified ladle analysis

Element	Specified limits %	Permissible deviation [a]
C	$\leqslant$ 0,20	+ 0,02
Mn	$\leqslant$ 1,7	± 0,10
Si	$\leqslant$ 0,60	+ 0,05
P and S	$\leqslant$ 0,035	+ 0,005
Nb	$\leqslant$ 0,050	± 0,010
V	$\leqslant$ 0,20	± 0,02
Ti	$\leqslant$ 0,05	+ 0,01
Cr	$\leqslant$ 0,30	+ 0,05
Ni	$\leqslant$ 0,80	+ 0,05
Mo	$\leqslant$ 0,20	+ 0,03
Cu	$\leqslant$ 0,35	+ 0,04
	$>$ 0,35 $\leqslant$ 0,70	+ 0,07
N	$\leqslant$ 0,025	+ 0,002
Al_{tot}	$\geqslant$ 0,020	− 0,005

[a] The deviations apply either above or below the specified limits of the range, but not simultaneously. When maxima only are specified, the deviations are positive only.

5.2 Mechanical properties

The steels in the delivery conditions as defined in 4.3, shall comply with the mechanical properties specified in Table 2 of ISO 4951-2:2001 for normalized, normalized rolled and as-rolled steels or of ISO 4951-3:2001 for thermomechanically rolled steels, when these are determined on test pieces prepared in accordance with the requirements of 6.3.

NOTE In the case of angles and beams, the thickness of the product means the thickness of the flange measured on the cross-section where the test pieces are taken for the mechanical test (see Figure A.1).

6 Inspection and testing

6.1 General

The products covered by this part of ISO 4951 are subject to specific inspection and testing in accordance with the conditions specified in clause 8 of ISO 404:1992 relating to the chemical composition and mechanical properties of the product. Verification of the chemical composition of the product is only carried out by agreement at the time of enquiry and order.

6.2 Test unit

6.2.1 General

The verification of mechanical properties shall be per cast (heat).

6.2.2 Tensile tests

A test unit shall contain products of the same form, grade and delivery condition and be from the same thickness range in accordance with Table 2 in ISO 4951-2:2001 and ISO 4951-3:2001 for the specified yield strength.

For a test unit not exceeding 50 t, one tensile test shall be carried out.

For a test unit exceeding 50 t, two tensile tests shall be carried out.

6.2.3 Impact tests

A test unit shall contain products of the same form, grade and delivery condition.

For a test unit not exceeding 50 t, one impact test shall be carried out.

For a test unit exceeding 50 t, two impact tests shall be carried out.

For product thicknesses between 6 mm and 40mm, one set of tests from the thickest product shall be carried out using subsurface specimens.

For product thicknesses exceeding 40 mm, one set of tests from the thickest product shall be carried out using specimens taken from the quarter thickness position.

6.3 Position and orientation of test sample

See ISO 377 and annex A.

6.3.1 Sections

The longitudinal axes of the test pieces shall be parallel to the direction of rolling.

Test samples shall be taken so that the axis of the test piece is at 1/3 from the outer edge of the half-flange (for I sections) or in the case of small sections, as near as possible to this position (see Figure A.1).

In the case of tapered flange sections, test pieces may also be taken at the outer quarter position of the web.

6.3.2 Rounds, squares, flats, hexagons and other similar products

The longitudinal axis of test pieces shall be parallel to the direction of rolling.

For small sizes, the test piece shall consist of a length of the product; in other cases, test samples shall be taken so that the axis of the test piece, as far as possible, is located:

— for squares and flat bars: at 1/2 of the half-width (from the outer face) or the half-diagonal;

— for rounds and hexagons: at 1/2 of the half-diagonal or radius.

See Table A.1.

7 Test methods

7.1 Tensile test

See ISO 6892.

Normally the test piece used shall be a proportional prismatic or cylindrical test piece and have an original gauge length, L_o, given by the formula:

$$L_o = 5{,}65\sqrt{S_o}$$

where S_o is the original cross-sectional area of the gauge length.

The prismatic test piece of rectangular cross-section shall have a maximum width on the gauge length portion of 40 mm, its thickness being that of product. If the product thickness exceeds 30 mm, however, it may be reduced to 30 mm by planing or milling on one face only.

A cylindrical test piece may be used for products more than 40 mm thick. It shall have a diameter of 10 mm to 30 mm, the original gauge length being determined by the above formula. The axis of the test piece shall be situated at 1/4 of the thickness of the product.

A non-proportional test piece with fixed original gauge length may be used. In this case, reference shall be made to the conversion table in ISO 2566-1:1984.

In case of dispute, only the results obtained on a proportional test piece shall be taken into consideration.

The yield strength in Table 2 of ISO 4951-2:2001 and of ISO 4951-3:2001 is the upper yield stress, R_{eH}. If the yield phenomenon is not visible, either the 0,2 % proof strength, $R_{p0,2}$, or the 0,5 % total elongation, $R_{t0,5}$, may be used. The specification of the materials is complied with in this respect if either value satisfies the specified value of yield strength.

In cases of dispute, the 0,2 % proof strength ($R_{p0,2}$) shall be determined for yield strength.

7.2 Impact test

7.2.1 The impact test shall normally be carried out on products having a thickness $\geqslant$ 12 mm or a diameter $\geqslant$ 16 mm. The test piece shall be machined so that the face nearest to the rolled surface is not more than 1 mm from it; for products over 40 mm thick the test piece shall be taken such that its axis is situated at 1/4 thickness. The notch shall be perpendicular to the rolled surface.

If agreed at the time of enquiry and order, impact tests may be carried out on products having a thickness < 12 mm. The dimensions of the test pieces shall be in accordance with the requirements of ISO 148, i.e. 10 mm $\times$ 7,5 mm or 10 mm $\times$ 5 mm or be 10 mm $\times$ d where d is the product thickness.

The minimum required energy value for smaller test pieces shall be decreased proportionally to the test piece width.

7.2.2 The test shall be carried out using a V-notch test piece supported at both ends (see ISO 148). The value to be taken into account is the average of the results obtained from three test pieces adjacent to each other from the same product unless there are reasons for a retest (see 7.4).

7.3 Chemical analysis

7.3.1 If a product analysis is specified on the order, one sample shall be taken per cast unless otherwise specified on the order.

The samples may be taken from the test pieces used to check the mechanical properties or from the full thickness of the product at the same place as the test pieces. In case of dispute, only the analysis of material from the full thickness of the product shall be taken into consideration.

For the selection and preparation of samples for chemical analysis, the requirements of ISO 14284 shall be applied.

7.3.2 In case of dispute about analytical methods the chemical composition shall be determined in accordance with a reference method of ISO standards listed in ISO/TR 9769. If no standard exists, the method to be used shall be agreed between the parties concerned.

7.4 Retests

If, during inspection, a test does not give the required result, additional tests in accordance with ISO 404 shall be carried out.

8 Inspection documents

The type of inspection documents required shall be chosen from those defined in ISO 10474 and then specified in the order.

9 Sorting and reprocessing

The requirements of clause 9 of ISO 404 shall apply.

10 Non-destructive tests

If the purchaser requires non-destructive tests to verify the soundness of the products, these tests shall be agreed at the time of enquiry and order. The agreement shall include details of the test methods and interpretation of results.

11 Marking

Unless otherwise agreed at the time of order, products shall bear the following marks:

— the identification symbols for the grade and quality of the steel;

— the brand of the manufacturer;

— where necessary, symbols, letters and numbers which relate the inspection document, test pieces and products to each other.

In the case of products which are consigned in bundles, the above information may be marked on a tag securely attached to each bundle (or it may be marked on the topmost item in the bundle, if appropriate).

12 Information to be supplied by the purchaser

In addition to the information mentioned in ISO 404, the following information shall be also given if applicable:

— the particular steelmaking process required (4.1);

— the delivery condition required (4.3);

— if repair by welding is not permitted (4.4.3);

— if sites of repair welds are required (4.4.3);

— if a product analysis is required (5.1.2) and the number of samples required (7.3.1);

— if impact tests for products less than 12 mm thick are required (7.2.1);

— the type of inspection document required (clause 8);

— if non-destructive tests are required (clause 10);

— other types of marking required (clause 11).

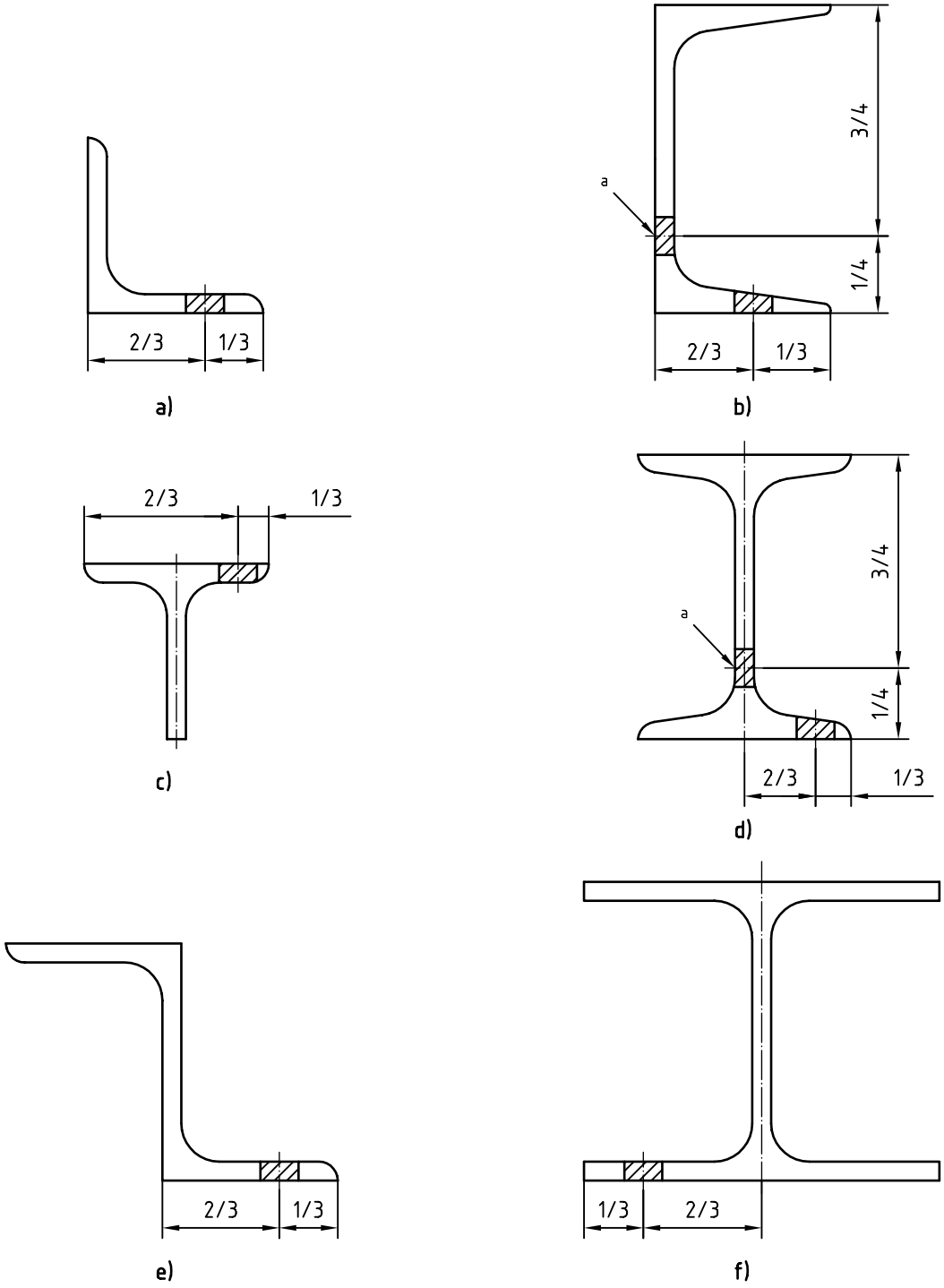
Points not specified shall not be taken into account by the manufacturer.

Annex A
(informative)

Position and orientation of samples

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

See Figure A.1.



NOTE For sections with inclined flanges, the inclined surface may be machined in order to make it parallel to the other surface.

a By agreement, the sample can be taken from the web, at a quarter of the total height.

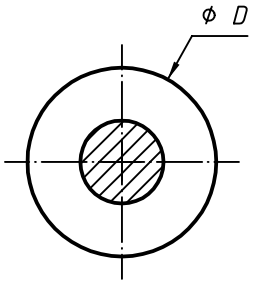
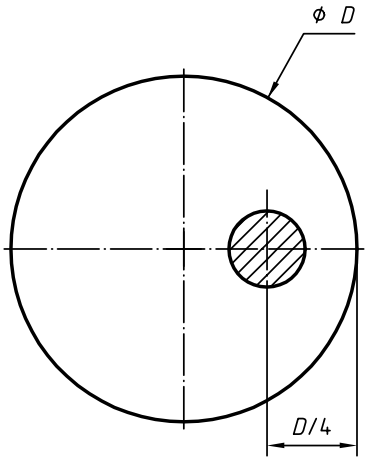
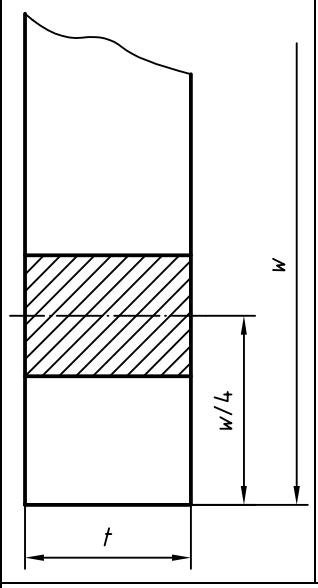
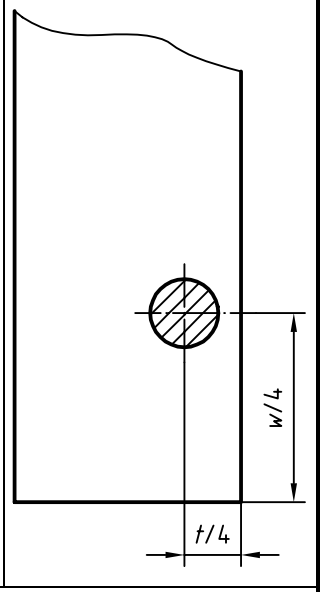
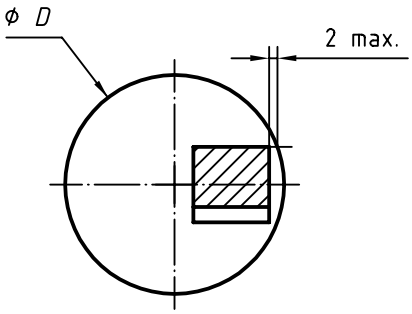
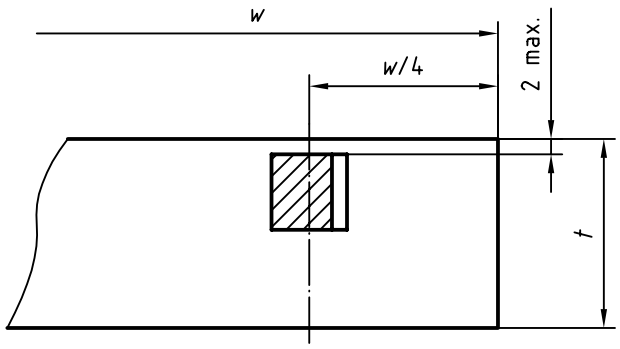
Figure A.1 — Position and orientation of samples for mechanical tests

A.2 Bars

See Table A.1.

Table A.1 — Position and orientation of samples for mechanical tests

Dimensions in millimetres

Type of test	Products with round cross section		Products with rectangular cross-section	
Tensile test	$D \leqslant 25$ [a]	$D > 25$ [b]	$t \leqslant 25$ [a]	$t > 25$ [b]
				
Impact test [c]	$D \geqslant 16$		$t \geqslant 12$	
				

[a] For products with small dimensions (D or $t \leqslant 25$ mm) the test piece, if possible, consists of an unmachined full section of the product.

[b] For products of diameter or thickness $\leqslant 40$ mm the manufacturer may either apply:

— the rules specified for the products of diameter or thickness $\leqslant 25$ mm or

— take the test piece at a location nearer the centre than indicated in the figure.

[c] 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.

ICS 77.140.60; 77.140.70

Price based on 11 pages