

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 Standard Specification for Aircraft Material.*

## HIGH TENSILE NICKEL CHROMIUM STEEL STRIPS (65-75 TONS — 0·1 PER CENT PROOF STRESS.)

This Specification covers two qualities defined as A and B, quality A having better bending properties in the hardened and tempered condition, although the tensile values are the same.

- Section 1.** Provisions applicable to all Sections of this Specification.
- Section 2.** (No Specification).
- Section 3. S. 88.—B. Softened Strips.**
- Section 4. S. 88.—C. Hardened and Tempered Strips.**

### SECTION I.

#### Provisions Applicable to all Sections of this Specification.

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

Carbon	-	-	not less than 0·25 nor more than 0·35 per cent.
Silicon	-	-	not more than 0·30 per cent.
Manganese	-	-	not more than 0·70 per cent.
Sulphur	-	-	not more than 0·05 per cent.
Phosphorus	-	-	not more than 0·05 per cent.
Nickel	-	-	not less than 3·00 nor more than 5·00 per cent.
Chromium	-	-	not less than 0·50 nor more than 1·50 per cent.

Any of the following elements may be present at the option of the Manufacturer :—

Vanadium	-	-	not more than 0·25 per cent.
Molybdenum	-	-	not more than 0·50 per cent.
Tungsten	-	-	not more than 1·00 per cent.

(b) The complete analysis of every cast shall be supplied to the Inspector.

2. **Condition.** The strips shall be supplied either:—

- (i) In the softened condition.
- (ii) In the hardened and tempered condition.

The condition required shall be specified on the order.

3. **Methods of Testing.** (a) All tests shall be carried out to the satisfaction of the Inspector.

(b) *Tensile Test.* 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.

Proof Stress determinations shall be carried out as follows:—

(i) On one test sample from each cast of steel, the proof stress shall be obtained from an accurately determined load-elongation diagram. The proof stress is defined as that stress at which the stress-strain curve departs by 0.1 per cent of the gauge length from the line of proportionality.

This sample shall be broken in tension and the ultimate tensile stress recorded on the diagram.

(ii) On all remaining tensile test samples proof stress determinations shall be carried out by an approved method.

These samples shall be broken in tension and the ultimate tensile stresses recorded.

All tensile test samples shall be cut from the selected strip so that the longitudinal axis of the test piece is in a direction parallel to the length of the strip. The tensile test pieces shall have a width of 0.5 inch in the parallel test portion and the elongation shall be measured on a gauge length of 2 inches.

(c) *Single Bend Test* (12 S.W.G. (0.104 in.) and thinner). The test piece shall be bent through 180° by steadily applied pressure round the end of a former of the specified radius. Bending may be effected by pressing the test piece into lead by means of an appropriate former, and in cases of dispute this method shall be used.

Where the specified radius is less than 0.012 inch the test piece shall first be bent round a radius of 0.012 inch and the U piece thus formed shall be subsequently closed in a vice until the inner surfaces of the bend are twice the specified radius apart, or are in general contact if the test piece is to be closed flat.

(d) *Reverse Bend Test* (12 S.W.G. (0.104 in.) and thinner). One end of each test piece shall be fixed in a vice between suitable formers the inner edges of which are rounded to a radius equal to three times the nominal thickness of the strip. The projecting length of the test piece shall then be bent at right angles to the fixed end, first to one side and then to the other until the test piece breaks. Each test piece must withstand without cracking the specified number of bends through 180°, the first bend through 90° not being counted.

The fractured surfaces must show freedom from pipe or other defect.



(e) All single bend and reverse bend test pieces shall be 0.5 inch wide and shall be cut from each selected strip so that the longitudinal axis of the test piece is in a direction at right angles to the direction of rolling. The longer edges shall be carefully smoothed and chamfered so that the cross section has approximately semi-circular ends.

The test pieces shall be bent in such a manner that the axis of the bend lies in a direction parallel to the direction of rolling. Where the width of the strip does not permit of the above procedure the test pieces 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.

(f) All test samples shall be marked as directed by the Inspector before they are cut from the strips.

4. **Freedom from Defects.** (a) The strips shall be free from defects.

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

(c) The strips shall be so free from lateral curvature that when laid out flat no part of their edges shall be distant from a 10 foot chord by more than  $\frac{1}{4}$  inch.

5. **Margins of Manufacture.** The margins of manufacture shall not exceed those given in the Table (page 7).

6. **Identification.** All strips passed by the Inspector shall be stamped with the mark of the Inspector and such other marking as shall ensure full identification of the material.

### SECTION 3.

#### S. 88.—B. Softened Strips.

7. **Selection and Preparation of Mechanical Test Samples.** (a) Strips from the same cast and softened together shall be grouped in parcels.

(b) *Strips 12 S.W.G. (0.104 in.) and thinner.* Each strip 12 S.W.G. and thinner shall be subjected to a single bend test at each end as specified in Clause 8 (A) (b) and the Inspector shall select from each parcel one strip of the thickest gauge from which test samples shall be cut for:—

(i) a tensile test and a reverse bend test as specified in Clause 8 (A). These test samples shall not be further heat-treated or mechanically worked before testing;

(ii) a tensile test and a single bend test as specified in Clause 8 (B). These test samples shall be heat-treated as follows before testing:—

The test samples shall be hardened by heating to a temperature not exceeding 860°C. and cooling in air. The test samples shall then be tempered to give the mechanical properties specified in Clause 8 (B). The method and period of heating and the temperatures used shall be stated on the test certificate.

(c) *Strips thicker than 12 S.W.G. (0.104 in.).* Each strip thicker than 12 S.W.G. shall be submitted to the Brinell (or other approved) hardness test. The Inspector shall then select from each parcel the strip giving the highest hardness number, and test samples shall be cut from this strip for the tensile tests specified in Clause 8 (A) and (B).

The test sample for the tensile test specified in Clause 8 (A) shall not be further heat-treated or mechanically worked before testing.

The test sample for the tensile test specified in Clause 8 (B) shall be heat-treated as specified in paragraph (b) (ii) above before testing.

8. **Mechanical Tests.** The mechanical properties of the test pieces machined from the samples selected and prepared as specified in Clauses 7 and 3 must comply with the following tests:—

(A) *Tests in the softened condition.* (a) *Tensile Test.*

Ultimate Tensile Stress (All thicknesses) - Not more than 47 tons per sq. in.

For strips thicker than 12 S.W.G. (0.104 in.):—

Elongation on 2 inches - - - Not less than 14 per cent.

(b) *Single Bend Test* (12 S.W.G. (0.104 in.) and thinner). The test pieces must withstand without cracking being bent as specified in Clause 3 (c) over the radius shown in the following table:—

Nominal Thickness (T) of Strip	Radius of Bend
Inch	
0.104 to 0.092	1 T
0.091 to 0.024	½ T
0.023 and thinner	To be closed flat

(c) *Reverse Bend Test* (12 S.W.G. (0.104 in.) and thinner). The test pieces must withstand without cracking two bends in the manner specified in Clause 3 (d).

(B) *Tests on the hardened and tempered samples.* (a) *Tensile Test.*

Proof stress (All thicknesses) - not less than 65 nor more than 75 tons per sq. in.

For strips thicker than 12 S.W.G. (0.104 in.):—

Elongation on 2 inches - - - not less than 5 per cent.

(b) *Single Bend Test* (12 S.W.G. (0.104 in.) and thinner). The test pieces must withstand without cracking being bent as specified in Clause 3 (c) over the appropriate radius as shown in the following tables:—

**QUALITY A.**

Nominal Thickness (T) of Strip	Radius of Bend
Inch	
0.104 to 0.064	5 T
0.063 to 0.040	4 T
0.039 to 0.024	3 T
0.023 and thinner	2 T

**QUALITY B.**

Nominal Thickness (T) of Strip	Radius of Bend
Inch	
0.104 to 0.024	5 T
0.023 and thinner.	3 T

9. **Re-tests.** (a) If any test piece fails to comply with the mechanical tests specified in Clause 8 (A), 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 samples, one of which must be from the strip from which the original test sample was taken unless that strip has been withdrawn by the Manufacturer. Test pieces prepared from these two further samples as specified in Clauses 7 and 3, must comply with the mechanical tests specified in Clause 8 (A).

(ii) Allow the parcel of strips to be re-softened and re-tested in accordance with Clauses 3, 7 and 8 (A).



(b) If any test piece fails to comply with the mechanical tests specified in Clause 8 (B), the Inspector may reject the parcel represented by that test piece, or at the request of the Manufacturer select for test from the same parcel two other samples, one of which must be from the strip from which the original test sample was taken unless that strip has been withdrawn by the Manufacturer. Test pieces prepared from these two further samples as specified in Clauses 7 and 3 must comply with the mechanical tests specified in Clause 8 (B).

#### SECTION 4.

##### S. 88.—C. Hardened and Tempered Strips.

10. **Heat Treatment.** (a) Strips supplied in the hardened and tempered condition shall be hardened by heating to a temperature not exceeding 860° C. and cooling in a suitable manner. They shall then be tempered to comply with the mechanical properties specified in Clause 12.

(b) The final hardening and tempering shall be carried out by the continuous or other approved heat treatment process and not in the coil.

11. **Selection and Preparation of Mechanical Test Samples.** (a) The Inspector shall select one tensile test sample from each strip for the tensile test specified in Clause 12 (a). These samples shall not be further heat-treated or mechanically worked before testing.

Each strip 12 S.W.G. (0.104 in.) and thinner shall be subjected to a single bend test at each end as specified in Clause 12 (b).

(b) *Strips (12 S.W.G. (0.104 in.) and thinner).* Strips 12 S.W.G. and thinner from the same cast shall be grouped in parcels. One reverse bend test piece shall be selected by the Inspector from one strip of the thickest gauge in each parcel for the reverse bend test specified in Clause 12 (c). The reverse bend test may be carried out on a softened test sample. This sample may be cut from the selected strip before the material is hardened and tempered or the test sample may be cut from the strip and softened before testing.

12. **Mechanical Tests.** The mechanical properties of the test pieces machined from the samples selected and prepared as specified in Clauses 11 and 3, must comply with the following tests:—

(a) *Tensile Test.*

0.1 per cent Proof Stress (All thicknesses) - not less than 65 nor more than 75 tons per sq. in.

For strips thicker than 12 S.W.G. (0.104 in.):—

Elongation on 2 inches - - - - - not less than 5 per cent.

(b) *Single Bend Test (12 S.W.G. (0.104 in.) and thinner).* The test pieces must withstand without cracking being bent as specified in Clause 3 (a) over the radius shown in the following tables:—

##### QUALITY A.

Nominal Thickness (T) of Strip	Radius of Bend
Inch	
0.104 to 0.064	5 T
0.063 to 0.040	4 T
0.039 to 0.024	3 T
0.023 and thinner	2 T

**QUALITY B.**

Nominal Thickness (T) of Strip	Radius of Bend
Inch	
0.104 to 0.024	5 T
0.023 and thinner	3 T

(c) *Reverse Bend Test* (12 S.W.G. (0.104 in.) and thinner). The softened test pieces must withstand without cracking two bends in the manner specified in Clause 3 (d).

13. **Re-tests.** (a) If any tensile or single bend test piece fails to comply with the mechanical tests specified in Clause 12 (a) or (b), the Inspector may reject the strip represented by that test piece, or, at the request of the Manufacturer, allow the strip to be re-heat-treated in accordance with Clause 10 and re-tested in accordance with Clauses 3, 11 and 12.

(b) If any reverse bend test piece fails to comply with the test specified in Clause 12 (c), the Inspector may reject the parcel represented by that test piece or, at the request of the Manufacturer, select for test from the same parcel two other samples, one of which must be from the strip from which the original test sample was taken unless that strip has been withdrawn by the Manufacturer. Test pieces prepared from these two further samples as specified in Clauses 3 and 11 must comply with the reverse bend test specified in Clause 12 (c).

MARGINS OF MANUFACTURE.

1	2	3	4		5	
			Tolerance on Thickness			
Nominal Width	Tolerance on Sheared Width	Nominal Thickness	Centre portion		Edges (12½ per cent of the total width on each side after shearing)	
inch	inch	inch	inch		inch	
Under 4	+0 -·010	Under 0·020	+·0010	-0	+·0010	-·0005
	+0 -·010	0·020 to 0·031	+·0015	-0	+·0015	-·0005
	+0 -·015	0·032 to 0·047	+·0020	-0	+·0020	-·0005
	+0 -·015	0·048 to 0·063	+·0025	-0	+·0025	-·0010
	+0 -·020	0·064 to 0·091	+·0030	-0	+·0030	-·0010
	+0 -·020	0·092 to 0·127	+·0035	-0	+·0035	-·0015
	+0 -·025	0·128 to 0·159	+·0040	-0	+·0040	-·0015
	+0 -·025	0·160 to 0·191	+·0045	-0	+·0045	-·0015
	+0 -·030	0·192 to 0·232	+·0050	-0	+·0050	-·0020
4 and under 6	+0 -·010	Under 0·020	+·0010	-0	+·0010	-·0005
	+0 -·015	0·020 to 0·031	+·0015	-0	+·0015	-·0010
	+0 -·020	0·032 to 0·047	+·0020	-0	+·0020	-·0010
	+0 -·020	0·048 to 0·063	+·0025	-0	+·0025	-·0015
	+0 -·025	0·064 to 0·091	+·0030	-0	+·0030	-·0015
	+0 -·025	0·092 to 0·127	+·0035	-0	+·0035	-·0020
	+0 -·030	0·128 to 0·159	+·0040	-0	+·0040	-·0020
	+0 -·030	0·160 to 0·191	+·0045	-0	+·0045	-·0020
	+0 -·035	0·192 to 0·232	+·0050	-0	+·0050	-·0025
6 and under 10	+0 -·015	Under 0·020	+·0015	-0	+·0015	-·0010
	+0 -·020	0·020 to 0·031	+·0020	-0	+·0020	-·0010
	+0 -·025	0·032 to 0·047	+·0020	-0	+·0020	-·0015
	+0 -·025	0·048 to 0·063	+·0030	-0	+·0030	-·0015
	+0 -·030	0·064 to 0·091	+·0040	-0	+·0040	-·0020
	+0 -·030	0·092 to 0·127	+·0045	-0	+·0045	-·0025
	+0 -·035	0·128 to 0·159	+·0050	-0	+·0050	-·0025
	+0 -·035	0·160 to 0·191	+·0055	-0	+·0055	-·0030
	+0 -·040	0·192 to 0·232	+·0060	-0	+·0060	-·0030
10 and under 16	+0 -·020	Under 0·020	+·0015	-0	+·0015	-·0010
	+0 -·025	0·020 to 0·031	+·0025	-0	+·0025	-·0010
	+0 -·030	0·032 to 0·047	+·0025	-0	+·0025	-·0015
	+0 -·030	0·048 to 0·063	+·0035	-0	+·0035	-·0015
	+0 -·035	0·064 to 0·091	+·0045	-0	+·0045	-·0020
	+0 -·035	0·092 to 0·127	+·0050	-0	+·0050	-·0025
	+0 -·040	0·128 to 0·159	+·0055	-0	+·0055	-·0025
	+0 -·040	0·160 to 0·191	+·0060	-0	+·0060	-·0030
	+0 -·045	0·192 to 0·232	+·0065	-0	+·0065	-·0030
16 to 24 inclusive	+0 -·020	Under 0·020	+·0020	-0	+·0020	-·0015
	+0 -·025	0·020 to 0·031	+·0030	-0	+·0030	-·0015
	+0 -·030	0·032 to 0·047	+·0035	-0	+·0035	-·0015
	+0 -·035	0·048 to 0·063	+·0035	-0	+·0035	-·0015
	+0 -·040	0·064 to 0·091	+·0045	-0	+·0045	-·0020
	+0 -·040	0·092 to 0·127	+·0050	-0	+·0050	-·0025
	+0 -·045	0·128 to 0·159	+·0060	-0	+·0060	-·0025
	+0 -·045	0·160 to 0·191	+·0065	-0	+·0065	-·0030
	+0 -·050	0·192 to 0·232	+·0070	-0	+·0070	-·0030

This Specification having been approved by the Aircraft Industry Committee and endorsed by the Chairman of the Engineering Divisional Council, was published by the authority of the General Council of the Institution as a British Standard on 24th February, 1936.

NOTE.

*In order to keep abreast of progress in the Industries concerned, the British Standard Specifications are subjected 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 Specifications to which they refer.*