INTERNATIONAL STANDARD

ISO 4999

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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 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 4999 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 4999:2005), which has been technically revised.

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

1 Scope

This International Standard is applicable to cold-reduced carbon steel sheet of commercial, drawing and structural qualities coated by a continuous hot-dip terne (lead alloy) coating process. It includes the group of products commonly known as terne plate or terne sheets (or in the USA as terne coated).

Terne sheets are used where ease of solderability, a degree of corrosion resistance, or amenability to stamping, pressing or deep-drawing would be advantageous.

Terne (lead alloy) coated steel sheet can be ordered in one of two ordering conditions:

a) Condition A: steel ordered to satisfy mechanical property requirements.

b) Condition B: steel ordered to make an identified part.

2 Normative references

The following referenced documents are indispensable for the application of this document. 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 7438, *Metallic materials — Bend test*

ISO 16162, *Continuously cold-rolled steel sheet products — Dimensional and shape tolerances*

ISO 16163, *Continuously hot-dipped coated steel sheet products — Dimensional and shape tolerance*s

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Quality applications

3.1.1
commercial
intended for general fabricating purposes where sheet is used in the flat condition, or for bending or moderate forming

3.1.2
drawing
intended for parts where drawing or severe forming may be involved

3.1.3
deep drawing
intended for parts where severe forming or severe drawing may be involved

3.1.4
deep drawing/aluminum killed (non-aging)
intended for fabricating parts where particularly severe drawing or forming may be involved or essential freedom from aging is required

3.1.5
extra-deep drawing (stabilized)
intended for applications requiring interstitial-free steel (IF) which is non-aging and has maximum formability

3.1.6
structural quality
structural quality which is available in several grades and classes

See Tables 2 and 6.

3.2
aluminum killed
steel which has been deoxidized with sufficient aluminum to prevent the evolution of gas during solidification

3.3
stabilized interstitial-free steel
extra-low-carbon steel in which all interstitial elements are combined with titanium and/or equivalent elements

NOTE Stabilized steel is sometimes referred to as interstitial-free steel.

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

NOTE 1 Tin is the most common alloying element, but antimony is also used commercially, as are combinations of both elements.

NOTE 2 If a specific alloy composition is required, it shall be by agreement between the manufacturer and purchaser.

3.5
skin pass
light cold rolling of the coated steel sheet

NOTE 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 some loss in ductility will result from skin passing.

3.6
differential coating
coating having a coating mass on one surface significantly different from the coating mass on the other surface

3.7
lot
50 t or less of sheet of the same grade rolled to the same thickness and coating condition

4 Thickness

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.

The thickness of hot-dip terne (lead alloy) coated steel sheet may be specified as a combination of base metal and metallic coating, or as base metal alone. The purchaser shall indicate on the order which specification method is required. In the event that the purchaser does not indicate any preference, the thickness as a combination of the base metal and coating will be provided. Annex B describes the requirements for specifying the thickness as base metal alone.

5 Conditions of manufacture

5.1 Chemical composition

The chemical composition (heat analysis) shall not exceed the values given in Tables 1, 2 and 3. On request, a report of the heat analysis shall be made to the purchaser.

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 4.

The processes used in making the steel and in manufacturing terne (lead alloy) 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) commercial and drawing qualities

Mass fractions in percent

Quality		C max.	Mn max.	P max.	S max.	Ti max.
Designation	**Name**					
T0 01	Commercial	0,15	0,60	0,035	0,035	—
T0 02	Drawing	0,10	0,50	0,025	0,035	—
T0 03	Deep drawing	0,08	0,45	0,03	0,03	[a]
T0 04	Deep drawing aluminum killed	0,06	0,50	0,025	0,035	[a]
T0 05	Extra-deep drawing stabilized	0,02	0,25	0,02	0,02	0,15[a]

[a] For interstitial-free steels only, the value of 0,15 % titanium, and 0,10 % maximum for niobium and vanadium, are acceptable to ensure that the carbon and nitrogen are fully stabilized.

Table 2 — Chemical composition (heat analysis) structural quality

Mass fractions in percent

Grade	Class	Method of deoxidation	C max.	Mn max.	P max.	S max.
TCR220	B D	E or NE CS	0,15 0,15	Not applicable Not applicable	0,035 0,035	0,035 0,035
TCR250	B D	E or NE CS	0,20 0,20	Not applicable Not applicable	0,035 0,035	0,035 0,035
TCR320	B D	E or NE CS	0,20 0,20	1,50 1,50	0,035 0,035	0,035 0,035
TCH550	Not applicable	Not applicable	0,20	1,50	0,035	0,035

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

NOTE 2 The mass fraction of nitrogen is controlled, normally not exceeding 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.

Table 3 — Limits on additional chemical elements[a]

Mass fractions in percent

Elements	Heat analysis max.	Product analysis max.
Cu[b] Ni[b]	0,20 0,20	0,23 0,23
Cr[bc]	0,15	0,19
Mo[bc]	0,06	0,07
Nb[e] V[de] Ti[e]	0,008 0,008 0,008	0,018 0,018 0,018

[a] Each of the elements listed in this table 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 %".

[b] 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.

[c] 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.

[d] Analysis greater than 0,008 % may be supplied after agreement between the producer and consumer.

[e] For interstitial-free steels only, the value of 0,15 % titanium, and 0,10 % maximum for niobium and vanadium, are acceptable to ensure that the carbon and nitrogen are fully stabilized.

Table 4 — Product analysis tolerances

Mass fractions in percent

Element	Maximum of specified element	Tolerance over maximum specified
C	0,20	0,04
Mn	1,50	0,05
P	0,05	0,01
S	0,035	0,01

NOTE The above maximum tolerance is the allowable excess over the specified requirement and not of the heat analysis.

5.2 Mechanical properties

5.2.1 Commercial and drawing qualities

Terne (lead alloy) coated sheet of designations T0 02, T0 03, T0 04 and T0 05 are supplied under the following two ordering conditions.

a) Ordering condition A: Steel when ordered according to its mechanical properties, at the time the steel is made available for shipment, shall satisfy the applicable requirements of Table 5.

b) Ordering condition B: Steel when ordered to make an identified part shall be supplied with a commitment for satisfactory manufacturing performance within a properly established breakage allowance, which shall have been agreed upon previously between the interested parties. In these cases, the part name, the details of fabrication, and special requirements (such as freedom from stretcher strain or fluting) shall be specified.

Prolonged storing of the sheet can result in a change in mechanical properties (increase in hardness and decrease in elongation) leading to a decrease in formability. To minimize this effect, qualities of designations T0 04 and T0 05 should be specified.

Table 5 — Mechanical properties other than structural quality

Quality		R_m max.[a]	A min.[b]		$\bar{r}$ [cde]	$\bar{n}$ [cde]
Designation	Name	MPa	L_o = 50 mm	L_o = 80 mm	min.	min.
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	1,4	0,17

R_m = tensile strength
A = percentage elongation after fracture
L_o = gauge length on test piece
$\bar{r}$ = index of drawability
$\bar{n}$ = index of stretchability
1 MPa = 1 N/mm^2

a The minimum tensile strength for qualities T0 02, T0 03, T0 04 and T0 05 would normally be expected to be 270 MPa. All tensile strength values are determined to the nearest 10 MPa.

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

c $\bar{r}$ and $\bar{n}$ values are only applicable to thickness a 0,5 mm. For thickness > 2,0 mm, the $\bar{r}$ value is reduced by 0,2.

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

e $\bar{r}$ and $\bar{n}$ values may be modified or excluded from this specification, by agreement between the producer and the purchaser.

5.2.2 Structural quality

The mechanical properties, at the time the steel is made available for shipment, shall satisfy the requirements of Table 6.

Table 6 — Mechanical properties — Structural quality

Grade	R_e min.	R_m min.	A min, %[a]		Coating bend test 180° bend-mandrel diameter	
	MPa	MPa	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
e = thickness of steel sheet, in millimetres
1 MPa = 1 N/mm^2
R_{eL} can be measured by 0,5 % total elongation proof stress (proof stress under load) or by 0,2 % offset when a definite yield phenomenon is not present.

[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 6892-1.

5.2.3 Fabrication qualities

Terne (lead alloy) coated steel sheet is available in several fabrication qualities.

— Commercial: intended for general fabrication purposes where sheet is used in the flat condition or for bending or moderate forming.

— Drawing: intended for fabricating parts where drawing or severe forming may be involved.

— Deep drawing: intended for fabricating parts where severe drawing or severe forming may be involved.

— Deep drawing/aluminium killed (non-aging): intended for fabricating parts where particularly severe drawing or forming may be involved or essential freedom from aging is required.

— Extra-deep drawing (stabilized interstitial-free): intended for applications requiring interstitial-free steel (IF), which is non-aging and has maximum formability.

5.3 Coating

5.3.1 Coating mass

The coating mass limits shall conform to the limits for the designations shown in Table 7. The coating mass is the total amount of coating on both sides of the sheet, expressed in grams per square metre.

Table 7 — Coating designations and limits

Coating designation	Minimum coating mass limits, g/m^2 (total for 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 1 The coating mass, in grams per square metre, refers to the total coating on both surfaces. Because of the many variables and changing conditions that are characteristic of continuous hot-dip coating, the coating mass is not always evenly divided between the two surfaces of a sheet, neither is the coating evenly distributed from edge to edge. However, it can normally be expected that no less than 40 % of the single-spot test limit will be found on either surface.

NOTE 2 "No minimum" means that there are no established minimum check limits for triple-spot and single-spot tests.

NOTE 3 The coating thickness can be estimated from the coating mass by using the following relationship: 100 g/m^2 total for both sides ≅ 0,006 8 mm total for both sides.

5.3.2 Coating adherence

The coated sheet shall be capable of being bent in any direction, in accordance with the mandrel requirements of Table 8 for commercial and drawing qualities and Table 6 for structural quality, without flaking of the coating on the outside of the bend. Flaking of the coating within 7 mm from the edge shall not be cause for rejection.

Table 8 — Coating bend test requirements, excluding structural quality

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

5.4 Weldability

Terne sheet is suitable for welding, soldering or brazing if appropriate methods and procedures are selected, with special attention to the heavier coatings. When the mass fraction of carbon increases above 0,15 %, spot welding becomes increasingly difficult. Because the heat of welding might have a significant effect on lowering the strength of grade 550, this grade is not recommended for welding.

WARNING — When sheet is subjected to joining techniques involving heat, suitable precautions must be taken to avoid toxic effects.