

JUNE, 1942.

1358

EMERGENCY STANDARD
No. (E) 2D.506—1942
(Superseding No. (E) D.506—1940)
Being British Standards Institution
Specification for Aircraft Material
B.S. No. 3 S. 21*
endorsed without amendment.

STANDARDS ASSOCIATION OF AUSTRALIA.

Headquarters :
Science House, Gloucester and Essex Streets, Sydney.

AUSTRALIAN STANDARD SPECIFICATION FOR AIRCRAFT MATERIAL
(Emergency Series).

“20” CARBON STEEL
(Suitable for Welding)

This standard forms one of a series prepared by the Standards Association of Australia at the request of Departments of the Commonwealth Government for use in relation to the supply of materials required for defence purposes. In appropriate cases these specifications will be reviewed for inclusion in the normal series of Australian standards.

First Issued - - - April, 1940
Revised - - - May, 1942

The term “forging” in this Specification includes forgings and drop forgings.

- Section I. Provisions applicable to all Sections of this Specification.**
Section II. S. 21-A. Bars and Billets for Forging.
Section III. S. 21-B. Bars for Machining.
Section IV. S. 21-C. Forgings.
Section V. (No specification.)

SECTION I.

Provisions applicable to all Sections of this Specification.

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

Carbon	- - -	not more than 0.25 per cent.
Silicon	- - -	not more than 0.30 per cent.
Manganese	- - -	not more than 1.0 per cent.
Sulphur	- - -	not more than 0.05 per cent.
Phosphorus	- - -	not more than 0.05 per cent.
Nickel (if present)	- - -	not more than 0.3 per cent.

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

2. **Mechanical Tests.** (a) All tests shall be carried out to the satisfaction of the Inspector.

- (b) The mechanical properties of the material shall be as follows :

Ultimate Tensile Stress	-	not less than 25 nor more than 35 tons per square inch.
Elongation	- - -	not less than 25 per cent.†

* In order to avoid confusion it is recommended that this specification be referred to by its British classification No. 3 S. 21, by which it is already well known.

† *Note.*—When the material is supplied in the cold drawn condition the elongation value obtained shall be not less than 17 per cent.

(c) *Tensile Test.* The tensile test pieces shall be machined from the selected samples to the dimensions of the British Standard Tensile Test Piece, Fig. 1 of British Standard Specification 2 A. 4, or, if the samples are too small, they shall be machined to the dimensions shown in Figs. 2, 3 or 4 thereof.

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.

3. **Freedom from Defects.** (a) The material shall be free from defects.

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

SECTION II.

S. 21-A. Bars and Billets for Forging.

4. **Rough Machining.** All surface defects in the bars or billets which might produce defects in the forgings made therefrom shall be removed by rough machining, chipping, grinding, or other approved process.

5. **Margins of Manufacture.** Margins of manufacture, when required, shall be specified on the order.

6. **Heat Treatment.** (a) All bars and billets shall be delivered as rolled or forged.

(b) The test samples selected as specified in Clause 7 (a) shall be normalised from a temperature of not less than 880° C. and not more than 910° C. to give the tensile values specified in Clause 2.

7. **Selection and Preparation of Mechanical Test Samples.** (a) The Inspector shall select one sample from a bar or billet in each cast for mechanical testing. The sample shall be of sufficient length to allow of the preparation of the tensile test piece specified in Clause 2. The diameter of the test sample shall be not less than the ruling thickness of the forgings which are to be manufactured from the bars or billets, and this diameter shall be stated on the order. The test samples shall be prepared as specified in Clause 20 A (b) and shall be heat treated as specified in Clause 6 (b) before testing. For the purpose of all subsequent orders, this test sample will be accepted as representing all sizes of bars and billets from the same cast where the specified diameter of test sample does not exceed that of the sample already tested and approved under this clause.

(b) The test pieces shall be machined from the test samples as specified in Clause 20 A (c).

8. **Mechanical Tests.** The test pieces machined from the samples selected and prepared as specified in Clause 7 must comply with the tensile test specified in Clause 2.

9. **Re-tests.** If any test piece fails to comply with the tensile test specified in Clause 2, the Inspector may reject the bars or billets represented by that test piece, or at the request of the manufacturer, select for test from the same cast two other samples, one of which must be from the bar or billet from which the original test sample was taken, unless that bar or billet has been withdrawn by the manufacturer. Test pieces prepared from these two further samples as specified in Clause 7 must comply with the tensile test specified in Clause 2.

10. **Identification.** (a) All bars under $\frac{3}{4}$ inch diameter or width across flats and from the same cast, passed by the Inspector, shall be wired up in bundles which shall bear a tag stamped with the mark of the Inspector and such other marking as shall ensure full identification of the material.

(b) All billets and bars $\frac{3}{4}$ inch diameter or width across flats and over, 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. All stamping shall be done at one extreme end of each bar or billet.

SECTION III.

S. 21-B. Bars for Machining.

11. **Rough Machining.** All surface defects in the ingots or blooms which might produce defects in the bars made therefrom shall be removed by rough machining, chipping, grinding or other approved process.

12. **Margins of Manufacture.** The margins of manufacture shall be specified on the order.

13. **Straightness.** (a) All black bars shall be commercially straight.

(b) All bright bars shall be straight.

14. **Heat Treatment.** The bars shall be delivered as rolled or forged, or cold drawn.

15. **Selection and Preparation of Mechanical Test Samples.** (a) Bars from the same cast shall be grouped in parcels of not more than 100.

The Inspector shall select one test sample from the largest size of bar in each parcel for mechanical testing. The sample shall be of sufficient length to allow of the preparation of the tensile test piece specified in Clause 2.

(b) (i) For bars up to and including $1\frac{1}{8}$ inches diameter or minor sectional dimension, the tensile test piece shall be machined concentrically from the test sample.

(ii) For bars over $1\frac{1}{8}$ inches and up to and including $2\frac{1}{2}$ inches diameter or minor sectional dimension, the longitudinal axis of the tensile test piece shall be not less than $\frac{9}{16}$ inch from the surface of the test sample.

(iii) For bars over $2\frac{1}{2}$ inches diameter or minor sectional dimension, the longitudinal axis of the tensile test piece shall coincide with a position half-way between the centre and outside of the test sample.

(c) The test samples shall be marked as directed by the Inspector before they are cut from the bars and shall not be further heat treated or mechanically worked before testing.

16. **Mechanical Tests.** The test pieces machined from the samples selected as specified in Clause 15 must comply with the tensile test specified in Clause 2.

17. **Re-tests.** If any test piece fails to comply with the tensile test specified in Clause 2, the Inspector may reject the parcel represented by that test piece, or at the request of the manufacturer, adopt the following procedure :

Select for test from the same parcel two other samples one of which must be from the bar from which the original test sample was taken unless that bar has been withdrawn by the manufacturer. Test pieces prepared from these two further samples, as specified in Clause 15, must comply with the tensile test specified in Clause 2.

18. **Identification.** (a) All bars under $\frac{3}{4}$ inch diameter or width across flats and from the same cast, passed by the Inspector, shall be wired up in bundles which shall bear a tag stamped with the mark of the Inspector and such other marking as shall ensure full identification of the material.

(b) All bars $\frac{3}{4}$ inch diameter or width across flats and over, 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. All such stamping shall be done at one extreme end of each bar.

SECTION IV.

S. 21-C. Forgings.

19. **Heat Treatment.** (a) The forgings shall be delivered in the normalised condition, unless otherwise specified on the order.

(b) The forgings and the test samples, selected and prepared as specified in Clause 20, shall be normalised together. They shall be normalised from a temperature of not less than 880° C. and not more than 910° C. to give the tensile values specified in Clause 2.

(c) No forging or test sample shall be re-normalised more than three times.

20. **Selection and Preparation of Mechanical Test Samples.** A. *General Procedure.*
(a) The test samples shall be prepared from the bars or billets from which the forgings are made. They shall be marked as directed by the Inspector and shall be normalised with the forgings they represent. They shall be of sufficient length to allow of the preparation of the tensile test piece specified in Clause 2 and shall be selected as follows :

Forgings under 10 lb. One test sample, unless more are specified on the order, shall be provided for testing from each parcel of forgings of the same type, from the same cast and normalised together.

Forgings of 10 lb. and over. One test sample, unless more are specified on the order, shall be provided for testing from each parcel of 100 forgings of the same type, from the same cast and normalised together.

(b) The test samples may be heat treated in the size as cut from the bars or billets or they may be forged and/or machined to the ruling thickness of the forgings and heat treated in that size. Where it is necessary to remove the surface, they shall be heat treated as near that size as possible.

(c) (i) For test samples up to and including $1\frac{1}{8}$ inches diameter or minor sectional dimension, the tensile test piece shall be machined concentrically from the test samples.

(ii) For test samples over $1\frac{1}{8}$ inches and up to $2\frac{1}{2}$ inches diameter or minor sectional dimension, the longitudinal axis of the tensile test piece shall be not less than $\frac{9}{16}$ inch from the surface of the test samples.

(iii) For test samples over $2\frac{1}{2}$ inches diameter or minor sectional dimension, the longitudinal axis of the tensile test piece shall coincide with a position half-way between the centre and surface of the test sample.

B. The test samples cut from forgings. (a) When the order states that test samples shall be cut from the actual forgings, the test samples shall be of sufficient length to allow of the preparation of the tensile test piece specified in Clause 2, and shall be taken from a part of the forging representing the ruling thickness, and prepared as specified in paragraph A above.

(b) When the forgings are under 10 lb. in weight, one forging shall be provided for testing from each parcel of forgings of the same type, from the same cast and normalised together.

(c) When the forgings are 10 lb. and over in weight, one forging shall be provided for testing from each parcel of 100 forgings of the same type, from the same cast and normalised together.

(d) The test samples shall not be further heat treated or mechanically worked before testing.

21. **Mechanical Tests.** The test pieces machined from the samples selected and prepared as specified in Clause 20 must comply with the tensile test specified in Clause 2.

22. **Re-tests.** A. *General Procedure.* (i) If any test piece selected and prepared as specified in Clause 20 A fails to comply with the tensile test specified in Clause 2, the Inspector may reject the parcel represented by that test piece or, at the request of the manufacturer, adopt either of the following procedures :

(a) Select for test two other test samples which have been normalised with the parcel of forgings. Test pieces prepared from these two further samples, as specified in Clause 20 A, must comply with the tensile test specified in Clause 2.

(b) Allow the parcel to be re-normalised and re-tested in accordance with Clauses 20 (a) and 21.

(ii) Failing the provision of the necessary test samples to permit of the re-test in paragraph A above, the re-tests may be made on test samples cut from forgings as specified in paragraph B below.

B. *Test Samples Cut from Forgings.* If any test piece machined from a test sample cut from the actual forging fails to comply with the tensile test specified in Clause 2, the Inspector may reject the forgings represented by the test piece or, at the request of the manufacturer, adopt either of the following procedures :

(i) Select for test two other forgings from the same parcel. Test pieces prepared from these two further forgings as specified in Clause 20 B must comply with the tensile test specified in Clause 2.

(ii) Allow the parcel to be re-normalised and re-tested in accordance with Clauses 20 B and 21.

23. **Identification.** (a) *Forgings under 10 lb.* All forgings under 10 lb., passed by the Inspector, shall be made into parcels which shall bear a tag stamped with the mark of the Inspector, and such other marking as shall ensure full identification of the material.

(b) *Forgings of 10 lb. and over.* All forgings 10 lb. and over, 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. All stamping must be done wherever it is least liable to be detrimental to the forging.

SECTION V.

(No Specification.)

For the purposes of this specification as an Australian standard the term "Inspector" shall be interpreted in the manner directed by the Australian Airworthiness Authority concerned.

This specification, prepared by the Special Committee on Aircraft Materials and Components, was approved on behalf of the Council of the Association on 20th June, 1942.

NOTE.

In order to keep abreast of progress in the industries concerned, Australian standards are subject to periodical review. Suggestions for improvement, addressed to the Headquarters of the Association, will be welcomed.