INTERNATIONAL STANDARD

ISO 3574

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Cold-reduced carbon steel sheet of commercial and drawing qualities

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

Reference number
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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 3574 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 3574:2008), which has been technically revised.

Cold-reduced carbon steel sheet of commercial and drawing qualities

1 Scope

This International Standard applies to cold-reduced carbon steel sheet of commercial and drawing qualities. It is suitable for applications where the surface is of prime importance.

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 10113, *Metallic materials — Sheet and strip — Determination of plastic strain ratio*

ISO 10275, *Metallic materials — Sheet and strip — Determination of tensile strain hardening exponent*

ISO 16162, *Cold-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
cold-reduced steel sheet
product obtained from hot-rolled descaled steel sheet by cold reducing to the required sheet thickness followed by annealing to recrystallize the grain structure

3.2
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.

3.3
camber
greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straightedge

3.4
out-of-square
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 described in ISO 16162, or measurable as one-half the difference between the diagonals of the cut-length sheet

3.5
stabilized interstitial free steel
extra-low-carbon steel in which all interstitial elements are combined with titanium and/or equivalent elements

4 Dimensions

4.1 Cold-reduced carbon steel sheet is produced in thicknesses of 0,36 mm and thicker (commonly produced up to 4 mm) and in widths of 600 mm and over, in coils and cut lengths.

4.2 Cold-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 that 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)

Mass fractions in percent

Quality		Carbon max.	Manganese max.	Phosphorus max.	Sulfur max.	Titanium[a] max.
Designation	**Name**					
CR1	Commercial	0,15	0,60	0,050	0,035	—
CR2	Drawing[b]	0,10	0,50	0,040	0,035	—
CR3	Deep drawing[b]	0,08	0,45	0,030	0,03	—
CR4	Deep drawing aluminum killedb (non-ageing)	0,06	0,45	0,030	0,03	—
CR5	Extra deep drawing[c] (stabilized interstitial free)	0,02	0,25	0,020	0,02	0,15

[a] Titanium may be replaced totally or partially by niobium or vanadium. Carbon and nitrogen shall be completely stabilized.

[b] If interstitial free (IF steel) is to be applied to CR2, CR3 and CR4 orders, the values of 0,15 % maximum Ti, and 0,10 % maximum Nb and V, are acceptable to ensure that the carbon and nitrogen are fully stabilized.

[c] By agreement, the manganese, phosphorus and sulfur maximums may be adjusted.

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] For stabilized steels, the maximum for titanium is 0,15 %, and the maximum for each of niobium and vanadium is 0,10 %, to ensure that the carbon and nitrogen are fully stabilized.

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	0,05	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 Skin passing

This product is normally supplied skin passed (see 3.2) but may be supplied annealed last (i.e. without a skin pass), if specified by the purchaser on the order.

5.3 Oiling

As a deterrent to rusting, a coating of oil is usually applied to the product. 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 of which type of oil has been used. The product may be ordered not oiled, if required, in which case, the supplier has limited responsibility if oxidation occurs.

5.4 Weldability

This product is normally suitable for welding if appropriate welding conditions are selected.

5.5 Fabrication qualities

5.5.1 Commercial quality sheet (CR1) is intended for general fabricating purposes where sheet is used in the flat condition or for bending, moderate forming, and welding operations.

5.5.2 Drawing quality sheet (CR2, CR3, CR4, CR5) is intended for drawing or severe forming, including welding. It is produced in thicknesses of 0,36 mm and thicker (commonly produced up to 4 mm) and in widths of 600 mm and wider, 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:

CR2 — Drawing quality

CR3 — Deep drawing quality

CR4 — Deep drawing quality aluminium killed (non-ageing)

CR5 — Extra deep drawing quality (stabilized interstitial free)

5.5.3 Interstitial free steel (IF steel) can be applied on orders of CR2, CR3 and CR4, provided that the customer is informed of the substitution and related shipping documents reflect the actual material shipped.

5.6 Strain ageing

Cold-reduced sheet, in qualities CR1, CR2, and CR3 supplied in the skin-passed condition, tends to strain age and this may lead to the following:

a) surface markings from stretcher strains (Lüders lines) or fluting when the steel is formed;

b) deterioration in ductility.

Because of these factors, it is essential that the period between final processing at the mill and fabrication be kept to a minimum. Rotation of stock, by using the oldest material first, is important. Stocking of such steels for extended periods of time should be avoided; for optimum performance, the period should not exceed 6 weeks.

For skin-passed sheet in qualities CR1, CR2 and CR3, and with due regard to the foregoing precautions, reasonable freedom can be achieved by effective roller leveling immediately prior to fabrication at the purchaser's plant. Freedom from stretcher strain and fluting for a period of six months can be achieved by the supply of skin-passed non-ageing steels. Grades CR4 or CR5 shall be specified in such cases where Lüders lines are not acceptable and where roller leveling is not possible.

5.7 Surface condition

The CR1 product surface condition is supplied as specified in 11.1. Drawing quality products are supplied with either of the surface qualities A or B.

5.7.1 Surface quality A (unexposed)

Imperfections, such as pores, slight imperfections, small marks, minor scratches and slight colouring, which do not affect the formability or the application of surface coatings, are permitted.

5.7.2 Surface quality B (exposed)

The better surface shall be free of imperfections, which might affect the uniform appearance of quality coating. The other surface shall at least conform to surface quality A.

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 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.

5.8 Surface finish

Cold-reduced steel sheet is normally produced in a matte finish, dull in appearance, which is suitable for ordinary decorative painting but is not recommended for electroplating.

When cold-reduced steel sheet is deformed during fabrication, localized areas may roughen to some degree and such affected portions of the part may require hand finishing to prepare the surface for the intended application.

5.9 Application

It is desirable that cold-reduced steel sheet be identified for fabrication by the name of the part or by the intended application. Cold-reduced steel sheet of drawing qualities CR2, CR3, CR4 and CR5 may be produced to make an identified part within a properly established breakage allowance, which shall be previously agreed between the manufacturer and purchaser. In this case, the part name, the details of fabrication, and special requirements (i.e. exposed or unexposed, freedom from stretcher strain or fluting) shall be specified, and the mechanical properties of Table 4 do not apply.

5.10 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.

The values specified in Table 4 are applicable for the periods indicated in Table 5 from the time that the steel is available for shipment.

Table 4 — Mechanical property requirements for cold-rolled steel sheet

Quality		R_e max.[a] MPa	R_m max.[a] MPa	A[b] min. %		r [c, d, e]	n [c, d, f]
Designation	Name			L_o = 80 mm	L_o = 50 mm		
CR1	Commercial [g]	280	410	27 (≤ 0,6 mm) 28 (> 0,6 mm)	28	—	—
CR2	Drawing	240	370	33 (≤ 0,6 mm) 34 (> 0,6 mm)	31	—	—
CR3	Deep drawing	220	350	35 (≤ 0,6 mm) 36 (> 0,6 mm)	35	1,3 min.[h]	0,16 min.[h]
CR4	Deep drawing aluminum killed (non-aging)	210	350	37 (≤ 0,6 mm) 38 (> 0,6 mm)	37	1,4 min.[h]	0,19 min.[h]
CR5	Extra deep drawing (stabilized interstitial free)	190	350	39 (≤ 0,6 mm) 40 (> 0,6 mm)	38	1,7 min.[h]	0,22 min.[h]

R_e yield stress

R_m tensile strength

A percent elongation after fracture

L_o gauge length of original test piece

r plastic strain ratio

n tensile strain hardening exponent

1 MPa = 1 N/mm^2

[a] The minimum tensile strength for qualities CR2, CR3 and CR4 would normally be expected to be 270 MPa. All tensile strength values are determined to the nearest 10 MPa. For designing purposes, the lower limit for R_e may be assumed to be 140 MPa for grades CR1, CR2, CR3 and CR4 and 120 MPa for grade CR5.

[b] For material up to and including 0,6 mm in thickness, the elongation values in this table shall be reduced by 1.

[c] r and n values are only applicable to thicknesses W 0,5 mm. For thicknesses > 2,0 mm, the r value is reduced by 0,2.

[d] r can also be written as r-bar and n can also be written as n-bar.

[e] r is an index of the drawability of the product.

[f] n is an index of the stretchability of the product. The producer and purchaser may agree on a strain range over which n is measured that differs from that specified in ISO 10275.

[g] Mechanical properties are not generally tested on commercial quality products and the values in this table are for information only.

[h] For grades CR3, CR4 and CR5, r-bar and n-bar values may be modified or excluded from this specification, by agreement between the producer and the purchaser.

Table 5 — Applicable period for values specified in Table 4

Designation	Period
CR1	Not applicable
CR2	8 days
CR3	8 days
CR4	6 months
CR5	6 months

6 Dimensional and shape tolerances

Dimensional and shape tolerances applicable to cold-reduced steel sheet shall be as given in ISO 16162.

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.

The plastic strain ratio shall be determined in accordance with ISO 10113. The tensile strain hardening exponent shall be determined in accordance with ISO 10275.

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) 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

11.1 Commercial quality CR1

The surface condition should be that normally obtained in a cold-reduced 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.

11.2 Drawing quality CR2, CR3, CR4, CR5

The surface condition of sheets of drawing qualities for exposed or unexposed parts shall be as specified in 5.7.

Processing for shipment in coils does not afford the manufacturer the 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 cold-reduced 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 3574:2012;

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

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

a) the number of this International Standard, i.e. ISO 3574:2012;

b) the name and quality of the material, (see 5.5);

c) the dimensions of the product and the quantity required;

d) the application (name of part), and whether it is an exposed or unexposed part (see 5.9);

e) for drawing qualities CR2, CR3, CR4 and CR5, any special requirements for surface finish, when required (see 5.7 and 5.8);