de Havilland Inc.

Material Specification

TITLE:	**18% NICKEL MARAGING STEEL SHEET, STRIP & PLATE, VACUUM MELTED**
SPECIFICATION NUMBER:	**DHMS M2.01**
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AMENDMENT:	**1**
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1 SCOPE

This specification covers the requirements for high strength, 18% nickel maraging steel.

2 INTRODUCTION

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

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3 APPLICABLE SPECIFICATIONS

3.1 Standards

AMS 2252A - Tolerances

DHMS MI-1 - Ultrasonic Inspection of Maraging Steel

4 REQUIREMENTS

4.1 Composition

Maraging steel shall be composed of the following elements in % by weight:

Nickel	17.00 - 19.00
Molybdenum	4.60 - 5.10
Cobalt	7.00 - 8.50
Titanium	0.30 - 0.50
Aluminum	0.05 - 0.15
Boron	0.003 added
Zirconium	0.02 added
Calcium	0.06 added

4.1 Composition (Continued)

Carbon	0.03 max.
Manganese	0.10 max.
Phosphorous	0.01 max.
Sulphur	0.01 max.
Silicon	0.10 max.

4.2 Condition

4.2.1 The material shall be available in the hot rolled, annealed, descaled and oiled condition unless otherwise specified.

4.3 Manufacturing Process

4.3.1 The steel shall be melted by the consumable electrode vacuum melting process, requiring no protective atmosphere.

4.3.2 All billets shall be forged prior to rolling.

4.3.3 Decarburization control is not needed on maraging steel because of the low carbon content.

4.3.4 The material shall be solution annealed by the producer at 1500°F - 1650°F for one hour per inch of thickness and air cooled to room temperature to produce a Rockwell "C" hardness of 28 - 34 having also the following MINIMUM mechanical properties:

	Long.	Trans.
U.T.S. KSI	140	140
Yield at .2% offset (KSI) Max.	100	100
Elongation (3/4" Plate) %	12	12
Reduction of Area %	60	60

4.3.5 Subsequent aging performed by the fabricator at 900°F ± 25°F for 3 hours followed by air cooling produces a Rockwell "C" hardness of 49 - 54 having also the following MINIMUM mechanical properties:

	Long.	Trans.
U.T.S. KSI	240 (270 Max.)	240 (270 Max.)
Yield at .2% offset (KSI) Max.	230 (260 Max.)	230 (260 Max.)
Elongation (3/4" Plate) %	7	5
Reduction of Area %	45	35
* Notch Tensile Stg. (KSI) K_t=9)	350	350
Grain Size	6 & finer	

* Notch tensile values shall not form a basis for rejection of material.

4.3.6 The material shall maintain a good dimensional stability throughout the aging process.

4.4 Analysis

An analysis check shall be made on one sample taken from each melt conforming to AMS 2248. Check limits for Molybdenum shall be .10 over max. and .10 under min.

4.5 Workmanship

The product shall be uniform in quality, free of alloy segregation, sound and free from foreign materials and from internal and external defects detrimental to fabrication or to performance of parts. The product shall be free of heavy banding resulting from alloy segregation as agreed between De Havilland and the supplier.

4.6 Tolerances

Tolerances shall be in accordance with those laid down in AMS 2252A unless otherwise specified.

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, 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.

6 IDENTIFICATION

6.1 Unless otherwise specified, each plate, sheet and strip shall be marked, in the respective location indicated below, with DHMS M2.01, heat number, manufacturer’s identification, and nominal thickness in inches. 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 Plate, Flat Sheet, and Flat Strip Over 6 Inches in Width: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 2 feet, the rows being spaced not more than 3 inches apart and alternately staggered.

6.3 Flat Strip 6 Inches and Under in Width: Shall be marked near one end.

6.4 Coiled Sheet and Strip: Shall be marked near the outside end of the coil.

7 TESTING

7.1 For widths 9 inches and over, tensile test specimens shall be taken with the axis perpendicular to the direction of rolling. For widths less than 9 inches, tensile test specimens shall be taken with the axis parallel to the direction of rolling.

7.2 Micro Inclusion Test: The producer of the material shall prepare radial specimens approximately .28 sq. in. surface area, cut from mid-radius and representing the cross section of slab stock from the top and bottom of each ingot. The specimens shall be solution annealed and aged. The specimens shall be polished, on a face parallel to the longitudinal axis, for micro inclusion rating in accordance with the Jernkontoret Chart in ASTM #E45-51. No sample shall exceed the limits laid down in Table 1.

7.3 Ultrasonic Inspection:

Ultrasonic inspection shall be done by the supplier to limits as agreed upon between the supplier & De Havilland Aircraft of Canada, Limited.

8 ORDERING DATA

8.1 Procurement documents should specify the following:

- Title, number and issue of this specification.
- Condition (Ref. 4.2.1.).
- Size and Shape.
- Exact lengths of length tolerances if manufacturer cannot comply with AMS 2252A.

9 REJECTIONS

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

Table I

Inclusion Type	Thin	Heavy	Worst Field
A	X		1.0
A		X	1.0
B	X		1.0
B		X	1.0
C	X		1.0
C		X	1.0
D	X		1.5
D		X	1.0
E	X		2.0
E		X	1.5