INTERNATIONAL STANDARD

ISO 4999

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

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

Reference numbe
(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*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This third edition cancel and replaces the second edition (ISO 4999:1991) which has been technically revised.

Annex A forms an integral part of this International Standard.

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Continuous hot-dip terne (lead alloy) coated cold-reduced carbon steel sheet of commercial, drawing and structural 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 terne coated). 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 4. 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 0,3 mm to 2 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 flat, or for bending or moderate forming.

1.4 Drawing quality terne sheet (T0 02, T0 03, T0 04 and T0 05) 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 5 do not apply. Drawing qualities are identified as follows:

T0 02 drawing quality

T0 03 deep drawing quality

T0 04 drawing quality aluminum killed

T0 05 extra deep drawing stabilized — interstitial free

1.5 Structural quality is available in several grades, TCR220, TCR250, TCR320 and TCH550 in the classes included in table 2.

1.6 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 should 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 6892:1998, *Metallic materials — Tensile testing at ambient temperature.*

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

3 Definitions

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

3.1
aluminum killed
steel which has been deoxidized with aluminum sufficient to prevent the evolution of gas during solidification

3.2
stabilized interstitial free steel
extra low carbon steel in which all interstitial elements are combined with titanium and/or equivalent elements

3.3
continuous hot-dip terne (lead alloy) coated cold-reduced steel sheet
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

3.4
terne (lead alloy)
any lead-based alloy in commercial use for the hot-dip coating of steel sheet

NOTE 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.

3.5
skin pass (except grade TCH550)
light cold rolling of the product the purpose of which is one or more of the following:

a) to minimize the appearance of coilbreaks, stretcher strains and fluting;

b) to control the shape;

c) to obtain the required surface finish

NOTE Some increase in hardness and some loss in ductility will result from skin passing.

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 to 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, 04 and 05 are common to other standards indicating the qualities of commercial, drawing, deep drawing, drawing aluminum killed and extra deep drawing stabilized. 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 4)

— N = normal coating

— 01 = commercial quality

The hot-dip coatings in table 4 are also available in structural qualities TCR220, TCR250, TCR320 and TCH550.

5 Conditions of manufacture

5.1 Steelmaking

Unless otherwise agreed upon, the processes used in making the steel and in manufacturing terne 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 of the steel (heat analysis) shall not exceed the values given in table 1 or table 2.

Table 1 — Chemical composition commercial and drawing qualities (heat analysis)

Content levels in percent

Quality		C	Mn	P	S	Ti
		max.	max.	max.	max.	max.
Designation	Name					
T0 01	Commercial	0,15	0,60	0,035	0,04	—
T0 02	Drawing	0,10	0,50	0,025	0,035	—
T0 03	Deep drawing	0,10	0,45	0,03	0,03	—
T0 04	Drawing aluminum killed	0,10	0,50	0,025	0,035	—
T0 05	Extra deep drawing stabilized	0,02	0,25	0,02	0,02	0,30

Table 2 — Chemical composition (heat analysis), structural quality

Content levels in percent

Grade	Class	Method of deoxidation	C max.	Mn max.	P max.	S max.
TCR220	B	E or NE	0,15	n.a.	0,035	0,035
	D	CS	0,15	n.a.	0,035	0,035
TCR250	B	E or NE	0,20	n.a.	0,035	0,035
	D	CS	0,20	n.a.	0,035	0,035
TCR320	B	E or NE	0,20	1,50	0,035	0,035
	D	CS	0,20	1,50	0,035	0,035
TCH550	n.a.	n.a.	0,20	1,50	0,035	0,035

NOTE 1 E = rimming
NE = non-rimming
CS = aluminum killed

NOTE 2 The nitrogen content is controlled; normally it should not exceed 0,009 % for E or NE steel or 0,015 % for CS steel.

NOTE 3 Class B steels are intended for use in welded structures or structural parts, subjected to normal loading conditions.

NOTE 4 Class D steels are to be used for structures or structural parts where, owing to loading conditions and the general design of the structure, a high resistance to brittle fracture is necessary.

5.3 Chemical analyses

5.3.1 Heat analysis

A heat analysis of each heat of steel shall be made by the manufacturer to determine compliance with the requirements in tables 1 and 3 for commercial and drawing qualities or tables 2 and 3 for structural quality. When requested at the time of ordering, this analysis shall be reported to the purchaser or his representative.

Each of the elements listed in table 3 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 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 product and shall take into consideration any normal heterogeneity.

Non-killed steels (such as rimmed or capped) 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.

5.4 Terne coating

5.4.1 Flash metallic coating

This may be applied electrolytically prior to hot dipping to enhance corrosion resistance.

5.4.2 Terne (lead alloy) coating mass

The mass of coating shall conform to the requirements presented in table 4 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 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 and T0 05) may be produced to make an identified part within a properly established breakage allowance which shall be previously agreed upon between 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 5 do not apply.

Table 3 — Limits on additional chemical elements

Content levels 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] Analysis greater than 0,008 % may be supplied after agreement between producer and consumer.

5.6 Mechanical properties

5.6.1 For grades other than structural quality

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 5 when they are determined on test pieces obtained according to the requirements of 8.1 (mechanical property tests).

NOTE 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 or T0 05 should be specified.

5.6.2 For structural quality grades

The mechanical properties shall be as stated in table 6.

5.7 Strain ageing

Terne sheet (except T0 04 and T0 05) tends to strain age. Grade T0 04 and T0 05 should be specified where strain ageing is not acceptable and where roller levelling is not possible.

5.8 Passivation

After hot dipping a passivation treatment may be applied.

5.9 Oiling

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

6 Dimensional tolerance

Dimensional tolerances: applicable tolerance limits for terne sheet are shown in tables 8 to 17 inclusive.

Restricted tolerances are given in tables 9 and 16.

7 Sampling

7.1 Tensile test

When ordered to mechanical properties, one representative sample for the tensile property test required in tables 5 and 6 shall be taken from each lot of sheet for shipment. A lot consists of 50 t or less of sheet of the same quality rolled to the same thickness and condition.

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 4. The purchaser may verify the mass of coating by the 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 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.

8.2 Coating tests

8.2.1 Triple spot test

The triple spot test result is the average coating mass found on the three specimens 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 purchaser.

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 Coating bend test

8.2.3.1 For all qualities other than structural

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 7. See ISO 7438. Flaking of coating within 7 mm from the edge of the test specimen shall not be cause for rejection.

8.2.3.2 For structural quality

The bend test mandrel diameter shall be as shown in table 6.

9 Retests

If a test does not give the specified results, two more tests shall be carried out at 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 Markings

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, i.e. ISO 4999;

c) the quality or grade 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 the requirements of this International Standard, all inquiries and orders shall include the following information.

a) the number of this International Standard, i.e. ISO 4999;

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 the part or intended usage if possible) (see 5.5);

e) for drawing qualities T0 02, T0 03, T0 04, T0 05, whether ordered to mechanical properties (see 5.6) or to fabricate an identified part (see 5.5);

f) oiled if required (see 5.9);

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

h) the report of heat 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).

EXAMPLE

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

Table 4 — 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
170	170	125
260	260	215
335	335	275
NOTE "No minimum" means that there are no established minimum check limits for triple spot and single spot tests.		

Table 5 — Mechanical properties other than structural quality

Quality		R_m [a] max.	A [b] min.	
Designation	**Name**	N/mm²	L_o = 50 mm	L_o = 80 mm
T0 01	Commercial			
T0 02	Drawing	430	24	23
T0 03	Deep drawing	410	26	25
T0 04	Deep drawing aluminum killed	410	29	28
T0 05	Extra deep drawing stabilized	350	37	36

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

1 N/mm² = 1 MPa

[a] Minimum tensile strength for qualities T0 02, T0 03, T0 04 and T0 05 would normally be expected to be 260 N/mm². All tensile strength values are determined to the nearest 10 N/mm².

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

Table 6 — Mechanical properties, structural quality

Grade	R_e min. N/mm²	R_m min. N/mm²	A min. % [a]		Coating bend test 180° bend-mandrel diameter	
			L_o = 50 mm	L_o = 80 mm	$e < 3$ mm	$e \geqslant 3$ mm
TCR220	220	300	22	20	1a	2a
TCR250	250	330	20	18	1a	2a
TCR320	320	400	16	14	3a	3a
TCH550	550	[b]	—	—	—	—

R_e = yield stress - can be either R_{eL} or R_{eH} but not both

R_{eL} = lower yield stress

R_{eH} = higher yield stress

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

[a] Use either L_o = 50 mm or L_o = 80 mm.

[b] For grade TCH550 the yield point approaches the tensile strength and since there is no hesitation of the pointer or drop of the beam, the lower yield stress (R_{eL}) shall be taken as the stress at 0,5 % total elongation under load in accordance with ISO 6892.