de Havilland Inc.

Material Specification

TITLE:	**INCONEL 718 ROD, BAR AND FORGING**
SPECIFICATION NUMBER:	**DHMS M2.08**
ISSUE:	**1**
AMENDMENT:	
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PAGE:	**1 of 7**

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1 SCOPE

1.1 This specification covers the requirements for Inconel 718 rod, bar and forgings.

2 INTRODUCTION

2.1 The clauses of this specification are written under the following headings:

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3 APPLICABLE SPECIFICATIONS

Federal Test Method Standard No. 151 Metals: Test Methods

AMS 2261 - Tolerances: Nickel and Nickel Base Alloys Bars

AMS 2269 - Chemical Check Analysis Limits: Wrought Nickel and Nickel Base Alloys

AMS 2808 - Identification of Forgings

ASTM E112-61 - Determining Average Grain Size of Metals

DHMS MI-2 - Ultrasonic Inspection of Inconel 718

4 REQUIREMENTS

4.1 Chemical Composition

Element	Analysis, percent
Carbon	0.10 max.
Manganese	0.40 max.
Silicon	0.45 max.

4.1 Chemical Composition (Cont'd)

Element	Analysis, percent
Sulphur	0.015 max.
Phosphorous	0.015 max.
Chromium	17.00 - 21.00
Nickel	50.00 - 55.00
Cobalt, if determined	1.00 max.
Molybdenum	2.80 - 3.30
Columbium + Tantalum	4.75 - 5.50
Titanium	0.70 - 1.40
Aluminum	0.20 - 0.80
Boron	0.0060 max.
Copper	0.30 max.
Iron	Remainder

4.1.1 Check Analysis: Composition variations shall meet the requirements of the latest issue of AMS 2269.

4.2 Condition

4.2.1 Rods and Bars: Unless otherwise specified, rods, bars and forgings shall be annealed by heating for 1 to 2 hours at 1750°F ± 25°F and cooled at a rate equivalent to air cool or faster.

4.2.1.1 Round bars shall be ground or turned.

4.2.1.2 Forgings shall be descaled.

4.2.1.3 Hardness shall not be higher than Brinell 275 or equivalent.

4.2.2 Stock for Forging: As ordered by forging manufacturer.

4.3 Properties After Precipitation Hardening:

4.3.1 Rods and Bars: Specimens taken from as-received rods and bars shall conform to the following requirements after age hardening at 1325°F ± 25°F for 8 hours, furnace cooling to 1150°F 25°F, holding at 1150°F ± 25°F long enough to make the total aging time (1325° + furnace cool + 1150°) 18 hours, and air cooling.

4.3.1.1 Tensile Properties: Tensile test specimens cut from the product and tested at room temperature shall conform to the following requirements:

4.3.1.1 Tensile Properties: (Cont'd)

	Longitudinal	Transverse
Tensile Strength, psi, min	180,000	180,000
Yield Strength, psi, min.	150,000	150,000
Elongation, % in 4 Diam., min.	12.0	10.0
Reduction of Area, %, min.	15.0	12.0

NOTE: Test pieces shall be selected in accordance with paragraph 7.

4.3.1.2 Hardness: Shall not be less than Brinell 320 or equivalent.

4.3.1.3 Grain Size: For rods and bars with a maximum cross-section dimension of 6 inches or less, grain size shall be predominantly 4 or finer with occasional grains as large as 2 permissible, as determined by comparison of a polished and etched specimen with the chart in ASTM E112-61. In larger sizes, grain size would be measured and reported for information only.

4.3.2 Stock for Forging: When a sample of stock is forged to a test coupon and annealed as in Para 4.2.1 and precipitation hardened as in Para. 4.3.1, specimens taken from the heat treated coupons shall conform to the requirements of Para's 4.3.1.1 and 4.3.1.2. If specimens taken from the forging after heat treatment as in Para's 4.2.1 and 4.3.1 conform to the requirements of Para's 4.3.1.1 and 4.3.1.2, the tests shall be accepted as equivalent to tests of the forged coupon.

4.4 Manufacturing Process: Material shall be produced by multiple melting using the consumable electrode melting practice in the remelt cycle unless otherwise permitted. The product shall be uniform in quality and condition, clean, sound and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

4.5 Tolerances: Unless otherwise specified, tolerances shall conform to the latest issue of AMS 2261 as applicable.

5 REPORTS

5.1 Unless otherwise specified, the vendor of the product shall furnish with each shipment, three copies of a report of the results of tests for chemical composition of each heat in the shipment and the results of tests on each thickness from each heat to determine conformance to the technical requirements of this specification. This report shall include the purchase order number, heat number, material specification number, thickness, size and quantity from each heat.

5.2 Unless otherwise specified, the vendor of finished or semi-finished parts shall furnish with each shipment, three copies of a report showing the purchase order number, material specification number, contractor or other direct supplier of material, part number and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

5.3 If forgings are supplied the Part Number and size of stock used to make the forgings shall also be included.

6 IDENTIFICATION

6.1 Unless otherwise specified, individual pieces or bundles shall have attached a metal tag stamped with DHMS M2.08, the purchase order number, nominal size and heat number or shall be boxed and the box marked with the same information.

In addition to the above information, flats 2 in. and larger in both dimensions and other bars 2 in. and over in diameter or distance between parallel sides shall be stamped with heat number within 2 in. of one end.

The characters shall not be less than 3/8" in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in hot alkaline cleaning solution without rubbing.

The markings shall have no deleterious effect on the material or its performance. The characters shall be sufficiently stable to withstand ordinary handling.

6.2 Forgings shall be identified in accordance with the latest issue of AMS 2808.

7 TESTING

7.1 General methods of testing and inspection shall conform to Federal Test Method Std. No. 151 when applicable. Chemical composition shall be determined for each heat. The mechanical property requirements shall be determined on each size bar (excluding length) of each heat.

7.2 A strain rate of .005 in/in/min shall be used up to the yield point in tensile tests. After the yield point has been reached, the movement rate of the crosshead shall be increased to approximately .075 in/min for a one inch gage length specimen and to approximately .15 in/min for a two inch gage length specimen.

7.3 Rectangles having one dimension greater than 3 in. and the other dimension less than 3 in. test specimens should be removed in the long transverse direction at the centre position. If both dimensions exceed 3 in. transverse test specimens shall be removed as in Fig. 1.

NOTE: Mechanical test specimens for forgings shall be taken as indicated by drawing. Where the drawing does not specify the location of test specimens, samples shall be taken from a forging in the longitudinal direction and in a section where the least reduction takes place.

7.4 Ultrasonic inspection shall be in accordance with DHMS MI-2.

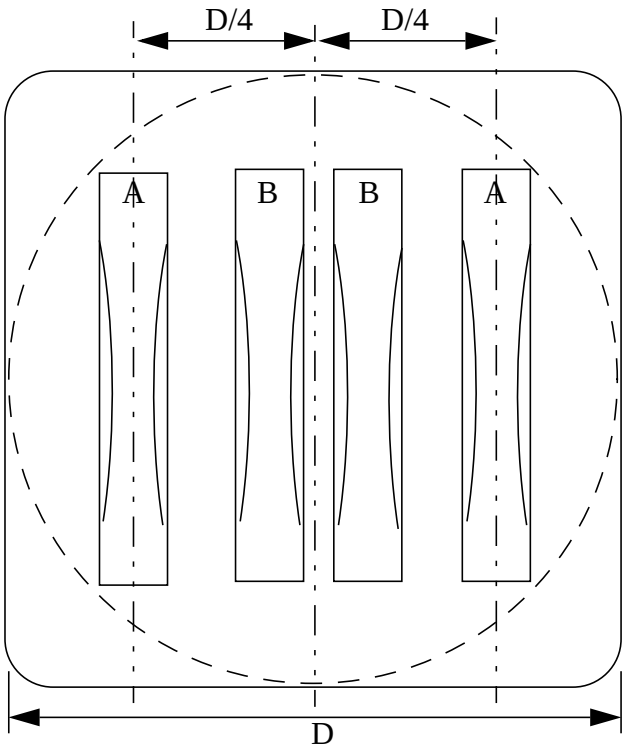
8 ORDERING DATA

8.1 Procurement documents should specify the following:

- Title, number and issue of this specification.
- Condition (4.2).
- Size and Shape.
- Exact lengths of length tolerances if manufacturer cannot comply with AMS 2261.

9 REJECTIONS

9.1 Material not conforming to this specification or to authorized modifications will be subject to rejection.



A - Mid-radius
B - Center

Fig. 1 Location of transverse tensile specimens.