

AUGUST, 1942

EMERGENCY STANDARD
No. (E) D. 533—1942

*For Commercial Steel
and Forge Co 533*

(S.A.E. 2330)

STANDARDS ASSOCIATION OF AUSTRALIA.

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

AUSTRALIAN STANDARD SPECIFICATION FOR AIRCRAFT MATERIAL
(Emergency Series)

* 3 1/2% NICKEL STEEL.

For Bars up to and including 1 1/2 in. Diameter or Minimum Nominal Dimension.

- Section I. Provisions Applicable to all Sections of this Specification.
- Section II. (E) D. 533-A. "As Rolled" Bars.
- Section III. (E) D. 533-B. Finally Heat-Treated Bars for Machining.
- Section IV. (E) D. 533-C. Forgings.

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 or defence purposes. In appropriate cases these specifications will be reviewed for inclusion in the normal series of Australian standards.



SECTION I.

Provisions Applicable to all Sections of this Specification.

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

Carbon	...	...	...	...	...	0.25 to 0.35%
Manganese	...	...	...	...	...	0.50 to 0.80%
Phosphorus	...	...	...	...	...	0.05% maximum
Sulphur	...	...	...	...	...	0.05% "
Nickel	...	...	...	...	...	3.25 to 3.75%
Silicon	...	...	...	...	...	0.15 to 0.30%

(b) The complete analysis of every cast shall be supplied by the steel-maker.

2. Inspection of Blooms. Every bloom shall be inspected at both ends and any showing signs of pipe shall be rejected or cut back to sound metal. One of the top end blooms so passed shall be examined by sulphur-printing or deep etching and if any harmful segregation is noticed, all of the top end blooms in the heat shall be similarly examined.

3. Manufacture. All surface defects in the blooms, billets or bars which might produce defects in the bars or forgings made therefrom shall be removed by rough machining, chipping, grinding, or scarfing.

4. Condition. Bars shall be delivered in the "as rolled" condition ((E) D. 533-A.) or in the finally heat-treated condition ((E) D. 533-B.), as stated on the order. Parts made from "as rolled" bars shall be finally heat-treated to give the properties specified in Clause 5.

*This specification applies only to bars up to and including 1 1/2 in. diameter or minimum nominal dimension. Where a 55-65 ton steel is required in sizes larger than this, it is recommended that British Standard No. 4S.11 (endorsed as Australian Standard No. (E) D. 502—1940) be used.

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5. Mechanical Properties. Test pieces selected and prepared in accordance with Clauses 6, 8, 13 and 22 shall comply with the following tests:

- (a) (i) Ultimate Tensile Strength not less than 55 tons per sq. in. nor more than 65 tons per sq. in.
- (ii) 0.1% Proof Stress not less than 45 tons per sq. in.
- (iii) Elongation on gauge length $4\sqrt{A}$ not less than 18%
- (iv) Izod value (test on 120 ft. lb. machine) not less than 35 ft. lb.
- (v) Nicked fracture test see Clauses 15 and 24.

(b) When the dimension of the test sample for the notched bar test is too small to make one of the B.S. Izod test pieces, the nicked fracture test (Clauses 15 and 24) shall be substituted for the Izod test.

6. Preparation of Mechanical Test Pieces. (a) Test pieces shall be prepared from the samples specified in Clauses 8, 13 and 22 to the dimensions shown in the latest issue of British Standard No. A. 4, and shall not be further heat-treated or mechanically worked before testing.

(b) The tensile and Izod test pieces shall be machined concentrically from the test sample.

(c) Should any test piece break outside the middle half of the gauge length, the test may be discarded and another test made.

(d) All test pieces shall be marked in such a way as will positively identify them with the parcel of material they represent.

SECTION II.

(E) D. 533-A. "As Rolled" Bars.

(For subsequent heat-treatment).

7. Margins of Manufacture. (a) The margins of manufacture shall be in accordance with the order to the steel-maker.

(b) All bars shall be commercially straight.

8. Selection and Preparation of Test Samples. (a) From each cast two bars shall be selected for testing.

(b) One test sample shall be taken from each bar selected. The test samples shall be of sufficient size to enable the tensile and notched bar test pieces both to be machined from the one sample. The test samples shall be heat-treated to give the properties specified in Clause 5.

Details of the heat-treatment given shall be supplied by the manufacturer.

(c) Test samples shall be marked in such a way as will positively identify them with the bars from which they are taken.

9. Re-tests and Rejection of Material. (a) If any test piece fails to meet the requirements of Clause 5:

- (i) the manufacturer may withdraw the parcel represented by the test piece, or
- (ii) two further samples from the same parcel may be selected, one sample of which shall be from the bar from which the original test piece was taken unless that bar has been withdrawn by the manufacturer; if either sample fails to meet the requirements of Clause 5, the parcel shall be rejected.

(b) Any bar may be rejected for faults in manufacture notwithstanding that it has been passed previously for chemical composition and physical properties.

10. Identification. (a) Each bar shall, unless otherwise agreed between the manufacturer and the purchaser, be colour identified in accordance with the provisions of Australian Standard No. (E) D. 500*.

(b) All bars under 1 in. nominal dimension shall be wired up in bundles to each of which shall be securely attached a durable tag bearing such marks as will ensure identification of the bars with this specification, with the cast and heat-treatment batch numbers and with the manufacturer.

(c) Each bar 1 in. and over in any sectional dimension shall be stamped near one end or marked on the colour band with such marks as will ensure identification of the bars with this specification, with the cast and heat-treatment batch numbers and with the manufacturer.

*A.S. No. (E) D. 500, "Colour Identification of Metallic Materials for Aircraft," in course of preparation.

SECTION III.

(E) D. 533-B. Finally Heat-Treated Bars for Machining.

11. Margins of Manufacture. (a) The margins of manufacture shall be in accordance with the order to the steel-maker.

(b) All bars shall be commercially straight.

12. Heat-Treatment. (a) All black bars shall be hardened and tempered after rolling. All bright bars shall be hardened and tempered either before or after the bars are cold rolled, drawn or ground to size.

(b) Details of the heat-treatment given shall be supplied by the manufacturer.

13. Selection and Preparation of Test Samples. (a) Bars of the same size from the same cast and heat-treated together shall be grouped in parcels of not more than one ton weight.

(b) (i) For bars of $\frac{1}{2}$ in. nominal dimension and over, each bar shall be tested for hardness.

(ii) For bars under $\frac{1}{2}$ in. nominal dimension, 10% of each parcel shall be tested for hardness.

(iii) Two test samples representing each parcel shall be selected, one from the hardest bar and one from the softest bar as determined in (i) and (ii) of this sub-clause. The test samples shall be of sufficient size to enable the tensile and notched bar test pieces both to be machined from the one sample.

(c) Test samples shall be marked in such a way as will positively identify them with the bar from which they are taken.

14. Hardness Test. The hardness number of all bars tested in accordance with Clause 13 (b) above shall be between 241 and 293 Brinell (3.90 mm. and 3.55 mm.) or equivalent on the scale of the method adopted.

15. Nicked Fracture Test. (a) Ten per cent of all bars for machining shall be subjected to the nicked fracture test. If any bars are found unsatisfactory, all bars of that parcel shall be tested, or the parcel may be re-heat-treated and re-submitted for inspection and testing.

(b) The test piece, nicked or sawn so that the area of the portion to be fractured is not less than one half of the sectional area of the sample, shall show a fibrous structure and be free from defects when broken by a minimum number of blows.

16. Re-tests and Rejection of Material. (a) If the material fails to meet the requirements of Clause 5, the manufacturer may:

(i) withdraw the parcel represented by the test piece, or

(ii) re-heat-treat the whole parcel and re-submit it for inspection and testing. If the material again fails to meet the requirements of Clause 5, the parcel shall be rejected.

(b) Any material may be rejected for faults in manufacture notwithstanding that it has been passed previously for chemical composition and physical properties.

17. Identification. (a) Each bar shall, unless otherwise agreed between the manufacturer and the purchaser, be colour identified in accordance with the provisions of A.S. No. (E)D. 500*.

(b) All bars under 1 in. nominal dimension shall be wired up in bundles to each of which shall be securely attached a durable tag bearing such marks as will ensure identification of the bars with this specification, with the cast and heat-treatment batch numbers and with the manufacturer.

(c) Each bar 1 in. and over in any sectional dimension shall be stamped near one end or marked on the colour band with such marks as will ensure identification of the bars with this specification, with the cast and heat-treatment batch numbers and with the manufacturer.

SECTION IV.

(E) D. 533-C. Forgings.

18. Material. The bars for the manufacture of forgings shall comply with Sections I and II of this specification.

19. Margins of Manufacture. The dimensions of the forgings shall be within the limits specified on the relevant drawings.

*A.S. No. (E)D.500, "Colour Identification of Metallic Materials for Aircraft," in course of preparation.

20. Surface Treatment. The forgings shall be descaled by an approved process and subsequently treated to prevent corrosion.

21. Heat-Treatment. (a) All forgings shall be hardened and tempered to give the properties specified in Clause 5.

(b) Details of the heat-treatment given shall be supplied by the manufacturer.

22. Selection and Preparation of Test Samples. (a) One test sample, unless more are specified on the order, shall be selected to represent each half ton or less of forgings to the same drawing number, from the same cast and heat-treated together.

(b) (i) The test sample shall, where possible, be cut from the actual forging or from a prolongation forged integrally and heat-treated with the forging. Test samples integral with forgings should preferably not be cut off until after final heat-treatment.

(ii) Where samples cannot be cut from forgings they shall be taken from the bars from which the forgings were made and shall be heat-treated with the forgings they represent.

(iii) The test samples may be heat-treated in the size as cut from the bars, or they may be reduced to the ruling thickness of the forgings and heat-treated in that size. Where it is necessary to remove the surface, it shall be done with the minimum reduction of section.

(iv) The test samples shall be of sufficient size to enable the tensile and notched bar test pieces both to be machined from the one sample.

All test samples shall be heat-treated with the forgings or rough machined parts they represent to give the properties specified in Clause 5.

(c) Test samples shall be marked in such a way as will positively identify them with the forgings they represent.

23. Hardness Test. (a) All finally heat-treated forgings, or machined parts made therefrom, shall be tested for hardness by an approved method and in such a position (as indicated on the drawing) that the serviceability of the part is not affected.

(b) The hardness numbers shall be between 241 and 293 Brinell, (3.90 mm. and 3.55 mm.) or equivalent on the scale of the method adopted.

24. Nicked Fracture Test. The test piece, nicked or sawn so that the area of the portion to be fractured is not less than one half of the sectional area of the sample, shall show a fibrous structure and be free from defects when broken by a minimum number of blows.

25. Re-tests and Rejection of Material. (a) If the material fails to meet the requirements of Clause 5, the manufacturer may:

(i) withdraw the parcel represented by the test piece, or

(ii) re-heat-treat the whole parcel and re-submit it for inspection and testing. If the material again fails to meet the requirements of Clause 5, the parcel shall be rejected.

(b) Any material may be rejected for faults in manufacture notwithstanding that it has been passed previously for chemical composition and physical properties.

26. Identification. (a) All forgings under 10 lb. weight, of the same part number, from the same cast and heat-treated together, shall be made up into parcels to each of which shall be securely attached a durable tag bearing the part number and such other marks as will ensure identification of the forgings with this specification, with the cast and heat-treatment batch numbers and with the manufacturer.

(b) All forgings of 10 lb. weight or over shall be stamped, in the position indicated on the relevant drawing, with the part number and such other marks as will ensure identification of the forging with this specification, with the cast and heat-treatment batch numbers and with the manufacturer.

This specification, prepared by the Special Committee on Aircraft Materials and Components, was approved on behalf of the Council of the Association on 21st July, 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.