INTERNATIONAL STANDARD

ISO 3573

Third edition
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Hot-rolled carbon steel sheet of commercial and drawing qualities

Tôles en acier au carbone laminées à chaud de qualité commerciale et pour emboutissage

Reference number
ISO 3573:1999(E)

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.

International Standard ISO 3573 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This third edition cancels and replaces the second edition (ISO 3573:1986) which has been technically revised.

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Hot-rolled carbon steel sheet of commercial and drawing qualities

1 Scope

1.1 This International Standard applies to hot-rolled carbon steel sheet of commercial and drawing qualities.

Hot-rolled steel sheet is suitable for many applications where the presence of oxide or scale, or normal surface imperfections disclosed after removal of oxide or scale, are not objectionable. It is not suitable for applications where surface is of prime importance.

NOTE 1 Hot-rolled sheet up to but not including 3 mm in thickness is commonly known as 'sheet'. Hot-rolled sheet 3 mm and over in thickness is commonly known as either 'sheet' or 'plate'.

NOTE 2 Steel sheet that is to be subjected to subsequent rerolling is not covered by this International Standard.

1.2 Commercial quality sheet (HR1) is intended for general fabricating purposes where sheet is used in the flat or for bending, moderate forming and welding operations. It is commonly produced in the range of thickness 0,8 mm to 12,5 mm inclusive, and in widths of 600 mm and over, in coils and cut lengths.

1.3 Drawing quality sheet (HR2, HR3, HR4) is intended for drawing or severe forming, including welding. It is commonly produced in the range of thickness 0,8 mm to 12,5 mm inclusive, and in widths of 600 mm and over, in coils and cut lengths. Drawing quality sheet shall be furnished to all the requirements of this International Standard, or, by agreement when ordered, to fabricate an identified part, in which case the mechanical properties in Table 2 do not apply. Drawing qualities are identified as follows:

— HR2 – drawing quality

— HR3 – deep drawing quality

— HR4 – deep drawing quality aluminum killed

1.4 Hot-rolled sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, this publication do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document 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 6892:1998, *Metallic materials — Tensile testing at ambient temperature.*

3 Terms and definitions

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

3.1
hot-rolled steel sheet
product obtained by rolling heated steel through a continuous-type strip mill to the required sheet thickness and tolerances, the product having a surface covered with oxide or scale resulting from the hot-rolling operation

3.2
hot-rolled descaled steel sheet
hot-rolled steel sheet from which oxide or scale has been removed, commonly by pickling in an acid solution or by mechanical means such as grit blasting

NOTE Some change in properties may result from descaling.

3.3
skin pass:
light cold-rolling of hot-rolled steel sheet or hot-rolled descaled steel sheet

3.4
edges
Material is normally supplied as described in 3.4.1 and 3.4.2. Other edges may be supplied as agreed upon.

3.4.1
mill edge
normal side edge without any definite contour produced in hot-rolling possibly containing some irregularities such as cracked or torn edges or thin (feathered) edges

3.4.2
sheared edge
normal edge obtained by shearing, slitting, or trimming a mill edge product

NOTE Normal processing does not necessarily provide a definite positioning of the slitting burr.

3.5
aluminum killed
steel which has been deoxidized with aluminum sufficient to prevent the evolution of gas during solidification

4 Other Information

4.1 Descaling

Some increase in hardness and some loss of ductility may result from descaling, if mechanical means such as grit blasting is used.

The purchaser should state whether descaling is required.

4.2 Surface condition

Oxide or scale on hot-rolled steel sheet is subject to variations in thickness, adherence and colour. Removal of the oxide or scale by pickling or blast cleaning may disclose surface imperfections not readily visible prior to this operation. Also, after drawing, imperfections may be visible which were not apparent in the flat sheet.

4.3 Skin pass

The purpose of skin passing is one or more of the following:

a) to temporarily minimize the appearance of coil breaks, stretcher strains (Lüder's lines) or fluting during fabrication of finished parts;

b) to obtain the required surface finish suitable for ordinary decorative painting;

c) to control the shape.

Some increase in hardness and some loss of ductility will result from skin passing.

The purchaser should state whether skin passing is required.

4.4 Oiling

As a deterrent to rusting, a coating of oil is usually applied to hot-rolled descaled steel sheet, but sheet may be furnished not oiled if required. The oil is not intended as a drawing or forming lubricant and should be easily removable with degreasing chemicals. On request, the manufacturer shall advise the purchaser which type of oil has been used. Hot rolled descaled steel sheet may be ordered not oiled, if required, in which case, the supplier has limited responsibility, if oxidation occurs.

5 Conditions of manufacture

5.1 Steelmaking

The processes used in making the steel and in manufacturing hot-rolled sheet are left to the discretion of the manufacturer. On request, the purchaser shall be informed of the steelmaking process being used.

5.2 Chemical composition

The chemical composition (heat analysis) shall not exceed the values given in Table 1.

Table 1 — Chemical composition (heat analysis)

Content levels in percent by mass

Quality		C	Mn	P	S
Designation	Name	max.	max.	max.	max.
HR1	Commercial	0,12	0,60	0,045	0,045
HR2	Drawing	0,10	0,45	0,035	0,035
HR3	Deep drawing	0,08	0,40	0,030	0,030
HR4	Deep drawing aluminum killed	0,08	0,35	0,025	0,025

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat of steel shall be made by the manufacturer to determine the percentage by mass of carbon, manganese, phosphorus and sulfur. On request, this analysis shall be reported to the purchaser or to his representative.

5.3.2 Product analysis

A product analysis may be made by the purchaser to verify the specified analysis of the semi-finished or finished steel and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped) are not technologically suited to product analysis.

For killed steels, the sampling method and deviation limits shall be agreed upon between the manufacturer and purchaser at the time of ordering.

5.4 Weldability

The product is normally suitable for welding if appropriate welding conditions are selected. For undescaled steel, it may be necessary to remove the scale or oxide depending upon the welding method.

5.5 Application

It is desirable that hot-rolled steel sheet be identified for fabrication by the name of the part or by the intended application. Hot-rolled steel sheet (HR1, HR2, HR3, HR4) may be produced to make an identified part within a properly established breakage allowance, which shall be previously agreed upon between the manufacturer and purchaser. In this case part name, details of fabrication and special requirements (freedom from stretcher strain or fluting) shall be specified and the mechanical properties in Table 2 do not apply.

5.6 Mechanical properties

Except when ordered to an identified part, as explained in 5.5, at the time that the steel is made available for shipment, the mechanical properties shall be as given in Table 2, when they are determined on test pieces obtained in accordance with the requirements of clause 8.

Prolonged storage of the sheet can cause a change in the mechanical properties (increase in hardness and a decrease in elongation), leading to a decrease in drawability. To minimize this effect, quality HR4 should be specified.

Table 2 — Mechanical property requirements for hot-rolled carbon steel sheet [a]

Base metal quality		R_m [b] max. N/mm²	A [c,d] min. %			
			$e < 3$		$3 \leqslant e \leqslant 6$	
Designation	Name		L_o = 80 mm	L_o = 50 mm	$L_o = 5{,}65\sqrt{S_o}$	L_o = 50 mm
HR1 [e]	Commercial	440	23	24	28	29
HR2	Drawing	420	25	26	30	31
HR3	Deep drawing	400	28	29	33	34
HR4	Deep drawing aluminium killed	380	31	32	36	37

a R_m tensile strength
A percentage elongation after fracture
L_o gauge length on test piece
S_o original cross sectional area of gauge length
e thickness of steel sheet, in millimetres
1 N/mm² = 1 MPa

b Minimum tensile strength for qualities HR1, HR2, HR3 and HR4 would normally be expected to be 270 N/mm². Where minimum tensile strength is required, the value of 270 N/mm² may be specified. All tensile strength values are determined to the nearest 10 N/mm².

c The non-proportional test piece with a fixed original gauge length (50 mm), up to 6 mm thick sheet can be used in conjunction with a conversion table. In case of dispute, however, only the results obtained on a proportional test piece will be valid for material 3 mm and over in thickness.

d For materials over 6 mm in thickness, values for elongation are subject to agreement between the manufacturer and purchaser.

e Refer to 5.5.

6 Dimensional tolerances

Dimensional tolerances applicable to hot-rolled steel sheet shall be as given in Tables 3 to 11 inclusive.

Restricted thickness tolerances are given in Table 4.

7 Tensile test sampling

One representative sample for the tensile test required in Table 2 shall be taken from each lot of sheet for shipment. A lot consists of 50 t or less of sheet of the same designation rolled to the same thickness and condition.

8 Tensile test

The tensile test shall be carried out in accordance with ISO 6892. Transverse test pieces shall be taken midway between the centre and edge of the sheet as rolled.

9 Retests

9.1 Machining and flaws

If any test piece shows defective machining or develops flaws, it shall be discarded and another test piece substituted.

9.2 Elongation

If the percentage elongation of any test piece is less than that specified in Table 2 and if any part of the fracture is outside the middle half of the gauge length as scribed before the test, the test shall be discarded and a retest shall be carried out.

9.3 Additional tests

If a test does not give the specified results, two more tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this International Standard; otherwise, the lot may be rejected.

10 Resubmission

The manufacturer may resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after he has subjected them to a suitable treatment (selection, heat treatment) which, on request, will be indicated to the purchaser. Tests shall be carried out as if they applied to a new batch.

The manufacturer has the right to present the rejected products for a new examination for compliance with the requirements for another grade.

11 Workmanship

The surface condition shall be that normally obtained in a hot-rolled or hot-rolled descaled product.

The steel sheet in cut lengths shall be free from any laminations, surface flaws and other imperfections that are detrimental to subsequent appropriate processing.

Processing for shipment in coils does not afford the manufacturer opportunity to observe readily or to remove defective portions as can be carried out on the cut length product.

12 Inspection and acceptance

While not usually required for products covered by this International Standard, when the purchaser specifies that inspection and tests for acceptance be observed prior to shipment from the manufacturer's works, the manufacturer shall afford the purchaser's inspector all reasonable facilities to determine that the steel is being furnished in accordance with this International Standard.

Steel that is reported to be defective after arrival at the user's works shall be set aside, properly and correctly identified and adequately protected. The supplier shall be notified in order that he may properly investigate.

13 Coil size

When hot-rolled steel sheet is ordered in coils, a minimum or range of acceptable inside diameter (ID) shall be specified. In addition, the maximum outside diameter (OD) and maximum acceptable coil mass shall be specified.

14 Marking

Unless otherwise stated, the following minimum requirements for identifying the steel shall be legibly stencilled on the top of each lift or shown on a tag attached to each coil or shipping unit:

a) the manufacturer's name or identifying brand;

b) the number of this International Standard, i.e. ISO 3573;

c) the quality designation number;

d) the order number;

e) the product dimensions;

f) the lot number;

g) the mass.

15 Information to be supplied by the purchaser

To adequately specify the requirements of this International Standard, inquiries and orders shall include the following information:

a) reference to this International Standard, i.e. ISO 3573;

b) the name and quality of the material, eg., hot-rolled steel sheet, deep drawing quality HR3 (see 1.2 and 1.3);

c) the dimensions of the product and quantity required;

d) the application (name of part), if possible (see 5.5);

e) for drawing qualities HR2, HR3, HR4, whether ordered to mechanical properties or to fabricate an identified part (see 5.5 and 5.6);

f) whether pickling or descaling by grit or shot blasting is required (material so specified will be oiled unless ordered not oiled) (see 4.1);

g) the type of edge (see 3.4);

h) whether skin passing is required (see 4.3);

i) the report of heat analysis, if required (see 5.3.1);

j) limitations on mass and dimensions of individual coils and bundles, if applicable (see clause 13);

k) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see clause 12).

EXAMPLE 1 ISO 3573, hot-rolled steel sheet, commercial quality HR1, 3 mm × 1 200 mm × 2 440 mm, 10 000 kg, to be used for warehouse resale, edge trimmed, report of cast analysis required, maximum lift mass 4 000 kg.

EXAMPLE 2 ISO 3573, hot-rolled steel sheet, deep drawing quality HR3, 2,5 mm × 1 200 mm coil, 50 000 kg, ordered to mechanical properties, pickled and oiled, mill edge, coils 600 mm minimum ID, 1 500 mm maximum OD, maximum coil mass 15 000 kg.

Table 3 — Normal thickness tolerances for hot-rolled sheet steel (including descaled sheet), coils and cut lengths

Values in millimetres

Specified width	Thickness tolerance [a,b], for specified thickness									
	> 0,8 ⩽ 1,5	> 1,5 ⩽ 2,0	> 2,0 ⩽ 2,5	> 2,5 ⩽ 3,0	> 3, ⩽ 4,0	> 4,0 ⩽ 5,0	> 5,0 ⩽ 6,0	> 6,0 ⩽ 8,0	> 8,0 ⩽ 10,0	> 10,0 ⩽ 12,5
600 ⩽ 1 200	± 0,15	± 0,17	± 0,18	± 0,20	± 0,22	± 0,24	± 0,26	± 0,29	± 0,32	± 0,35
> 1 200 ⩽1 500	± 0,17	± 0,19	± 0,21	± 0,22	± 0,24	± 0,26	± 0,28	± 0,30	± 0,33	± 0,36
> 1 500 ⩽1 800	—	± 0,21	± 0,23	± 0,24	± 0,26	± 0,28	± 0,29	± 0,31	± 0,34	± 0,37
> 1 800	—	—	± 0,25	± 0,26	± 0,27	± 0,29	± 0,31	± 0,35	± 0,40	± 0,43

a The values specified do not apply to the uncropped ends for a total length "l" of a mill edge coil. The total length "l" would be calculated using the following formula:

$$\text{total length } "l" \text{ in metres} = \frac{90}{\text{Thickness in mm}}$$ provided that the result be no greater than 20 m.

b Thickness is measured at any point on the sheet not less than 25 mm from a trimmed edge and 40 mm from an untrimmed edge. Points closer than these are subject to negotiation.

Table 4 — Restricted thickness tolerances for hot-rolled sheet steel (including descaled sheet), coils and cut lengths

Values in millimetres

Specified width	Thickness tolerance [a,b], for specified thickness									
	> 0,8 ⩽ 1,5	> 1,5 ⩽ 2,0	> 2,0 ⩽ 2,5	> 2,5 ⩽ 3,0	> 3,0 ⩽ 4,0	> 4,0 ⩽ 5,0	> 5,0 ⩽ 6,0	> 6,0 ⩽ 8,0	> 8,0 ⩽ 10,0	> 10,0 ⩽ 12,5
600 ⩽1 200	± 0,10	± 0,13	± 0,14	± 0,15	± 0,17	± 0,19	± 0,21	± 0,23	± 0,26	± 0,28
>1 200 ⩽1 500	± 0,12	± 0,14	± 0,15	± 0,17	± 0,18	± 0,21	± 0,22	± 0,24	± 0,28	± 0,29
> 1 500 ⩽1 800	–	± 0,14	± 0,17	± 0,19	± 0,21	± 0,22	± 0,23	± 0,25	± 0,27	± 0,30
> 1 800	–	–	± 0,20	± 0,21	± 0,22	± 0,23	± 0,25	± 0,28	± 0,32	± 0,38

a The values specified do not apply to the uncropped ends for a total length "l" of a mill edge coil. The total length "l" would be calculated using the following formula:

$$\text{total length } "l" \text{ in metres} = \frac{90}{\text{Thickness in mm}}$$ provided that the result be no greater than 20 m.

b Thickness is measured at any point on the sheet not less than 25 mm from a trimmed edge and 40 mm from an untrimmed edge. Points closer than these are subject to negotiation.

Table 5 — Width tolerance for hot-rolled steel sheet (including descaled sheet), for mill edge coils and cut lengths

Values in millimeters

Specified width	Tolerance [a]
⩽ 1 500	$^{+20}_{0}$
> 1 500	$^{+25}_{0}$
[a] The values specified do not apply to the uncropped ends for a total length l of a mill edge coil. The length l, would be calculated using the formula: Total length l in metres = 90/thickness in millimetres, provided that the result be no greater than 20 m.	

Table 6 — Width tolerance for hot-rolled steel sheet (including descaled sheet), sheared edge, not resquared coils and cut lengths

Values in millimeters

Specified width	Tolerance [a]
⩽1 200	$^{+3}_{0}$
> 1 200 ⩽1 500	$^{+5}_{0}$
> 1 500	$^{+6}_{0}$
[a] For resquared material more restrictive tolerances are subject to negotiation.	

Table 7 — Length tolerances for hot-rolled steel sheet (including descaled sheet), not resquared

Values in millimeters

Specified width	Tolerance [a]
⩽2 000	$^{+10}_{0}$
> 2 000 ⩽ 8 000	$^{+0,5\ \% \times \text{length}}_{0}$
> 8 000	$^{+40}_{0}$
[a] For resquared material more restrictive tolerances are subject to negotiation.	

Table 8 — Camber tolerances for hot-rolled steel sheet (including descaled sheet), not resquared

Form	Camber tolerance
Cut length	0,5 % × length
Coil	25 mm in any 5 000 mm length
NOTE 1 For resquared material more restrictive tolerances are subject to negotiation. NOTE 2 The values specified do not apply to the uncropped ends of a mill edge coil for a total length of 7 metres. NOTE 3 Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straight edge. See Figure 1.	

Table 9 — Out-of-square [a] tolerance for hot-rolled steel sheet for cut lengths (including descaled sheet), not resquared

Dimensions	Out-of-square tolerance
All thicknesses and all sizes	1,0 % × width
[a] Out-of-square is the greatest deviation of an end edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in Figure 2. It can also be measured as one-half the difference between the diagonals of the cut length sheet.	

Table 10 — Out-of-square [a] width, and length tolerances for hot-rolled steel sheet, resquared [b]

Values in millimeters

Specified length	Specified width	Tolerance [c] Thickness ⩽ 6
⩽ 3 000	⩽ 1 200	$^{+2}_{0}$
	> 1 200	$^{+3}_{0}$
> 3 000	All widths	$^{+3}_{0}$
[a] Out-of-square is the greatest deviation of an end edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in Figure 2. It can also be measured as one-half the difference between the diagonals of the cut length sheet. [b] When measuring material to resquared tolerances, consideration may have to be given to extreme variations in temperature. [c] Tolerances for thicknesses over 6 mm are subject to agreement between the manufacturer and purchaser.		