



5 L. 3. May, 1939.

(Cancelling B.S. Specification 4 L. 3.)

NOTE.—The Institution desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to but does not purport to comprise all the necessary provisions of a contract.

British Standards Institution.

Incorporated by Royal Charter.

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE.

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BRITISH STANDARD SPECIFICATION

FOR

ALUMINIUM ALLOY SHEETS AND COILS

FOR AIRCRAFT PURPOSES.

(Specific Gravity not greater than 2.85.)

1. **Quality of Material.** (a) The aluminium used for making this alloy shall be in accordance with the latest issue of British Standard L. 31.

(b) The copper used for making this alloy shall assay not less than 99.8 per cent.

(c) No scrap shall be used other than that derived from the Manufacturer's own manufacture.

2. **Chemical Composition.** (a) The chemical composition of the alloy shall be:—

Copper	-	-	not less than 3.5 nor more than 4.5 per cent.
Manganese	-	„ „ „	0.4 „ „ „ 0.7 per cent.
Magnesium	-	„ „ „	0.4 „ „ „ 0.8 per cent.
Silicon	-	-	not more than 0.7 per cent.
Iron	-	-	„ „ „ 0.7 per cent.
Titanium	-	-	„ „ „ 0.3 per cent.
Aluminium	-	-	the remainder.

(b) The Manufacturer shall supply, when required, the complete analysis of the alloy to the Inspector.

(c) A cast shall be defined as:—

- (i) The product of one furnace melt.
- (ii) The product of one crucible melt.
- (iii) The product of a number of crucible or furnace melts where such are aggregated and mixed prior to casting.
- (iv) Where a continuous melting process is employed, a cast shall be taken as the amount of metal tapped from the furnace without any further additions of alloying constituents having been made.
- (v) Or as otherwise defined from time to time.

3. **Heat Treatment.** (a) Unless otherwise specified on the order, sheets and coils shall be delivered in the finally heat-treated and aged condition, and in this condition before straightening must comply with the mechanical tests specified in Clause 7.

(b) The sheets and coils shall be finally heat-treated by being heated uniformly to a temperature of 495° C. plus or minus 10° C. and quenched in water or oil; they shall then be aged at room temperature for five days.

All material to be used for aeronautical purposes must give the required mechanical properties after heat-treatment at the temperature specified above. Material for other purposes may be heat-treated at different temperatures from those specified, provided that these temperatures are stated by the Manufacturer on the test certificate. On no account in workshop practice should the temperature be greater than 505° C. owing to the danger of overheating the material and rendering it brittle in consequence.

4. **Freedom from Defects.** (a) The sheets and coils shall be free from defects.

(b) Any sheet or coil may be rejected for faults in manufacture, notwithstanding that it has been passed previously on chemical composition and mechanical tests.

5. **Margins of Manufacture.** (a) The margins of manufacture on the nominal thickness of the sheets and coils shall not exceed those given in Tables 1 and 2, respectively.

(b) The margins of manufacture on the nominal width of the sheared coils shall not exceed those given in Tables 3 and 4. The class of tolerance required shall be stated on the order.

(c) Unless otherwise agreed between the Purchaser and the Manufacturer, the coil, unless ordered in short lengths, shall be so free from lateral curvature that when laid out flat no part of its edge shall be distant from a 10 foot chord by more than the following amount:—

Class A	¼ inch.
„ B	1 inch.

The class of tolerance required shall be stated on the order.

6. **Selection and Preparation of Mechanical Test Samples.** (a) *Before straightening.* All sheets or coils of the same nominal thickness made from the same cast and heat-treated together shall be grouped in parcels of not more than 50 sheets or 20 coils. Test samples shall be cut from three sheets or coils selected by the Inspector from each parcel, and one of these samples shall be submitted to the tensile test specified in Clause 7 (a). If this sample complies with the tensile test specified in Clause 7 (a) the parcel shall be accepted. The two remaining samples are to be retained for re-testing in the event of the first sample failing to meet requirements (see Clause 9 (a)).

(b) *After straightening.* All sheets or coils of the same nominal thickness from the same cast and heat-treated together shall be retained in the parcels of not more than 50 sheets or 20 coils specified in paragraph (a) above.

All sheets and coils in each parcel shall be tested for hardness by an approved method, and the values obtained must be within the limits specified in Clause 8.

For sheets or coils 12 S.W.G. (0.104 in.) or thinner, one test sample shall be selected from each parcel for the single bend test specified in Clause 7 (b); for sheets or coils thicker than 12 S.W.G. (0.104 in.) one tensile test sample shall be selected from each parcel for the elongation test specified in Clause 7 (a). If these test samples comply with the tests specified in Clause 7 (b) or (a) the parcel shall be accepted.

(c) *Annealed Sheets and Coils.* If sheets or coils are ordered to be supplied in the annealed condition, all the sheets or coils of the same nominal thickness made from the same cast and annealed together shall be grouped in parcels. From each parcel the Inspector shall select one test sample to represent the parcel. The test sample shall be heat-treated as specified in Clause 3 (b) and the test pieces prepared therefrom shall comply with the mechanical tests specified in Clause 7 (a) and (b).

(d) All test samples shall be marked as directed by the Inspector before they are cut from the sheets or coils and, unless the sheets or coils are ordered to be supplied in the annealed condition, they shall not be further heat-treated. The test samples shall not be mechanically worked before testing.

(e) The tensile test samples from all material over 12 inches wide shall be cut so that the longitudinal axis of the test piece is at right angles to the direction of final rolling. The tensile test samples from material 12 inches wide and under shall be cut so that the longitudinal axis of the test piece is parallel to the direction of rolling.

The width of the tensile test piece, where possible, shall be not less than $\frac{1}{2}$ inch and the elongation shall be measured on a gauge length of 2 inches.*

(f) All single bend test pieces shall be $\frac{1}{2}$ inch wide and shall be cut from each selected sheet or coil so that the longitudinal axis of the test piece is in a direction at right angles to the direction of final rolling. Where the width of the coil does not permit of this procedure the test piece shall be cut and bent in such a manner that the axis of the bend is in a direction at right angles to the direction of rolling. The longer edges shall be carefully rounded and smoothed so that the cross section has approximately semi-circular ends.

7. **Mechanical Tests.** The mechanical properties of the test pieces machined from the samples selected and prepared as specified in Clause 6 must comply with the following tests to the satisfaction of the Inspector:—

(a) *Tensile Test*:—

	0.1 per cent proof stress. Tons per sq. in. For material thicker than 25 S.W.G. (0.020 in.) only.	Ultimate tensile stress. Tons per sq. in.	Elongation per cent. For material thicker than 12 S.W.G. (0.104 in.) only.
Material over 12 in. wide (transverse test)	not less than 14.5	not less than 25	not less than 15
Material 12 in. wide and under (longitudinal test)	15	25	15

The load shall be applied axially. Should a tensile test piece break outside the middle half of its gauge length the test may be discarded and another test made.

(b) *Single Bend Test.* (Applicable only to sheets and coils 12 S.W.G. (0.104 in.) and thinner). Each test piece must withstand without cracking, being bent by steadily applied pressure through 180° over a former having a radius equal to three times the nominal thickness of the sheet or coil, care being taken to ensure continued contact between the test piece and the former.

8. **Hardness Test.** (a) The hardness value of the tensile test piece selected as specified in Clause 6 (a) shall be determined by an approved method, prior to the tensile test being carried out, and all sheets or coils in each parcel represented by this test piece shall be tested for hardness by the same method and under identical conditions of testing.

The minimum hardness value allowable on any sheet or coil in the parcel is X per cent below that of the tensile test piece, where the value of X depends on the ultimate tensile stress of the test piece as shown in the following table:—

When the ultimate tensile stress of the test piece is:—	Value of X.
25 to under 26 tons per sq. in. 	5 per cent
26 " " 27 " " " 	7½ "
27 " " 28 " " " 	10 "
28 and over 	12½ "

(b) If any sheet or coil is below the specified hardness it may be rejected, or at the request of the Manufacturer be submitted to the tensile test specified in Clause 7 (a). Alternatively, sheets or coils which do not give the specified hardness value may be re-heat-treated in accordance with Clause 3 (b) and re-tested in accordance with Clauses 6, 7 and 8.

9. **Re-Tests.** (a) If any test piece fails to comply with the tensile test specified in Clause 7 (a), the sheet or coil from which the test piece was taken shall be rejected and the two further samples selected as specified in Clause 6 (a) shall be submitted to the tensile test specified in Clause 7 (a). If either of these further

* A suitable test piece is shown in B.S. Specification No. 485—Tests on Thin Metal Sheet and Strip.

samples fails to pass the tensile test specified in Clause 7 (a) the parcel may be rejected or re-heat-treated in accordance with Clause 3 (b) and re-tested in accordance with Clauses 6, 7 and 8.

(b) If any single bend or elongation test piece selected as specified in Clause 6 (b) fails to comply with the single bend or elongation tests specified in Clause 7 (b) or (a) respectively the Inspector may reject the parcel represented by that test piece or, at the request of the Manufacturer, adopt either of the following procedures :—

(i) Select for test from the same parcel two other test samples, one of which must be from the sheet or coil from which the original sample was taken, unless that sheet or coil has been withdrawn by the Manufacturer. Test pieces prepared from these two further samples, as specified in Clause 6 (b), must comply with the single bend or elongation test specified in Clause 7 (b) or (a) respectively.

(ii) Allow the parcel to be re-heat-treated in accordance with Clause 3 (b) and re-tested in accordance with Clauses 6, 7 and 8.

10. **Identification.** All sheets and coils passed by the Inspector shall be identified to his satisfaction.

MARGINS OF MANUFACTURE.

Table 1. Tolerance on Thickness of Sheets.

Nominal thickness		Tolerance
Inch	S.W.G.	Inch
Thinner than 0·028	Thinner than 22	+ 0·004 - 0
0·028 to thinner than 0·048	22 to thinner than 18	+ 0·006 - 0
0·048 „ „ „ 0·092	18 „ „ „ 13	+ 0·008 - 0
0·092 „ „ „ 0·144	13 „ „ „ 9	+ 0·010 - 0
0·144 to 0·192	9 to 6	+ 0·012 - 0

For sheets over 3 feet wide an additional plus tolerance of 0·002 inch will be accepted. For sheets thicker than 6 S.W.G. (0·192 inch) the tolerance on thickness shall be plus 10 per cent, minus 0, of the nominal thickness.

Table 2. Tolerance on Thickness of Coils.

Nominal thickness		Tolerance on thickness		
Inch	S.W.G.	Maximum width of coil		
		12 inch	16 inch	20 inch
		inch	inch	inch
0·008	—	+ 0·002 - 0	—	—
0·012	—	+ 0·002 - 0	—	—
0·016	—	+ 0·002 - 0	+ 0·002 - 0	—
0·020	25	+ 0·002 - 0	+ 0·003 - 0	+ 0·003 - 0
0·022	24	+ 0·002 - 0	+ 0·003 - 0	+ 0·003 - 0
0·024	23	+ 0·003 - 0	+ 0·003 - 0	+ 0·003 - 0
0·028	22	+ 0·003 - 0	+ 0·003 - 0	+ 0·003 - 0
0·032	21	+ 0·004 - 0	+ 0·004 - 0	+ 0·004 - 0
0·036	20	+ 0·004 - 0	+ 0·004 - 0	+ 0·004 - 0
0·040	19	+ 0·004 - 0	+ 0·004 - 0	+ 0·004 - 0
Thicker than 0·040 to 0·080	Thicker than 19 to 14	+ 0·005 - 0	+ 0·005 - 0	+ 0·005 - 0
Thicker than 0·080 to 0·104	Thicker than 14 to 12	+ 0·007 - 0	+ 0·007 - 0	+ 0·007 - 0
Thicker than 0·104 to 0·144	Thicker than 12 to 9	+ 0·008 - 0	+ 0·008 - 0	+ 0·008 - 0
Thicker than 0·144 to 0·192	Thicker than 9 to 6	+ 0·010 - 0	+ 0·010 - 0	+ 0·010 - 0

Table 3. Ordinary Tolerances on Width of Sheared Coils.

1	2	3
Nominal width of coil	Nominal thickness of coil	Tolerance on width of sheared coil
Inches	Inch	Inch
¼ to 4	Up to and including 0·036 (20 S.W.G.)... ..	+ 0 - 1/32
	Over 0·036 (20 S.W.G.) and under 0·160 (8 S.W.G.)	+ 0 - 1/16
	0·160 (8 S.W.G.) and thicker	+ 0 - 3/32
Over 4 and up to 16	Under 0·128 (10 S.W.G.)	+ 0 - 1/16
	0·128 (10 S.W.G.) and thicker	+ 0 - 3/32

For coils over 16 inches wide the tolerances shall be determined by agreement between the Purchaser and the Manufacturer.

Table 4. Special Tolerances on Width of Sheared Coils.

1	2	3
Nominal width of coil	Nominal thickness of coil	Tolerance on width of sheared coil
Inches	Inch	Inch
Under 4	Under 0·032	+ 0 - 0·010
	0·032 to 0·063	+ 0 - 0·015
	0·064 to 0·127	+ 0 - 0·020
	0·128 to 0·159	+ 0 - 0·032
	0·160 to 0·232	+ 0 - 0·064
4 and under 6	Under 0·020	+ 0 - 0·010
	0·020 to 0·031	+ 0 - 0·015
	0·032 to 0·063	+ 0 - 0·020
	0·064 to 0·127	+ 0 - 0·025
	0·128 to 0·159	+ 0 - 0·032
6 and under 10	Under 0·020	+ 0 - 0·015
	0·020 to 0·031	+ 0 - 0·020
	0·032 to 0·063	+ 0 - 0·025
	0·064 to 0·127	+ 0 - 0·030
	0·128 to 0·159	+ 0 - 0·035
10 and under 16	Under 0·020	+ 0 - 0·020
	0·020 to 0·031	+ 0 - 0·025
	0·032 to 0·063	+ 0 - 0·030
	0·064 to 0·127	+ 0 - 0·035
	0·128 to 0·159	+ 0 - 0·040
0·160 to 0·232	+ 0 - 0·064	

For coils 16 inches wide and over the tolerances shall be determined by agreement between the Purchaser and the Manufacturer.

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This Specification having been approved by the Aircraft Industry Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council of the Institution as a British Standard on 22nd May, 1939.

NOTE.

In order to keep abreast of progress in the Industries concerned, the British Standards are subject to periodical review.

Suggestions for improvements, addressed to the British Standards Institution, 28 Victoria Street, London, S.W.1, will be welcomed at all times. They will be recorded and in due course brought to the notice of the Committees charged with the revision of the Publications to which they refer.

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