Inspector-in-Charge A.I.D.
Commercial Steels & Forge Pty. Ltd.
Lidcombe.

APRIL, 1941

EMERGENCY STANDARD
No. (E)D.523—1941
Being British Standards Institution
Specification for Aircraft Material
B.S. No. S. 80 *
endorsed without amendment

STANDARDS ASSOCIATION OF AUSTRALIA.

Headquarters :

Science House, Gloucester and Essex Streets, Sydney.

AUSTRALIAN STANDARD SPECIFICATION FOR AIRCRAFT MATERIAL

(Emergency Series)

HIGH CHROMIUM STEEL (NON-CORROSIVE)

(55 tons per sq. in.)

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.

NOTE.—Attention is directed to the general effect of surface condition upon the liability to corrosion of steel to this Specification. The maximum resistance is offered by a polished surface of material which is in the undistorted condition and metallically clean. The more roughly the surface is machined the more this resistance is impaired.

The heat-treatment temperatures specified have been selected as representing an average figure for general practice for the particular class of material, and are given in the Specification as guides. Where variation from the specified figures is found to be necessary the exact temperature must be stated in the test report.

SECTION I.

Provisions applicable to all Sections of this Specification.

1. **Chemical Analysis.** (*a*) The steel shall contain :

Carbon	- - - -	not more than 0·25 per cent.
Silicon	- - - -	not more than 0·50 per cent.
Manganese	- - -	not more than 1·0 per cent.
Nickel	- - - -	not less than 1·0 per cent.
Chromium	- - -	between 16·0 and 20·0 per cent.

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

2. **Mechanical Tests.** (*a*) The mechanical properties obtained from test pieces selected and prepared as specified in the appropriate Clause 7, 15 or 20 shall be as follows :

Maximum Stress	- -	not less than 55 tons per sq. inch.
Elongation	- - -	not less than 15 per cent.
Izod Value	- - -	not less than 25 ft. lb.
Brinell Hardness Number	-	not less than 241 (3·90 mm.).
Nicked Fracture	- -	*See* Clause 2 (*e*).

(*b*) *Tensile Test.* The tensile test pieces shall be machined from the samples selected as specified in the appropriate Clause 7, 15 or 20 to the dimensions of the British Standard Tensile Test Piece, Fig. 1 of B.S. Specification 2 A. 4, or, if the samples are too small, machined to suitable test pieces as shown in Figs. 2 to 4.

The testing appliances shall be such that the load when applied shall be axial.

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

---

* In order to avoid confusion it is recommended that this specification be referred to by its British classification No. S. 80, by which it is already well known.

Price 1/–, *post free* 1/2.

Copyright.

AID
83

(*c*) *Izod Test.* The test pieces shall be machined from the samples selected as specified in the appropriate Clause, 7, 15 or 20, to the dimensions of the British Standard Notched Bar Test Piece, Fig. 7 or 10 of B.S. Specification 2 A. 4, and tested in a 120 ft.-lb. Izod machine.

(*d*) *Brinell Test.* (i) The test shall be made with a 10 mm. diameter ball and a load of 3,000 kg.,* which shall not be exceeded even momentarily, and shall be maintained for not less than 15 seconds. Prior to testing, the skin of the sample shall be removed by filing, grinding or machining the areas to be tested.

(ii) The diameter of the impression shall be measured to the nearest 0·05 mm.

(*e*) *Nicked Fracture Test.* A test piece or bar 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 bar shall show a grey fibrous fracture when broken by a minimum number of blows.

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

(*b*) Any material may be rejected at any time for faults in manufacture, notwithstanding that it has been previously passed on analysis and mechanical tests.

SECTION II.

S. 80—A. Bars and Billets for Forging and Drop Forging.

4. **Manufacture.** All bars and billets for forging and drop forging shall be rough-machined or made from rough-machined blooms or ingots.

5. **Margins of Manufacture.** No margins of manufacture are specified.

6. **Heat Treatment.** (*a*) All bars and billets for forging or drop forging shall be delivered in the softened condition.

(*b*) *Hardening and Tempering.* The mechanical test samples shall be hardened by heating to a temperature of 950° C. and cooling in air or oil. They shall then be tempered by heating to a suitable temperature to give the mechanical tests specified in Clause 2 (*a*).

7. **Selection and Preparation of Mechanical Test Samples.** (*a*) The bars or billets of each size and from the same cast shall be grouped in parcels of not more than :

50 for sizes up to and including $1\frac{1}{8}$ inches diameter or width across flats.
25 for sizes over $1\frac{1}{8}$ inches diameter or width across flats.

The Inspector shall select one sample from each parcel for mechanical testing. A mechanical test sample shall be of sufficient length to allow of the preparation of the test pieces specified in Clause 2.

(*b*) The portion of the bar or billet selected for the preparation of the test samples shall be prepared in one of the following ways :

(i) Test samples from bars $1\frac{1}{8}$ inches diameter or width across flats and under shall not be forged or machined but shall be heat-treated in the full size. Where it is necessary to remove the surface, they shall be heat-treated as near full size as possible.

(ii) Bars and billets over $1\frac{1}{8}$ inches and up to 3 inches diameter or width across flats may be forged and/or machined at the option of the Steelmaker to test samples $1\frac{1}{8}$ inches diameter, and be heat-treated in that size.

(iii) Bars and billets over 3 inches diameter or width across flats may be forged and/or machined at the option of the Steelmaker to test samples $2\frac{1}{2}$ inches diameter and be heat-treated in that size.

(iv) When it is agreed between the Purchaser and the Director of Aeronautical Inspection that a special size of test sample more nearly represents the section of the designed part as heat-treated, that special test sample may be used for the mechanical tests. At the option of the Steelmaker it may be forged and/or machined to size and heat-treated in that size. The size of the special test sample shall be stated on the order.

(*c*) The mechanical test samples shall be marked as directed by the Inspector before they are cut from the bar or billet, and shall be hardened and tempered as specified in Clause 6 (*b*).

8. **Mechanical Tests.** (*a*) (i) The test pieces machined from the samples selected and prepared as specified in Clause 7 shall comply with the mechanical tests specified in Clause 2. These tests shall be carried out in the presence of the Inspector and to his satisfaction.

(ii) When the dimension of the test sample is such that one of the British Standard Notched Bar Test Pieces cannot be made from it, the Nicked Fracture Test shall be substituted for the Izod Test.

(*b*) If any test piece machined from the sample fails to give the mechanical tests specified in Clause 2 (*a*) the Inspector may reject the parcel represented by the test piece or at his discretion select two other samples for test, one of which must be from the bar or billet from which the original test sample was taken. If that bar or billet has been withdrawn by the Steelmaker one other bar or billet shall be selected. If both samples fulfil the test the parcel from which the samples were selected will be accepted.

9. **Up-ending Test.** From each parcel of bars or billets the Inspector shall select at least one bar or billet and up to five per cent. of the bars or billets, for the up-ending test. From the bars or billets so selected, samples shall be cut equal in length to their diameter or width across flats and

* It is recommended that the Brinell Hardness determination for small size bars be made with a suitably reduced load and/or ball in accordance with B.S. Specification No. 240.

forged down at normal forging temperature to half their original length by a minimum number of blows. The samples must be tested as cut from the bars or billets and must not be further machined before testing. After testing they must not reveal the presence of any defect.

10. **Identification.** (*a*) All bars or billets half-inch diameter or width across flats and over shall be stamped with the number S. 80, the cast number and the Steelmaker's trade mark or symbol. All such stamping must be done at one extreme end of each bar or billet.

(*b*) All bars or billets under half-inch diameter or width across flats, from the same cast, shall be wired up into bundles which shall bear a metal tag stamped with the number S. 80, the cast number and the Steelmaker's trade mark or symbol.

SECTION III.

S. 80—B. Bars for Machining.*

11. **Manufacture.** All bars for machining shall be made from rough-machined blooms or ingots.

12. **Margins of Manufacture.** The margins of manufacture shall be in accordance with the order to the Steelmaker.

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

(*b*) All bright bars shall be straight.

14. **Heat Treatment.** (*a*) The bars shall be delivered in the finally heat-treated condition.

(*b*) 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.

(*c*) The bars shall be hardened by heating to a temperature of 950° C. and cooling in air. They shall then be tempered by heating to a suitable temperature to give the mechanical tests specified in Clause 2 (*a*).

(*d*) No bar shall be re-hardened more than twice.

15. **Selection and Preparation of Mechanical Test Samples.** (*a*) The bars of each size and from the same cast shall be grouped in parcels of not more than 25.

The Inspector shall select one sample from each parcel for mechanical testing. A mechanical test sample shall be of sufficient length to allow of the preparation of the test pieces specified in Clause 2.

(*b*) The mechanical test samples shall be marked as directed by the Inspector before they are cut from the bars and shall not be further heat-treated before testing.

16. **Mechanical Tests.** (*a*) (i) The test pieces machined from the samples selected as specified in Clause 15 (*a*) shall comply with the Tensile and Izod Tests specified in Clause 2. These tests shall be carried out in the presence of the Inspector and to his satisfaction.

(ii) When the dimension of the bar is such that one of the British Standard Notched Bar Test Pieces cannot be made from it, the Nicked Fracture Test shall be substituted for the Izod Test.

(*b*) If any test piece machined from the sample fails to give the mechanical tests specified in Clause 2 (*a*) the Inspector may reject the parcel represented by the test piece or at his discretion adopt either of the following procedures:

(i) Select two other samples for test, one of which must be from the bar from which the original test sample was taken. If that bar has been withdrawn by the Steelmaker one other bar shall be selected. If both samples fulfil the tests the parcel from which the samples were selected will be accepted.

(ii) Allow the parcel to be re-heat-treated and re-tested.

(*c*) Notwithstanding acceptance of a parcel of bars under paragraph (*a*) or (*b*), all bars in that parcel must also pass the tests specified in the following paragraphs (*d*) and (*e*).

(*d*) All bars in each parcel shall be submitted to the Brinell Hardness Test specified in Clause 2 (*d*), the Brinell impression being made at one end of each bar. The Inspector may, at his discretion, require a Brinell impression to be made at both ends of every bar. Bars which fail to give the specified test shall be rejected, but may, at the option of the Steelmaker, be re-heat-treated in accordance with Clause 14 and submitted again to the Brinell Test. All bars which fail to pass the Brinell Test after this re-heat-treatment shall be rejected.

(*e*) All bars in each parcel shall be submitted to the Nicked Fracture Test specified in Clause 2 (*e*), and bars which fail to give the specified fracture shall be rejected, but may, at the option of the Steelmaker, be (1) submitted to the Izod Test, when the bar will be accepted if the value specified in Clause 2 (*a*) is obtained, or (2) be re-heat-treated in accordance with Clause 14 and submitted again to the Brinell, Nicked Fracture or Izod Tests. All bars which fail to pass the Brinell, Nicked Fracture or Izod Tests after this re-heat-treatment shall be rejected.

17. **Identification.** (*a*) All bars, half-inch diameter or width across flats and over, shall be stamped with the number S. 80, the cast number, and the Steelmaker's trade mark or symbol. All such stamping must be done at one extreme end of each bar.

---

* Note.—It is desired to draw attention to the undesirability of using heat-treated bars of large diameter for the production of machined parts, owing to the difficulty of obtaining the specified mechanical properties, particularly the Izod value from such bars.

Where large bars are required for the manufacture of machined parts, users of this material should consider the advisability of ordering the bars to Section II of this Specification and heat-treating the parts after rough-machining.

AID
83

(*b*) All bars under half-inch diameter or width across flats, from the same cast, shall be wired up in bundles which shall bear a metal tag stamped with the number S. 80, the cast number and the Steelmaker's trade mark or symbol.

SECTION IV.

S. 80—C. Forgings and Drop Forgings.

18. **Material.** The forgings and drop forgings shall be made from bars or billets which have been inspected and passed as complying with Section II of this Specification.

19. **Heat Treatment.** (*a*) The forgings and drop forgings shall be delivered in the finally heat-treated condition unless otherwise stated on the order.

(*b*) Large forgings and drop forgings shall preferably be rough-machined before heat-treatment.

(*c*) The forgings and drop forgings, and mechanical test samples, selected and prepared as specified in Clause 20, shall be hardened by heating to a temperature of 950° C. and cooling in air. They shall then be tempered by heating to a suitable temperature to give the mechanical tests specified in Clause 2. The mechanical test samples shall be quenched in the same manner as the forgings they represent.

(*d*) No forging or drop forging shall be re-hardened more than twice.

20. **Selection and Preparation of Mechanical Test Samples.** (*A*) *Small Forgings and Drop Forgings* (*under* 6 *lb.*). (*a*) The Contractor shall supply one test sample, unless more are specified on the order, to represent each batch of forgings or drop forgings made from the same cast and heat-treated at the same time. The test samples shall be cut from the material from which the forgings or drop forgings were made, and shall be of sufficient length to allow of the preparation of the test pieces specified in Clause 2.

(*b*) The portion of the bar or billet selected for the preparation of the test samples shall be prepared in one of the following ways :

(i) Test samples from bars $1\frac{1}{8}$ inches diameter or width across flats and under shall not be forged or machined, but shall be heat-treated in the full size ; provided that if it is necessary to remove the surface they shall be heat-treated as near full size as possible.

(ii) Bars and billets over $1\frac{1}{8}$ inches and up to 3 inches diameter or width across flats may be forged and/or machined at the option of the Contractor, to test samples $1\frac{1}{8}$ inches diameter and be heat-treated in that size.

(iii) Bars and billets over 3 inches diameter or width across flats may be forged and/or machined, at the option of the Contractor, to test samples $2\frac{1}{2}$ inches diameter and be heat-treated in that size.

(iv) When it is agreed between the Purchaser and the Director of Aeronautical Inspection that a special size of test sample more nearly represents the section of the designed part as heat-treated, that special test sample may be used for the mechanical tests. At the option of the Contractor it may be forged and/or machined to size and heat-treated in that size. The size of the special test sample shall be stated on the order to the Contractor.

(*c*) The mechanical test samples shall be hardened and tempered as specified in Clause 19 (*c*) and marked as directed by the Inspector.

(*d*) If any test piece machined from the sample fails to give the mechanical tests specified in Clause 2 (*a*) the Inspector may reject the parcel represented by the test piece or at his discretion adopt either of the following procedures :

(i) Select two other samples for test which have been heat-treated with the batch of forgings or drop forgings. If both samples fulfil the tests the batch from which the samples were selected will be accepted.

(ii) Allow the batch to be re-heat-treated and re-tested.

(*e*) Failing the provision of the necessary test samples to permit of the re-tests in paragraph (*d*) above, the re-tests may be made, where possible, on test samples cut from forgings or drop forgings selected by the Inspector.

(*f*) The above procedure may, by agreement between the Purchaser and the Director of Aeronautical Inspection, also be used for large forgings and drop forgings, in which case it must be so stated on the order.

(*B*) *Large Forgings and Drop Forgings* (**6** *lb. and over*). (*a*) The Contractor shall make all the forgings and drop forgings with a test sample forged on them, the dimensions of the test samples being not less than two-thirds the ruling thickness of the forgings, or as may be otherwise agreed between the Purchaser and the Director of Aeronautical Inspection as specified in Clause 7 (iv), unless the consent of the Director of Aeronautical Inspection has been obtained for the testing procedure to be in accordance with that specified in Clause 20 (*A*).

(*b*) All test samples shall be heat-treated with the forgings they represent, and test samples integral with the forgings shall not be cut off before heat-treatment. The test samples shall be marked as directed by the Inspector and shall not be further hammered or machined before heat-treatment.

(*c*) If any test sample fails to fulfil the tests specified in Clause 2, the forging may, at the option of the Contractor, be re-heat-treated and submitted to a further test, provided there is sufficient material in the remainder of the test sample to make all the mechanical tests specified.

21. **Mechanical Tests.** (*a*) The test piece from forgings and drop forgings selected as specified in Clause 20 shall comply with the Tensile, Izod (or Nicked Fracture) and Brinell Tests specified in Clause 2 ; these tests shall be carried out in the presence of the Inspector and to his satisfaction.

(*b*) If in the opinion of the Inspector these tests indicate that any forgings or drop forgings are not within the specified limits, those forgings or drop forgings will be rejected, but may be re-treated as specified in Clause 20.

SECTION V.

S. 80—D. Finished Machined Parts.

22. **Material.** The parts shall be made from bars or forgings which have been inspected and passed as complying with Sections III and IV, respectively, of this Specification.

23. **Brinell Test.** The Inspector may require Brinell Hardness tests to be made on as many of the finished machined parts as he may consider necessary to ensure that they comply with the tensile strength specified, provided that the Brinell impression does not affect the serviceableness of the part.

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 7th April, 1941.

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.

AUSTRALASIAN MEDICAL PUBLISHING COMPANY LIMITED

AID 83 D 3