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**High yield strength steel plates and wide  
flats for cold forming —**

**Part 1:  
Delivery conditions for  
thermomechanically-rolled steels**

iTeh STANDARD PREVIEW

*Tôles et larges-plats en acier à haute limite d'élasticité pour formage à  
froid —*

*Partie 1: Conditions de livraison des aciers à l'état de laminage  
thermomécanique*

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Printed in Switzerland

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## Foreword

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

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 6930 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6930-1 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 3, *Steels for structural purposes*.

This first edition, together with ISO 6930-2, cancels and replaces ISO 6930:1983, all clauses of which have been modified, especially clauses 1, 5, 6, Tables 1, 2, 3 and annex A, which has been technically revised.

ISO 6930 consists of the following parts, under the general title *High yield strength steel plates and wide flats for cold forming*:

- *Part 1: Delivery conditions for thermomechanically-rolled steels*
- *Part 2: Delivery conditions for normalized, normalized rolled and as-rolled steels*

Annex A of this part of ISO 6930 is for information only.

# High yield strength steel plates and wide flats for cold forming —

## Part 1:

### Delivery conditions for thermomechanically-rolled steels

## 1 Scope

**1.1** This part of ISO 6930 specifies the requirements for weldable high yield strength steels for cold forming.

This part of ISO 6930 applies to plate hot-rolled on reversing mills and to hot-rolled wide-flats both having a thickness between 4 mm and 20 mm inclusive and supplied in the thermomechanically rolled delivery condition.

**1.2** This part of ISO 6930 does not apply to weldable structural steels, whether or not of special quality, which are covered by other International Standards, namely:

- high yield strength steel products for cold forming delivered in normalized, normalized rolled and as-rolled condition (ISO 6930-2);
- structural steels (ISO 630);
- high yield strength flat steel products (ISO 4950-1, ISO 4950-2 and ISO 4950-3);
- hot-rolled steel sheet of higher yield strength with improved formability (ISO 5951).

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6930. 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 6930 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, *Steel — Charpy impact test (V-notch)*.

ISO 377, *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 6892, *Metallic materials — Tensile testing at ambient temperature*.

ISO 7438, *Metallic materials — Bend test*.

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

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

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

### 3 Terms and definitions

For the purposes of this part of ISO 6930, the following terms and definitions apply.

#### 3.1

##### **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, the supplier should be informed.

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 and quenching and tempering.

#### 3.2

##### **thermomechanically rolled steel**

steel obtained by thermomechanical rolling

#### 3.3

##### **wide flat**

finished flat product of width greater than 150 mm and a thickness generally over 4 mm, always supplied in lengths, i.e. not coiled and whose edges are sharp

NOTE The wide flat is hot-rolled on the four sides (or in box passes) or produced by shearing or flame-cutting wider flat products. Wide flats rolled on all four sides are sometimes termed universal plates.

[ISO 6929:1987]

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### 4 General requirements

#### 4.1 Steelmaking process

Unless otherwise specified at the time of the enquiry and the order, the steelmaking process is left to the discretion of the manufacturer; it shall, however, be possible to disclose it to the purchaser, if he so requests, at the time of the delivery.

#### 4.2 Method of deoxidation

The steels shall be fully killed and made to a fine grain practice.

#### 4.3 Production process

Unless otherwise specified at the time of the enquiry and the order, the production process is left to the discretion of the manufacturer.

#### 4.4 Delivery condition

Plates and wide flats are supplied in the thermomechanically rolled supply condition.

Unless specially agreed at the time of enquiry and order, the products are generally supplied with their surface as-rolled. On request, they may be delivered with descaled surfaces. However, the fact that certain descaling processes are liable to modify the cold forming properties shall be taken into account.

Descaled products may be delivered with their surfaces protected, by agreement with the purchaser.

The type of the protection shall be agreed at the time of the enquiry or order.

## 5 Technical requirements

### 5.1 Chemical composition

#### 5.1.1 Ladle analysis

The composition limits for the ladle analysis are given in Table 1.

**Table 1 — Chemical composition of thermomechanically rolled steels (ladle analysis)**

Grades	C % max.	Mn % max.	Si % max.	P % max.	S % max. <sup>a</sup>	Al <sub>total</sub> % min. <sup>b</sup>	Nb % max. <sup>c</sup>	V % max. <sup>c</sup>	Ti % max. <sup>c</sup>	Mo % max.	B % max.
FeE 315	0,12	1,3	0,5	0,025	0,020	0,015	0,09	0,2	0,15	—	—
FeE 355	0,12	1,5	0,5	0,025	0,020	0,015	0,09	0,2	0,15	—	—
FeE 420	0,12	1,6	0,5	0,025	0,015	0,015	0,09	0,2	0,15	—	—
FeE 460	0,12	1,6	0,5	0,025	0,015	0,015	0,09	0,2	0,15	—	—
FeE 500	0,12	1,7	0,5	0,025	0,015	0,015	0,09	0,2	0,15	—	—
FeE 550	0,12	1,8	0,5	0,025	0,015	0,015	0,09	0,2	0,15	—	—
FeE 600	0,12	1,9	0,5	0,025	0,015	0,015	0,09	0,2	0,22	0,50	0,005
FeE 650	0,12	2,0	0,6	0,025	0,015	0,015	0,09	0,2	0,22	0,50	0,005
FeE 700	0,12	2,1	0,6	0,025	0,015	0,015	0,09	0,2	0,22	0,50	0,005

<sup>a</sup> If agreed at the time of the enquiry and order the sulfur content shall be maximum 0,010 % (ladle analysis).

<sup>b</sup> If agreed at the time of enquiry and order the minimum content of total aluminium does not apply when other grain-refining elements are present in sufficient quantity.

<sup>c</sup> The sum of niobium, vanadium and titanium shall be maximum 0,22 %.

#### 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 2 gives the permissible deviations of the product analysis from the specified limits of the ladle analysis given in Table 1.

### 5.2 Mechanical properties

**5.2.1** The mechanical properties given in Table 3 apply to plates and wide flats supplied in the delivery condition given in 4.4 and are determined on test pieces in accordance with clause 6.

The mechanical properties for products having a thickness greater than 20 mm shall be the subject of agreement at the time of enquiry or order.

**5.2.2** If agreed at the time of the enquiry and order, the impact energy value shall be verified at  $-20^{\circ}\text{C}$  and shall meet a minimum average value of 40 J based on a full size (10 mm  $\times$  10 mm) test piece (see 7.2). If the thickness is not sufficient for the preparation of full size impact test pieces, test pieces of smaller width shall be taken and the applicable values shall be decreased proportionally.

Table 2 — Permissible deviations for the product analysis in relation to the specified ladle analysis

Element	Specified limits %	Permissible deviation <sup>a</sup>
C	≤ 0,12	+ 0,02
Mn	≤ 2,1	+ 0,1
Si	≤ 0,6	+ 0,05
P	≤ 0,025	+ 0,005
S	≤ 0,020	+ 0,002
Al <sub>total</sub>	≥ 0,015	− 0,005
Nb	≤ 0,09	+ 0,01
V	≤ 0,20	+ 0,02
Ti	≤ 0,22	+ 0,01
Mo	≤ 0,5	+ 0,05
B	≤ 0,005	+ 0,001

<sup>a</sup> 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.

Table 3 — Mechanical properties for thicknesses up to twenty millimetres

Grade	Minimum yield strength $R_{eH}$ N/mm <sup>2</sup>	Minimum tensile strength $R_m$ N/mm <sup>2</sup>	Minimum percentage elongation at fracture $A$ % $L_o = 5,65\sqrt{S_o}$
FeE 315	315	390	24
FeE 355	355	430	23
FeE 420	420	480	19
FeE 460	460	520	17
FeE 500	500	550	14
FeE 550	550	600	14
FeE 600	600	650	13
FeE 650	650 <sup>a</sup>	700	12
FeE 700	700 <sup>a</sup>	750	12

<sup>a</sup> For thicknesses > 8 mm the minimum yield strength can be 20 N/mm<sup>2</sup> lower.

## 5.3 Technical properties

### 5.3.1 Weldability

The steels are weldable by all appropriate processes provided the rules of the technology are followed.

A maximum value of the carbon equivalent (CEV) based on the ladle analysis can be agreed at the time of enquiry and order. The carbon equivalent value shall be determined using the following formula:

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



### 5.3.2 Bending and cold-edging ability

Information about bending and cold-edging ability is given in annex A.

## 6 Inspection and testing

### 6.1 General

The product covered by this part of ISO 6930 shall be the subject of 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.

### 6.2 Test unit

#### 6.2.1 General

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

#### 6.2.2 Tensile properties

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

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.

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#### 6.2.3 Impact tests

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

For a test unit not exceeding 50 t, one set of impact tests shall be carried out. For a test unit exceeding 50 t, two sets of impact tests shall be carried out.

Tests shall be carried out at  $-20^{\circ}\text{C}$  using sub-surface specimens from the thickest product. (See 5.2.2 for impact energy values.)

### 6.3 Position and orientation of sample

#### 6.3.1 General

Sampling shall be carried out in such a way that the axis of the test piece is approximately equidistant from the centre line and the edge of the rolled product. See ISO 377.

#### 6.3.2 Plate and wide-flat of width at least six hundred millimetres

The axis of the tensile test pieces shall be transverse to the direction of rolling if not otherwise agreed at enquiry.

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