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INTERNATIONAL STANDARD

ISO 4999

Second edition
1991-04-15

Continuous hot-dip terne (lead alloy) coated cold-reduced carbon steel sheet of commercial and drawing qualities

Tôles en acier au carbone laminées à froid, revêtues d'un alliage au plomb en continu par immersion à chaud, de qualité commerciale et pour emboutissage

Reference number
ISO 4999:1991(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.

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 4999 was prepared by Technical Committee ISO/TC 17, *Steel*.

This second edition cancels and replaces the first edition (ISO 4999:1978), table 5 of which has been technically revised and annex A deleted.

Annex A of this International Standard is for information only.

International Organization for Standardization
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Continuous hot-dip terne (lead alloy) coated cold-reduced carbon steel sheet of commercial and drawing qualities

1 Scope

1.1 This International Standard applies to cold-reduced carbon steel sheet of commercial and drawing qualities coated by a continuous hot-dip terne (lead alloy) coating process. It includes that group of products commonly known as terne plate or terne sheets (or in the U.S.A. as long ternes). Terne sheets are used where ease of solderability, a degree of corrosion resistance, or amenability to stamping, pressing or deep-drawing will be advantageous. The mass of coating may be specified in accordance with table 2. It is expressed as the total coating on both surfaces in grams per square metre. The coating mass specified should be compatible with the desired service life, thickness of the base metal and the forming requirements involved. A designation system (see clause 4) includes the coating designation, coating condition and quality.

1.2 Terne sheet is normally produced in thicknesses from 0,30 mm to 2,0 mm, and in widths of 600 mm to 1 400 mm in coils and cut lengths. Terne sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet. Slit sheet is not available from all producers.

1.3 Commercial quality terne sheet (T0 01) is intended for general fabricating purposes where sheet is used in the flat, or for bending or moderate forming.

1.4 Drawing quality terne sheet (T0 02, T0 03 and T0 04) is intended for drawing or severe forming. It is furnished to all the requirements of this International Standard, or, with agreement when ordered, to fabricate an identified part, in which case the mechanical properties in table 3 do not apply. Drawing qualities are identified as follows:

T0 02 Drawing quality

T0 03 Deep drawing quality

T0 04 Deep drawing quality special killed

1.5 Terne sheet is suitable for welding, soldering or brazing if appropriate methods and procedures are selected with special attention to the heavier coatings. When sheet is subjected to joining techniques involving heat, suitable precautions must be taken to avoid toxic effects.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6892:1984, *Metallic materials — Tensile testing.*

ISO 7438:1985, *Metallic materials — Bend test.*

3 Definitions

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

3.1 continuous hot-dip terne (lead alloy) coated cold-reduced steel sheet: A product obtained by hot-dip coating cold-reduced sheet coils on a continuous lead alloy coating line to produce either lead alloy coated coils or lead alloy coated cut lengths.

3.2 terne (lead alloy): In the context of this International Standard, any lead-based alloy in commercial use for the hot-dip coating of steel sheet. Tin is the most common alloying element, but antimony is also commercially used, as are combinations of both elements. If a specific alloy composition is required,

it shall be by agreement between the manufacturer and purchaser.

3.3 skin pass: A light cold rolling of terne sheet. The purposes of skin passing are one or more of the following:

a) To minimize temporarily the occurrence of conditions known as stretcher strain (Lüder's lines) or fluting during fabrication of finished parts.

b) To control shape.

c) To produce a higher degree of surface smoothness and to improve appearance or suitability for decorative painting. This process may adversely affect the ductility of the base metal.

4 Designation system — Terne coating and qualities

The produced hot-dip terne coating is designated T0 (the "0" is inserted to fill a computer space and has no significance in the designation) as shown in table 1. The coating mass designation follows the T0 and three spaces are allocated for coating mass designation. If only two spaces are required, such as for designation "75", then the "75" is preceded by a "0" to fill computer space and is shown as "075". If the product is skin passed, designation "S" is used to indicate the coating condition. If the product has not been skin passed, the designation "N" for normal coating (as produced) is shown. The numbers 01, 02, 03 and 04 are common to other standards indicating the qualities of commercial, drawing, deep drawing, and deep drawing special killed. An example of a complete designation, including coating, coating mass, coating condition and quality, is T0120N01. This is composed by combining the following:

T0 = Terne coating
120 = Coating designation (see table 2)
N = Normal coating
01 = Commercial quality

5 Conditions of manufacture

5.1 Steelmaking

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

5.2 Chemical composition

The chemical composition of the steel (cast analysis) shall not exceed the values given in table 1.

Table 1 — Chemical composition (cast analysis), %

Quality		C	Mn	P	S
Designation	Name	max.	max.	max.	max.
T0 01	Commercial	0,15	0,60	0,05	0,05
T0 02	Drawing	0,12	0,50	0,04	0,04
T0 03	Deep drawing	0,10	0,45	0,03	0,03
T0 04	Deep drawing special killed	0,08	0,45	0,03	0,03

5.3 Chemical analysis

5.3.1 Cast analysis

A cast analysis of each cast of steel shall be made by the manufacturer to determine the percentage of carbon, manganese, phosphorus and sulphur. On request, this analysis shall be reported to the purchaser or his representative.

5.3.2 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. Non-killed steels (such as rimmed or capped) are not technologically suited to verification analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between manufacturer and purchaser at the time of ordering.

5.4 Terne (lead alloy) coating mass

The mass of coating shall conform to the requirements presented in table 2 for the specific coating designation. The mass of coating is the total amount on both surfaces of the sheet, expressed in grams per square metre (g/m^2) of sheet. Methods of checking that the material complies with this International Standard are given in 7.2, 8.2, and annex A. Procedures other than those covered in annex A should be permitted upon agreement between manufacturer and purchaser.

5.5 Application

It is desirable that terne sheet be identified for fabrication by name of the part or by the intended application. Terne sheet of drawing qualities (T0 02, T0 03, T0 04) may be produced to make an identified part within a properly established breakage allowance, which shall be previously agreed upon be-

tween producer and purchaser. In this case, the part name, the details of fabrication and special requirements (i.e. exposed or unexposed, freedom from stretcher strains or fluting, coating performance requirements) shall be specified and the mechanical properties of table 3 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 stated in table 3 when they are determined on test pieces obtained according to the requirements of 8.1 (mechanical property tests).

NOTE 1 Prolonged storage of the sheet after skin passing can cause a change in mechanical properties (increase in hardness and decrease in elongation), leading to a decrease in drawability. To minimize this effect, quality T0 04 should be specified.

5.7 Strain ageing

Terne sheet (except T004) tends to strain age. Grade T0 04 should be specified where strain ageing is not acceptable and where roller levelling is not possible.

5.8 Oiling

Terne sheet is produced either oiled or not oiled, and is usually not degreased.

6 Dimensional tolerances

Applicable tolerance limits for terne sheet are shown in table 5 to table 13 inclusive.

7 Sampling

7.1 Mechanical property tests

7.1.1 Tensile test

When ordered to mechanical properties, one representative sample for the tensile property test required in table 3 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.

7.1.2 Bend test

One representative sample for the bend test (applicable only to quality 001) shall be taken from each lot (see 7.1.1) of sheet for shipment.

7.2 Coating tests

7.2.1 Mass of coating

The producer shall make such tests and measurements as he deems necessary to ensure that the material produced complies with the values in table 2. The purchaser may verify the mass of coating by use of the following sampling method:

Three specimens shall be cut, one from the mid-width position, and one from each side not closer than 25 mm from the side edge. The minimum specimen area should be 2 000 mm^2.

7.2.2 Bend test

One representative sample shall be taken from each lot of sheet for shipment. The specimens shall be taken for the coated bend test, not closer than 25 mm from the side edge. The minimum specimen width shall be 50 mm.

8 Test methods

8.1 Mechanical property tests

8.1.1 Tensile test (base metal)

The tensile test shall be performed in accordance with ISO 6892. Transverse or longitudinal test pieces shall be taken mid-way between the centre and edge of the sheet as rolled. Since the tensile test is for determination of properties of the base metal, ends of test pieces should be stripped of the coating to measure base metal thickness for calculation of cross-sectional area.

8.1.2 Bend test (base metal) (applicable only to quality 001)

The transverse bend test piece, stripped of coating in a suitably inhibited acid, shall withstand being bent through 180° in the direction shown in figure 1, around the inside diameter as shown in table 3, without cracking on the outside of the bent portion. The bend test shall be performed at ambient temperature as specified in ISO 7438.

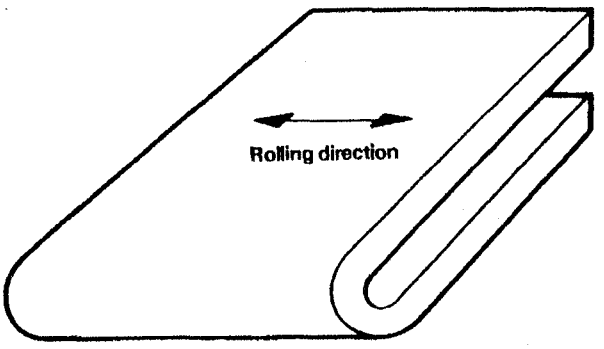


Figure 1 — Transverse bend test piece (after bending)

8.2 Coating tests

8.2.1 Triple spot test

The triple spot test result is the average coating mass found on the three pieces taken according to 7.2.1. The test is normally carried out by stamping out a known area of sheet and calculating the coating mass from the loss in mass after removing the terne (lead alloy) coating in suitably inhibited acid. (See annex A for suggested methods.) Procedures other than those in annex A should be permitted upon agreement by manufacturer and puchaser.

8.2.2 Single spot test

The single spot test result shall be the minimum coating mass found on any one of the three specimens used for the triple spot test. Material slit from wide coil shall be subject to a single spot test.

8.2.3 Bend test (coating)

Bend test pieces taken after coating (before additional processing) shall withstand being bent through 180° in either direction without flaking of the coating on the outside of the bend. The radius of the bend is determined by the number of pieces of the same thickness (or mandrel equivalent) as shown in table 4. Flaking of coating within 7 mm from the edge of the test specimen shall not be cause for rejection.

9 Retests

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

10 Workmanship

The terne sheet in cut lengths shall be free from laminations, surface flaws and other imperfections that are detrimental to subsequent appropriate processing. Processing for shipment in coils does not afford the producer the opportunity to observe readily or to remove defective portions, as can be carried out on the cut length product.

11 Inspection and acceptance

11.1 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.

11.2 Terne sheet 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 terne sheet is ordered in coils, a minimum inside diameter (I.D.) or range of acceptable inside diameters shall be specified. In addition, the maximum outside diameter (O.D.) and maximum acceptable coil mass shall be specified.

13 Marking

Unless otherwise stated, the following minimum requirements for identifying the terne sheet 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;

c) the quality designation;

d) the coating designation;

e) the order number;

f) the product dimensions;

g) the lot number;

h) the mass.

14 Information to be supplied by the purchaser

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

a) the number of this International Standard;

b) the name, coating designation, coating condition and quality of material (for example, terne sheet (T0120N02): (see 1.3, 1.4 and clause 4);

c) the dimensions of the product (the thickness includes the coating) and quantity required;

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

e) for drawing qualities T0 02, T0 03, T0 04, whether ordered to mechanical properties (see 5.6) or to fabricate an identified part (see 5.5);

f) oiled if required (see 5.7);

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

h) the report of cast analysis, if required (see 5.3.1);

i) details of fabrication or special requirements (fluting or coating performance);

j) inspection and tests for acceptance prior to shipment from the producer's works, if required (see 11.1).

NOTE 2 A typical ordering description is as follows:

ISO 4999, terne sheet, T0100N02, drawing quality, coating designation 100—0,46 × 1 200 × 2 400 mm, 20 000 kg, to fabricate drawn fuel tanks ≠ 7201.

Table 2 — Coating designations and limits

Coating designation	Minimum coating mass limits, g/m² (total both sides)	
	Triple spot test check limits	Single spot test check limits
001	No minimum	No minimum
050	50	40
075	75	60
100	100	75
120	120	90

NOTE — "No minimum" means that there are no established minimum check limits for triple spot and single spot tests.

Table 3 — Mechanical properties

Quality		R_m max. [1]	A min. [2]		180°, bend mandrel diameter, for all thicknesses
Designation	Name	N/mm²	L_o = 50 mm	L_o = 80 mm	
T0 01	Commercial				1a
T0 02	Drawing	430	24	23	—
T0 03	Deep drawing	410	26	25	
T0 04	Deep drawing special killed	410	29	28	

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

a = thickness of bend test piece

1 N/mm² = 1 MPa

1) Minimum tensile strength for qualities T0 02, T0 03 and T0 04 would normally be expected to be 260 N/mm². All tensile strength values are determined to the nearest 10 N/mm².

2) For material up to and including 0,6 mm in thickness, the elongation values in the table shall be reduced by 2. For thicknesses up to 2 mm, use either L_o = 50 mm or L_o = 80 mm.

Table 4 — Coating bend test requirements

180° bend mandrel diameter, for all thicknesses and all coating designations	
Commercial quality	**Drawing qualities**
1*a*	0 (flat on itself)
a = thickness of bend test piece	

Table 5 — Thickness tolerances for coils and cut lengths

Values in millimetres

Specified widths	Thickness tolerances[1], over and under, for specified thicknesses						
	0,3 up to and including 0,4	over 0,4 up to and including 0,6	over 0,6 up to and including 0,8	over 0,8 up to and including 1,0	over 1,0 up to and including 1,2	over 1,2 up to and including 1,6	over 1,6 up to and including 2,0
up to and including 1 200	0,04	0,05	0,07	0,08	0,09	0,11	0,13
over 1 200	0,05	0,06	0,08	0,09	0,10	0,12	0,14
The thickness tolerances for sheet in coil form are the same as for sheets supplied in cut lengths but in cases where welds are present, the tolerances shall be double those given over a length of 15 m in the vicinity of the weld.							
1) Thickness is measured at any point on the sheet not less than 25 mm from a side edge.							

Table 6 — Width tolerances for coils and cut lengths, not resquared

Values in millimetres

Specified widths	Tolerance
Up to and including 1 200	$^{+5}_{0}$
Over 1 200	$^{+7}_{0}$

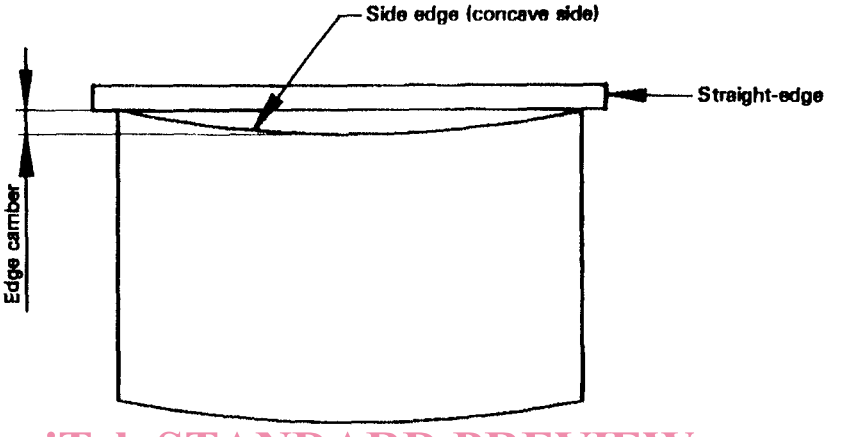
Table 7 — Length tolerances for cut lengths, not resquared

Values in millimetres

Specified lengths	Tolerance
Up to and including 3 000	$^{+20}_{0}$
Over 3 000 up to and including 6 000	$^{+30}_{0}$
Over 6 000	$^{+0,5\ \%}_{0}$

Table 8 — Camber tolerances

Form	Camber tolerance
Coils	20 mm in any 5000 mm length
Cut lengths	0,4 % × length



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.

Figure 2 — Measurement of camber

Table 9 — Out-of-square tolerance for cut lengths, not resquared

Dimensions	Out-of-square tolerance
All thicknesses and all sizes	1,0 % × width

Table 10 — Out-of-square tolerances for resquared material

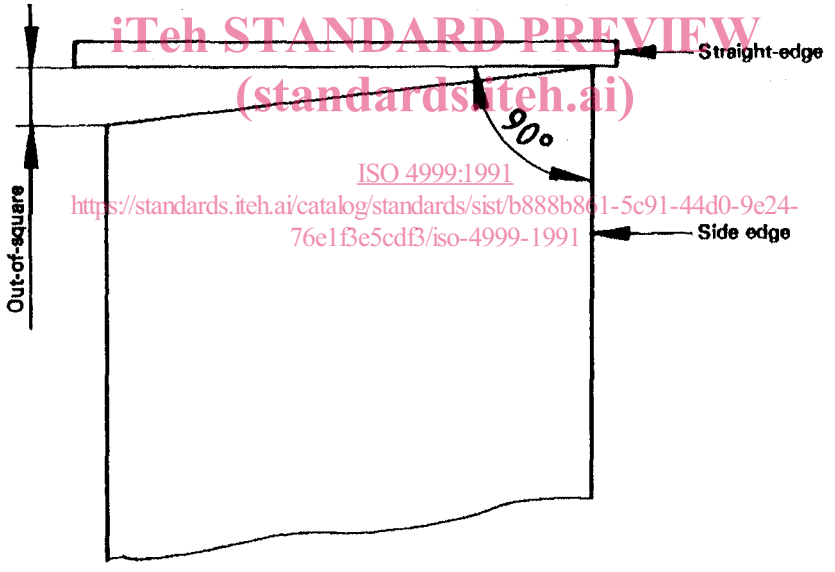
Values in millimetres

Specified lengths	Specified widths	Out-of-square tolerance
Up to and including 3 000	Up to and including 1 200	$^{+2}_{0}$
	Over 1 200	$^{+3}_{0}$
Over 3 000	All widths	$^{+3}_{0}$

NOTES

1 See figure 3.

2 When measuring material ordered to resquared tolerances, consideration may have to be given to extreme variations in temperature.



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 3. It can also be measured as one-half the difference between the diagonals of the cut length sheet.

Figure 3 — Measurement of out-of-square

Table 11 — Standard flatness tolerances for cut lengths

Values in millimetres

Specified thicknesses	Specified widths	Flatness tolerance[1]
Up to and including 0,7	Up to and including 1 200	15
	Over 1 200	18
Over 0,7 up to and including 1,2	Up to and including 1 200	12
	Over 1 200	15
Over 1,2	Up to and including 1 200	10
	Over 1 200	12

These tolerances are only applicable to sheet up to and including 5 000 mm length when their thickness is 1,6 mm or less. This table also applies to sheet cut to length from coil by the purchaser when adequate flattening procedures are performed. Tolerances for sheet exceeding 5 000 mm in length are subject to agreement.

1) Maximum deviation from a flat horizontal surface. With the sheet lying under its own weight on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness.

Table 12 — Special flatness tolerances for cut lengths, roller-levelled or stretcher-levelled

Values in millimetres

Specified thicknesses	Specified widths	Flatness tolerance[1]
Up to and including 0,7	Up to and including 1 200	6
	Over 1 200	7
Over 0,7 up to and including 1,2	Up to and including 1 200	5
	Over 1 200	6
Over 1,2	Up to and including 1 200	4
	Over 1 200	5

Tolerances for sheet exceeding 5 000 mm in length are subject to agreement.

1) Maximum deviation from a flat horizontal surface. With the sheet lying under its own weight on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness (see figure 4).

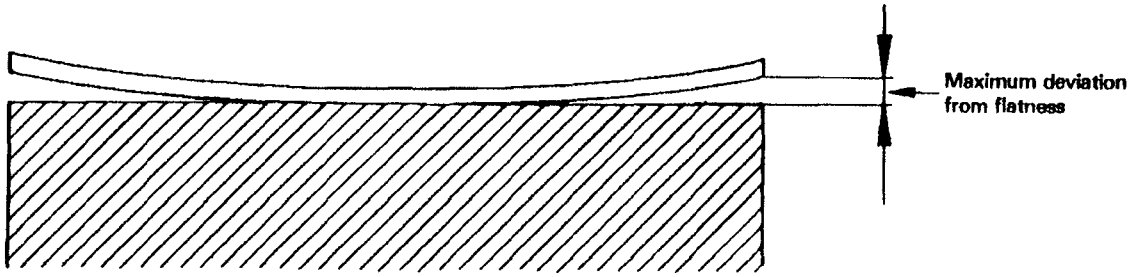


Figure 4 — Measurement of flatness