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BRITISH STANDARD : AEROSPACE SERIES

PROCEDURE FOR INSPECTION AND TESTING OF WROUGHT ALUMINIUM AND ALUMINIUM ALLOYS

FOREWORD

This British Standard has been compiled to cover the general inspection and testing requirements for wrought aluminium and aluminium alloys to be used for aerospace purposes. The procedure set out herein is for use in conjunction with the relevant specifications in the 'L' series. The procedure is also applicable to other specifications for wrought aluminium and aluminium alloy products for aerospace purposes, where appropriate, such as those in the Ministry of Defence (Procurement Executive), D.T.D. Series.

The first edition of this British Standard was published in March, 1951 and a revised edition, which incorporated changes agreed between manufacturers and users of the materials in the light of working to the provisions of the first edition, was published in January, 1961. This further revision has been undertaken to bring the procedures in line with current industrial practice in the United Kingdom and with international inspection and testing procedures established in A.E.C.M.A.* and also to take account of metrication in the aluminium industry.

As amended
Sept., 1981

The principal alterations are the deletion of all references to imperial units, the deletion of the section relating to tubes for rivets, the inclusion of a section relating to hot-rolled plate for use as forging stock and the complete revision of the tables of dimensional tolerances. In addition, the standard now requires test samples representing material delivered in the solution treated and naturally aged condition to be taken from material in the condition of delivery instead of being selected immediately after solution treatment and prior to flattening and rectification.

NOTE 1 For a limited period, material in imperial unit sizes will be available subject to negotiation regarding tolerances between the supplier and the purchaser. In general, it is intended that these tolerances should be conversions of the tolerances given in the tables in this standard.

NOTE 2. British Standard M 46, 'Tubing diameters and thicknesses'†, lists the outside diameters and thicknesses of tubes to be selected for all uses in aircraft design. Recommended thicknesses for sheet and diameters for wire, in the metric series, are given in Reference Sheets RS 701 and RS 702, respectively, published by the Society of British Aerospace Companies Limited.

This standard makes reference to the following specifications:

British Standards

A 4. Test pieces and test methods for metallic materials for aircraft.

Part 1. Tensile tests.

Part 4. Drifting tests on tubes.

Part 5. Hardness tests.

As amended
Sept., 1981

BS 1133 Packaging code.

Section 6 Temporary protection of metal surfaces against corrosion (during transport and storage).

As amended
Sept., 1981

Ministry of Defence (Procurement Executive) Specifications

D.T.D. 936. Ultrasonic inspection of aluminium alloy extrusions and hand forgings.

D.T.D. 937. Ultrasonic inspection of aluminium alloy plate.

As amended
Sept., 1981

* Association Européenne des Constructeurs de Matériel Aérospatial.

† Implements ISO 2964.

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1. GENERAL REQUIREMENTS

NOTE. Where reference is made to a British Standard or other specification, the latest issue shall be used.

1.1 DEFINITIONS

For the purposes of this British Standard and associated material specifications the following definitions apply.

1.1.1 Materials

(1) *Approved scrap*. Scrap which is:

a. derived from material the composition of which has been established with regard to the complete range of both the alloying elements and impurity elements appropriate to the class of alloy being made, and

b. segregated and identifiable to the satisfaction of the Inspecting Authority.

(2) *Bar*. A length of wrought material of uniform round, square, rectangular or regular polygonal solid cross section.

(3) *Billet or slab*. A cast product destined for subsequent hot working. A rectangular billet is usually called a slab.

(4) *Cast*

a. The product of one furnace melt;

b. the product of one crucible melt;

c. the product of a number of crucible or furnace melts mixed prior to casting;

d. the amount of metal tapped from the furnace without any further addition of metal having been made (when a continuous melting process is employed); or

e. as may be otherwise defined by the Quality Assurance Authority.

(5) *Coil*. A length of a product wound into a cylindrical or annular form for convenient handling.

(6) *Extruded length*. The length produced from one cast billet or, if a multi-hole die is used, each length produced from one cast billet.

(7) *Extruded section*. A length of extruded material not covered by the term 'bar' as defined in (2), nor in the form of tube or wire.

(8) *Forging*. A shape produced by hammering or pressing, usually when hot, between open or closed dies.

(9) *Plate*. A rolled product of rectangular section, over 6.0 mm thick, supplied flat and with less control of surface finish than applies to sheet.

(10) *Sheet*. A rolled product of rectangular section, over 0.2 mm up to and including 6.0 mm thick, supplied flat.

(11) *Strip*. A rolled product of rectangular section, over 0.2 mm up to and including 3.0 mm thick, supplied in coil.

(12) *Tube*. A hollow product of uniform wall thickness.

(13) *Wire*. A round, square or regular polygonal solid section of not more than 10.0 mm diameter or width across flats, finished by drawing.

1.1.2 Other terms

(1) *Certification*. Confirmation by the manufacturer or supplier that the material conforms to the requirements of the relevant specification, drawing, order or Inspection Schedule.

NOTE. The issue of certificates, etc., is normally subject to the regulations of the Quality Assurance Authority.

(2) *Cold compression*. Compression, after solution treatment and before precipitation treatment, to effect a specified permanent set in order to relieve internal stresses and to minimize distortion during machining.

(3) *Controlled stretching*. Stretching to effect a specified permanent extension (percentage permanent set) in order to relieve internal stresses and to minimize distortion during machining.

(4) *Harmful defect*. Any defect prejudicial to the subsequent manufacture, fabrication or use of the material.

(5) *Heat treated*. Annealed, solution treated, solution treated and aged at room temperature, or solution treated and precipitation treated, as stipulated in the material specification.

(6) *Quality Assurance Authority*. The body responsible for authorizing the manufacturer or supplier to issue certification*. As amended
Sept., 1981

(7) *Inspection Schedule*. A schedule of any special test requirements agreed between the supplier and the purchaser.

(8) *Inspector*. The individual responsible for the executive inspection and release of material.

(9) *Lateral curvature*. The deviation from straightness of a sheet or strip edge when the sheet or strip is laid flat.

(10) *Manufacturer*. The firm that produces the material in the form (billet, bar, forging, sheet, etc.) in which it is consigned to the purchaser.

(11) *Supplier*. The firm that consigns the material to the purchaser.

(12) *Convertibility*. The ability of material, supplied in one specification condition, to meet other specification requirements after stipulated heat treatment(s). As added
Sept., 1981

(13) *Diffusion*. The migration of an alloying element (e.g. copper) from the core to the cladding of a coated material.

1.2 CERTIFICATION*

1.2.1 The manufacturer shall supply to the purchaser the necessary certification* in respect of all material governed by this British Standard and relevant material specifications.

1.2.2 Except as provided in 1.2.3, if any certification* is issued by a supplier other than the manufacturer, such supplier shall hold the equivalent certification* issued by the manufacturer of the material.

1.2.3 If a batch of material consigned by the manufacturer is subdivided by an approved non-manufacturer before re-consignment, the non-manufacturer shall carry out any consequent additional dimensional inspection and identification marking and shall certify accordingly.

1.3 MANUFACTURE AND FREEDOM FROM DEFECTS

1.3.1 The material shall be made in accordance with the requirements of this British Standard and the material specification.

1.3.2 The material shall be free from harmful defects.

1.3.3 Any material may be rejected for faults in manufacture although it may have been passed previously on chemical composition and mechanical tests.

*As defined in 1.1.2.(1).

As amended
Sept., 1981

As amended
Sept., 1981

3L 100, August, 1971**1.4 CHEMICAL COMPOSITION**

1.4.1 The chemical composition of the material shall comply with the requirements of the material specification. The values stipulated in the specification shall be applied in accordance with the instructions of the Quality Assurance Authority. Elements not quoted in the specification shall not be added for any purpose other than fluxing, degassing, grain refinement and the like.

*As amended
Sept., 1981*

1.4.2 If, in the course of routine analysis, the presence of elements other than those named in the material specification is detected, the amounts of such other elements and their total shall be shown to be in conformity with the requirements of the material specification.

*As added
Nov. 1974*

1.4.3 Overall control of the chemical composition and the regulation of the use of scrap shall be such that the method of analytical control adopted for each particular material shall enable the inspector to certify compliance with the requirements of 1.4.1. and 1.4.2

Clause 1.5 Heat treatment temperatures

1.5.1 If a temperature with a tolerance is stated in a material specification, it shall be mandatory. If a temperature range is stated, a suitable temperature within that range shall be selected to give the required properties, and shall be quoted on the release certificate.

1.5.2 If a minimum period of ageing at room temperature is stated in a material specification, testing for release purposes may be commenced before this period is completed. If the material satisfies the requirements of the material specification, it may be released, but, if it does not, testing shall be delayed until the minimum period of ageing has been completed. If, from such early tests, the elongation results are only marginally within the specification limits, the inspector may require that retest for elongation be made at the expiry of the full period of ageing. The period of ageing shall be stated on the release certificate.

1.6 TENSILE TEST**1.6.1 General**

1.6.1.1 The test pieces, prepared as required by the following clauses, shall be tested in accordance with the requirements of British Standard A4, Part 1, Section One. The secondary methods of proof stress verification may be employed and the values obtained shall comply with the requirements of the material specification or, if appropriate, with requirements agreed between the manufacturer and the purchaser in accordance with this standard. The values stipulated in the specification shall be applied in accordance with the instructions of the Quality Assurance Authority.

*As amended
Sept., 1981*

1.6.1.2 The test samples shall be selected and identified as directed by the inspector before they are removed from the material.

1.6.2 Bars for forging, bars for machining, extruded sections and forgings

1.6.2.1 Except as provided in 1.6.2.2 and 1.6.2.3, the test piece shall be machined from the selected test sample (see 1.6.2.4) to the dimensions of the largest practicable size of the proportional round test pieces shown in Table 1 of British Standard A4, Part 1, Section One.

1.6.2.2 Alternatively to 1.6.2.1, at the option of the manufacturer, round, square and hexagonal bars not exceeding 16 mm diameter or major sectional dimension shall be

tested in full section. For these test pieces the elongation shall be measured on a gauge length of $5.65\sqrt{\text{area}}$ or 50 mm, at the discretion of the manufacturer. The gauge length used shall be recorded on the manufacturer's test report.

1.6.2.3 Alternatively to 1.6.2.1, at the option of the manufacturer, for rectangular bars and extruded sections not exceeding 12.5 mm minor sectional dimension in the thickest part, a test piece of rectangular cross section shall be machined with maximum available thickness and 12.5 mm width or as near 12.5 mm width as the section will permit. For these test pieces the elongation shall be measured on a gauge length of $5.65\sqrt{\text{area}}$ or 50 mm, at the discretion of the manufacturer. The gauge length used shall be recorded on the manufacturer's test report.

1.6.2.4 Unless otherwise stated in the specification, drawing or order the following requirements govern the location of test pieces:

(1) For bars and for test samples representing forgings or bars for forging, up to and including 50 mm diameter or minor sectional dimension, the test piece shall be machined coaxially from the test sample.

(2) For bars over 50 mm diameter or minor sectional dimension, the longitudinal axis of the test piece shall be half way between the central axis and the outer surface of the test sample.

(3) For extruded sections whose minor sectional dimension in the thickest part is not more than 50 mm, the test piece shall be machined from the thickest part of the section. The longitudinal axis of the test piece shall be equidistant from the longer sides and 25 mm (or as near 25 mm as is practicable) from a shorter side of the selected part of the section.

(4) For extruded sections whose minor sectional dimension in the thickest part is greater than 50 mm, the longitudinal axis of the test piece shall be half way between the central axis and the outer surface of the thickest part of the section.

1.6.3 Sheet and strip

1.6.3.1 The test pieces shall be prepared in accordance with the requirements of British Standard A4, Part 1, Section One.

1.6.3.2 For material under 300 mm wide, a test piece shall be cut from each test sample so that the longitudinal axis of the test piece is parallel to the direction of final rolling.

1.6.3.3 For material 300 mm wide and over, a test piece shall be cut from each test sample so that the longitudinal axis of the test piece is at right angles to the direction of final rolling.

1.6.4 Tube. The tensile test pieces shall be prepared in accordance with the requirements of British Standard A4, Part 1, Section One.

1.6.5 Wire. The test pieces shall be prepared in accordance with the requirements of British Standard A4, Part 1, Section One.

1.6.6 Plate

1.6.6.1 For plate that is not more than 12.5 mm thick, a test piece shall be cut from each test sample so that the longitudinal axis of the test piece is at right angles to the

direction of final rolling and at the centre of the plate thickness. The dimensions of the test piece shall comply with the requirements for non-proportional test pieces shown in British Standard A4, Part 1, Section One.

1.6.6.2 For plate over 12.5 mm but not more than 25 mm thick, a test piece shall be cut from each test sample so that the longitudinal axis of the test piece is at right angles to the direction of final rolling and at the centre of the plate thickness. The test pieces shall be machined to the dimensions of the largest practicable size of the proportional round test pieces shown in Table 1 of British Standard A4, Part 1, Section One.

1.6.6.3 For plate over 25 mm thick, three test pieces shall be cut from each test sample, as follows:

(1) *Longitudinal*. The axis of the test piece shall be parallel to the direction of final rolling and at the centre of the plate thickness.

(2) *Long transverse*. The axis of the test piece shall be at right angles to the direction of final rolling and at the centre of the plate thickness.

(3) *Short transverse*. The axis of the test piece shall be at right angles to the surface of the plate and the midpoint of the gauge length shall be at the centre of the plate thickness.

These test pieces shall be machined to the dimensions of the largest practicable size of the proportional round test pieces shown in Table 1 of British Standard A4, Part 1, Section One.

However, if the thickness of the plate is too small to allow the preparation of a short transverse test piece complying with that table, the form and dimensions of the test piece shall be agreed between the manufacturer and the purchaser. By agreement with the Quality Assurance Authority, for these test pieces elongation shall be determined by micrometer measurements of the overall length of the test piece, which shall have flat faced ends normal to the longitudinal axis of the test piece, the overall extension being divided by the original length of the parallel portion. The test report shall record the cross-sectional dimensions, the gauge length and the overall length of the test piece used.

1.7 HARDNESS TEST

1.7.1 If hardness tests are required, the Brinell hardness test in accordance with the requirements of British Standard A4, Part 5, Section One, or the Vickers hardness test in accordance with the requirements of British Standard A4, Part 5, Section Two, shall be used, except as provided in 1.7.3.

1.7.2 For Brinell tests the ratio used for F/D^2 shall be 10 for aluminium alloys, unless otherwise stated in the material specification.

1.7.3 Direct reading hardness testing machines complying with the requirements of British Standard A4, Part 5, Section Three, may be used, subject to the requirements of the Quality Assurance Authority.

1.7.4 All tests on the same batch of material, including those on the test pieces, shall be made by the same method and under the same conditions of loading, unless otherwise authorized by the Quality Assurance Authority.

1.8 SPECIAL TESTS FOR TUBES

1.8.1 Hydraulic test. The tube shall withstand, without showing signs of failure, the test conditions stipulated in

the material specification when tested by a method approved by the Quality Assurance Authority.

1.8.2 Single drifting test. The test shall be made in accordance with the requirements of British Standard A4, Part 4. Each end of the tube shall be drifted, using a drift of suitable angle, as shown in Fig. 1; until the outside diameter of the drifted end (D_2) exceeds the original outside diameter (D_1) of the tube by not less than the percentage shown in the following table. The tube shall show no sign of cracking.

Outside diameter of tube (D_1)	Minimum increase*
mm	%
4 up to and including 6	45
Over 6 up to and including 10	40
Over 10	25

$$\frac{D_2 - D_1}{D_1} \times 100$$

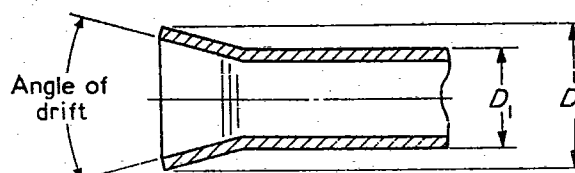


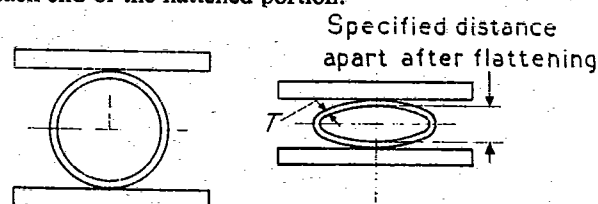
Fig. 1

1.8.3 Bore test to verify freedom from constriction

1.8.3.1 Tube of bore diameter less than 12.5 mm. The bore of the tube shall permit a metallic bob or wire to pass through freely. The diameter of the bob or wire shall be 80 % of the nominal internal diameter of the tube. The length of the bob shall be not less than twice its diameter.

1.8.3.2 Tube of bore diameter of 12.5 mm and over. The bore of the tube shall be examined as in 1.8.3.1 or alternatively, if the tube can be mounted so as to ensure full end-to-end visibility, it shall be examined visually and shall be to the satisfaction of the inspector.

1.8.4 Flattening test. Flattening shall be effected between flat faces; hammer blows may be used at the option of the manufacturer. A distance piece of the required thickness may be inserted in the tube to limit the degree of flattening. The selected test pieces shall withstand, without cracking, being flattened over a parallel length of not less than 25 mm until the greatest distance between the inner sides of the test piece in the direction of flattening has attained the value required by the material specification (see Fig. 2). The flattened portion shall be at the middle of the test piece. The length of the test piece shall be such as to leave lengths of not less than 25 mm of unflattened tube at each end of the flattened portion.



T = Wall thickness of tube

Fig. 2

As amended
Sept., 1981

As amended
Sept., 1981

As amended
Sept., 1981

As amended
Sept., 1981

3L 100, August, 1971**1.9 CAPABILITY***As added
Sept., 1981*

If the material specification stipulates that the material shall be 'capable' of meeting particular requirements, the manufacturer shall adopt one of the following procedures, unless a particular procedure is stated on the order.

(1) Verify compliance with those particular requirements, by inspecting and/or testing the material in accordance with the appropriate requirements of this British Standard, and state the results on the release note.

(2) Give his guarantee, which shall be based on statistical evidence, that the material will meet those particular requirements.

If the manufacturer gives his guarantee and it is subsequently demonstrated by the customer or Quality Assurance Authority that the material does not comply with the capability requirements, the material may be rejected even though it complied with the requirements for the condition of delivery.

1.10 PROTECTION AGAINST CORROSION

The material shall be protected before despatch to a standard that will ensure that it is in a satisfactory condition on delivery. Guidance on the level of packaging and protection to be used may be obtained from BS 1133, Section 6.

*As added
Sept., 1981***2. CAST BILLETS AND SLABS FOR HOT WORKING**

NOTE. This section covers material purchased for subsequent hot working.

2.1 CONDITION

Unless otherwise stated on the order, the material shall be delivered as cast.

2.2 DIMENSIONAL TOLERANCES

Dimensional tolerances, when required, shall be stated on the order.

2.3 SELECTION OF MECHANICAL TEST SAMPLES

None.

2.4 PREPARATION OF MECHANICAL TEST SAMPLES

None.

2.5 TENSILE TEST

None.

2.6 HARDNESS TEST

None.

2.7 SPECIAL TESTS*As amended
Sept., 1981*

2.7.1 Material not subject to heat treatment. The material shall be inspected to verify freedom from defects, by methods agreed between the manufacturer and the

purchaser and acceptable to the Quality Assurance Authority.

2.7.2 Material subject to heat treatment. Unless otherwise agreed by the Quality Assurance Authority, the material shall be tested in one or both of the following ways, as decided by the manufacturer, and shall be free from harmful defects:

*As amended
Sept., 1981*

(1) Not less than 1 % of the billets or slabs shall be sectioned transversely and the sections shall be examined by a method to the satisfaction of the Quality Assurance Authority.

(2) The billets or slabs shall be examined by a non-destructive test to the satisfaction of the Quality Assurance Authority.

2.8 RETESTS

2.8.1 Special tests. If, on sectioning, any billet or slab exhibits harmful defects, further billets or slabs shall be examined as required by the Quality Assurance Authority.

*As amended
Sept., 1981***2.9 IDENTIFICATION**

Each billet and slab, 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.

3. EXTRUDED BARS AND SECTIONS FOR FORGING

3.1 CONDITION

The bars and sections shall not be heat treated unless otherwise stated on the drawing, order or Inspection Schedule.

3.2 DIMENSIONAL TOLERANCES

Dimensional tolerances, when required, shall be agreed between the supplier and the purchaser and shall be stated on the drawing, order or Inspection Schedule.

3.3 SELECTION OF MECHANICAL TEST SAMPLES

3.3.1 Bars and sections from the same cast and manufactured by the same process shall be grouped in batches.

3.3.2 The inspector shall select one test sample from a bar or section of the largest size in each batch for the specified tensile test (see 3.5).

3.4 PREPARATION OF MECHANICAL TEST SAMPLES

3.4.1 Test samples from bars or sections not greater than 30 mm diameter or minor sectional dimension shall be heat treated (if applicable) in full section, as stated in the material specification.

3.4.2 Test samples from bars or sections greater than 30 mm diameter or minor sectional dimension shall be prepared in accordance with (1) or (2), at the option of the manufacturer.

(1) A length of the bar or section shall be heat treated (if applicable) in full section.

(2) A piece of the bar or section shall be forged to not less than 30 mm diameter or equivalent section and subsequently heat treated (if applicable).

3.4.3 The test samples shall not be mechanically worked after they have been separated from the material they represent.

3.5 TENSILE TEST

The tensile test piece, machined in accordance with the requirements of 1.6 from the test sample selected in accordance with 3.3 and prepared in accordance with 3.4, shall satisfy the appropriate tensile test requirements of the material specification.

3.6 HARDNESS TEST

None.

3.7 SPECIAL TESTS

3.7.1 Etching test. During each single working period a specimen of each size of bar or section produced shall be selected. Each specimen shall be of the full cross section and

shall be taken from the back end of the extruded length or from the front end of the final discard. The specimen shall be solution treated in accordance with the material specification, suitably prepared and etched. The etched surface shall be free from harmful defects. When examination of the front end of the selected bar or section is required, the details shall be agreed between the manufacturer and the purchaser, and shall be stated on the order or Inspection Schedule.

NOTE. The permissible depth of coarsely crystalline structure may be limited by agreement between the manufacturer and the purchaser.

3.7.2 Ultrasonic testing. If the purchaser requires the material to be examined by ultrasonic inspection in the condition in which it is to be delivered, details of such method of examination and standards of acceptance shall be agreed with the manufacturer and stated on the order or Inspection Schedule.

3.8 RETESTS

3.8.1 Tensile test. If any test piece fails to satisfy the specified tensile test requirements, the inspector shall select for test from the same cast two further samples, one of which shall be taken from the bar or section from which the original test sample was taken, unless that bar or section has been withdrawn by the manufacturer. The test pieces prepared from both these further samples shall satisfy the tensile test requirements of the material specification.

3.8.2 Etching test. If any specimen reveals a harmful defect, the relevant length of bar or section shall be cropped, and a further specimen subsequently prepared and examined in accordance with the requirements of 3.7.1. The inspector shall verify, by examination of specimens from other bars or sections of the same size, that the whole of the material represented by the selected bar or section is free from harmful defects.

3.9 IDENTIFICATION

3.9.1 Each bar and each section over 20 mm diameter or major sectional dimension, 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 on or near one end of the bar or section.

3.9.2 Bars and sections not exceeding 20 mm diameter or major sectional dimension and from the same cast, passed by the inspector, shall be either individually marked as required by 3.9.1 or, at the option of the supplier, tied securely in bundles, each of which shall have attached a durable label bearing the mark of the inspector and such other marking as shall ensure full identification of the material.

3L 100, August, 1971

4. BARS FOR MACHINING AND EXTRUDED SECTIONS NOT SUBJECT TO SOLUTION TREATMENT

4.1 CONDITION

4.1.1 The bars and sections shall be delivered in the condition required by the material specifications.

As amended Sept., 1981 4.1.2 Hollow sections shall be extruded by a process approved by the Quality Assurance Authority.

4.2 DIMENSIONAL TOLERANCES

4.2.1 Length, thickness and diameter. The length, thickness and diameter of bars and regular sections shall comply with the appropriate requirements of Table 4, Table 5 and Table 7 respectively.

4.2.2 Width

4.2.2.1 The overall width and width across flats of bars and regular sections shall comply with the appropriate requirements of Table 7.

4.2.2.2 The internal and external dimensions of open end channels and I beams shall comply with the requirements of Table 8.

4.2.3 Straightness

4.2.3.1 The straightness of bars and regular sections shall comply with the requirements of Table 1.

4.2.3.2 If required, tolerances for straightness of other sections shall be agreed between the manufacturer and the purchaser, either directly or through an intermediary, and shall be stated on the drawing, order or Inspection Schedule.

4.3 SELECTION OF MECHANICAL TEST SAMPLES

4.3.1 Bars and extruded sections of the same nominal cross-sectional dimensions, to the same material specification and, if annealed, that have been annealed together shall be grouped in batches as follows:

Nominal diameter or major sectional dimension		Maximum size of batch
Over	Up to and including	
mm	mm	kg
10	10	500*
20	20	1000
50	50	1500
		2000

*Or 3000 m, whichever is the lesser mass.

4.3.2 The inspector shall select one test sample from a bar or section in each batch for the specified tensile test (see 4.5).

4.3.3 The test samples shall be selected after the material has been straightened.

4.4 PREPARATION OF MECHANICAL TEST SAMPLES

The test samples selected in accordance with the requirements of 4.3 shall not be heat treated or mechanically worked after having been separated from the material they represent.

4.5 TENSILE TEST

The test piece, machined in accordance with the requirements of 1.6 from the sample selected in accordance with 4.3 and prepared in accordance with 4.4, shall satisfy the appropriate tensile test requirements of the material specification.

4.6 HARDNESS TEST

None.

4.7 SPECIAL TESTS

None.

4.8 RETESTS

If any test piece fails to satisfy the specified tensile test requirements, the inspector shall adopt one or both of the following procedures, as requested by the manufacturer:

(1) Select for test from the same batch two further samples, one of which shall be taken from the bar or section from which the original test sample was taken, unless that bar or section has been withdrawn by the manufacturer. The test pieces prepared from both these further samples shall satisfy the tensile test requirements.

(2) (Applicable to annealed material only.) Allow the batch to be re-annealed in accordance with the material specification and retested in accordance with the requirements of 4.3 to 4.5.

4.9 IDENTIFICATION

4.9.1 Each bar and each section over 20 mm diameter or major sectional dimension, 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 on or near one end of the bar or section.

4.9.2 Bars and sections not exceeding 20 mm diameter or major sectional dimension and from the same batch, passed by the inspector, shall be either individually marked as required by 4.9.1 or, at the option of the supplier, tied securely in bundles, each of which shall have attached a durable label bearing the mark of the inspector and such other marking as shall ensure full identification of the material.

5. BARS FOR MACHINING AND EXTRUDED SECTIONS SUBJECT TO SOLUTION TREATMENT

NOTE. If highly stressed components are to be machined from extrusions, it is essential that the mechanical properties in all important parts of the components are known. In such instances the materials should, at the discretion of the design firm, be ordered to the requirements of Section 6 and not those of this section.

5.1 CONDITION

5.1.1 The bars and sections shall be delivered in the condition required by the material specification, unless the manufacturer and the purchaser agree otherwise, in which case the condition in which the material is to be supplied shall be stated on the order.

5.1.2 If manufacture by multi-hole die is not acceptable, this shall be stated on the order.

5.1.3 If so required by the purchaser and stated on the order, the material shall be controlled stretched to a permanent extension of not less than 1.5 % nor more than 2.5 %.

5.1.4 Unless otherwise stated on the order, the material shall be protected before dispatch by an effective coating of corrosion preventive.

5.2 DIMENSIONAL TOLERANCES

5.2.1 General. Unless special tolerances are agreed between the supplier and the purchaser, the dimensions of the material shall comply with the appropriate requirements in 5.2.2 to 5.2.7.

5.2.2 Length, thickness and diameter. The length, thickness and diameter of bars and regular sections shall comply with the appropriate requirements of Table 4, Table 5 and Table 7, respectively.

5.2.3 Width

5.2.3.1 The width across flats of hexagonal bars for the manufacture of bolts and nuts shall comply with the requirements of Table 6.

5.2.3.2 The overall width and width across flats of bars, other than those covered by 5.2.3.1, and of regular sections shall comply with the appropriate requirements of Table 7.

5.2.3.3 The internal and external dimensions of open end channels and I beams shall comply with the requirements of Table 8.

5.2.4 Straightness

5.2.4.1 The straightness of bars and regular sections shall comply with the requirements of Table 1.

5.2.4.2 If required, tolerances for straightness of other sections shall be agreed between the manufacturer and the purchaser, either directly or through an intermediary, and shall be stated on the drawing, order or Inspection Schedule.

5.2.5 Twist. The twist on extruded sections shall comply with the requirements of Table 2.

5.2.6 Concavity and convexity. A maximum tolerance on concavity and convexity of 0.05 mm per 10 mm shall apply over the width of the flat faces of bars and sections.

5.2.7 Angles

5.2.7.1 The angles of regular sections shall comply with the requirements of Table 3.

5.2.7.2 Tolerances on angles of other sections shall be agreed between the manufacturer and the purchaser, either directly or through an intermediary, and shall be stated on the drawing, order or Inspection Schedule.

5.3 SELECTION OF MECHANICAL TEST SAMPLES

5.3.1 Annealed and as-extruded material

5.3.1.1 Bars and extruded sections of the same nominal cross-sectional dimensions, from the same cast, in the same condition and, if annealed, that have been annealed together shall be grouped in batches.

5.3.1.2 The inspector shall select one test sample from a bar or extruded section in each batch for the specified tensile test (see 5.5.1).

5.3.2 Material solution treated and aged at room temperature

5.3.2.1 Bars and extruded sections of the same nominal cross-sectional dimensions, from the same cast, in the same condition (i.e. controlled stretched or non-controlled stretched) and that have been heat treated together shall be grouped in batches.

5.3.2.2 The inspector shall select one test sample from a bar or extruded section in each batch for the specified tensile test (see 5.5.1). At the option of the manufacturer, the selected sample shall be of the lowest hardness (see 5.6).

5.3.3 Solution treated material to be precipitation treated after delivery

5.3.3.1 Bars and extruded sections of the same nominal cross-sectional dimensions, from the same cast, in the same condition (i.e. controlled stretched or non-controlled stretched) and that have been solution treated together shall be grouped in batches.

5.3.3.2 The inspector shall select one test sample from a bar or extruded section in each batch for the specified tensile test (see 5.5.1). At the option of the manufacturer, the selected sample shall be of the lowest hardness (see 5.6).

5.3.4 Solution treated and precipitation treated material

5.3.4.1 Bars and extruded sections of the same nominal cross-sectional dimensions, from the same cast, in the same condition (i.e. controlled stretched or non-controlled stretched) and that have been heat treated together shall be grouped in batches.

5.3.4.2 The inspector shall select one test sample from a bar or extruded section in each batch for the specified tensile test (see 5.5.1). At the option of the manufacturer, the selected sample shall be of the lowest hardness (see 5.6).

5.4 PREPARATION OF MECHANICAL TEST SAMPLES

5.4.1 Test samples selected in accordance with the requirements of 5.3.1 shall be solution treated and aged, or solution treated and precipitation treated, as required by the material specification, and shall not be further heat treated or mechanically worked before being tested.

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5.4.2 Test samples selected in accordance with the requirements of 5.3.3 shall be precipitation treated as required by the material specification and shall not be further heat treated or mechanically worked before being tested.

5.4.3 Test samples selected in accordance with the requirements of 5.3.2 or 5.3.4 shall not be further heat treated or mechanically worked after having been separated from the material they represent.

5.5 TENSILE TEST

5.5.1 The tensile test piece, machined in accordance with the requirements of 1.6 from the test sample selected in accordance with 5.3 and prepared in accordance with 5.4, shall satisfy the tensile test requirements of the material specification.

5.5.2 The specified mechanical properties refer to the longitudinal direction, relate to test pieces machined from defined positions in the bars or extruded sections and will not necessarily be realized when tests are carried out on test pieces selected from other positions in the material. If it is decided that tests in other directions are necessary, the required directions and locations of the test samples and the required properties shall be agreed between the manufacturer and the purchaser, and shall be stated on the drawing, order or Inspection Schedule.

5.6 HARDNESS TEST

5.6.1 Each bar and section which has been solution treated and aged at room temperature, or solution treated and precipitation treated, and which is of a cross section that cannot be contained in a circle 20 mm diameter, shall be hardness tested. If the length of a bar or section is 4.5 m or more it shall be hardness tested at both ends.

5.6.2 The procedure for hardness testing shall be as given in (1), (2) or (3), at the option of the manufacturer:

(1) The bar or section of lowest hardness shall be selected for tensile test sampling (see 5.3.2.2, 5.3.3.2 and 5.3.4.2).

(2) The tensile test sample shall be hardness tested and the Brinell or Vickers hardness number of each bar or section in the batch shall be not less than the number that is $X\%$ below the hardness number of the tensile test piece, where X is given the appropriate value stated in the material specification.

NOTE. The value of X depends upon the tensile strength of the test piece.

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(3) The manufacturer shall establish to the satisfaction of the Quality Assurance Authority limiting hardness values appropriate to the material specification. Due account shall be taken of the possible value of setting both lower and upper limits of hardness and the need for limiting values appropriate to certain section sizes. The hardness of each bar or section shall comply with the limit or limits so agreed.

5.7 SPECIAL TESTS

*As amended
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5.7.1 Ultrasonic testing. If required by the drawing, order or Inspection Schedule, each bar and extruded section shall be examined by ultrasonic inspection in accordance

with Ministry of Defence (Procurement Executive) Specification D.T.D.936, if applicable. The release note shall be suitably annotated.

5.7.2 Etching test

5.7.2.1 The etching test shall be applied to bars and extruded sections that are greater in minor sectional dimension than 5 mm and are of a cross section that cannot be contained in a 25 mm diameter circle.

5.7.2.2 During each single working period a specimen of each pattern of extrusion and each size of bar produced shall be selected. Each specimen shall be of the full cross section and shall be taken from the back end of the extruded length (see 1.1.1(6)). The specimen shall be heat treated in accordance with the material specification, suitably prepared and etched. The etched surface shall be free from harmful defects.

5.8 RETESTS

5.8.1 Tensile test. If any test piece fails to satisfy the specified tensile test requirements, the inspector shall adopt one or both of the following procedures, as requested by the manufacturer:

(1) Select for test from the same batch two further samples, one of which shall be taken from the bar or section from which the original test sample was taken and adjacent to that sample, unless that bar or section has been withdrawn by the manufacturer. If the material has been hardness tested, the additional sample(s) shall be taken from a bar or section of the next lowest hardness. The test pieces prepared from both these further samples shall satisfy the tensile test requirements of the material specification.

(2) Allow the batch to be re-heat treated in accordance with the material specification and to be retested in accordance with the requirements of 5.3 to 5.7.1.

5.8.2 Etching test. If any specimen reveals a harmful defect, the relevant length of bar or section shall be cropped, and a further specimen subsequently prepared and examined in accordance with the requirements of 5.7.2. The inspector shall verify, by examination of specimens from other bars or sections of the same size, that the whole of the material represented by the selected bar or section is free from harmful defects.

5.9 IDENTIFICATION

5.9.1 Each bar and each section over 20 mm major sectional dimension, 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 on or near one end of the bar or section.

5.9.2 Bars and sections not exceeding 20 mm major sectional dimension and from the same cast, passed by the inspector, shall be either individually marked as required by 5.9.1 or, at the option of the supplier, tied securely in bundles, each of which shall have attached a durable label bearing the mark of the inspector and such other marking as shall ensure full identification of the material.

6. BARS FOR MACHINING AND EXTRUDED SECTIONS FOR HIGHLY STRESSED STRUCTURES

NOTE. If highly stressed components are to be machined from bars or extruded sections, it is essential that the mechanical properties in all important parts of the components are known. In such instances the material should, at the discretion of the design firm, be ordered to the requirements of this section and not those of Section 5.

6.1 CONDITION

6.1.1 The bars and sections shall be delivered in the condition required by the material specification, unless the manufacturer and the purchaser agree otherwise, in which case the condition in which the material is to be supplied shall be stated on the order.

6.1.2 Unless otherwise agreed and stated on the order, multi-hole dies shall not be used.

6.1.3 Unless otherwise agreed between the manufacturer and the purchaser and stated on the order, the material shall be controlled stretched to a permanent extension of not less than 1.5 % nor more than 2.5 %.

6.1.4 Unless specifically prohibited by the purchaser and stated on the order, the material may be subjected to minor straightening or other rectification after controlled stretching. Such rectification shall be carried out as soon as possible after solution treatment and controlled stretching and, in any case, before any artificial ageing.

When minor straightening or other rectification is prohibited, the dimensional tolerances shall be subject to agreement between the manufacturer and the purchaser in accordance with 6.2.1.

6.1.5 Unless otherwise stated on the order, the material shall be protected before dispatch by an effective coating of corrosion preventive.

6.2 DIMENSIONAL TOLERANCES

6.2.1 General. Unless special tolerances are agreed between the supplier and the purchaser, the dimensions of the material shall comply with the appropriate requirements in 6.2.2 to 6.2.7.

6.2.2 Length, thickness and diameter. The length, thickness and diameter of bars and regular sections shall comply with the appropriate requirements of Table 4, Table 5 and Table 7, respectively.

6.2.3 Width

6.2.3.1 The width across flats of hexagonal bars for the manufacture of bolts and nuts shall comply with the requirements of Table 6.

6.2.3.2 The overall width and width across flats of bars, other than those covered by 6.2.3.1, and of regular sections shall comply with the appropriate requirements of Table 7.

6.2.3.3 The internal and external dimensions of open end channels and I beams shall comply with the requirements of Table 8.

6.2.4 Straightness

6.2.4.1 The straightness of bars and regular sections shall comply with the requirements of Table 1.

6.2.4.2 If required, tolerances for straightness of other sections shall be agreed between the manufacturer and the purchaser, either directly or through an intermediary, and

shall be stated on the drawing, order or Inspection Schedule.

6.2.5 Twist. The twist on extruded sections shall comply with the requirements of Table 2.

6.2.6 Concavity and convexity. A maximum tolerance on concavity and convexity of 0.05 mm per 10 mm shall apply over the width of the flat faces of bars and sections.

6.2.7 Angles

6.2.7.1 The angles of regular sections shall comply with the requirements of Table 3.

6.2.7.2 Tolerances on angles of other sections shall be agreed between the manufacturer and the purchaser, either directly or through an intermediary, and shall be stated on the drawing, order or Inspection Schedule.

6.3 SELECTION OF MECHANICAL TEST SAMPLES

6.3.1 Bars and extruded sections of the same nominal cross-sectional dimensions, from the same cast, in the same condition (i.e. controlled stretched or non-controlled stretched) and that have been heat treated together shall be grouped in batches. The inspector shall select from each batch a test sample from the location stated in 1.6.

6.3.2 The inspector shall also select from each extruded length one or more test samples; the basis of selection, the location(s) of the test sample(s) and the number of samples to be taken from each extruded length shall be agreed between the manufacturer and the purchaser, and shall be stated on the drawing, order or Inspection Schedule.

6.4 PREPARATION OF MECHANICAL TEST SAMPLES

6.4.1 Test samples representing non-heat treated or annealed material shall be solution treated and aged, or solution treated and precipitation treated, as required by the material specification.

6.4.2 Test samples representing solution treated material shall be aged or precipitation treated as required by the material specification.

6.4.3 Test samples representing solution treated and aged, or solution treated and precipitation treated material, shall not be further heat treated.

6.4.4 Test samples shall be heat treated in full section and shall not be further mechanically worked after they have been separated from the material they represent.

6.5 TENSILE TEST

6.5.1 The tensile test piece, machined in accordance with the requirements of 1.6 from the test sample selected in accordance with 6.3.1 and prepared in accordance with 6.4, shall satisfy the tensile test requirements of the material specification.

6.5.2 The location, form and size of the test pieces machined from the test samples selected in accordance with the requirements of 6.3.2, and prepared in accordance with 6.4, shall be

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agreed between the manufacturer and the purchaser, and shall be stated on the drawing or Inspection Schedule. If it is desired to determine the effect of peripheral coarse grain, a thin flat test piece shall be used, prepared so as to include a portion of the surface of the extrusion in a location likely to have the coarsest grain, i.e. the back-end of the extruded length.

6.5.3 The specified mechanical properties refer to the longitudinal direction, relate to test pieces machined from defined positions in the bars or extruded sections and will not necessarily be realized when tests are carried out on test pieces selected from other positions in the material. If it is decided that tests in other directions are necessary, the required directions and locations of the test samples and the required properties shall be agreed in accordance with the requirements of 6.3.2.

6.6 HARDNESS TEST

None.

6.7 SPECIAL TESTS

*As amended
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6.7.1 Ultrasonic testing. Unless otherwise stated on the order, each bar and extruded section coming within the limits of Ministry of Defence (Procurement Executive) Specification D.T.D. 936 shall be examined by ultrasonic inspection in accordance with that specification. The release note shall be suitably annotated.

6.7.2 Etching test

6.7.2.1 A specimen of the full cross section shall be taken from the back-end of each extruded length (see 1.1.1(6)). The specimen shall be heat treated in accordance with the material specification, suitably prepared and etched. The etched surface shall be free from harmful defects.

6.7.2.2 The permissible depth of coarsely crystalline structure shall be agreed between the manufacturer and the purchaser, and shall be stated on the drawing, order or Inspection Schedule.

6.8 RETESTS

6.8.1 Tensile tests. If any test piece fails to satisfy the specified tensile test requirements, the inspector shall adopt one or both of the following procedures, as requested by the manufacturer:

(1) Select for test from the same length of bar or section a further sample complying with the requirements of 6.3.2 and taken from a location comparable with that of the original sample. The test piece prepared from this further sample shall comply with the requirements of 6.5.

(2) Allow the length of bar or section to be re-heat As amended
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6.8.2 Etching test. If any specimen reveals a harmful defect, the relevant length of bar or section shall be cropped and a further specimen subsequently prepared and examined in accordance with the requirements of 6.7.2.

6.9 IDENTIFICATION

Each bar and each section, passed by the inspector, shall bear the mark of the inspector and such other marking as shall ensure full identification of the material. All stamping shall be done on or near one end of the bar or section. If incised markings are unsuitable, the method of marking shall be stated on the order.

7. FORGINGS

NOTE. Attention is directed to the difficulty of specifying mechanical test values which will represent accurately the mechanical properties of forgings. Test samples (other than those cut from forgings—see Procedures D and X) indicate only the quality of the material; it must not be assumed that the properties of the forgings and of the test samples are the same.

7.1 PROCEDURE FOR INITIAL PRODUCTION AND MANUFACTURING PROCESS CONTROL

7.1.1 The drawing shall be agreed between the manufacturer and the purchaser and shall indicate the purchaser's requirements for grain flow within the forging. If Procedure X (see 7.5) is called up, the location of the test pieces shall also be shown.

7.1.2 If a method of production has been agreed between the manufacturer and the purchaser, this shall be stated on the drawing, order or Inspection Schedule and shall not be altered except by mutual consent.

7.1.3 Forging approval procedure shall be initiated in cases involving any significant change in the manufacturing process, i.e. new design, change of material specification and alteration in forging technique.

7.1.4 If appropriate, the drawing, order or Inspection Schedule shall define the areas of the forging which are critical and for which special finishing prior to inspection is required, together with the standard of such finish.

7.1.5 The manufacturer and the purchaser shall agree when a particular pattern of forging is to be partially or fully machined prior to heat treatment. Details of the agreement, including the machining to be done by the manufacturer, shall be stated on the drawing, order or Inspection Schedule.

7.2 CONDITION

7.2.1 The forgings shall be delivered in the condition required by the material specification, unless the manufacturer and the purchaser agree otherwise, in which case the condition in which the forgings are to be supplied shall be stated on the drawing or order.

7.2.2 If agreed between the manufacturer and the purchaser and stated on the drawing, order or Inspection Schedule, the forgings shall be cold compressed (see 1.1.2(2)). The permanent set shall be not less than 1 % nor more than 5 %.

7.2.3 Unless specifically prohibited by the purchaser and stated on the order, the forgings may be subjected to minor straightening or other rectification after cold compression. Such rectification shall be carried out as soon as possible after solution treatment and cold compression and, in any case, before any artificial ageing.

When minor straightening or other rectification is prohibited, the dimensional tolerances shall be subject to agreement between the manufacturer and the purchaser in accordance with 7.3.

7.3 DIMENSIONAL TOLERANCES

Unless otherwise agreed between the manufacturer and the purchaser and stated on the drawing or order, the forgings shall comply with the dimensional tolerances in Appendix A.

7.4 BATCH ACCEPTANCE TEST SAMPLES

7.4.1 The procedure to be followed shall be one of the following as stipulated by the purchaser on the order. When no procedure is stipulated on the order, Procedure A shall be used.

- (1) *Procedure A.* Separate test samples (7.6).
- (2) *Procedure B.* The use of separate heat treatment

control samples (7.8). (This procedure may only be used in conjunction with Procedure X (7.5) and, except as provided in 7.12.2, only when the forgings are heat treated at the manufacturer's works.)

(3) *Procedure C.* Integrally forged test samples (7.9).

(4) *Procedure D.* Test samples machined from the bodies of the forgings (7.11), i.e. the selected forgings are destroyed in the test.

7.4.2 When separate or integrally forged test samples are used, they can be employed either alone (Procedure A or C) or with the addition of tests on test pieces cut from forgings (Procedure AX or CX). The manufacturing process control testing procedure is mandatory when Procedure AX, B or CX is stipulated.

PROCEDURE X. MANUFACTURING PROCESS CONTROL TEST SAMPLES

7.5.1 The mechanical properties of a forging may vary within the forging due to the effects of the grain flow, hot working, size and shape, etc., and will be affected by the forging process employed. The process control procedure permits the purchaser to specify mechanical tests on test pieces prepared from the forging at defined locations. As the mechanical properties obtained from such test pieces may not comply with the requirements of the material specification, minimum acceptance figures under Procedure X are subject to agreement between the manufacturer and the purchaser*. Procedure X also provides tests to verify that such properties are maintained during production.

7.5.2 If process control tests are required, the purchaser shall add the suffix X to his test requirements, i.e. AX, BX or CX.

7.5.3 Procedure X shall consist of (1) and (2) as follows:

(1) *Initial tests and tests after any significant change in the manufacturing process* (see 7.1.3). One forging shall be selected for test. The position, size and number of test pieces to be machined from the forging, together with the properties required, shall be stated on the drawing, order or Inspection Schedule. If no required properties are specified by the purchaser, the manufacturer shall select a forging from the prototype production, cut up the forging to obtain the requisite test samples and report, to the purchaser, the results of testing the test pieces cut from those samples. The purchaser shall then signify his agreement for production to proceed and agree the minimum properties to be expected.

(2) *Routine tests.* Forgings shall be selected for test at a frequency to be agreed between the manufacturer and the purchaser, and stated on the drawing, order or Inspection Schedule. The number of forgings manufactured between

*The purchaser is responsible for securing the concurrence of the parent design firm.

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the selection of test samples shall not be more than the following:

Mass of forging		Number of forgings
Over	Up to and including	
kg	kg	
—	0.75	2000
0.75	1.5	1000
1.5	5	400
5	25	200
25	—	As stipulated by the purchaser and stated on the order or Inspection Schedule.

7.5.4 If macroscopical examination is employed to confirm that the desired grain flow is maintained in production, the number of test pieces machined from a forging for a routine test may be less than that machined from the initial test forging, provided that the manufacturer and the purchaser* so agree.

7.6 PROCEDURE A. SEPARATE TEST SAMPLES

7.6.1 Selection and preparation of mechanical test samples

7.6.1.1 The forgings shall be made from material complying with the requirements of Section 2, Section 3 or Section 13.

7.6.1.2 Each batch of forgings from the same cast and that have been heat treated together shall be represented by a sample made from the same cast as the forgings.

7.6.1.3 The test sample shall be prepared from a bar, section or rolled plate of the same size as those used for making the forgings or, where the forgings are made directly from a cast billet, from a billet of the same cast.

7.6.1.4 Test samples from bars, sections or rolled plate not greater than 30 mm diameter or minor sectional dimension shall be heat treated in full section.

7.6.1.5 Test samples from billets, bars, sections or rolled plate greater than 30 mm diameter or minor sectional dimension shall be prepared in accordance with the requirements of (1) or (2), at the option of the manufacturer:

(1) A length of the bar, section or rolled plate shall be heat treated in full section. The test piece shall then be machined from the heat-treated material in accordance with the requirements of 1.6.2.

(2) A piece of the billet, bar, section or rolled plate shall be forged to not less than 30 mm diameter or equivalent section and subsequently heat treated. The test piece shall then be machined from this forged and heat-treated sample in accordance with the requirements of 1.6.2.

7.6.1.6 The test samples and the forgings represented shall be heat treated together in accordance with the material specification. The test samples shall not be further mechanically worked after heat treatment.

7.6.1.7 If forgings are to be heat treated by the purchaser, the manufacturer shall supply, with the forgings, representative test samples together with details of the heat treatment to be applied.

*The purchaser is responsible for securing the concurrence of the parent design firm.

7.6.2 Tensile test. The test pieces, machined in accordance with the requirements of 1.6 from the test sample selected and prepared in accordance with 7.6.1, shall satisfy the tensile test requirements of the material specification.

7.6.3 Hardness test

7.6.3.1 Unless otherwise agreed between the manufacturer and the purchaser, with the concurrence of the Quality Assurance Authority, each forging and the representative tensile test piece shall be hardness tested.

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7.6.3.2 The hardness number of each forging shall be not less than:

- (1) that stipulated in the material specification, or
- (2) the minimum agreed between the manufacturer and the purchaser and stated on the drawing, order or Inspection Schedule, or

(3) the minimum agreed between the manufacturer and the Quality Assurance Authority.

*As amended
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7.6.4 Retests

7.6.4.1 Tensile test

7.6.4.1.1 Except as provided in 7.6.4.1.2, if any test piece tested in accordance with the requirements of 7.6.2 fails to satisfy the tensile test requirements, the inspector shall adopt one or both of the following procedures, as requested by the manufacturer:

(1) Select for test from the same batch two other samples that have been heat treated with the forging or batch from which the original sample was taken. Test pieces machined from these two further samples shall satisfy the tensile test requirements of the material specification.

(2) Allow the forging or batch to be re-heat treated in accordance with the material specification and retested in accordance with the requirements of 7.6.1, 7.6.2 and 7.6.3.

7.6.4.1.2 Alternatively to 7.6.4.1.1, if any test piece tested in accordance with the requirements of 7.6.2 fails to satisfy the tensile test requirements, the Quality Assurance Authority may allow a forging from each batch to be cut up and tensile test pieces to be taken and machined in accordance with the requirements of 1.6 at positions specified by the purchaser. These test pieces shall satisfy the appropriate requirements agreed between the manufacturer and the purchaser*.

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7.6.4.2 Hardness test. If any forging fails to satisfy the hardness test, the inspector shall allow the forgings of incorrect hardness to be re-heat treated and retested in accordance with the requirements of 7.6.2 and 7.6.3.

7.7 PROCEDURE AX. SEPARATE TEST SAMPLES, WITH TEST PIECES CUT FROM FORGINGS

7.7.1 Selection and preparation of mechanical test samples

7.7.1.1 The forgings shall be made from material complying with the requirements of Section 2, Section 3 or Section 13.

7.7.1.2 Batch test samples shall be prepared in accordance with the requirements of 7.6.1.

7.7.1.3 Test pieces shall be cut from forgings in accordance with the requirements for Procedure X (7.5).

7.7.2 Tensile test