INTERNATIONAL STANDARD

ISO 11949

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Cold-reduced electrolytic tinplate

Fer-blanc électrolytique laminé à froid

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Reference number
ISO 11949:1995(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 11949 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 9, *Tinplate and blackplate*.

It cancels and replaces ISO 1111-1:1983, ISO 1111-2:1983, ISO 4977-1:1984 and ISO 4977-2:1988.

Annexes A and B form an integral part of this International Standard. Annexes C, D and E are for information only.

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Cold-reduced electrolytic tinplate

1 Scope

This International Standard specifies requirements for single and double cold-reduced low-carbon mild steel electrolytic tinplate in the form of sheets or coils for subsequent cutting into sheets.

Single-reduced tinplate is specified in nominal thicknesses that are multiples of 0,005 mm, from 0,17 mm up to and including 0,49 mm. Double-reduced tinplate is specified in nominal thicknesses that are multiples of 0,005 mm, from 0,14 mm up to and including 0,29 mm.

This International Standard applies to coils and sheets cut from coils in nominal minimum widths of 500 mm.

Annex E lists the relevant clauses for the selected product.

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 1024:1989, *Metallic materials — Hardness test — Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T and 45T).*

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

3 Definitions

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

3.1 electrolytic tinplate: Low-carbon mild steel sheet or coil coated on both surfaces with tin that is applied in continuous electrolytic operation.

3.2 differentially coated electrolytic tinplate: Cold-reduced electrolytic tinplate, one surface of which carries a heavier tin coating than the other.

3.3 single cold-reduced: Term used to describe those products where the steel substrate has been reduced to the desired thickness in a cold-reduction mill and subsequently annealed and temper rolled.

3.4 double cold-reduced: Term used to describe those products in which the steel base has had a second major reduction after annealing.

3.5 standard grade tinplate: Material in sheet form which is the product of line inspection. It is suitable, under normal conditions of storage, for established lacquering and printing over the entire surface of the sheet and does not contain any of the following:

a) pinholes, i.e. any perforation through the whole thickness of the material;

b) thickness outside the tolerance range specified in 10.3;

c) surface defects which render the material unsuitable for the intended use;

d) damage or shape-related defects which render the material unsuitable for the intended use.

3.6 second grade tinplate: Material which represents the best sheets rejected from the standard grade but may contain sheets exhibiting defects in surface appearance and shape of limited extent. Suitability for established lacquering and printing over the entire surface of the sheet is not assured.

3.7 batch annealed; box annealed (BA): Annealed by the process in which the cold-reduced strip is annealed in tight coil form, within a protective atmosphere, for a predetermined time-temperature cycle.

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3.8 continuously annealed (CA): Annealed by the process in which cold-reduced coils are unwound and annealed in strip form within a protective atmosphere.

3.9 finish: Surface appearance of tinplate, determined by the surface characteristics of the steel base together with the conditioning of the tin coating which can be either flow-melted or unflow-melted.

3.9.1 bright finish: Finish resulting from the use of temper-mill work rolls that have been ground to a high degree of polish together with a flow-melted or unflow-melted tin coating.

3.9.2 stone finish: Finish on flow-melted tinplate characterized by a directional pattern, resulting from the use of final-mill work rolls that have been ground to a lower degree of polish than those used for the smooth finish, together with a flow-melted tin coating.

3.9.3 silver finish: Finish resulting from the use of temper-mill work rolls that have been shot blasted, together with a flow-melted tin coating.

3.9.4 matt finish: Finish resulting from the use of temper-mill work rolls that have been shot blasted, together with an unflow-melted tin coating.

3.10 coil: Rolled flat strip product which is wound into regularly superimposed laps so as to form a coil with almost flat sides.

3.11 longitudinal bow; line bow: Residual curvature in the strip remaining along the direction of rolling.

3.12 transverse bow; cross bow: Mode of curvature in the sheet such that the distance between its edges parallel to the direction of rolling is less than the sheet width.

3.13 centre buckle; full centre: Intermittent vertical displacement or wave in the strip occurring other than at the edges.

3.14 edge wave: Intermittent vertical displacement occurring at the strip edge when the strip is laid on a flat surface.

3.15 feather edge; transverse thickness profile: Variation in thickness, characterized by a reduction in thickness close to the edges, at right angles to the direction of rolling.

3.16 burr: Metal displaced beyond the plane of the surface of the strip by shearing action.

3.17 rolling width: Width of the strip perpendicular to the direction of rolling.

3.18 consignment: Quantity of material of the same specification made available for dispatch at the same time.

3.19 bulk package; bulk: Packaging unit comprising a base platform or pallet, the sheets and packaging material. (See pallet.)

3.20 pallet: Base platform on which a coil is placed to facilitate ready transportation.

3.21 stillage platform: Base platform on which sheets are stacked to facilitate packing and ready transportation.

3.22 sample unit: 750 m of coil cut into sheets, for the purposes of sampling.

3.23 line inspection: Final inspection of the finished product performed by instruments and/or visual examination at normal production-line speeds.

3.24 anvil effect: Effect which a hard anvil can produce on the numerical hardness value obtained when a hardness test is performed on very thin sheet supported on such an anvil.

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4 Information to be supplied by the purchaser

4.1 General

The following information shall be given in the enquiry and order to assist the manufacturer in supplying the correct material:

a) the designation as given in clause 5 excluding the annealing code, unless a specific type of annealing is required;

b) the quantity, expressed on an area or mass basis;

c) for single-reduced tinplate, the finish required (see 6.2.1);

d) marking requirements for differentially coated tinplate (see clause 12);

e) any further special requirements.

NOTE 1 Appropriate classifications are suitable for shaping operations such as stamping, drawing, folding, beading and bending, and assembly work such as joint forming, soldering and welding. However, for tin coatings less than 2,8 g/m^2, high-speed soft soldering cannot be guaranteed. Welding, for coatings less than 1,4 g/m^2, cannot be guaranteed. The end use should be borne in mind when the classification is selected.

4.2 Options

In the event that the purchaser does not indicate his wish to implement any of the options included in this International Standard and does not specify his requirements at the time of the enquiry and order, the product shall be supplied on the following basis:

a) with cathodic surface passivation treatment using a dichromate salt of an alkali metal (see 6.3);

b) where differential tin coatings are ordered, the heavier coated surface shall be indicated by continuous parallel lines spaced at 75 mm intervals (see clause 12);

c) for double-reduced tinplate, with a stone surface finish (see 6.2.2);

d) for coils, the location of each joint shall be indicated by a piece of non-rigid material and punched holes (see 11.3);

e) for coils, they shall be dispatched with their cores vertical and an internal diameter of 420 mm or 508 mm (see 16.1);

f) for sheets, the direction of the runners of the stillage platform is at the discretion of the producer but shall be consistent within a consignment (see 16.2);

g) for sheets, the rolling width shall be either of the two specified dimensions (see note 2);

h) with a coating of DOS (see 6.3).

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4.3 Additional information

In addition to the information in 4.1 and 4.2, the purchaser may wish to provide further information to the supplier to ensure that the order requirements are consistent with the end use of the product.

The purchaser shall inform the supplier of any modifications to his fabrication operations that will significantly affect the way in which the tinplate is used.

NOTE 2 When ordering double cold-reduced tinplate, the purpose of manufacture for which the material is intended should be stated. It should be noted that double cold-reduced tinplate is relatively less ductile than single cold-reduced tinplate and has very distinct directional properties, so for some uses, for example for built-up can bodies, the direction of rolling should be stated. When double cold-reduced tinplate is used for built-up can bodies, the direction of rolling should be around the circumference of the can so as to minimize the hazard of flange cracking.

5 Designation

5.1 Single-reduced tinplate

For the purposes of this International Standard, single-reduced tinplate is designated in terms of a temper classification based on the Rockwell HR30Tm hardness values given in table 2.

Single-reduced material covered by this International Standard shall be designated by the following characteristics in the given sequence:

a) a description of the material (either tinplate coil or sheet);

b) the number of this International Standard;

c) the temper designation in accordance with table 2;

d) the type of annealing used by the manufacturer (see 9.1);

e) the type of finish (see 3.9);

f) the coating masses and their combinations, E (for equally coated) or D (for differentially coated), together with numbers representing the nominal coating mass on each surface (see clause 12);

g) the dimensions, in millimetres:

— for coils, strip thickness × width;

— for sheets, thickness × width × length.

EXAMPLE

Single cold-reduced tinplate sheet, in accordance with this International Standard, of steel grade TH61+SE (tinplated coating), continuously annealed (CA), stone finish, equally coated with a coating mass of 2,8 g/m^2, with a thickness of 0,22 mm, a width of 800 mm and a length of 900 mm shall be designated:

Tinplate sheet ISO 11949 - TH61+SE - CA - stone - E 2,8/2,8 - 0,22 × 800 × 900.

5.2 Double-reduced tinplate

For the purposes of this International Standard, the mechanical properties in which double-reduced tinplate complying with this International Standard is supplied are designated in terms of a system of mechanical property classifications based on 0,2 % proof stress given in table 3.

Double-reduced material covered by this International Standard shall be designated by the following characteristics in the given sequence:

a) a description of the material (either tinplate coil or sheet);

b) the number of this International Standard;

c) the mechanical property designation (see table 3);

d) the type of annealing used by the manufacturer (see 9.1);

e) the coating masses and their combinations, E (for equally coated) or D (for differentially coated), together with numbers representing the nominal coating mass on each surface (see clause 12);

f) the dimensions, in millimetres:

— for coils, strip thickness × width;

— for sheets, thickness × width × length.

EXAMPLE

Double cold-reduced tinplate coil, in accordance with this International Standard, of steel grade T620+SE, continuously annealed (CA), differentially coated with coating masses of 8,4 g/m² and 5,6 g/m², with a thickness of 0,18 mm and a width of 750 mm shall be designated:

Tinplate coil ISO 11949 - T620+SE - CA - D 8,4/5,6 - 0,18 × 750.

6 Manufacturing features

6.1 Manufacture

The purity of tin used to produce the coating shall be not less than 99,85 % (*m/m*).

The methods of manufacture of tinplate are the province of the manufacturer and are not specified in this International Standard.

The purchaser shall be informed if any alteration is made to the method of manufacture that will affect the properties of the tinplate.

NOTE 3 It is recommended that the manufacturer supplies to the purchaser such details of the manufacturing process as may assist the purchaser in his efficient use of the tinplate.

6.2 Finish

6.2.1 Single-reduced tinplate

Single cold-reduced tinplate can be supplied with either a bright, silver, stone or matt finish, and the finish required shall be specified at the time of ordering [see 4.1 c)].

The appearance is governed by

a) the surface characteristics of the steel base which principally result from controlled preparation of the work rolls used during the final stages of temper rolling;

b) the mass of the coating applied;

c) whether the tin layer is flow-melted or unflow-melted.

6.2.2 Double-reduced tinplate

Double cold-reduced tinplate is usually supplied with a stone surface finish and a flow-brightened tin coating.

6.3 Passivation and oiling

The surface of electrolytic tinplate is normally subjected to a passivation treatment and to oiling. Passivation, produced either by a chemical or an electrochemical treatment, gives a surface with an improved resistance to oxidation and improved suitability for lacquering and printing. Unless otherwise agreed at the time of ordering [see 4.2 a)], the usual passivation procedure is a cathodic treatment in a solution of a dichromate salt of an alkali metal.

Under normal conditions of transport and storage, electrolytic tinplate shall be suitable for surface treatments such as established lacquering and printing operations.

Tinplate coils and sheets are supplied with an oil coating. The oil shall be one that is recognized (i.e. by the relevant national or international authority) as being suitable for food packaging. Unless otherwise agreed at the time of ordering [see 4.2 h)], DOS (dioctyl sebacate) shall be used.

6.4 Defects

6.4.1 Coils

The producer is expected to employ his normal quality control and line inspection procedures to ensure that the tinplate manufactured is in accordance with the requirements of this International Standard.

However, the production of tinplate coils in continuous-strip mill operations does not afford the opportunity for removal of all tinplate that does not comply with the requirements of this International Standard.

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At the time of shearing, sheets not conforming to the standard grade shall be set aside by the purchaser or his agent.

The quantity of sheets complying with this International Standard shall be at least 90 % of any one coil.

NOTE 4 Items c) and d) in 3.5 cannot be verified by specific tests and should be the subject of a special agreement between the producer and user.

If, when processing tinplate coil, the purchaser (or his agent) encounters recurring defects which in his opinion seem excessive, it is essential, where practicable, that he stops processing the coil and advises the supplier.

The purchaser is expected to have adequate handling, roller levelling and shearing equipment and inspection facilities, and to take reasonable care during these operations.

6.4.2 Sheets

Sheets shall not contain any defects as defined in 3.5, when sampled as described in 13.2.

7 Specific requirements

Standard grade tinplate shall comply with the appropriate requirements of clauses 8 to 12.

When tests are carried out to verify compliance with the requirements of clauses 8 to 10, sample sheets shall be selected from consignments in accordance with clause 13.

Coils shall be dispatched as described in 16.1 and sheets shall be packaged as described in 16.2.

8 Tin coating mass

The coating mass, on each surface, shall be expressed in grams per square metre. The lowest value specified in this International Standard shall be 1 g/m^2 on each surface, and no upper limit is specified. Values of preferred coating masses are 1,0 g/m^2, 1,5 g/m^2, 2,0 g/m^2, 2,8 g/m^2, 4,0 g/m^2, 5,0 g/m^2, 5,6 g/m^2, 8,4 g/m^2 and 11,2 g/m^2.

Whatever the coating mass used, the tolerance shall be as indicated in table 1, and the mass per unit area for equally and differentially coated tinplate is determined on test pieces taken from samples selected in accordance with clause 13 and tested in accordance with 14.2. In cases of dispute, the reference method given in annex A shall be used.

NOTE 5 For both equally coated and differentially coated tinplate, the individual test pieces of the sample may show tin coatings as low as, for example, 80 % of the minimum average coating mass, but it is emphasized that isolated test pieces have no representative value in relation to the consignment under consideration.

Table 1 — Tolerances on tin coating masses

Ranges of mass (m) per surface g/m^2	Permissible deviation for sample average from nominal coating mass g/m^2
$1,0 \leqslant m < 1,5$	− 0,25
$1,5 \leqslant m < 2,8$	− 0,30
$2,8 \leqslant m < 4,1$	− 0,35
$4,1 \leqslant m < 7,6$	− 0,50
$7,6 \leqslant m < 10,1$	− 0,65
$10,1 \leqslant m$	− 0,90

9 Mechanical properties

9.1 General

For the purposes of this International Standard, single-reduced tinplate is classified into temper grades based on Rockwell HR30Tm hardness values and double-reduced tinplate classification is based on the 0,2 % proof stress properties.

Other mechanical properties will significantly influence the performance of tinplate in processing, and the subsequent intended end use will vary depending on the steel type and the methods of casting, annealing and temper rolling employed.

NOTE 6 By agreement, the type of annealing for tinplate, i.e. BA or CA (see 3.7 or 3.8) may be specified when ordering.

9.2 Single-reduced tinplate

The hardness values for single-reduced tinplate shall be as given in table 2, when tested as described in D.3.

9.3 Double-reduced tinplate

The proof stress shall be as given in table 3, when tested as described in 14.3.

NOTES

7 For routine testing, the proof stress may be determined using the springback test as described in annex B. However, in cases of dispute, the method described in 14.3 is used.

8 Annex D gives hardness values for information.

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10 Tolerances on dimensions and shape

10.1 General

Tolerances on dimensions (i.e. thickness and linear dimensions) and shape (i.e. edge camber, out-of-squareness, lateral weave) are specified in 10.2 and 10.3, together with appropriate methods of measurement.

NOTE 9 Other geometrical features may be present, such as burr, edge wave, centre buckle, longitudinal bow and transverse bow. This International Standard does not specify methods of measurement and does not specify limits for these geometrical features, certain of which are subject to the equipment employed by the purchaser. The producer should endeavour to keep the occurrence and magnitude of burr, edge wave, centre buckle and transverse bow to a minimum. He should also endeavour to minimize the variation of the longitudinal bow.

10.2 Coils

10.2.1 Length

The difference between the actual length and the producer's indicated length, measured on any single coil, shall not exceed ± 3 %.

The accumulated difference between the actual lengths and producer's indicated lengths, measured on at least 100 coils, shall not exceed 0,1 %.

NOTE 10 The purchaser normally verifies the length of strip in a coil by multiplying the average length of the sheets sheared from the coil by the number of sheets obtained and adding the accumulated lengths of any other portions of the coil as received. The average length of the sheets sheared from the coil is normally determined by measuring the lengths of at least ten sheets, taken at random, to an accuracy of 0,2 mm. Coil lengths may be measured by other methods, provided that the method adopted is acceptable to both the producer and purchaser.

10.2.2 Width

The width of each sample sheet, selected in accordance with clause 13, shall be measured to the nearest 0,5 mm. The width shall be measured across the centre of the sheet, at right angles to the direction of rolling, with the sheet lying on a flat surface. The measured width shall be not less than the ordered width and shall not exceed the ordered width by more than 3 mm.

Table 2 — Hardness values (HR30Tm) for single-reduced tinplate

Steel grade (previous designation)	$e \leqslant 0,21$		$0,21 < e \leqslant 0,28$		$e > 0,28$	
	Nominal	Range for sample average	Nominal	Range for sample average	Nominal	Range for sample average
TH50+SE (T50)	53 max.		52 max.		51 max.	
TH52+SE (T52)	53	± 4	52	± 4	51	± 4
TH55+SE (T55)	56	± 4	55	± 4	54	± 4
TH57+SE (T57)	58	± 4	57	± 4	56	± 4
TH61+SE (T61)	62	± 4	61	± 4	60	± 4
TH65+SE (T65)	65	± 4	65	± 4	64	± 4

NOTES

1 It is important to distinguish HR30Tm from HR30T, the former denoting that depressions on the under surface of the test piece are permitted (cf. ISO 1024).

2 e is the thickness, in millimetres.

Table 3 — Proof stress values of double-reduced tinplate

Steel grade (previous designation)	Average 0,2 % proof stress	
	Nominal N/mm²	Permitted range N/mm²
T550+SE (DR550)	550	480 to 620
T580+SE (DR580)	580	510 to 650
T620+SE (DR620)	620	550 to 690
T660+SE (DR660)	660	590 to 730
T690+SE (DR690)	690	620 to 760

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10.2.3 Thickness

10.2.3.1 General

The transverse thickness profile shall be measured using the micrometer method described in 14.1.2. All other thicknesses shall be determined by the weighing method (see 14.1.1) or by direct measurement using the micrometer method. However, in cases of dispute and for all retests, except for the transverse thickness profile, the weighing method shall be used.

10.2.3.2 Individual sheets

When shearing a coil, sheets shall be eliminated if they deviate from the nominal thickness by more than ± 8,5 %.

10.2.3.3 Average thickness of a consignment

The average thickness of a consignment, determined by the weighing method described in 14.1.1, on the sample sheets selected in accordance with 13.1, shall not deviate from the ordered nominal thickness by more than

a) ± 2,5 % for consignments comprising more than 15 000 m; or

b) ± 4 % for consignments comprising 15 000 m or less.

10.2.3.4 Thickness variation across the width

The thickness of each of the two individual test pieces, determined in accordance with 14.1.1, shall not deviate from the actual average thickness of the whole sheet by more than 4 %.

10.2.3.5 Feather edge (transverse thickness profile)

The minimum thickness, when measured by the micrometer method described in 14.1.2, shall not differ from the actual centre thickness of the sheet by more than 8 %.

10.2.4 Edge camber of coils

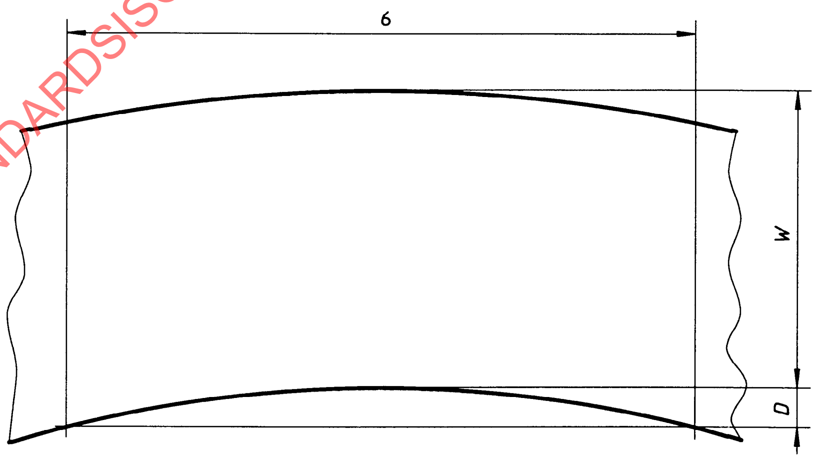
Edge camber is the maximum deviation (in the plane of the sheet) of an edge from a straight line forming a chord to its extremities (see figure 1).

The edge camber expressed as a percentage of the chord length, is calculated using the following formula:

$$\text{Edge camber} = \frac{\text{Deviation } (D)}{\text{Length of chord (6 m)}} \times 100$$

The edge camber, measured over a distance (chord length) of 6 m, shall not exceed 0,1 % (i.e. 6 mm).

Dimensions in metres



W: rolling width

D: deviation from a straight line

Figure 1 — Edge camber of coils

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10.2.5 Lateral weave (short pitch camber) of coils

Lateral weave is the deviation of a mill-trimmed edge from a straight line lying in the same plane and forming a chord to it over a relatively short distance.

The lateral weave, measured over a chord length of 1 m, shall not exceed 1,0 mm when measured prior to shearing.

NOTE 11 If the coil is used for scroll shearing, the permissible values should be agreed upon between the manufacturer and purchaser.

10.3 Sheets

10.3.1 Linear dimensions of sheets

Each sample sheet shall be such that a rectangle of the ordered dimensions can fit into it. To determine the linear dimensions, lay each sample sheet, selected in accordance with 13.2.2, on a flat surface and measure the length and width to the nearest 0,5 mm across the centre of the sheet.

The dimensions of each sample sheet shall be not less than the ordered dimensions and neither dimension shall exceed the ordered dimension by more than 3 mm.

10.3.2 Thickness of sheets

10.3.2.1 General

The transverse thickness profile shall be measured using the micrometer method described in 14.1.2. All other thicknesses shall be determined by the weighing method (see 14.1.1) or by direct measurement using the micrometer method. However, in cases of dispute and for all retests, except for the transverse thickness profile, the weighing method shall be used.

10.3.2.2 Individual sheets

The thickness of each of the individual sample sheets, selected from a consignment in accordance with 13.2.2, shall not deviate from the ordered nominal thickness by more than ± 8,5 %.

10.3.2.3 Average thickness of a consignment

The average thickness of a consignment, determined by the weighing method described in 14.1.1 on the sample sheets selected in accordance with 13.2.2 shall not deviate from the ordered nominal thickness by more than

a) ± 2,5 % for a consignment of more than 20 000 sheets; or

b) ± 4 % for a consignment of 20 000 sheets or less.

10.3.2.4 Tolerances on local thickness within a sheet (crown)

The thickness of each of the two individual test pieces, determined by the weighing method described in 14.1.1, shall not deviate from the actual average thickness of the whole sheet by more than 4 %.

10.3.2.5 Feather edge (transverse thickness profile)

The minimum thickness, when measured by the micrometer method described in 14.1.2, shall not differ from the actual centre thickness of the sheet by more than 8 %.

10.3.3 Edge camber of sheets

Edge camber is the maximum deviation (in the plane of the sheet) of an edge from a straight line forming a chord to it (see figure 2).

The edge camber, expressed as a percentage of the chord length, is calculated using the following formula:

$$\text{Edge camber} = \frac{\text{Deviation } (D)}{\text{Length of chord } (L)} \times 100$$

For each sample sheet, the edge camber shall not exceed 0,15 %.

10.3.4 Out-of-squareness of sheets

Out-of-squareness is the deviation of an edge from a straight line drawn at a right angle to the other edge of the sheet, touching one corner and extending to the opposite edge (see figure 3).

The out-of-squareness, expressed as a percentage, is calculated using the following formula:

$$\text{Out-of-squareness} = \frac{\text{Deviation } (A)}{\text{Sheet dimension } (B)} \times 100$$

For each sheet in the sample, the out-of-squareness shall not exceed 0,20 %.

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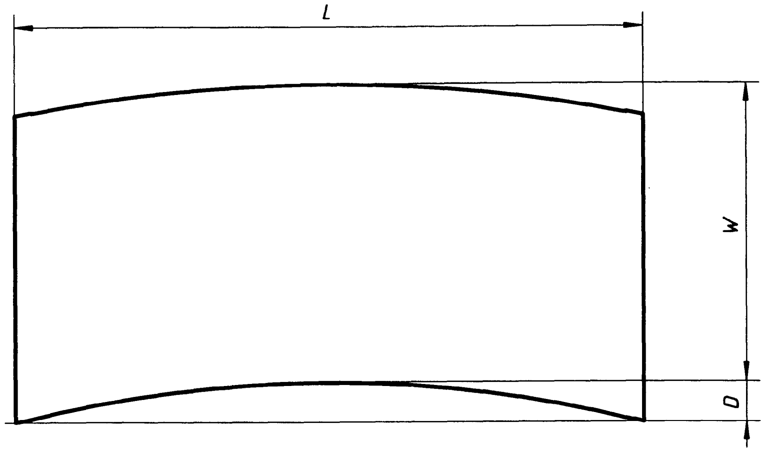
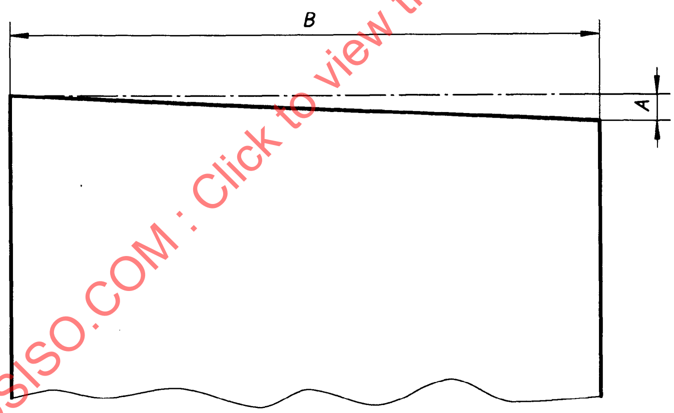


L: length of chord

W: rolling width

D: deviation from a straight line

Figure 2 — Edge camber of sheet



A: deviation

B: length or width of the sheet measured at a right angle to an edge

Figure 3 — Out-of-squareness of sheets

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11 Joints within a coil

11.1 General

The producer shall ensure continuity of the coils within the limits of the lengths ordered, if necessary by means of electrically welded joints made after cold reduction. Requirements relating to the numbers, locations and dimensions of the joints permitted within a coil are given in 11.2 to 11.4.

11.2 Number of joints

The number of joints in a coil shall not exceed three in lengths of 10 000 m.

11.3 Location of joints

The location of each joint in a coil shall be indicated clearly.

NOTE 12 The location of each joint may be indicated, for example by the insertion of a piece of non-rigid material and punched holes. However, alternative methods may be agreed between the producer and purchaser at the time of enquiry and order.

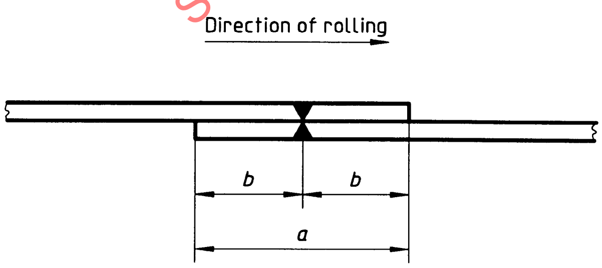
11.4 Dimensions of joints

11.4.1 Thickness

The total thickness of any joint shall not exceed three times the nominal thickness of the material forming the joint.

11.4.2 Overlap

In any lap joint, the total length of overlap shall not exceed 10 mm. The free overlap shall not exceed 5 mm (see figure 4).



a: total length of overlap

b: free overlap

Figure 4 — Joint overlap

12 Marking of differentially coated cold-reduced tinplate

In order to distinguish between tinplate with differential tin coatings and tinplate with equal coatings on the two surfaces, differentially coated tinplate shall be marked on one surface only.

Differentially coated tinplate shall be marked either

a) on the heavily coated surface by dull, straight, continuous parallel lines up to 1 mm wide and spaced at 75 mm intervals; or

b) on the lightly coated surface by alternate interrupted, dull, straight, parallel lines spaced at 75 mm intervals.

If no option is indicated at the time of ordering, option a) will be adopted (see 4.2 b)].

The following examples show how to indicate the marked side and its position when ordering:

D 2,8/5,6: Marked on the 2,8 coated side. The marks are on the top of sheets or on the outside of the coil.

D 5,6/2,8: Marked on the 5,6 coated side. The marks are on the top of sheets or on the outside of the coil.

2,8/5,6 D: Marked on the 5,6 coated side. The marks are on the bottom of sheets or on the inside of the coil.

5,6/2,8 D: Marked on the 2,8 coated side. The marks are on the bottom of sheets or on the inside of the coil.

Annex C gives details of an alternative marking system for certain coating combinations only.

13 Sampling

13.1 Coils

13.1.1 General

When tests are carried out to assess compliance with the requirements for coating mass (see clause 8), tolerances on dimensions and shape (see clause 10) and mechanical properties (see clause 9), samples of the tinplate coil shall be selected in accordance with 13.1.2.

After the coils in a consignment have been cut into rectangular or scrolled sheets, the sheets deemed not to be of standard grade tinplate shall be excluded. The standard grade sheets that remain shall be sampled on the basis of units of strip 750 m in length, in accordance with 13.1.2.3.

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NOTE 13 Because the samples have to be cut from coils in the consignment, the taking of samples is usually carried out by the purchaser during his normal shearing operation.

The purchaser shall allow the producer, or his representatives, to be present during the sampling and subsequent testing and to be able to confirm that the identities of the samples and test pieces correspond with the coils in the consignment supplied.

13.1.2 Selection of samples

13.1.2.1 Lots and units

For the purpose of sampling, each consignment of coils shall be considered as one lot.

13.1.2.2 Selection of sample units

For lots comprising up to and including 20 units, 4 sample units shall be selected at random.

For lots comprising more than 20 units, 4 units shall be selected at random from each 20 units and from any remaining part of 20 units.

13.1.2.3 Selection of sample sheets

From each sample unit selected in accordance with 13.1.2.2, the following sample sheets shall be taken at random:

a) for verification of the coating mass and mechanical properties: two sheets;

b) for verification of the dimensions and shape: five sheets.

13.2 Sheets

13.2.1 General

If tests are carried out to ascertain whether the sheets in a consignment comply with the requirements for coating mass (see clause 8), tolerances on dimensions and shape (see clause 10), and mechanical properties (see clause 9), sample sheets shall be selected in accordance with 13.2.2.

13.2.2 Selection of sample sheets

13.2.2.1 Number of bulk packages

Sample bulk packages shall be selected at random from the total number of bulk packages, at a rate of 20 % rounded to the nearest greater whole number of bulk packages and subject to a minimum of four bulk packages.

For consignments comprising less than four bulk packages, each bulk package shall be taken as a sample.

13.2.2.2 Number of sheets

From each of the sample bulk packages selected in accordance with 13.2.2.1, take at random:

a) for verification of standard grade material (see 3.5), sheets at the rate of 1 % per bulk package;

b) for verification of mechanical properties and coating mass, two sheets;

c) for verification of dimensions, sheets at the rate of 0,5 % per bulk package, to the nearest whole number of sheets.

NOTE 14 The rate of sampling is specified on a percentage basis (except for the verification of mechanical properties and coating masses) because the number of sheets per bulk package may vary, for example between 1 000 and 2 000.

14 Test methods

14.1 Thickness

14.1.1 Weighing method for determination of thickness

14.1.1.1 Determine the thickness of each sample sheet as follows:

a) weigh the sheet to give the mass, to the nearest 2 g;

b) measure the length and width of the sheet, to the nearest 0,5 mm, and calculate the area;

c) calculate the thickness of the sheet, to the nearest 0,001 mm, using the following formula:

$$\text{Thickness (mm)} = \frac{\text{Mass (g)}}{\text{Area (mm}^2\text{)} \times 0{,}007\ 85\ \text{(g/mm}^3\text{)}}$$

14.1.1.2 To determine the average thickness for a consignment, calculate the arithmetic mean of the calculated thicknesses of all the sample sheets representing the consignment.

14.1.1.3 To determine the variation in thickness within each sample sheet, take two test pieces Y (see figure 5) from the sheet. Weigh each test piece to the nearest 0,01 g, measure the length and width of each test piece to the nearest 0,1 mm, and calculate the thickness of each test piece to the nearest 0,001 mm using the formula given in 14.1.1.1 c).

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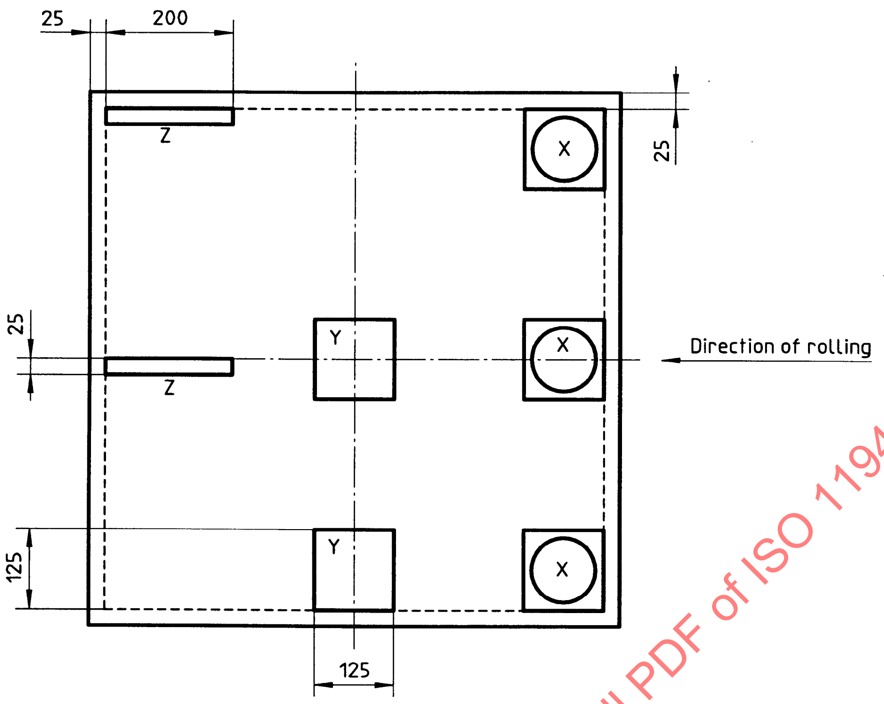
Dimensions in millimetres



X: test pieces for the coating mass

Y: test pieces for hardness and determination of local thickness variation within a sheet

Z: test pieces for tensile or springback tests

Figure 5 — Location of test pieces

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14.1.2 Micrometer method for measurement of thickness

Measure the thickness using a hand-operated, spring-loaded micrometer to an accuracy of 0,001 mm:

a) for transverse thickness profile, 6 mm from the mill-trimmed edge;

b) for all other thicknesses, 10 mm from the mill-trimmed edge.

NOTE 15 It is recommended that the micrometer should have a ball-ended shank and a curved-surface base anvil.

14.2 Tin coating masses

14.2.1 Test pieces

From each sheet selected in accordance with clause 13, three test pieces, each of an accurately determined area not less than 2 500 mm^2, and preferably in the form of discs, shall be carefully prepared. These test pieces shall be selected at edge-centre-edge locations (positions X in figure 5) along a line normal to the direction of rolling. Ensure that the edge test pieces clear the edges of the sheet by a minimum of 25 mm.

14.2.2 Method of determination

The tin coating mass shall be expressed in grams of tin per square metre to the nearest 0,1 g/m^2.

For routine quality control purposes, the coating masses may be determined by any of the recognized and acceptable analytical methods but, in cases of dispute and for all retests, the method described in annex A shall be the referee method.

Whether tin coating determinations are made on individual or grouped test pieces, the tin coating mass of a consignment shall be taken as the average of all the results.

14.3 Tensile tests

14.3.1 Test pieces

For each sheet selected in accordance with clause 13, cut two rectangular test pieces approximately 200 mm × 25 mm wide with the direction of rolling parallel to the length of the test piece, at the position marked Z in figure 5. Ensure that the edge test pieces clear the edges of the sheet by a minimum of 25 mm. Before carrying out the tensile test described in 14.3.2, artificially age the test pieces at 200 °C for 20 min.

14.3.2 Test method

Determine the 0,2 % proof stress as described in ISO 6892 using the conditions specified in annex B of ISO 6892:1984 for thin products and test piece type 1, i.e. width 12,5 mm ± 1 mm and original gauge length L_0, of 50 mm.

Carry out one test on each of the test pieces selected in accordance with 14.3.1, i.e. two tests per sheet selected.

Calculate the representative proof stress for the consignment as the arithmetic mean of all the proof stress results on all the sample sheets taken from the consignment.

15 Retests

15.1 Coils — Dimensions, coating mass and mechanical properties

If any of the results obtained are unsatisfactory, the measurements for that particular property shall be repeated twice on new samples; on each occasion using the sampling specified in 13.1. If the results on both repeated tests meet the stated requirements, the consignment represented shall be deemed to comply with this International Standard, but if the results of either of the retests fail to meet the stated requirements, the consignment represented shall be deemed not to comply with this International Standard.

15.2 Sheets

15.2.1 Standard grade

In the event of the samples inspected for standard grade not complying with the defined requirements in 3.5, further sheets shall be taken at random and inspected at a rate of 5 % per bulk package.

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15.2.2 Dimensions, coating mass and mechanical properties

If any of the results obtained are unsatisfactory, the measurements for that particular property shall be repeated twice on new samples; on each occasion using the sampling specified in 13.2. If the results on both repeated tests meet the stated requirements the consignment represented shall be deemed to comply with this International Standard, but if the results of either of the retests fail to meet the stated requirements, the consignment represented shall be deemed not to comply with this International Standard.

16 Dispatch and packaging

16.1 Coils

Unless otherwise requested at the time of ordering, coils shall be dispatched with their cores in a vertical position [see 4.2e)] (the other option would be with the cores horizontal). The internal diameters of the coils shall be either (420^{+10}_{-15}) mm or (508^{+10}_{-15}) mm.

NOTE 16 Tinplate strip is usually supplied in consignments of coils with outside diameters of at least 1 200 mm, but a limited number of coils with smaller outside diameters may be included in the consignment.

16.2 Sheets

The sheets shall be supplied in bulk packages in which the numbers of sheets are multiples of 100.

NOTES

17 The sheets are customarily packed on a stillage platform forming a bulk package weighing approximately between 1 000 kg and 2 000 kg.

18 If the purchaser has any preference for the direction of the runners of the stillage platform, his requirements should be agreed with the producer and stated on the order [see 4.2 f)].

Annex A
(normative)

Volumetric method for the determination of the tin coating mass (iodine method)

A.1 Principle

The tin coating is dissolved in hydrochloric acid and the tin in an aliquot is reduced to the bivalent state with metallic aluminium. The tin in the reduced state is determined by titration with potassium iodate standard solution.

The effective range of the method is from 0,5 g/m^2 up to 50 g/m^2 and the reproducibility is ± 0,1 g/m^2.

A.2 Reagents and materials

A.2.1 General

During the analysis, use only reagents of recognized analytical grade and only distilled water.

Freshly prepare and, where necessary, filter all solutions.

Prepare reagents A.2.4, A.2.5 and A.2.6 with freshly boiled distilled water to ensure that the solutions are as free from dissolved oxygen as is practicable.

A.2.2 Hydrochloric acid, ρ = 1,16 g/ml, diluted 3 + 1.

Dilute 750 ml of hydrochloric acid (ρ = 1,16 g/ml) to 1 000 ml with water.

A.2.3 Iron(III) chloride, 100 g/l solution.

Dissolve 100 g of hydrated iron(III) chloride in water containing 100 ml of hydrochloric acid (ρ = 1,16 g/ml) and dilute to 1 000 ml with water.

A.2.4 Potassium iodate standard solution, $c(1/6\ KIO_3)$ = 0,05 mol/l. For use only with electrolytic tinplate, equally coated.

Dissolve 1,783 5 g of potassium iodate, previously dried to constant mass at 180 °C, and 19 g of potassium iodide in water containing 0,5 g of sodium hydroxide and dilute to 1 000 ml with water.

1 ml of this solution is equivalent to 0,002 967 g of tin.

A.2.5 Potassium iodate standard solution, $c(1/6\ KIO_3)$ = 0,025 mol/l. For use only with electrolytic tinplate, differentially coated.

Dissolve 0,901 8 g of potassium iodate, previously dried to constant mass at 180 °C, and 1 g of potassium iodide in water containing 0,5 g of sodium hydroxide and dilute to 1 000 ml with water.

1 ml of this solution is equivalent to 0,001 484 g of tin.

A.2.6 Starch solution.

Prepare a suspension of 1 g of soluble starch in 10 ml of water and add to 100 ml of boiling water. Boil for 2 min to 3 min and cool.

A.2.7 Diethyl ether, ρ = 0,72 g/ml technical grade.

A.2.8 Platinum wire, approximately 750 mm long and 0,6 mm in diameter, formed into a flat spiral of two turns and approximately 125 mm in diameter (see figure A.1).

A.2.9 Aluminium metal foil, 99,99 % (*m/m*) purity (tin-free) 0,25 mm thickness.

A.2.10 Carbon dioxide, oxygen-free.

A.2.11 Cellulose lacquer, a suitable lacquer that dries in air.

A.2.12 Acetone, analytical reagent (AR) grade.

A.3 Apparatus

A suitable assembly for carrying out the reduction of tin consists of a 500 ml wide-neck conical flask marked at a volume of 200 ml. The flask is fitted with a rubber bung containing a bent gas inlet tube, a small Liebig-type condenser and a rubber-sealed tube for burette entry at the titration stage (see figure A.1).

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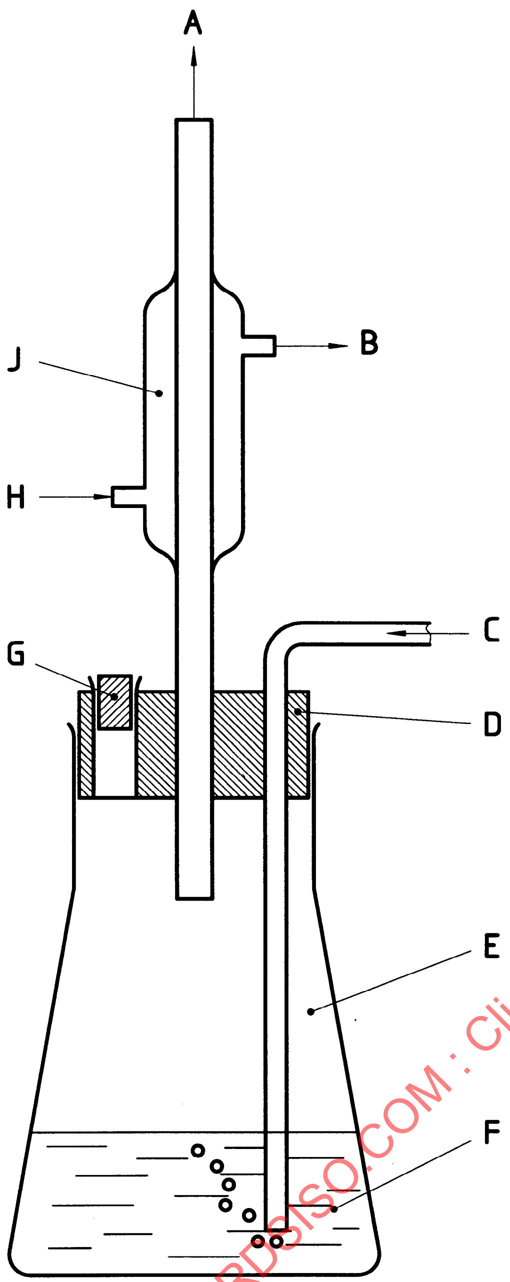

Key

A Gas exit

B Water out

C CO_2 entry

D Rubber bung

E 500 ml wide-neck flask

F Test solution

G Rubber seal and tube for burette entry

H Water in

J Small Liebig condenser

Figure A.1 — Apparatus for the reduction of tin

A.4 Procedure

A.4.1 Electrolytic tinplate — equally coated

A.4.1.1 Tin coating mass equal to or greater than 2,5 g/m²

Degrease with diethyl ether (A.2.7) the test pieces (in the form of discs) taken from sheets as described in 14.2.1. Place the spiral of platinum wire (A.2.8) centrally in a shallow dish (see figure A.2). Place six of the discs in a circle on the platinum wire and carefully pour 150 ml of hydrochloric acid (A.2.2) into the dish.

As soon as the tin coating is completely dissolved from both faces, leaving the steel surfaces exposed (see note 19), transfer the acid quantitatively to a 1 000 ml one-mark volumetric flask. Wash twice with 25 ml of water, transferring the washings to the flask. Repeat the whole procedure with the remaining six discs, combining the acid and washings in the same volumetric flask, and finally dilute to the mark with water.

Transfer a 100 ml aliquot of the solution to the 500 ml wide-neck conical flask (A.3), add 75 ml of hydrochloric acid (A.2.2) and 10 ml of iron(III) chloride solution (A.2.3) and dilute to the 200 ml mark with water. Add 2 g of aluminium metal foil (A.2.9). Insert the rubber bung fitted with a small Liebig condenser, a carbon dioxide entry tube and a rubber-sealed burette entry tube (see figure A.1). Connect the apparatus to the appropriate supply points and pass carbon dioxide gas (A.2.10) through for 5 min to displace the air within the flask. Heat carefully until boiling starts, avoiding vigorous evolution of hydrogen. Continue boiling for 5 min to 10 min after dissolution of the aluminium metal. Cool quickly to less than 20 °C, maintaining an adequate supply of carbon dioxide.

Remove the burette entry tube seal, add 5 ml of starch solution (A.2.6) and titrate with potassium iodate standard solution (A.2.4) to a permanent blue colour.

NOTES

19 The time required for complete dissolution depends on the coating mass. It may vary from about 3 min for an E 2,8/2,8 coating to about 10 min for an E 11,2 /11,2 coating.

20 Care is necessary when adding the aluminium foil, to avoid a violent reaction; it is recommended that the foil be cut into small sections beforehand.

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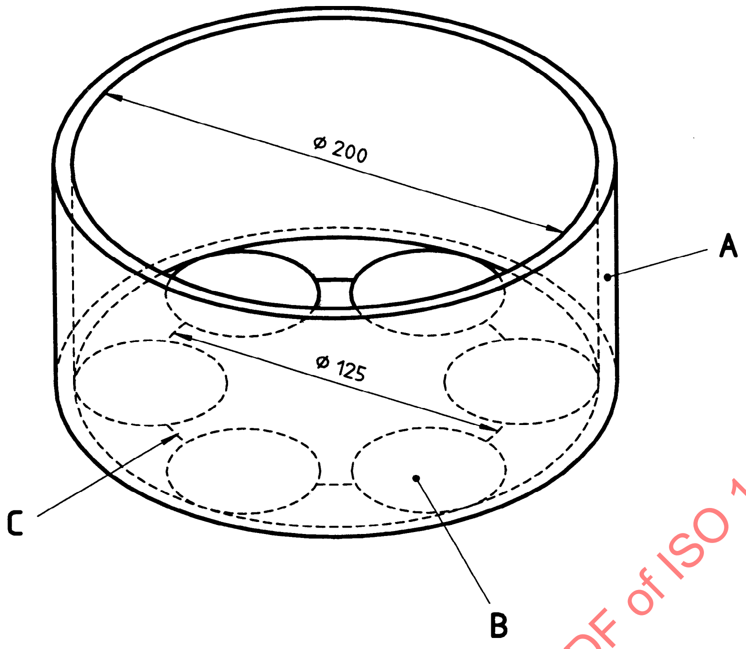
Approximate dimensions in millimetres



Key

A Shallow dish

B Tinplate specimen

C Platinum wire

Figure A.2 — Arrangement of specimens for dissolution of tin

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A.4.1.2 Tin coating mass less than 2,5 g/m²

Degrease with the diethyl ether (A.2.7) the test pieces (in the form of discs) taken from sheets as described in 14.2.1. Place the spiral of platinum wire (A.2.8) centrally in a shallow dish (see figure A.2). Place six of the discs in a circle on the platinum wire and carefully pour 150 ml of hydrochloric acid (A.2.2) into the dish.

As soon as the tin coating is completely dissolved from both faces, leaving the steel surfaces exposed (see note 19), transfer all the acid to a 1 000 ml one-mark volumetric flask. Wash twice with 25 ml of water, transferring the washings to the flask. Repeat this procedure with the remaining six discs, pouring the acid and washings into the same flask, and finally dilute to the mark with water.

Transfer 200 ml of the solution to the 500 ml wide-neck flask (A.3), add 30 ml of hydrochloric acid (A.2.2) and 10 ml of iron(III) chloride solution (A.2.3). Continue with the reduction and titration as described in A.4.1.1, but using the potassium iodate standard solution (A.2.5) as titrant.

A.4.2 Electrolytic tinplate — differentially coated

Degrease with diethyl ether (A.2.7) the test pieces (in the form of discs) from sheets as described in 14.2.1 and coat the faces carrying the heavier tin coating with a cellulose lacquer (A.2.11). Allow to dry for 15 min, apply a second coat of lacquer and allow to dry for 1 h. Place the spiral of platinum wire (A.2.8) centrally in a shallow dish (see figure A.2). Place six of the discs in a circle with the unlacquered faces in contact with the platinum wire. Carefully pour 150 ml of hydrochloric acid (A.2.2) into the dish.

As soon as the tin coating is completely dissolved from the unlacquered faces, leaving the steel surfaces exposed (see note 19), transfer the acid quantitatively to a 1 000 ml one-mark volumetric flask. Wash twice with 25 ml of water, transferring the washings to the flask. Repeat the whole procedure with the remaining six discs, combining the acid and the washings in the same volumetric flask, and finally dilute to the mark with water. Dry the discs and keep them for determination of the coating on the lacquered faces.

Transfer a 100 ml aliquot of the solution to the 500 ml wide-neck conical flask (A.3), add 75 ml of hydrochloric acid (A.2.2) and 10 ml of iron(III) chloride solution (A.2.3) and dilute to the 200 ml mark with water. Continue with the reduction and titration as in A.4.1.1, but using the potassium iodate standard solution (A.2.5) as titrant.

Remove the lacquer from the test pieces used above by swabbing with cotton wool soaked in acetone (A.2.12). Place six of the discs with the unstripped surface uppermost in a circle on the platinum wire and continue as above.

A.5 Expression of results

Calculate the average coating mass m, in grams per square metre, from the following equation:

$$m = \frac{V \times c \times 5{,}935 \times 10^5}{A}$$

where

V is the volume, in millimetres, of the potassium iodate solution;

c is the concentration, in moles per litre, of the potassium iodate solution;

A is the total test piece area, in square millimetres.

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Annex B
(normative)

Springback test for routine determination of proof stress for double-reduced material

This is not the reference method. In all cases of dispute, the method described in 14.3 (i.e. ISO 6892) is to be used.

B.1 Principle

The springback test provides a simple and rapid means of estimating the tensile yield strength of double-reduced products from measurement of thickness and angle of springback of a rectangular strip test piece, after bending through 180° around a cylindrical mandrel and then releasing.

B.2 Test pieces

The test pieces used are identical to those for the tensile test described in 14.3.1.

B.3 Test method

Make one test on each of the test pieces obtained in accordance with B.2 (i.e. two tests per sheet selected). Carry out the test using the Springback Temper Tester model G.67[1)].

In making the test, strictly observe the operational instructions provided with the Springback Temper Tester. The principal steps in the test are:

a) measure the thickness of the tinplate test piece, to the nearest 0,001 mm;

b) insert the test piece into the tester and fix it firmly in the testing position by gently tightening the clamping screw using light finger pressure;

c) bend the test piece through an angle of 180° around the mandrel by a gentle swing of the forming arm;

d) return the forming arm to its "start" position and read and record the springback angle by sighting directly over the test piece;

e) remove the test piece from the tester and, using the recorded thickness of the test piece and the springback angle, determine the appropriate springback index value from a suitable conversion formula (e.g. Bower) agreed between the producer and purchaser.

NOTE 21 Calibrate each new Springback Temper Tester using the standard tensile test (see 14.3) or another "reference" Springback Temper Tester. In addition, since malfunctions arising, for example from excessive wear or inadvertent abuse of the test equipment, may not be readily apparent, it is recommended that the Springback Temper Test readings should be regularly compared with readings from the standard tensile test or a "reference" Springback Temper Tester. It is also recommended that such direct cross-checks be further supplemented by the frequent use of reference samples of known proof stress.

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1) The Springback Temper Tester model G.67 is an example of a suitable product available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

Annex C
(informative)

Alternative marking system for differentially coated tinplate

The marking system consists of parallel straight lines up to 1 mm wide, the distance between the lines indicating the coating masses.

The following spacings should be used:

Designation	Line spacing
D 5,6/2,8	12,5 mm
D 8,4/2,8	25 mm
D 8,4/5,6	25 mm alternating with 12,5 mm
D 8,4/11,2	37,5 mm alternating with 25 mm
D 11,2/2,8	37,5 mm
D 11,2/5,6	37,5 mm alternating with 12,5 mm

An illustration of the marking system is given in figure C.1.

NOTE 22 This alternative marking system may be used for certain coating combinations only.

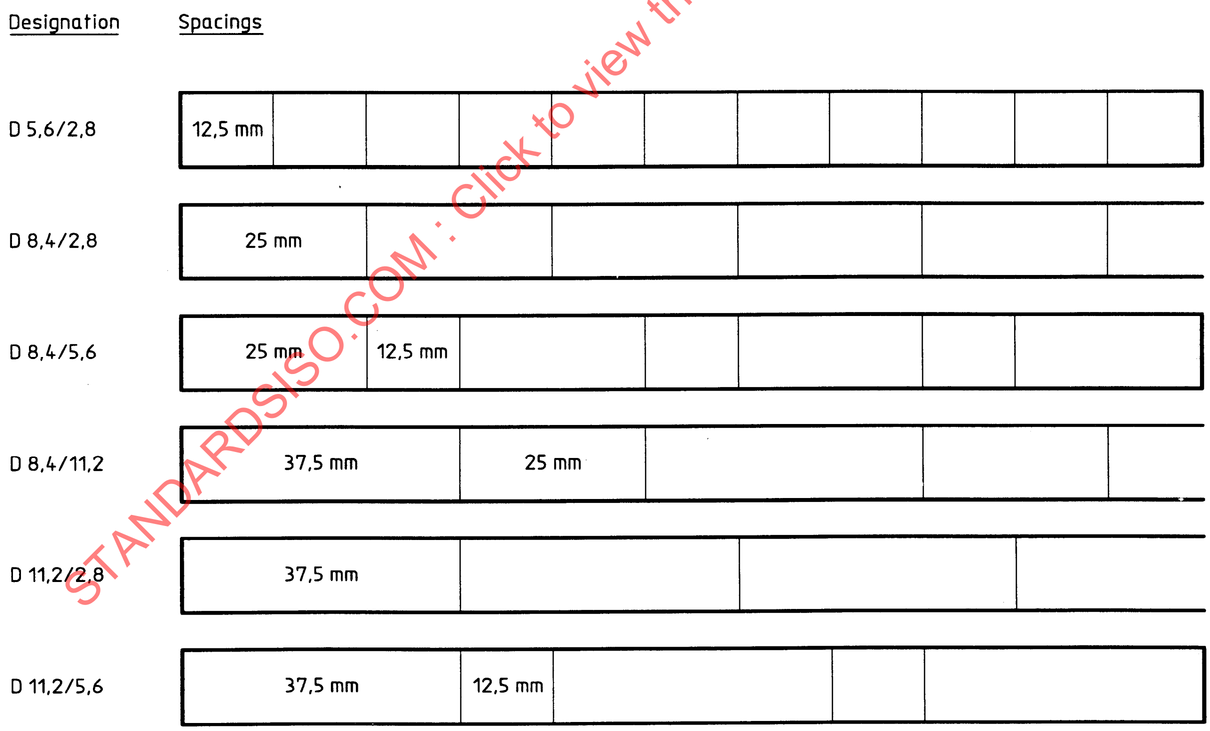

Figure C.1 — Alternative marking system for differentially coated electrolytic tinplate

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Annex D
(informative)

Recommended Rockwell hardness values for double-reduced tinplate

D.1 General

Recommended hardness values, determined as described in D.2 and D.3, are given in table D.1.

Table D.1 — Hardness values (HR30Tm) for double-reduced tinplate

Steel grade (previous designation)	**Average Rockwell hardness** (HR30Tm)[1]	
	Nominal	Range for sample average
T550+SE (DR 550)	73	± 3
T580+SE (DR 580)	74	± 3
T620+SE (DR 620)	76	± 3
T660+SE (DR 660)	77	± 3
T690+SE (DR 690)	80	± 3

1) It is important to distinguish HR30Tm from HR30T, the former denoting that depressions on the under surface of the test piece are permitted (cf. ISO 1024).

D.2 Test pieces

The hardness tests shall be carried out prior to lacquering or printing.

From each of the sample sheets obtained in accordance with clause 13, take two test pieces 125 mm × 125 mm from the positions marked Y in figure 5.

NOTE 23 The test pieces (Y) taken for the determination of thickness variations within the individual sample sheets may also be used for the hardness determinations, where appropriate.

Before carrying out the hardness tests in accordance with D.3, remove the tin coating and artificially age the test pieces at 200 °C for 20 min.

Polish material with a shot blast finish using emery paper of grade 600.

D.3 Test method

Determine the Rockwell HR30Tm indentation hardness either

a) directly, in accordance with ISO 1024; or

b) indirectly, on relatively thin sheets (e.g. 0,22 mm and thinner), by determining the HR15T hardness in accordance with ISO 1024 and then converting the HR15T values to HR30Tm values using table D.2.

Make three hardness measurements on each of the test pieces taken in accordance with D.2.

Calculate the representative hardness for the consignment as the arithmetic mean of all the hardness measurements on all the sample sheets taken from the consignment.

To measure the indentation hardness, use a Rockwell superficial hardness testing machine, employing the 30Tm or 15T scales (see ISO 1024), as appropriate.

Carry out the tests on test pieces from which all organic coatings have been removed. Avoid testing near the edges of the test pieces because of a possible cantilever effect.

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