de HAVILLAND Inc.

ENGINEERING STANDARD PRACTICE

TITLE

LEARJET 45 - SELECTION OF METALLIC MATERIALS

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de HAVILLAND Inc.

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REVISION CONTROL SHEET

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NIL	93-07-27	-----

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SCOPE

This document summarizes all the metallic materials that shall be used in the design of the Learjet model 45 wing. The use of metallic materials not listed in this document is not permitted, unless authorized by Manufacturing, Materials and Process Engineering.

This document contains general usage recommendations for each material which are based, among others, on material properties, structural efficiency and service experience. However, the material selection process should also take into account market price, availability, lead times and other important material-specific factors . The Procurement Department must be consulted prior to selecting a material so that the above factors are carefully weighed.

TABLE NO. 1 - ALUMINUM ALLOYS

ALLOY	FORM	TEMPER	APPLICABLE THICKNESS	GENERAL USAGE	SPECIFICATION
2004	Clad Sheet	O, T6	.032-.158	Restricted to parts requiring high degree of formability (superplasticity). Can be welded	AMS 4209
2024	Clad Sheet	T3, T42	.012-.249	Winglet skins, internal formed details	QQ-A-250/5
7075	Clad Sheet	T76	.016-.249	Miscellaneous formed details	QQ-A-250/25
6061	Bare Sheet	0, T4, T42, T6, T62	.020-.249	Leading edges, fusion welded parts	QQ-A-250/11
6013	Bare Sheet	T4, T6	.020-.249	Secondary structure details, good formability	AMS 4347 AMS 4216
2024	Plate	T351	.250-4.00	Lower wing skins, fatigue, toughness critical items. Corrosion resistance is poor; special protection req'd	QQ-A-250/4
6061	Plate	T651	.250-3.00	Machined parts requiring brazing, welding, good corrosion resistance	QQ-A-250/11
7075	Plate	T7351 T73	.250-3.00	Machined structural parts (frames, fittings)	QQ-A-250/12
7050	Plate	T7451	.250-6.00	Upper wing skins, machined primary structure and parts requiring plate thickness >3.00 (frames, spars)	AMS 4050
7075	"CV" Extruded shapes	T73, T73511	-	Cleats, brackets	QQ-A-200/11
7150	"CV" Extruded shapes	T77511	-	Stringers	AMS 4345
2024	Rod, Bar (Rolled)	T351, T4	<3.0	Fatigue, toughness critical items. Corrosion resistance is poor; special protection req'd.	QQ-A-225/6
6061	Rod, Bar (Rolled)	T4, T6	<8.0	Machined parts requiring brazing, welding, and good corrosion resistance	QQ-A-225/8

TABLE NO. 1 - ALUMINUM ALLOYS

ALLOY	FORM	TEMPER	APPLICABLE THICKNESS	GENERAL USAGE	SPECIFICATION
7075	Rod, Bar (Rolled)	T73, T7351	<3.0	Machined structural and mechanical parts	QQ-A-225/9
5052	Tubing	O	-	Systems with pressure <1500 psi	WW-T-700/4
6061	Tubing	T4, T6	-	Moderate strength structural parts	WW-T-700/6
356	Investment Casting	T6	-	Systems & secondary structure, parts stressed at low levels too difficult to machine from solid	AMS 4260
A356	Premium Investment Casting	T6	-	Too difficult to machine from solid	MIL-A-21180
7050	Hand Forging	T7452	<8.00	Centre spars, primary structural & mechanical parts	AMS 4108
7175	Die Forging	T74	<3.00	Premium strength, primary structural & mechanical parts; fatigue performance should be considered	AMS 4149

TABLE NO.2 - CARBON AND LOW ALLOY STEELS

ALLOY	FORM	TEMPER	APPLICABLE THICKNESS	GENERAL USAGE	SPECIFICATION
4340	Rod & Bar	125-145 ksi 150-170 ksi 180-200 ksi 200-220 ksi 260-280 ksi	<6.0 <4.0 <2.75 <2.00 <1.50	Structural and mechanical parts requiring good impact and fatigue resistance, (flap tracks, fittings). Crack growth rates should be considered on design	MIL-S-8844 CLASS I
300M	Forged billet	280-305 ksi	<100 in area <3.5	Primary structural parts requiring ultra-high strength (landing gear components, flap tracks). Crack growth rates should be considered on design	MIL-S-8844 CLASS II
4130		Tubing 125-145 ksi 150-170 ksi	Cond. N <.75 (wall) <.50 (wall)	Structural and mechanical parts also for fusion welding	MIL-T-6736
HIGH CARBON	Wire	"Music Spring Wire"	.004 -.250	For high quality springs requiring high torsion, bend and tensile strength	QQ-W-470
CARBON STEEL	Cable (7x19 const)	-	3/16 diam	Control cables	MIL-W-83420 TY I, COMP A
CARBON STEEL	Cable (7x7 const)	-	1/16 diam	Control cables	MIL-W-83420 TY I, COMP A

TABLE NO.3 - CORROSION RESISTANT STEELS

ALLOY	FORM	TEMPER	APPLICABLE THICKNESS	GENERAL USAGE	SPECIFICATION
301	Sheet	1/4 Hard 1/2 Hard 3/4 Hard Full Hard	-	Formed parts requiring good strength and corrosion resistance for service at <750°F	MIL-S-5059
321	Sheet	Annealed	-	Fusion welded, brazed and formed parts	AMS 5510
17-7 PH	Sheet, strip	TH 1050 (180-200 ksi) RH 950 (200-240 ksi)	-	High strength corrosion and oxidation resist. up to 600°F	MIL-25043
303SE	Rod & Bar	Cond. A	-	Machined fittings	QQ-S-764
303F	Flat bar	Cold Worked	-	Machined fittings	AMS 5738
321	Rod & Bar	Cond. A	-	Machined fittings requiring stabilized grade of stainless for fusion welding or elevated temp. service	QQ-S-763
17-4 PH	Rod & Bar	H1025 (155-175 ksi) H1150 (125-155 ksi)	<8.00 <8.00	Machined parts requiring high strength, corrosion and oxidation resistance to 600°F May be fusion welded.	AMS-5643
Custom 455	Bar & Forging	H 950455 (220-240 ksi) H 1000 (220-220 ksi) H 1050 (180-200 ksi)	<6.00 <8.00 <8.00	Machined parts requiring very high strength with high corrosion and oxidation resistance up to 800°F. May be fusion welded	AMS 5617
431	Bar	125-145 ksi 200-210 ksi	<7.00 <7.00	Same as Custom 455	MIL-S-18732
302	Wire	Spring Temper (Cond B)	.033-.375	Springs, hinge pins	QQ-W- 423
17-7 PH	Wire	CH 900	.016-.440	Springs requiring higher strength than 302	AMS 5678
17-4 PH	Investment Casting	H 1100 (130-160 ksi)	-	Standard steel casting material	AMS 5342
347	Investment Castings	Annealed	-	For high temp.(<1500°F) applications & where heat treat after welding is not desirable	AMS 5362

TABLE NO. 4 - TITANIUM ALLOYS

ALLOY	FORM	TEMPER	APPLICABLE THICKNESS	GENERAL USAGE	SPECIFICATION
Ti-CP-70	Sheet	Annealed	-	Fire zone parts requiring only single curvature forming	MIL-T-9046 Class CP-1 Formerly (Ty I, Comp B)
Ti-CP-40	Sheet	Annealed	-	Parts requiring double curvature forming for fire zone areas	MIL-T-9046 Class CP-3 Formerly (TY I, Comp A)
Ti-5Al-2.5Sn	Sheet	Annealed	-	For parts requiring higher strength than Ti-CP	MIL-T-9046 Class A-1 Formerly (Ty II, Comp A)
Ti-6Al-4V	Sheet	Annealed	-	For parts requiring higher strength & fatigue prop. than Ti-CP or Ti-5Al-2.5Sn	MIL-T-9046 Class AB-1 Formerly (Ty III,Comp C)
Ti-CP-40	Tube	Annealed (welded)	-	Bleed air, and anti-ice systems requiring strength up to 400°F and oxidation resistance up to 600°F	AMS 4941
Ti-3Al-2.5V	Tube	125 ksi min.	-	High pressure (3000 psi) hydraulic and pneumatic systems	AMS 4945

TABLE NO. 5 - MISCELLANEOUS

ALLOY	FORM	TEMPER	APPLICABLE THICKNESS	GENERAL USAGE	SPECIFICATION
Aluminum Comp. 1	Shim Stock	Type I Type II	.020 - .094 .094 - .125	Aluminum shim stock for aluminum structures	MIL-S-22499
Brass Comp. 2	Shim Stock	Type I Type II	.020 - .062 .062	Brass shim stock for monel, titanium components and structures	MIL-S-22499
Stainless Steel Comp.3	Shim Stock	Type I Type II	.020 - .062 -	Stainless steel shim stock for stainless steel components and structures	MIL-S-22499
Aluminum Bronze	Bar	85 ksi min 90 ksi min 100 ksi min	2.00-4.00 1.00-2.00 .50-1.00	Bushings, bearings, and sliding surfaces	ASTM-B-150 ALLOY 630