International Standard 5000

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Continuous hot-dip aluminium-silicon-coated cold-reduced carbon steel sheet of commercial and drawing qualities

Tôles en acier au carbone laminées à froid, revêtues par immersion à chaud en continu d'une couche d'aluminium-silicium, de qualité commerciale et pour emboutissage

First edition — 1980-10-01

UDC 669.14-415 : 621.793 : 669.715′782 **Ref. ISO 5000-1980 (E)**

Descriptors : metal plates, steels, unalloyed steels, metal coatings, cold rolled products, aluminium coatings, silicon coatings, hot dip coatings, designation, chemical composition, tests, mechanical properties, tensile properties, sampling, dimensional tolerances, form tolerances.

Price based on 13 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5000 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in November 1979.

It has been approved by the member bodies of the following countries :

Austria	Germany, F. R.	Poland
Belgium	India	Romania
Bulgaria	Ireland	South Africa, Rep. of
Canada	Italy	Sweden
Czechoslovakia	Japan	Switzerland
Denmark	Korea, Dem. P. Rep. of	Turkey
Egypt, Arab Rep. of	Korea, Rep. of	United Kingdom
Finland	Netherlands	USA
France	New Zealand	USSR

The member body of the following country expressed disapproval of the document on technical grounds :

Australia

Printed in Switzerland

Continuous hot-dip aluminium-silicon-coated cold-reduced carbon steel sheet of commercial and drawing qualities

1 Scope and field of application

1.1 This International Standard specifies the characteristics of cold-reduced carbon steel sheet of commercial and drawing qualities coated by a continuous hot-dip aluminium-silicon alloy coating process.[1] This product is used principally for heat-resisting applications and also where corrosion resistance and heat are involved. The coating mass may be specified in accordance with table 2[2]. This coating system normally produces a minimum alloy layer. The coating 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 with the forming requirements involved. A designation system (see 3.2) includes the coating designation, coating condition, and quality.

1.2 Aluminium-silicon-coated sheet is produced in the range of thicknesses 0,40 to 3,0 mm inclusive, and in widths of 600 to 1 500 mm in coils and cut lengths. Aluminium-silicon-coated sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

NOTE — Approximate conversions to inches are given in annex A, for information only. Values of total theoretical thickness for coating mass are given in annex B. A method for the determination of mass of coating is given in annex C.

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

1.4 Drawing quality aluminium-silicon-coated sheet (qualities 02, 03 and 04) is intended for drawing or severe forming. It is furnished to all the requirements of this International Standard, or, with agreement when ordered, to fabricate an identified part, in which case the mechanical properties in table 3 do not apply. The use of grade 04 minimizes strain ageing.

Drawing qualities are identified as follows :

02 — Drawing quality

03 — Deep drawing quality

04 — Deep drawing quality special killed

2 References

ISO 82, *Steel — Tensile testing.*

ISO/R 85, *Bend test for steel.*

ISO 86, *Steel — Tensile testing of sheet and strip less than* 3 mm *and not less than* 0,5 mm *thick.*

ISO/R 87, *Simple bend testing of steel sheet and strip less than* 3 mm *thick.*

3 Definitions and other information

3.1 continuous hot-dip aluminium-silicon-coated cold-reduced steel sheet : A product obtained by hot-dip coating cold-reduced sheet coils on a continuous aluminium-silicon alloy coating line to produce either aluminium-coated coils or aluminium-coated cut lengths. The aluminium-silicon alloy for coating is normally between 5 and 11 % silicon added to promote better adherence and heat resistance.

3.2 Designation system

The as-produced hot-dip aluminium coatings are designated AS (aluminium-silicon), as shown in table 2. The coating mass designation follows the AS and three spaces are allocated for coating mass designation. If only two spaces are required, such as for designation "80", then the "80" is preceded by a "0" to fill the computer space and is shown as "080". Since this product is normally skin passed, designation "S" is used to indicate the coating condition. The numbers 01, 02, 03 and 04 are common to other standards, indicating the qualities of commercial, drawing, deep drawing and deep drawing special killed.

An example of a complete designation, including coating mass, coating condition and quality is AS080S01. This is composed by combining the following :

AS : Aluminium-silicon coating

080 : Coating mass designation (See table 2)

S : Skin passed

01 : Commercial quality

1) This product is sometimes known as type 1.

2) Theoretical thicknesses for coating mass given in annex B are for information only.

3.3 skin pass : A light cold rolling of the aluminium-silicon-coated steel sheet. This product is normally skin passed. The purposes of skin passing are one or more of the following :

a) to produce a higher degree of surface smoothness and to improve appearance. This process may adversely affect the ductility of the base metal;

b) to minimize temporarily the occurence of conditions known as stretcher strain (Lüder's lines) or fluting during fabrication of finished parts;

c) to control shape.

3.4 Strain ageing

Aluminium-silicon-coated steel sheet tends to strain age, and this may lead to the following :

a) surface marking from stretcher strain (Lüder's lines) or fluting when the steel is formed;

b) deterioration in ductility.

Because of these factors, it is essential that the period between final processing at the mill and fabrication be kept to a minimum. Rotation of stock, by using the oldest material first, is important. Stocking of such steels for extended periods of time should be avoided and for optimum performance should not exceed six weeks. For skin passed sheet, reasonable freedom stretcher strain can be achieved by effective roller levelling immediately prior to fabrication at the purchaser's plant.

3.5 Mill passivating

A chemical treatment may be applied to aluminium-silicon-coated steel sheet to minimize the hazard of wet storage stain during shipment and storage. However, the inhibiting characteristics of the treatment are limited and if a shipment is received wet, the material shall be used immediately or dried.

3.6 Oiling

The aluminium-silicon-coated steel sheet as produced shall be oiled to prevent marring or scratching of the soft surface during handling or shipping and to minimize the hazard of wet storage stain. Sheet not oiled shall be by agreement between the producer and purchaser. When the aluminium-silicon-coated sheet has received a passivating treatment, oiling will minimize further the hazard of wet storage stain.

4 Conditions of manufacture

4.1 Steelmaking

The processes used in making the steel and in manufacturing aluminium-silicon-coated sheet are left to the discretion of the manufacturer. When requested, the purchaser shall be informed of the steelmaking process being used.

4.2 Chemical composition

The chemical composition (cast analysis) would not be expected to exceed the values given in table 1.

Table 1 — Chemical composition, %

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

4.3 Chemical analysis

4.3.1 Cast analysis

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

4.3.2 Verification analysis

A verification analysis may be made by the purchaser to verify the specified analysis of the semi-finished or finished steel and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped) are not technologically suited to verification analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between manufacturer and purchaser at the time of ordering.

4.4 Coating mass

The coating mass shall conform to the requirements presented in table 2 for the specific coating designation. The coating mass is the total amount of the aluminium-silicon alloy, including both sides of the sheet, expressed in grams per square metre (g/m^2) of sheet. Methods of checking that the material complies with this International Standard are given in 6.2.1 and 7.2, and annex C. Procedures other than those covered in annex C shall be permitted by agreement between manufacturer and purchaser.

4.5 Weldability

The product is suitable for welding if appropriate welding methods and procedures are used with special attention to the heavier coatings.

4.6 Application

Aluminium-silicon-coated steel sheet shall be identified for fabrication by name of the part or by the intended application. Steel sheet of drawing qualities (02, 03 and 04) may be produced to make an identified part, which shall be previously agreed upon between manufacturer and purchaser. In this

case, the part name, the details of fabrication and special requirements (freedom from stretcher strain, or fluting, coating performance requirements) shall be specified and the mechanical properties of table 3 do not apply.

4.7 Mechanical properties

Except when ordered to an identified part as explained in 4.6, at the time that the steel is made available for shipment the mechanical properties shall be as stated in table 3 when they are determined on test pieces obtained according to the requirements of 6.1 (mechanical tests). Prolonged storing of the sheet can cause a change in mechanical properties (increase in hardness and a decrease in elongation), leading to a decrease in drawability. To minimize this effect, quality 04 should be specified.

5 Dimensional tolerances

Dimensional tolerances applicable to aluminium-silicon-coated steel sheet shall be as given in tables 5 to 12 inclusive.

6 Sampling

6.1 Mechanical tests

6.1.1 Tensile test

When ordered to mechanical properties, one representative sample for the tensile test required in table 3 shall be taken from each lot of sheet for shipment. A lot consists of 50 tonnes or less of sheet of the same quality rolled to the same thickness and condition.

6.1.2 Bend test (when specified)

One representative sample for the bend test (quality 01) shall be taken from each lot of sheet for shipment. A lot consists of all sheet of the same quality rolled to the same thickness and condition.

6.2 Coating tests

6.2.1 Mass of coating

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

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

6.2.2 Bend test (when specified)

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.

7 Test methods

7.1 Mechanical tests

7.1.1 Tensile test (base metal)

The tensile test shall be carried out in accordance with ISO 82 and ISO 86. Transverse 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 shall be stripped of the coating to measure base metal thickness for calculation of cross-sectional area.

7.1.2 Bend test (base metal) (when specified)

The transverse bend test piece (quality 01), stripped of coating, shall withstand being bent in the direction as shown in figure 1 through 180°, without cracking on the outside of the bent portion, around the inside diameter as shown in table 3. The bend test shall be performed at ambient temperature and is described in ISO/R 85 and ISO/R 87. Small cracks on the edges of test pieces, and cracks which require magnification to be visible, shall be disregarded.

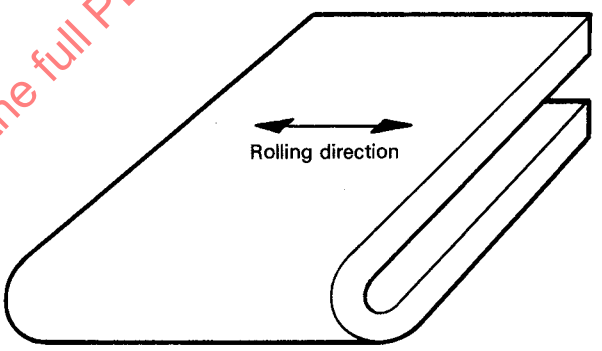

Figure 1 — Transverse bend test piece (after bending)

7.2 Coating tests

7.2.1 Triple spot test

The triple spot test result is the average coating mass found on the three specimens taken according to 6.2.1. 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 aluminium coating. See annex C. Other procedures than covered in annex C shall be permitted upon agreement by manufacturer and purchaser.

7.2.2 Single spot test

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

7.2.3 Bend test (coating)

Bend test pieces taken after coating (before additional processing) shall withstand being bent through 180° in either direction

without flaking of the coating on the outside of the bend. The radius of the bend is determined by the number of pieces of the same thickness (or mandrel equivalent) as shown in table 4. Flaking of coating within 7 mm from the edge of the test piece shall not be cause for rejection.

8 Retests

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

9 Resubmission

9.1 The manufacturer may resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after he has subjected them to a suitable treatment (selection, heat treatment) which, on request, will be indicated to the purchaser. In this case, the tests should be carried out as if they applied to a new batch.

9.2 The manufacturer has the right to present the rejected products to a new examination for compliance with the requirements for another grade.

10 Workmanship

The aluminium-silicon-coated steel sheet in cut lengths shall be free from amounts of laminations, surface flaws and other imperfections that are detrimental to subsequent appropriate processing. Processing for shipment in coils does not afford the manufacturer the opportunity to 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 Steel that is reported to be defective after arrival at the user's works shall be set aside, properly and correctly identified and adequately protected. The supplier shall be notified in order that he may properly investigate.

12 Coil size

When aluminium-silicon-coated steel sheet is ordered in coils, a minimum or range of acceptable inside diameter (I.D.) shall be specified. In addition, the maximum outside diameter (O.D.) and maximum acceptable coil mass shall be specified.

13 Marking

Unless otherwise stated, the following minimum requirements for identifying the steel shall be legibly stencilled on the top of each lift or shown on a tag attached to each coil or shipping unit :

a) the manufacturer's name or identifying brand;

b) the number of this International Standard;

c) the designation (coating, coating mass, coating condition and quality of base metal);

d) the order number;

e) the product dimensions;

f) the lot number;

g) the mass.

14 Information to be supplied by the purchaser

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

a) the number of this International Standard;

b) the name and designation of material; for example, aluminium-silicon-coated sheet, commercial quality, AS120S01 (see 1.3 and 3.2);

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

d) the application (name of part), if possible (see 4.6);

e) for drawing qualities (qualities 02, 03 and 04), whether ordered to mechanical properties (see 4.7) or to fabricate an identified part (see 4.6);

f) mill passivated, if required (see 3.5);

g) not oiled, if required (see 3.6);

h) the coil size requirements (see 12);

i) report of cast analysis, if required (see 4.3.1);

j) details of fabrication or special requirements (fluting or coating performance) (see 4.6);

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

NOTE — A typical ordering description is as follows :

International Standard ISO 5000, aluminium-silicon-coated steel sheet, drawing quality, designation AS120S02, 1,0 × 1 200 mm × Coil, 20 000 kg, exhaust pipe tubing, # 6201.

Table 2 — Mass of coating (total both sides)[1)]

Qualities for mass of coating	Coating designations	Minimum coating mass limits	
		Triple spot test check limits g/m² (of sheet)	Single spot test check limits g/m² (of sheet)
Commercial	AS300	300	240
	AS200	200	150
Commercial and drawing	AS150	150	115
	AS120	120	90
	AS100	100	75
	AS080	80	60
	AS060	60	45
	AS040	40	30

1) Because of the many variables and changing conditions that are characteristic of continuous aluminium-silicon coating, the mass of coating is not always evenly divided between the two surfaces of an aluminium-silicon-coated sheet; neither is the aluminium-silicon coating evenly distributed from edge to edge. However, it can normally be expected that not less than 40 % of the single spot check limit will be found on either surface.

Table 3 — Mechanical properties[1)] (see 4.7)

Base metal quality		R_m max.[2)] N/mm²	A min., %[3)]		180° bend mandrel diameter
Designation	Name		L_o = 50 mm	L_o = 80 mm	All thicknesses
01	Commercial	—	—	—	1 a
02	Drawing	430	24	23	Does not apply
03	Deep drawing	410	26	25	
04	Deep drawing special killed	410	29	28	

1) 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

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

3) For material up to and including 0,6 mm in thickness, the elongation values in the table shall be reduced by 2. For thicknesses up to 3,0 mm, use either L_o = 50 mm or L_o = 80 mm.

Table 4 — Coating bend test requirements

Coating designations	180° bend mandrel diameter, for			
	$e < 1,25$		$e \geqslant 1,25$	
	Commercial quality	Drawing qualities	Commercial quality	Drawing qualities
AS300	2 a	—	3 a	—
AS200	2 a	—	3 a	—
AS150	2 a	2 a	3 a	3 a
AS120	1 a	1 a	2 a	2 a
AS100	1 a	1 a	2 a	2 a
AS080	1 a	1 a	2 a	2 a
AS060	1 a	1 a	2 a	2 a
AS040	1 a	1 a	2 a	2 a

a = thickness of bend test piece

e = thickness of steel sheet, in millimetres

Table 5 — Thickness tolerances[1] for coils and cut lengths

Values in millimetres

Specified widths	Thickness tolerances[2], over and under, for specified thicknesses							
	0,4 up to and including 0,6	over 0,6 up to and including 0,8	over 0,8 up to and including 1,0	over 1,0 up to and including 1,2	over 1,2 up to and including 1,6	over 1,6 up to and including 2,0	over 2,0 up to and including 2,5	over 2,5 up to and including 3,0
600 up to and including 1 200	0,09	010	0,11	0,13	0,15	0,17	0,19	0,21
over 1 200 up to and including 1 500	0,10	0,11	0,12	0,14	0,16	0,18	0,21	0,23

1) Tolerances apply to the total thickness.

2) Thickness is measured at any point on the coated sheet not less than 40 mm from a side edge.

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

Values in millimetres

Specified widths	Tolerance
Up to and including 1 500	$^{+\ 7}_{\ 0}$

Table 7 — Length tolerances for cut lengths, not resquared

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

Table 8 — Camber tolerances for coils and cut lengths

Forms	Camber tolerance
Coils	20 mm in any 5 000 mm length
Cut lengths	0,4 % × length

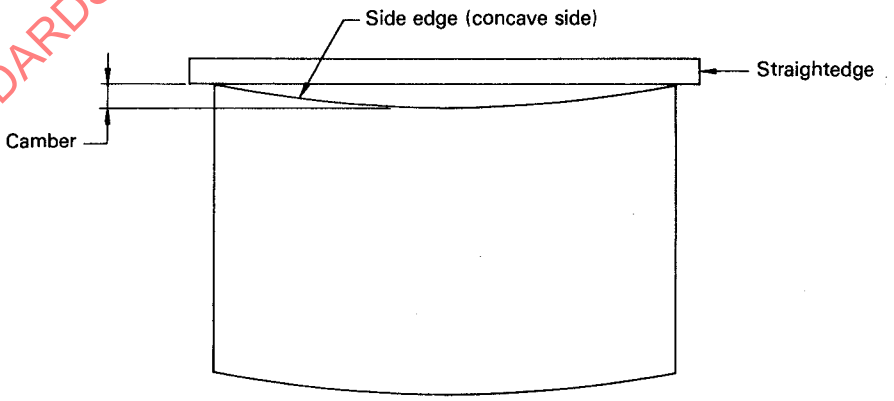

Figure 2 — Measurement of camber

Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straightedge.

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

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

Table 10 — Out-of-square tolerances for resquared sheet[1)]

Values in millimetres

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

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

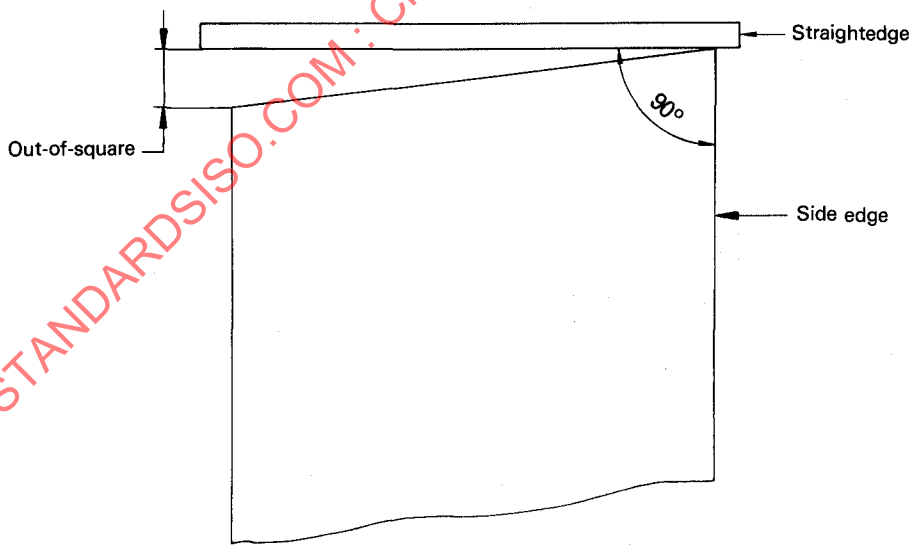

Figure 3 — Measurement of out-of-square

Out-of-square is the greatest deviation of an end edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in figure 3. It can also be measured as one half the difference between the diagonals of the cut length sheet.

Table 11 — Standard flatness tolerances[1] for cut lengths

Values in millimetres

Specified thicknesses	Specified widths	Flatness tolerance[2]
up to and including 0,7	Up to and including 1 200	15
	Over 1 200 up to and including 1 500	18
Over 0,7 up to and including 1,2	Up to and including 1 200	12
	Over 1 200 up to and including 1 500	15
Over 1,2	Up to and including 1 200	10
	Over 1 200 up to and including 1 500	12

1) These tolerances are only applicable to sheet up to and including 5 000 mm length when their thickness is 3,0 mm or less. This table also applies to sheet cut to length from coil by the customer when adequate flattening procedures are performed. Tolerances for sheet exceeding 5 000 mm in length are subject to agreement.

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

Table 12 — Special flatness tolerances[1] for cut lengths, roller levelled

Values in millimetres

Specified thicknesses	Specified widths	Specified lengths	Flatness tolerance[2]
Up to and including 2	Up to and including 1 200	Up to and including 2 500	9
	Over 1 200	Over 2 500	15
Over 2 to 3,0 inclusive	Up to and including 1 200	Up to and including 2 500	8
	Over 1 200	Over 2 500	13

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

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

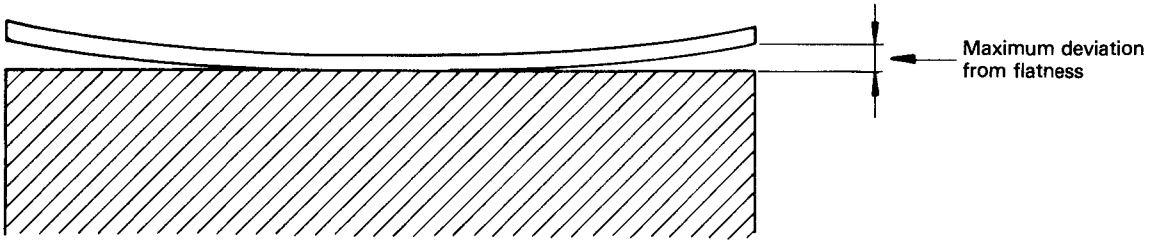

Figure 4 — Measurement of flatness

Annex A

Approximate inch conversions

(for information only)

mm	in
0,4 to 3,0	0.016 to 0.118
600 to 1 500	24 to 60

Table 13 — Mass of coating (total of both sides)[1)]
Values in oz/ft² (approximate conversions of table 2)

Qualities for mass of coating	Coating designations	Minimum coating mass limits	
		Triple spot test check limits oz/ft² (of sheet)	Single spot test check limits oz/ft² (of sheet)
Commercial	AS300	1.00	0.80
	AS200	0.66	0.50
Commercial and drawing	AS150	0.50	0.38
	AS120	0.40	0.30
	AS100	0.33	0.25
	AS080	0.25	0.20
	AS060	0.20	0.14
	AS040	0.13	0.10

1) Because of many variables and changing conditions that are characteristic of continuous aluminium-silicon coating, the mass of coating is not always evenly divided between the two surfaces of an aluminium-silicon coating sheet; neither is the aluminium-silicon coating evenly distributed from edge to edge. However, it can normally be expected that not less than 40 % of the single spot check limit will be found on either surface.

Table 14 — Thickness tolerances[1)] for coils and cut lengths
Values in inches (approximate conversions of table 5)

Specified widths	Thickness tolerances[2)], over and under, for specified thicknesses							
	0.016 up to and including 0.024	over 0.024 up to and including 0.032	over 0.032 up to and including 0.039	over 0.039 up to and including 0.047	over 0.047 up to and including 0.063	over 0.063 up to and including 0.079	over 0.079 up to and including 0.098	over 0.098 up to and including 0.118
24 up to and including 48	0.004	0.004	0.004	0.005	0.006	0.007	0.008	0.008
Over 48 up to and including 60	0.004	0.004	0.005	0.006	0.006	0.007	0.008	0.009

1) Tolerances apply to the total thickness.

2) Thickness is measured at any point on the coated sheet not less than 1.5 in from a side edge.