
Hot-rolled carbon steel sheet of commercial and drawing qualities

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

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This fourth edition cancels and replaces the third edition (ISO 3573:1999), 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 the surface is of prime importance.

NOTE 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 condition 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 is furnished according to all the requirements of this International Standard, or, by agreement when ordered, to fabricate an identified part, in which case the mechanical property requirements 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-reduced sheet less than 600 mm wide can be slit from wide sheet and will be considered as sheet.

2 Normative references

The following standards referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 16160, *Continuously hot-rolled steel sheet products — Dimensional and shape tolerances*

3 Terms and definitions

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

3.1

hot-rolled steel sheet

product obtained by rolling heated steel through a continuous hot strip mill or another hot-rolling process that produces a coiled product to the required sheet thickness and tolerances

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 1 Some change in properties can result from descaling.

NOTE 2 Descaling can also be performed by appropriate mechanical means.

3.3

skin pass

light cold-rolling of hot-rolled steel sheet or hot-rolled descaled steel

3.4 Edges

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

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.

3.5

aluminum killed

steel which has been deoxidized with aluminum sufficiently 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 are used.

The purchaser should state whether descaling is required.

4.2 Surface condition

The sheets shall not have slivers, seams, cracks or scratches which would adversely affect their use. Also, 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.

Pores, small pits, small marks, scratches, kinks from pay-off reels and slight coloration are permitted. Defects shall not be of such an extent that they run the risk of causing failure or damage to tooling or of creating welding difficulties.

In the case of delivery of coil and slit coil, the percentage of defects may be greater than in the case of delivery in sheet or cut lengths. This should be taken into account by the purchaser, and the percentage of admissible surface defects may be agreed upon at the time of the enquiry and order. Unless otherwise agreed, a single surface of the product shall comply with the specified requirements. The other surface shall be such that, during subsequent treatment, it does not have a deleterious effect on the better surface.

4.3 Skin passing

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

- a) to minimize temporarily the appearance of coil breaks, stretcher strains (Lüders 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 in 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 rust-preventative oil is usually applied to hot-rolled descaled steel sheet but sheet may be furnished not oiled if required. This 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 Tables 1 and 2.

Table 1 — Chemical composition (heat analysis)

Mass fractions in percent

Quality		C max.	Mn max.	P max.	S max.
Designation	Name				
HR1	Commercial	0,12	0,60	0,045	0,035
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	0,030

Table 2 — Limits on additional chemical elements

Mass fractions in percent

Elements	Heat analysis max.	Product analysis max.
Cu ^a	0,20	0,23
Ni ^a	0,20	0,23
Cr ^{a, b}	0,15	0,19
Mo ^{a, b}	0,06	0,07
Nb ^c	0,008	0,018
V ^c	0,008	0,018
Ti ^c	0,008	0,018
^a The sum of copper, nickel, chromium and molybdenum shall not exceed 0,50 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply. ^b The sum of chromium and molybdenum shall not exceed 0,16 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply. ^c An analysis greater than 0,008 may be supplied after agreement between the producer and the consumer.		

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat of steel shall be made by the manufacturer to determine compliance with the requirements given in Tables 1 and 2. When requested, this analysis shall be reported to the purchaser or his representative.

Each of the elements listed in Table 2 shall be included in the report of the heat analysis. When the amount of copper, nickel, chromium or molybdenum present is less than 0,02 %, the analysis result may be reported as “< 0,02 %”.

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 suitable for product analysis.

For killed steels, the sampling method shall be agreed between the manufacturer and the purchaser at the time of ordering. The product analysis tolerances shall be in accordance with Table 3.

Table 3 — Product analysis tolerances

Element	Maximum of specified element %	Tolerance over maximum specified %
Carbon	≤ 0,15	0,03
Manganese	≤ 0,60	0,03
Phosphorus	≤ 0,05	0,01
Sulfur	≤ 0,04	0,01
NOTE The maximum tolerance in this table is the allowable excess over the specified requirement and not the heat analysis.		

5.4 Weldability

This product is normally suitable for welding if appropriate welding conditions are selected. For underscaled 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, and HR4) may be produced to make an identified part within a properly established breakage allowance, which shall be previously agreed between the manufacturer and the purchaser. In this case, the part name, the details of fabrication, and special requirements shall be specified, and the mechanical properties in Table 4 do not apply.

5.6 Mechanical properties

Except when ordered according to an identified part as explained in 5.5, the mechanical properties shall be as given in Table 4 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 4 — Mechanical property requirements for hot-rolled carbon steel sheet

Quality		R_m^a max. MPa	$A^{b,c}$ min. %			
			$e < 3$		$3 \leq e \leq 6$	
			$L_o =$ 80 mm	$L_o =$ 50 mm	$L_o =$ $5,65 \sqrt{S_o}$	$L_o =$ 50 mm
Designation ^d	Name					
HR1	Commercial	440	23	24	28	29
HR2	Drawing	420	25	26	30	31
HR3	Deep drawing	400	28	29	33	34
HR4	Deep drawing aluminum killed	380	31	32	36	37
R_m tensile strength A percentage elongation after fracture L_o gauge length of original test piece S_o original cross sectional area of gauge length e thickness of steel sheet, in mm 1 MPa = 1 N/mm ²						
^a The minimum tensile strength for qualities HR1, HR2, HR3 and HR4 would normally be expected to be 270 MPa. Where the minimum tensile strength is required, the value of 270 MPa may be specified. All tensile strength values are determined to the nearest 10 MPa. ^b A 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. ^c For materials over 6 mm in thickness, values for elongation are subject to agreement between the manufacturer and the purchaser. ^d Refer to 5.5 (Application).						

6 Dimensional tolerances

Dimensional tolerances applicable to hot-rolled steel sheet shall be as given in ISO 16160.

Restricted thickness tolerances are given in ISO 16160.

7 Tensile test sampling

One representative sample for the tensile test required in Table 4 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 4, 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 additional 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. In this case, tests shall be carried out as if they applied to a new batch.

The manufacturer has the right to present the rejected products to 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 product or hot-rolled descaled product.

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

Processing for shipment in coils does not afford the manufacturer an opportunity to observe readily, or to remove, defective portions; however, this is possible with 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 provide the purchaser's inspector with 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 inside diameter or a range of acceptable inside diameters (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) manufacturer's name or identifying brand;
- b) the number of this International Standard; i.e. ISO 3573:2008;
- c) the quality designation number;
- d) the order number;
- e) the product dimensions;
- f) the lot number;
- g) the mass.