INTERNATIONAL STANDARD

ISO 5001

Third edition
1999-06-01

Cold-reduced carbon steel sheet for vitreous enamelling

Tôles en acier au carbone laminées à froid pour émaillage par vitrification

Reference number
ISO 5001:1999(E)

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.

International Standard ISO 5001 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 5001:1993) which has been technically revised.

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Cold-reduced carbon steel sheet for vitreous enamelling

1 Scope

1.1 This International Standard applies to cold-reduced carbon steel sheet of commercial and drawing qualities for vitreous enamelling, where surface of the sheet and chemical composition of the base metal are of prime importance.

1.2 Sheet for vitreous enamelling is produced in thicknesses of 0,36 mm and thicker (commonly produced up to 3 mm) and in widths 600 mm and wider in coils and cut lengths. Sheet for vitreous enamelling less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

1.3 Commercial quality sheet (VE01) is intended for general fabricating purposes where sheet is used in the flat form, or for bending or moderate forming.

1.4 Drawing quality sheet (VE02, VE03, VE04 and VE05) is intended for drawing or severe forming. It is furnished to all requirements of this International Standard or, by agreement when ordered, to fabricate an identified part, in which case the mechanical properties of Table 1 do not apply. If strain ageing is to be minimized, grade VE04 or VE05 should be specified.

Drawing qualities are identified as follows:

— VE02 – Drawing quality

— VE03 – Deep drawing quality

— VE04 – Deep drawing quality aluminum killed (non-ageing)

— VE05 – Extra deep drawing quality (stabilized interstitial free)

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
steel sheet for vitreous enamelling
product obtained from cold-reduced steel sheet having a matte finish and for which proper chemical composition and processing are selected by the producer to prepare the sheet for both fabrication and vitreous enamelling

3.2 Grades and qualities for vitreous enamelling

3.2.1
grade 1
extremely low carbon sheet suitable mainly for direct cover coat enamelling and also for two-coat enamelling for special applications (sag resistance)

NOTE The base metal of this grade loses strength after firing the enamel, and if this is a problem the producer should be consulted.

3.2.2
grade 2
sheet suitable for two-coat enamelling

Quality	Grade	
	1	2
VE01	×	×
VE02	—	×
VE03	×	×
VE04 (non-ageing)	×	×
VE05 (Stabilized interstitial free)	×	×

3.3
skin pass
final light cold rolling of cold-reduced fully processed sheet the purpose of which is one or more of the following:

a) to temporarily minimize the occurrence of stretcher strains (Lüders lines) or fluting during fabrication of finished parts;

b) to obtain the required surface finish for vitreous enamelling;

c) to control shape.

3.4
camber
greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straightedge

3.5
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 shown in Figure 2, also measurable as one-half the difference between the diagonals of the cut length sheet

4 Conditions of manufacture

4.1 Designations

The designations in 1.3 and 1.4 include the qualities of sheet steel for vitreous enamelling. The designation VE represents 'vitreous enamelling' similar to CR 'cold reduced'. The numbers 01, 02, 03, 04 and 05 are common to other standards indicating the qualities of commercial, drawing, deep drawing, deep drawing aluminum killed and extra deep drawing stabilized interstitial free.

4.2 Steelmaking

The processes used in making the steel and in manufacturing sheet for vitreous enamelling are left to the discretion of the producer. When requested, the purchaser shall be informed of the steelmaking process being used.

4.3 Chemical composition

The heat analysis for grades 1 and 2 is subject to agreement between the manufacturer and the purchaser and a report of heat analysis to the purchaser or verification by the purchaser shall be in accordance with 4.4.1 and 4.4.2. Because of the extremely low carbon of grade 1, as a result of special processing, the carbon content of this grade is not subject to heat analysis; however, the purchaser may check the carbon content to ensure no misapplication between grades 1 and 2.

4.4 Chemical analysis

4.4.1 Heat analysis

A heat analysis of each heat of steel shall be made by the manufacturer. When requested, only manganese, phosphorus and sulfur for grade 1 will be reported to the purchaser or his representative. For grade 2, carbon, manganese, phosphorus and sulfur will be reported to the purchaser or his representative when requested.

4.4.2 Verification analysis

A verification 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. A carbon determination for grade 1 may be made by the purchaser to verify the extremely low carbon content. Non-killed steels (such as rimmed or capped) are not technologically suited to product analysis.

4.5 Weldability

The product is easily welded. Certain precautions may be advisable due to the very low hardness of grade 1 material.

4.6 Application

Steel sheet for vitreous enamelling shall be identified for fabrication by name of the part or by the intended application. Steel sheet of drawing qualities (VE02, VE03, VE04 and VE05) may be produced to make an identified part, which shall be previously agreed upon between manufacturer and purchaser. In this case, the part name, the details of fabrication, vitreous enamelling practice and any special requirements (freedom from stretcher strain or fluting) shall be specified and the mechanical properties of Table 1 do not apply.

4.7 Mechanical properties

Except when ordered to an identified part as explained in 4.6, at the time that the steel is made available for shipment the mechanical properties shall be as stated in Table 1 when they are determined on test pieces obtained according to the requirements of clause 6. Prolonged storage of the sheet can cause a change in mechanical properties (increase in hardness and a decrease in elongation, leading to a decrease in drawability). To minimize this effect, quality VE04 or VE05 should be specified.

4.8 Strain ageing

Steel sheet for vitreous enamelling in qualities VE01, VE02 and VE03 supplied in the skin-passed condition tends to strain age and this may lead to the following:

a) surface markings from stretcher strain (Lüder's 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 and for optimum performance should not exceed six weeks.

For skin-passed sheet in qualities VE01, VE02 and VE03 and with due regard to the foregoing precautions, reasonable freedom can be achieved by effective roller levelling 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. Grade VE04 or VE05 shall be specified in such cases where Lüder's lines are not acceptable and where roller levelling is not possible.

4.9 Surface condition

The surface of steel sheet for vitreous enamelling shall be reasonably free of imperfections that affect the appearance of the enamelled product.

4.10 Surface finish

Steel sheet for vitreous enamelling is produced in a matte finish with the degree of roughness depending on the end application.

4.11 Oiling

Steel sheet for vitreous enamelling may be oiled or not oiled, as required.

5 Dimensional tolerances

Dimensional tolerances applicable to steel sheet for vitreous enamelling shall be as given in Tables 2 to 11 inclusive.

Restricted thickness tolerances are given in Table 3.

6 Tensile test sampling

When ordered to mechanical properties, one representative sample for the tensile test required in Table 1 shall be taken from each lot of sheet for shipment. A lot consists of 50 tonnes or less of sheet of the same quality rolled to the same thickness and condition.

7 Tensile test requirements

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

8 Retests

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

9 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, the tests should 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.

10 Workmanship

The steel sheet for vitreous enamelling 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 the opportunity to readily observe or to remove defective portions as can be carried out on the cut length product.

11 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.

12 Coil size

When steel sheet for vitreous enamelling 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.

13 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 5001;

c) the quality designation number;

d) the grade;

e) the order number;

f) the product dimensions;

g) the lot number;

h) the mass.

14 Information to be supplied by the purchaser

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

a) reference to this International Standard,i.e. ISO 5001;

b) the name and designation of the material (eg., steel sheet for vitreous enamelling, grade 1 for direct cover coat, commercial quality, VE01 (see 1.3 and 3.2.1);

c) the dimensions of the product and quantity required;

d) the application (name of part) (see 4.6);

e) the drawing qualities (VE02, VE03, VE04 and VE05), ordered to fabricate an identified part (see 1.4 and 4.6);

f) whether oiled or not oiled (see 4.11);

g) the coil size requirements (see clause 12);

h) the report of the heat analysis, if required (see 4.4.1);

i) details of fabrication including vitreous enamelling process, or special requirements (stretcher strain or fluting);

j) inspection and tests for acceptance prior to shipment from the producer's works, if required (see clause 11).

EXAMPLE: International Standard ISO 5001, steel sheet for vitreous enamelling, grade 2 for direct cover coat, drawing quality VE02, normal thickness tolerance, 1 mm × 1 200 mm × coil, 25 000 kg, for stove tops.

Table 1 — Mechanical Property Requirements [a] (see 4.7)

Base metal quality		R_m [b] max. N/mm²	A [c] min. %		$\bar{r}$ [d] min.	$\bar{n}$ [e] min.
Designation	**Name**		L_o = 80 mm	L_o = 50 mm		
VE01	Commercial [f]	410	27	28		
VE02	Drawing	370	30	31		
VE03	Deep drawing	350	34	35		
VE04	Deep drawing aluminum killed	350	36	37		
VE05	Extra deep drawing Stabilized interstitial free	350	38	38	1,6	0,20

a R_m tensile strength

A percent elongation after fracture

L_o gauge length on test piece

$\bar{r}$ plastic strain ratio (index of drawability of the product)

$\bar{n}$ tensile strain hardening exponent (index of the stretchability of the product)

b Minimum tensile strength for qualities VE02, VE03 and VE04 would normally be expected to be 270 N/mm². All tensile strength values are determined to the nearest 10 N/mm². For design purposes, the lower limit of R_e may be assumed to be 140 N/mm² for VE01, VE02, VE03, VE04 and 120 N/mm² for VE05.

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

d $\bar{r}$ can also be written as bar r.

e $\bar{n}$ can also be written as bar n.

f Mechanical properties are not generally done on Commercial Quality products and the values in Table 1 are for information only.