BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 23.04

PRODUCTION PROCESS STANDARD

DESIGNATION OF TITANIUM AND TITANIUM ALLOYS

Issue 4 - This standard supersedes PPS 23.04, Issue 3.
- Vertical lines in the left hand margin indicate changes over the previous issue.

Prepared By:	(Michael Wright)	May 28, 2009
	Core Strategy, PPS Group	
Approved By:	(L.K. John)	May 29, 2009
	Materials Technology	
	(B. Jenkins)	May 29, 2009
	Quality	

This PPS is effective as of the distribution date specified on the accompanying distribution notice.

Direct any PPS related questions to the PPS Group (416) 375-4365.

TABLE OF CONTENTS

Sections **Page**

1 SCOPE 3
2 HAZARDOUS MATERIALS. 3
3 REFERENCES 3
4 MATERIALS AND EQUIPMENT 3
5 PROCEDURE 3
5.1 Material Specifications 3
5.2 Alloy Designations 5
5.3 Temper Condition 6
6 REQUIREMENTS 6
7 SAFETY PRECAUTIONS 6
8 PERSONNEL REQUIREMENTS 6
9 SUBCONTRACTOR PROVISIONS 6

Tables

TABLE I - DESIGNATION OF TITANIUM AND TITANIUM ALLOYS - SHEET, STRIP AND PLATE (NOTE 1) 4
TABLE II - DESIGNATION OF TITANIUM AND TITANIUM ALLOYS - BARS (ROLLED OR FORGED) AND REFORGING STOCK (NOTE 1) 5
TABLE III - TEMPER CONDITION OF TITANIUM AND TITANIUM ALLOYS 6

1 SCOPE

1.1 This Production Process Standard (PPS) references the designation of titanium and titanium alloys.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

1.1.3 Procedure or requirements specified in a Bombardier BAPS, MPS, LES or P. Spec. **do not** supersede the procedure or requirements specified in this PPS. Similarly, the procedure and requirements specified in this PPS are not applicable when use of a BAPS, MPS, LES or P. Spec. is specified.

2 HAZARDOUS MATERIALS

2.1 Before receipt at Bombardier Toronto (de Havilland), all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto (de Havilland) Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact the Bombardier Toronto (de Havilland) Environment, Health and Safety Department.

3 REFERENCES

3.1 MIL-T-9046 - Titanium and Titanium Alloy Sheet, Strip and Plate.

3.2 MIL-T-9047 - Titanium and Titanium Alloy Bars (Rolled or Forged) and Reforging Stock, Aircraft Quality.

3.3 PPS 13.26 - General Subcontractor Provisions.

4 MATERIALS AND EQUIPMENT

4.1 Not applicable to this PPS.

5 PROCEDURE

5.1 Material Specifications

5.1.1 The titanium products used at de Havilland are controlled by military specifications.

5.1.2 The titanium and titanium alloy sheet, strip and plate are controlled by MIL-T-9046. These alloys are designated by type and composition as shown in Table I.

5.1.3 The titanium and titanium alloy bar (rolled or forged) and forging stock are controlled by MIL-T-9047. These alloys are designated by the type and composition as shown in Table II.

5.1.4 The alloy designations have changed with the various issues of the military specification as shown in Table I and Table II.

TABLE I - DESIGNATION OF TITANIUM AND TITANIUM ALLOYS - SHEET, STRIP AND PLATE (Note 1)

TYPE	MIL-T-9046H	MIL-T-9046J
COMMERCIALLY PURE TITANIUM (CP)		
Minimum Yield Strength - 70 ksi	Type I - Composition B	CP-1
Minimum Yield Strength - 55 ksi	Type I - Composition C	CP-2
Minimum Yield Strength - 40 ksi	Type I - Composition A	CP-3
Minimum Yield Strength - 25 ksi	—	CP-4
ALPHA TITANIUM ALLOYS (A)		
Ti-5Al-2.5Sn	Type II - Composition A	A-1
Ti-5Al-2.5Sn (ELI)	Type II - Composition B	A-2
Ti-6Al-2Cb-1Ta-0.8Mo	Type II - Composition G	A-3
Ti-8Al-1Mo-1V	Type II - Composition F	A-4
ALPHA-BETA TITANIUM ALLOYS (AB)		
Ti-6Al-4V	Type III - Composition C	AB-1 (Note 2)
Ti-6Al-4V (ELI)	Type III - Composition D	AB-2
Ti-6Al-6V-2Sn	Type III - Composition E	AB-3
Ti-6Al-2Sn-4Zr-2Mo	Type III - Composition G	AB-4
Ti-3Al-2.5V	—	AB-5
Ti-8Mn	—	AB-6
Ti-6Al-4V (SPL)	Type III - Composition H	—
BETA TITANIUM ALLOYS (B)		
Ti-13V-11Cr-3Al	Type IV - Composition A	B-1
Ti-11.5Mo-6Zr-4.5Sn	Type IV - Composition B	B-2
Ti-3Al-8V-6Cr-4Mo-4Zr	Type IV - Composition C	B-3
Ti-8Mo-8V-2Fe-3Al	Type IV - Composition D	B-4

Note 1. ELI denotes “extra low interstitials”.
Note 2. Aluminum has an upper limit of 6.75% instead of 6.50% as specified in MIL-T-9046H.

TABLE II - DESIGNATION OF TITANIUM AND TITANIUM ALLOYS - BARS (ROLLED OR FORGED) AND REFORGING STOCK (Note 1)

ALLOY	MIL-T-9047D	MIL-T-9047E & MIL-T-9047F	MIL-T-9047G
COMMERCIALLY PURE TITANIUM (CP)			
Minimum Yield Strength - 70 ksi	Type I - Composition A	Composition 1	Ti-CP-70
ALPHA TITANIUM ALLOYS (A)			
Ti-5Al-2.5Sn	Type II - Composition A	Composition 2	Ti-5Al-2.5Sn
Ti-5Al-2.5Sn (ELI)	Type II - Composition B	Composition 3	Ti-5Al-2.5Sn (ELI)
Ti-6Al-2Cb-1Ta-0.8Mo	—	—	Ti-6Al-2Cb-1Ta-0.8Mo
Ti-8Al-1Mo-1V	Type II - Composition D	Composition 5	Ti-8Al-1Mo-1V
ALPHA-BETA TITANIUM ALLOYS (AB)			
Ti-6Al-4V	Type III - Composition A	Composition 6	Ti-6Al-4V
Ti-6Al-4V (ELI)	Type III - Composition B	Composition 7	Ti-6Al-4V (ELI)
Ti-6Al-6V-2Sn	Type III - Composition C	Composition 8	Ti-6Al-6V-2Sn
Ti-6Al-2Sn-4Zr-2Mo	Type III - Composition I	Composition 11	Ti-6Al-2Sn-4Zr-2Mo
Ti-3Al-2.5V	—	—	Ti-3Al-2.5V
Ti-7Al-4Mo	Type III - Composition D	Composition 9	Ti-7Al-4Mo
Ti-11Sn-5Zr-2Al-1Mo	Type III - Composition G	Composition 10	—
Ti-6Al-2Sn-4Zr-6Mo	—	Composition 14	Ti-6Al-2Sn-4Zr-6Mo
BETA TITANIUM ALLOYS (B)			
Ti-13V-11Cr-3Al	Type IV - Composition A	Composition 12	Ti-13V-11Cr-3Al
Ti-11.5Mo-6Zr-4.5Sn	—	Composition 13	Ti-11.5Mo-6Zr-4.5Sn
Ti-3Al-8V-6Cr-4Mo-4Zr	—	—	Ti-3Al-8V-6Cr-4Mo-4Zr
Ti-8Mo-8V-2Fe-3Al	—	—	Ti-8Mo-8V-2Fe-3Al

Note 1. ELI denotes “extra low interstitials”.

5.2 Alloy Designations

5.2.1 Commercially pure titanium is designated by the minimum yield strength which is usually expressed in ksi (1 ksi = 1000 psi). The yield strength is related to the level of impurity. The lower the impurity level, the lower the yield strength. Refer to Table I and Table II for a list of commercially pure titanium compositions.

5.2.2 Titanium alloys are designated by a multi-part alpha-numeric code consisting of the symbol (Ti) followed by the nominal percentages and the element symbols of the major alloying elements (e.g., Ti-6Al-4V indicates a titanium alloy consisting of 6% aluminum and 4% vanadium). Refer to Table I and Table II for a list of titanium alloys.

5.3 Temper Condition

5.3.1 Temper condition for titanium and titanium alloys are shown in Table III.

TABLE III - TEMPER CONDITION OF TITANIUM AND TITANIUM ALLOYS

TEMPER CODE	DEFINITION
A	Annealed
DA	Duplex Annealed
ST	Solution Heat Treated
STA	Solution Heat Treated and Artificially Aged (Precipitation Heat Treated)
TA	Triplex Annealed

6 REQUIREMENTS

6.1 Not applicable to this PPS.

7 SAFETY PRECAUTIONS

7.1 Not applicable to this PPS.

8 PERSONNEL REQUIREMENTS

8.1 Not applicable to this PPS.

9 SUBCONTRACTOR PROVISIONS

9.1 Not applicable to this PPS.