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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*

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Contents

	Page
Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Dimensions	2
5 Conditions of manufacture	2
5.1 Chemical composition	2
5.2 Descaling	3
5.3 Edges	3
5.4 Skin passing	3
5.5 Oiling	3
5.6 Weldability	4
5.7 Fabrication qualities	4
5.8 Application	4
5.9 Mechanical properties	4
6 Dimensional and shape tolerances	5
7 Tensile test sampling	5
8 Tensile test	5
9 Retests	5
9.1 Machining and flaws	5
9.2 Elongation	6
9.3 Additional tests	6
10 Resubmission	6
11 Workmanship	6
12 Inspection and acceptance	6
13 Coil size	7
14 Marking	7
15 Information to be supplied by the purchaser	7
Bibliography	9

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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 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 fifth edition cancels and replaces the fourth edition (ISO 3573:2008), which has been technically revised

Hot-rolled carbon steel sheet of commercial and drawing qualities

1 Scope

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 This International Standard does not cover steel sheet that is to be subjected to subsequent rerolling.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the reference document (including any amendments) applies.

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

ISO 16160, *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 to entry: Some change in properties can result from descaling.

Note 2 to entry: 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

Note 1 to entry: The purpose of the skin pass is to produce a higher degree of surface smoothness and thereby improve the surface appearance. The skin pass also temporarily minimizes the occurrence of a surface condition known as stretcher strain (Luder's Lines) or fluting during the fabrication of finished parts. The skin pass also controls and improves flatness. Some increase in hardness and loss of ductility will result from skin passing.

3.4

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

3.5**sheared edge**

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

Note 1 to entry: Normal processing does not necessarily provide a definite positioning of the slitting.

3.6**aluminum killed**

steel which has been deoxidized with aluminum sufficiently to prevent the evolution of gas during solidification

4 Dimensions

4.1 Hot-rolled carbon steel sheet 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.

4.2 Hot-reduced sheet less than 600 mm wide can be slit from wide sheet and will be considered as sheet.

5 Conditions of manufacture

5.1 Chemical composition

The chemical composition (heat analysis) shall not exceed the values given in Tables 1 and 2. On request, a report of the heat analysis shall be made to the purchaser.

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 " $< 0,02 \%$ ".

A verification analysis may be made by the purchaser to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped steels) are not technologically suited to product analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering. The product analysis tolerances are shown in Table 3.

The processes used in making the steel and in manufacturing zinc-coated sheet are left to the discretion of the manufacturer. When requested, the purchaser shall be informed of the steel-making process used.

Table 1 — Chemical composition (heat analysis)

Quality		Mass fractions in percent			
Designation	Name	C max.	Mn max.	P max.	S max.
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.

Table 3 — Product analysis tolerances

Mass fractions in percent

Element	Maximum of specified element	Tolerance over maximum specified
Carbon	0,15	0,03
Manganese	0,60	0,03
Phosphorus	0,045	0,01
Sulfur	0,035	0,01

NOTE The maximum tolerance in this table is the allowable excess over the specified requirement and not the heat analysis.

5.2 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.

5.3 Edges

Material is normally supplied as described in either 3.4 or 3.5. The purchaser should state what edge condition is required. Other edges may be supplied as agreed.

5.4 Skin passing

The purchaser should state whether skin passing is required.

5.5 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.

5.6 Weldability

This 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.

5.7 Fabrication qualities

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.

Hot rolled carbon steel sheet is available in several fabrication qualities. Drawing quality sheet (HR2, HR3, HR4) is intended for drawing or severe forming, including welding. 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 aluminium killed

5.8 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.

5.9 Mechanical properties

Except when ordered according to an identified part as explained in 5.7, 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. %			
			$e < 3$		$3 \leq e \leq 6$	
Designation^d	Name		$L_o =$ 80 mm	$L_o =$ 50 mm	$L_o =$ $5,65\sqrt{S_0}$	$L_o =$ 50 mm
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_0 original cross sectional area of gauge length
 e thickness of steel sheet, in mm
1 MPa = 1 N/mm²

^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 5.8 (Application).

6 Dimensional and shape tolerances

Dimensional and shape tolerances applicable to hot-rolled steel sheet shall be as 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 6892-1. 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 (for example: selection, heat treatment) that, 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.

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.

The sheets shall not have slivers, seams, cracks or scratches that 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.

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. The purchaser should take this into account, 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.

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 nonconforming 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 the reported nonconforming material may be properly investigated.

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 3573:2012;
- 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

The following information shall be supplied by the purchaser:

- a) the number of this International Standard; i.e. ISO 3573:2012;
- b) the name and quality of the material, for example, hot-rolled steel sheet, deep drawing quality HR3 (see 5.7);
- c) the dimensions of the product and the quantity required;
- d) the application (name of part), if possible (see 5.8);
- e) for drawing qualities HR2, HR3, HR4, whether ordered according to mechanical properties or to fabricate an identified part (see 5.7, 5.8, and 5.9);
- f) whether pickling or descaling by grit or shot blasting is required (material so specified will be oiled, unless ordered not oiled) (see 5.2);
- g) the type of edge (see 5.3);
- h) whether skin passing is required (see 5.4);
- i) oil type for descaled steel (if required) (see 5.5);
- j) the report of heat analysis, if required (see 5.1);
- k) limitations on mass and dimensions of individual coils and bundles, if applicable (see Clause 13);
- l) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see Clause 12);

NOTE Typical ordering descriptions are as follows:

EXAMPLE 1 ISO 3573:2012, 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 heat analysis required, maximum lift mass 4 000 kg.