SAE Aerospace
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AEROSPACE INFORMATION REPORT

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Superseding AIR4066A

(R) Aerospace Fluid Power - Materials and Characteristics of Flight Control Servoactuators of Various Aircraft

RATIONALE

This document is a list of commonly used materials and associated characteristics for key components of linear flight control servo actuators for most current aircraft

1. SCOPE

This SAE Aerospace Information Report (AIR) defines the materials, strength, and finishes utilized in current linear hydraulic flight control actuators. To keep the information at a relevant minimum, only cylinders (barrels), glands, and pistons are listed. Also identified are the reasons for the material selection and any pertinent comments. All data were collected from the respective suppliers.

2. REFERENCES

There are no referenced publications specified herein.

3. PRESENTATION

The information is presented in tabular form and segregated as shown in Table 1 in the following categories:

TABLE 1

Table	Category	Pages
2	Commercial Transports	3 - 12
3	Military Transports	13 - 15
4	Fighters/Bombers	16 - 21
5	Helicopters	22 - 26
6	Missiles	27 - 29
7	Spacecraft	30 - 32

Each consists of unique tables for the cylinder, piston, and gland. The tables for each category are arranged alike: first, by alphanumerical order of the aircraft, and then, the suppliers.

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4. USAGE

The reader is advised to utilize the information contained herein with discretion. Since the information was supplied by the manufacturer, it is possible that a “no wear” or “no failure” statement may reflect a broad viewpoint. The manufacturer may have ignored occasional and/or sporadic problems, such as hydrogen embrittlement, corrosion, etc. which arose due to isolated circumstances. Certainly, problems typically encountered during qualification testing, and subsequently corrected, are not reflected in the tables either.

In summary, the information provided in this document is for historical purposes only. No endorsement of any specific material is to be construed.

5. NOTES

5.1 The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document.

PREPARED BY SAE SUBCOMMITTEE A-6B1, SERVO ACTUATION PANEL OF
COMMITTEE A-6, AEROSPACE FLUID POWER, ACTUATION, AND CONTROL TECHNOLOGY

TABLE 2A - CATEGORY - COMMERCIAL TRANSPORT - CYLINDER

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Liebherr Aerospace	A318/319/ 320/321	Rudder	15-5PH CRES, H1025	Bore: Chrome Plate		
Liebherr Aerospace	A330/340	Spoilers	15-5PH CRES, H1000	Hard chrome	Wear	
Liebherr Aerospace	A330/340E	Spoiler	15-5PH H1025	Bare		
Moog	A330/340	Inboard / Outboard Aileron	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, fatigue	
Parker Aerospace	A330/340	Rudder	15-5PH CRES, H1025	Bare		
Parker - Bertea	B707	Rudder	High transverse 4340 Steel, 180 ksi	Flash chrome	Fit envelope, strength	
Parker - Bertea	B727	Aileron	2014-T6 with 420 SS sleeve	Bare	Weight, wear	Excellent Life
Parker - Bertea	B727	Elevator	7075-T73 with 4340 Steel, 160 ksi liner	Bare	Weight, cost, wear	
Parker - Bertea	B727	Elevator - Original	7075-T73	Bare	Weight, cost	Wear area near neutral, no actual problems
Parker - Bertea	B727	Flight Spoiler	4340 Steel, 125 ksi	Bare	Customer design	
Parker - Bertea	B727	Rudder	7075-T73	Hard anodize	Weight, cost	
Parker - Bertea	B727	Rudder - Original	7075-T73	Bare	Weight, cost	Wear area near neutral, no actual problems
Smiths Aerospace	B737	Flight Spoiler	17-4PH CRES, 180-200 ksi	Bare	Customer design	
Parker - Bertea	B737	Aileron	7075-T73	Hard anodize	Cost, weight, part of body	
Parker - Bertea	B737	Elevator	7075-T73	Hard anodize	Cost, weight, part of body	
Parker - Bertea	B737	Rudder	7075-T73	Hard anodize	Cost, weight, part of body	
Parker Aerospace	B737NG	Rudder	4340 Steel, HT 150-170 ksi			
Moog	B737-200	Leading Edge	7075-T73	Hard anodize	Weight, cost	No wear except on contaminated hydraulic systems
HR Textron	B747	Lateral Control	7075-T73	Hard anodize	Weight, cost, wear	No reported failures or wear-out
Moog	B747	Ground Spoiler	7075 T73	Hard anodize	Wear, weight, cost	No reported failure or wear-out
Moog	B747	Inboard Aileron	17-4PH CRES, 165 ksi min.	Electrolize	Wear, Corrosion resistance	No reported failure or wear-out
Moog	B747	Inboard Spoiler	15-5PH CRES, 180-200 ksi	Bare	Wear, Corrosion resistance	No reported failure or wear-out
Moog	B747	Lateral Central Control	15-5PH CRES, H1025	Bare	Weight, wear	
Moog	B747	Outboard Aileron	17-4PH CRES, 165 ksi min.	Electrolize	Wear, Corrosion resistance	No reported failure or wear-out
Moog	B747	Outboard Spoiler	15-5PH CRES, 180-200 ksi	Bare	Wear, Corrosion resistance	No reported failure or wear-out

Moog	B747	Special Inboard Spoiler	15-5PH CRES, 180-200 ksi	Bare	Wear, Corrosion resistance	No reported failure or wear-out
Parker - Bertea	B747	Elevator - Original	4340 Steel, 180 ksi	Flash chrome	Strength, size	
Parker - Bertea	B747	Inboard Elevator	4340 Steel, 180 ksi	Flash chrome	Strength, size	
Parker - Bertea	B747	Outboard Elevator	4340 Steel, 180 ksi	Flash chrome	Strength, size	
Parker - Bertea	B747	Rudder	2014-T6	Hard anodize	Fatigue, weight	No reported failures or wear-out
Parker - Bertea	B747-400	Inboard Elevator	4340 Steel, 180 ksi	Flash chrome	Strength, wear	
Parker - Bertea	B747-400	Lower Rudder	15-5PH CRES, 180-200 ksi	Hard chrome	Good fatigue, wear	
Parker - Bertea	B747-400	Outboard Elevator	4340 Steel, 180 ksi	Bare	Strength, wear	
Parker - Bertea	B747-400	Upper Rudder	15-5PH CRES, 180-200 ksi	Hard chrome	Good fatigue, wear	
Moog	B757	Elevator	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosion, customer preference, fatigue strength	No reported failure or wear-out
Moog	B757	Flight Spoiler	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosion, customer preference, fatigue strength	No reported failure or wear-out
Moog	B757	Inboard Spoiler	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosion, customer preference, fatigue strength	No reported failure or wear-out
Moog	B757	Rudder	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosion, customer preference, fatigue strength	No reported failure or wear-out
Parker - Bertea	B767	Elevator	15-5PH CRES, H1025	Bare	Customer selected, wear, strength	
Parker - Bertea	B767	Inboard Aileron	15-5PH CRES, H1025	Bare	Customer selected, wear, strength	
Parker - Bertea	B767	Outboard Aileron	15-5PH CRES, H1025	Bare	Customer selected, wear, strength	
Parker - Bertea	B767	Rudder	15-5PH CRES, H1025	Bare	Customer selected, wear, strength	
Moog	B777	Spoiler	15-5PH CRES, H1025	Bare	Weight, wear	
Parker - Bertea	B777	Rudder	15-5PH CRES, H1025	Bare	Customer selected, wear, strength	
Nabtesco	B777	Aileron, Flaperon and Elevator	15-5PH CRES, H1025	Bare	Customer selected wear, strength	
Moog	BD-100	Rudder, Elevators, Spoilers	15-5PH CRES, H1025	Bare	Wear	
Goodrich Toronto	CRJ 200	Aileron, Elevator, Rudder, Spoileron	15-5PH CRES, HT 150-175 ksi			
Goodrich Toronto	CRJ 700	Elevator, Rudder, Ground Spoiler Multi Function Spoiler, Aileron	15-5PH CRES, HT 150-175 ksi			
Parker - Bertea	DC-10	All Primary Surfaces	4340 Steel, 180 ksi	Bare	Customer preference, strength	
Parker - Bertea	DC-10	Rudder	4340 Steel, 180 ksi	Bare	Customer preference, strength	
Parker - Bertea	DHC7	Flight Spoiler	7075-T73 with 4340 Steel , 160 ksi liner	Anodize bare	Weight, cost, wear	
Parker - Bertea	DHC7	Rudder	4340 Steel, 180 ksi	Bare	Strength, wear	
Smiths Aerospace	DHC8	Flight Spoiler	4340 Steel,	Bare	Wear	

Parker Aerospace	EMB 170/190	Aileron	4130 Steel, 150-170 ksi	Bare		
Parker Aerospace	EMB 170/190	Rudder, Elevator, MFS and Ground Spoiler	15-5PH CRES, H1025	Bare		
Parker - Bertea	GII	All Surfaces	7075-T73	Bare	Weight, cost	
Parker - Bertea	GII	Rudder	7075-T73	Bare	Weight, cost	
Parker - Bertea	GIII	Ground Spoiler	7075-T73	Bare	Weight, cost	
Parker Aerospace	Global Express	All	15-5PH CRES, H1025	Bare		
Moog	L-1011	Spoiler	4340 Steel, 180-200 ksi	Bare	Wear, high snubbing pressure	No reported wear. Corrosion of moisture retaining surfaces
Parker - Bertea	L-1011	Horizontal Stabilizer	4340 Steel, 180 ksi	Flash chrome	Strength, size	
Parker - Bertea	L-1011	Inboard Aileron	2014-T6	Hard anodize	Fatigue, weight	No reported failures or wear-out
Parker - Bertea	L-1011	Outboard Aileron	2014-T6	Hard anodize	Fatigue, weight	No reported failures or wear-out
Parker - Bertea	L-1011	Rudder	2014-T6	Hard anodize	Fatigue, weight	No reported failures or wear-out
Smiths Aerospace	MD 90	Elevator	15-5PH CRES, 180-200 ksi	Bare	Wear, corrosion resistance strength	
Parker - Bertea	MD-11	Outboard Aileron	4340 Steel, 180 ksi	Bare	Strength, wear	
Parker - Bertea	Metro	Landing Gear, Flap	2014-T6	Anodize	Weight, cost	
Smiths Aerospace	SAAB 2000	Elevator	4340 Steel, 160-190 ksi	Bare	Wear, corrosion resistance strength	
Smiths Aerospace	SAAB 2000	Rudder	4340 Steel, 160-190 ksi	Bare	Wear, corrosion resistance strength	

TABLE 2B - CATEGORY - COMMERCIAL TRANSPORT - PISTON

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Liebherr Aerospace	A318/319/ 320/321	Rudder	35 NCD 16	Rod: Chrome Plate Head: none		Good performance
Liebherr Aerospace	A330/340	Spoiler	PH13-8Mo CRES, H1000	Hard chrome	Min. weight, wear	
Liebherr Aerospace	A330/340E	Spoiler	15-5PH	Rod: Chrome Plate Head: Rilsan Coated	Head protection due to unbalanced piston design	Good performance
Moog	A330/340	Inboard / Outboard Aileron	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, fatigue	Good performance
Parker Aerospace	A330/340	Rudder	15-5PH CRES, H1025	Rod: Tungsten Carbide	Wear surface	
Parker Aerospace	B707	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B727	Aileron	410 SS, RC 39/44	Bare	Wear	Excellent
Parker Aerospace	B727	Elevator	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B727	Elevator - Original	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B727	Flight Spoiler	15-5PH CRES, 180 ksi	Hard chrome	Wear, strength, corrosion resistance	
Parker Aerospace	B727	Rudder - Original	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Smiths Aerospace	B737	Flight Spoiler	17-4PH CRES, 180-200 ksi	Hard chrome	Customer design	
Parker Aerospace	B737	Aileron	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B737	Elevator	17-4PH CRES, 180 ksi	Hard chrome	Corrosion resistance	
Parker Aerospace	B737	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B737NG	Rudder	15-5PH CRES, H1025	Rod: Tungsten Carbide	Wear surface	
Moog	B737-200	Leading Edge	15-5PH CRES, 180-200 ksi; or 4340 Steel, 180-200 ksi	Chrome plated rod; bare outer piston head + chrome plated inner piston head	Stress, wear	No reported wear
HR Textron	B747	Lateral Control	17-4PH CRES 180-200 ksi	Hard chrome	Wear corrosion resistance, strength	No reported failures or wear-out
Moog	B747	Ground Spoiler	4330M Steel, 220-240 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Moog	B747	Inboard Aileron	4330M Steel, 220-240 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Moog	B747	Inboard Spoiler	4340 Steel, 180-200 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Moog	B747	Lateral Central Control	15-5PH CRES, H1025	Hard chrome	Weight, wear	
Moog	B747	Outboard Aileron	15-5PH CRES, 180-200 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Moog	B747	Outboard Spoiler	15-5PH CRES, 180-200 ksi	Hard chrome	Wear, weight	No reported failures or wear-out

Moog	B747	Special Inboard Spoiler	4330M Steel, 220-240 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Parker Aerospace	B747	Elevator - Original	4340M Steel, 270 ksi (long) 4340 Steel, 180 ksi (short)	Hard chrome	Wear, Strength	Some corrosion problems were reported
Parker Aerospace	B747	Inboard Elevator	15-5Ph CRES, 180 ksi	Hard chrome	Corrosion resistance, good fatigue	
Parker Aerospace	B747	Outboard Elevator	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B747	Rudder	17-4PH CRES 190 ksi	Hard chrome	Wear	Excellent
Parker Aerospace	B747-400	Inboard Elevator	15-5PH CRES, 180-200 ksi	Hard chrome	Corrosion resistance, good fatigue	
Parker Aerospace	B747-400	Lower Rudder	15-5PH CRES, 180-200 ksi	Hard chrome	Corrosion resistance, good fatigue	
Parker Aerospace	B747-400	Outboard Elevator	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B747-400	Upper Rudder	15-5PH CRES, 180-200 ksi	Hard chrome	Corrosion resistance, good fatigue	
Moog	B757	Elevator	15-5PH CRES, 150-180 ksi	Hard chrome	Wear corrosion resistance, customer preference	No reported failures or wear-out
Moog	B757	Flight Spoiler	15-5PH CRES, 150-180 ksi	Hard chrome	Wear corrosion resistance, customer preference	No reported failures or wear-out
Moog	B757	Inboard Spoiler	15-5PH CRES, 150-180 ksi	Hard chrome	Wear corrosion resistance, customer preference	No reported failures or wear-out
Moog	B757	Rudder	15-5PH CRES, 150-180 ksi	Hard chrome	Wear corrosion resistance, customer preference	No reported failures or wear-out
Parker Aerospace	B767	Elevator	4330M Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B767	Inboard Aileron	4330M Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B767	Outboard Aileron	4330M Steel, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	B767	Rudder	4330M Steel, 180 ksi	Hard chrome	Wear, strength	
Moog	B777	Spoiler	15-5PH CRES, H1025 or PH13-8MO	Hard chrome	Wear, fatigue Wear, strength	
Parker Aerospace	B777	Rudder	15-5PH CRES, H1025	Hard chrome	Wear, strength	
Nabtesco	B777	Aileron, Flaperon Elevator	15-5PH CRES, H1025	Hard chrome	Wear	
Moog	BD-100	Rudder, Elevators, Spoilers	15-5PH H1025	Hard chrome	Wear, corrosion resistance	
Goodrich Toronto	CRJ 200	Aileron	13-8PH per AMS 5629	Chrome per MIL-STD-1501_CL 2 Type II		
Goodrich Toronto	CRJ 200	Elevator, Rudder, Spoileron	15-5PH per AMS 5659	Chrome per MIL-STD-1501_CL 2 Type II		
Goodrich Toronto	CRJ 700	Multi Function Spoiler, Aileron	13-8PH per AMS 5629	Chrome per MIL-STD-1501_CL 2 Type II		
Goodrich Toronto	CRJ 700	Elevator, Rudder, Ground Spoiler	15-5PH per AMS 5659	Chrome per MII-STD-1501_CL 2 Type II		
Parker Aerospace	DC-10	All Primary Surfaces	4340 Steel, vac. melt, 180 ksi	Hard chrome	Wear, strength	
Parker Aerospace	DHC-7	Flight Spoiler	Cust. 950CRES, H950	Hard chrome	Wear, strength, corrosion resistance	
Parker Aerospace	DHC-7	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	

Smiths Aerospace	DHC-8	Flight Spoiler	17-4PH CRES, H1075	Hard chrome	Wear, corrosion resistance, strength	
Parker Aerospace	EMB 170/ 190	All	15-5PH CRES, H1025	Rod: Tungsten Carbide	Wear surface	
Parker Aerospace	GII	All Surfaces	17-4PH CRES, H925 or H900	Hard chrome	Wear, strength, no interfinish	H900 & H925 are obsolete. No actual problems reported.
Parker Aerospace	GII	Rudder	17-4PH CRES, H925 or H900	Hard chrome	Wear, strength, no interfinish	H900 & H925 are obsolete. No actual problems reported.
Parker Aerospace	GIII	Ground Spoiler	15-5PH CRES, 180 ksi	Hard chrome	Wear, strength, corrosion resistance	
Parker Aerospace	Global Express	All	15-5PH CRES, H1025	Rod: Tungsten Carbide	Wear surface	
Parker Aerospace	Hawker Horizon	Rudder	15-5PH CRES, H1025	Rod: Tungsten Carbide	Wear surface	
Moog	L-1011	Spoiler	4340 Steel, 180-200 ksi	Chrome plated rod/ piston head	Wear, stress	No reported war. Corrosion of moisture retaining surfaces.
Parker Aerospace	L-1011	Horizontal Stabilizer	4340 Steel, 180 ksi Output side; 6061-T6 Tail side	Hard anodize	Weight, cost	
Parker Aerospace	L-1011	Inboard Aileron	15-5PH CRES RC 40/45	Hard chrome	Wear	Excellent
Parker Aerospace	L-1011	Outboard Aileron	17-4PH CRES RC 40/45	Hard chrome	Wear	Excellent
Parker Aerospace	L-1011	Rudder	17-4PH CRES RC 40/45	Hard chrome	Wear	Excellent
Smiths Aerospace	MD 90	Elevator	15-5PH CRES 150-170 ksi	Hard chrome	Wear, corrosion resistance	
Parker Aerospace	MD-11	Outboard Aileron	Hy-Tuf Steel 220-250 ksi 4340 Steel, 180-200 ksi	Hard chrome	Wear, strength	
Parker Aerospace	Metro	Landing Gear, Flap	4130 Steel, 140 ksi	Hard chrome	Wear, cost	
Smiths Aerospace	SAAB 2000	Elevator	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosioin resistance	
Smiths Aerospace	SAAB 2000	Rudder	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosion resistance	

TABLE 2C - CATEGORY - COMMERCIAL TRANSPORT - GLANDS

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
Liebherr Aerospace	A318/319/ 320/321	Rudder	CuBe2	Bare	Low friction	Good performance
Liebherr Aerospace	A330/340	Spoiler	Al-Ni Bronze	Bare	Wear	
Moog	A330/340	Inboard / Outboard Aileron	Al-Ni Bronze	Bare	Wear	Good performance
Parker Aerospace	A330/340	Rudder	Al-Ni Bronze	Bare		
Liebherr Aerospace	A330/340 E	Spoiler	15-5PH H1025	Bare	Low cost	Gland is part of cylinder housing
Parker Aerospace	B707	Rudder	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	B727	Aileron	420 SS	Bare	Wear	Excellent life
Parker Aerospace	B727	Elevator	Al-Ni Bronze	Bare	Customer preference, wear	Excellent life
Parker Aerospace	B727	Elevator - Original	Al-Ni Bronze	Bare	Customer prefrence, wear	Excellent life
Parker Aerospace	B727	Flight Spoiler	Al-Ni Bronze	Bare	Customer design, wear	
Parker Aerospace	B727	Rudder	Al-Ni Bronze	Bare	Customer preference, wear	Excellent life
Parker Aerospace	B727	Rudder - Original	Al-Ni Bronze	Bare	Customer preference, wear	Excellent life
Smiths Aerospace	B737	Flight Spoiler	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	B737	Aileron	Al-Ni Bronze	Bare	Customer preference, wear	
Parker Aerospace	B737	Elevator	Al-Ni Bronze	Bare	Customer preference, wear	
Parker Aerospace	B737	Rudder	Al-Ni Bronze	Bare	Customer preference, wear	
Moog	B737-200	Leading Edge	Al-Ni Bronze AMS 5659	Bare	Wear	
Parker Aerospace	B737NG	Rudder	Al-Ni Bronze	Bare		
HR Textron	B747	Lateral Control	Alum. Bronze	Bare	Wear	No reported failures or wear-out
Moog	B747	Ground Spoiler	7075-T73	Al Bronze		No reported failures or wear-out
Moog	B747	Inboard Aileron	17-4PH CRES, 165 ksi min	Al Bronze		No reported failures or wear-out
Moog	B747	Inboard Spoiler	15-5PH CRES	Be-Cu	Wear	No reported failures or wear-out
Moog	B747	Lateral Central Control	Al-Ni Bronze	Bare	Wear	
Moog	B747	Outboard Aileron	17-4PH CRES, 165 ksi min	Al Bronze		No reported failures or wear-out
Moog	B747	Outboard Spoiler	15-5PH CRES	Be-Cu	Wear	No reported failures or wear-out
Moog	B747	Special Inboard Spoiler	15-5PH CRES	Be-Cu	Wear	No reported failures or wear-out
Parker Aerospace	B747	Elevator - Original	Al-Ni Bronze	Bare	Customer preference, wear	
Parker Aerospace	B747	Inboard Elevator	Al-Ni Bronze	Bare	Customer preference, wear	
Parker Aerospace	B747	Outboard Elevator	Al-Ni Bronze	Bare	Customer preference, wear	
Parker Aerospace	B747	Rudder	Al-Ni Bronze	Bare	Wear	Excellent
Parker Aerospace	B747-400	Inboard Elevator	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	B747-400	Lower Rudder	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	B747-400	Outboard Elevator	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	B747-400	Upper Rudder	Al-Ni Bronze	Bare	Wear	

Moog	B757	Elevator	7075-T73 and 15-5PH CRES 150-170 ksi	Al-Ni Bronze	Wear, customer preference, weight	No reported failures or wear-out
Moog	B757	Flight Spoiler	7075-T73	Al-Ni Bronze	Wear, customer preference, weight	No reported failures
Moog	B757	Inboard Spoiler	7075-T73	Al-Ni Bronze	Wear, customer preference, weight	No reported failures
Moog	B757	Rudder	7075-T73 and 15-5PH CRES 150-170 ksi	Al-Ni Bronze	Wear, customer preference, weight	No reported failures or wear-out
Parker Aerospace	B767	Elevator	7075-T73511 Al-Ni Bronze Liner	Anodize Bare	Cost, weight, customer preference, wear	
Parker Aerospace	B767	Inboard Aileron	7075-T73511 Al-Ni Bronze Liner	Anodize Bare	Cost, weight, customer preference, wear	
Parker Aerospace	B767	Outboard Aileron	7075-T73511	Hard anodize	Cost, weight, no room for liner	
Parker Aerospace	B767	Rudder	7075-T73511 Al-Ni Bronze Liner	Anodize Bare	Cost, weight, customer preference, wear	
Moog	B777	Spoiler	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	B777	Rudder	Al-Ni Bronze	Bare	Wear	
Nabtesco	B777	Aileron, Flaperon Elevator	Al-Ni Bronze	Bare	Wear	
Moog	BD-100	Rudder, Elevators	Al-Ni Bronze	Bare	Wear, weight	
Moog	BD-100	Spoilers	7075 Alum.	Hard anodize	Side bearing load	
Goodrich Toronto	CRJ 200	Spoileron, Elevator, Rudder, Aileron	7075 T73 OR T7351 AL per AMS-QQ-A-225/9	Hard anodize		
Goodrich Toronto	CRJ 700	MF Spoiler, Ground Spoiler, Elevator, Rudder, Aileron	7075 T73 OR T7351 AL per AMS-QQ-A-225/9	Hard anodize		
Parker Aerospace	DC-10	All Primary Surfaces	6061-T6 Alum.	Hard anodize	Weight, cost	No wear-out, some part failed by fatigue
Parker Aerospace	DC-10	Lower Rudder	7075-T73	Hard anodize	Weight, cost	
Parker Aerospace	DHC-7	Flight Spoiler	7075-T7351 and 6061-T6	Hard anodize	Cost, weight	
Parker Aerospace	DHC-7	Rudder	7075-T7351 and 6061-T6	Hard anodize	Cost, weight	
Smiths Aerospace	DHC-8	Flight Spoiler	7075-T651	Anodize	Wear	
Parker Aerospace	EMB 170/ 190	Aileron, MFS & Ground Spoiler	Al-Ni Bronze	Bare		
Parker Aerospace	EMB 170/ 190	Elevator, Rudder	Al-Ni Bronze & 15-5PH CRES H1025	Bare		
Parker Aerospace	GII	All Surfaces	7075-T73 and 2024-T6	Bare	Weight, cost, part of barrel	Rudder rod end gland had excessive wear, no actual problems
Parker Aerospace	GII	Rudder	Al-Ni Bronze (rod end)	Bare	Wear	
Parker Aerospace	GIII	Ground Spoiler	2024-T4 (center) 7075-T73 (output end)	Bare	Cost, weight	
Parker Aerospace	Global Express	Aileron	7075-T7351 & 15-5PH CRES H1025	Bare		

Parker Aerospace	Global Express	Elevator	7075-T7351 & Beryllium Copper	Bare		
Parker Aerospace	Global Express	Rudder	Beryllium Copper	Bare		
Parker Aerospace	Global Express	MF Spoiler	15-5PH CRES H1025	Bare		
Parker Aerospace	Global Express	Ground Spoiler	7075-T7351	Bare		
Parker Aerospace	Hawker Horizon	Rudder	Al-Ni Bronze	Bare		
Moog	L-1011	Spoiler	4340 Steel, 180-200 ksi	Bare	Wear, high snubbing pressure	No reported wear, corrosion of moisture retaining surfaces
Parker Aerospace	L-1011	Horizontal Stabilizer	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	L-1011	Inboard Aileron	2024-T4	Alum. Bronze spray coated	Wear	Excellent
Parker Aerospace	L-1011	Outboard Aileron	2024-T4	Anodize	Wear, cost	Excellent
Parker Aerospace	L-1011	Rudder	2024-T4	Alum. Bronze spray coated	Wear	Excellent
Smiths Aerospace	MD-90	Elevator	Al-Ni Bronze	Bare	Wear	
Parker Aerospace	MD-11	Outboard Aileron	7075-T7351	Hard anodize	Weight, wear	
Parker Aerospace	Metro	Landing Gear, Flap	2024-T351	Anodize	Cost, weight	
Smiths Aerospace	SAAB 2000	Elevator	Al-Ni Bronze	Bare	Wear	
Smiths Aerospace	SAAB 2000	Rudder	Al-Ni Bronze	Bare	Wear	

TABLE 3A - CATEGORY - MILITARY TRANSPORT - CYLINDER

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Tactair	C-130H	All Primary Controls	7075-T73	Anodize	Weight	No failure or wear-out during normal service
Parker Aerospace	C-141	Aileron	2014-T6	Hard anodize	Weight, cost	
Parker Aerospace	C-141	Elevator	2014-T6	Hard anodize	Weight, cost	
Parker Aerospace	C-141	Rudder	2014-T6	Anodize	Weight, cost	
HR Textron	C-17	Inboard/Outboard Spoiler	15-5PH CRES, H1025 with carbon/ epoxy overwrap	Thin dense chrome	Weight, overwrap reinforces cylinder wall	
Parker Aerospace	C-17	All Primary Surfaces	Custom 455 CRES, H1000 or PH13-8 MO CRES, H1000	Bare	Strength, wear	
Parker Aerospace	C-5A	All Primary Controls	7075-T73	Hard anodize	Weight, cost	No reported failures or wear-out
Moog	C-5B	Spoiler	7075-T73	Sulfuric Acid Anodize	Weight, cost	No service related failures reported
Parker Aerospace	E-2C	Aileron, Rudder	2014-T6	Anodize	Weight, cost	No service failures reported
		Original Elevator; Elevator	2014-T6	Anodize	Weight, cost	Some fatigue problems
			15-5PH CRES	Bare	Customer prefer., strength	No service failures
Parker Aerospace	E3A/KC135R	Rudder	High transverse 4340 Steel, 180 ksi	Flash chrome	Fits envelope, strength, B707 mod.	
Moog	KC-10	Refueling Boom, Aerodynamic Controls	4340 Steel, 180-200 ksi	Hard chrome		
Parker Aerospace	S-3A	Rudder, Aileron, Elevator	17-4PH CRES, H1000, Invest. castg	Bare	Strength, cost, wear	

TABLE 3B - CATEGORY - MILITARY TRANSPORT - PISTON

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Tactair	C-130H	All Primary Controls	4130 Steel, 150 ksi	Hard chrome	Wear, cost	No reported failures or wear-out
Parker Aerospace	C-141	Aileron	17-4PH CRES	Hard chrome	Wear	No reported problems
Parker Aerospace	C-141	Elevator	4340 Steel	Hard chrome	Wear	No reported problems
Parker Aerospace	C-141	Rudder	17-4PH CRES	Hard chrome	Wear	No reported problems
HR Textron	C-17	Inboard/Outboard Spoiler	15-5PH CRES, H1025	Hard chrome	Wear, cost	
Parker Aerospace	C-17	All Primary Surfaces	Custom 455 CRES, H1000 or PH13-8 MO CRES, H1000	Hard chrome	Strength, wear	
Parker Aerospace	C-5A	All Primary Controls	4340 Steel, 180 ksi	Hard chrome	Wear, strength	No reported failures or wear-out
Moog	C-5B	Spoiler	4340 Steel, 180-200 ksi	Chrome plated rod/bare piston head	Stress, wear	No service related failures reported
Parker Aerospace	E-2C	Inboard Rudder and Elevator	17-4PH CRES	Hard chrome	Wear	No reported problems
Parker Aerospace	E-2C	Outboard Rudder and Aileron	15-5PH CRES	Hard chrome	Wear	No reported problems
Moog	KC-10	Refueling Boom, Aerodynamic Controls	4340 Steel, 180-200 ksi	Hard chrome		
Parker Aerospace	S-3A	Rudder, Aileron, Elevator	17-4PH CRES, H1025 (output side) 2024-T851 (tail side)	Hard chrome	Wear, strength, less magnetic Nonmagnetic, weight, cost	

TABLE 3C - CATEGORY - MILITARY TRANSPORT - GLANDS

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
Tactair	C-130H	All Primary Controls	Alum. Bronze	Bare	Wear	No reported failures or wear-out
Parker Aerospace	C-141	Aileron	2014-T6	Hard anodize	Wear, weight	No reported problems
Parker Aerospace	C-141	Elevator	2014-T6	Hard anodize	Wear, weight	No reported problems
Parker Aerospace	C-141	Rudder	2014-T6	Hard anodize		No reported problems
HR Textron	C-17	Inboard/Outboard Spoiler	7075-T73 with Al-Ni Bronze inserts	Anodize Bare	Wear, weight	
Parker Aerospace	C-17	All Primary Surfaces	7075-T73	Hard anodize	Wear, weight	
Parker Aerospace	C-5A	All Primary Controls	7075-T73	Hard anodize	Weight, cost	No reported failures or wear-out
Moog	C-5B	Spoiler	7075-T73	Sulfuric Acid Anodized	Weight, cost	
Parker Aerospace	E-2C	Inboard Rudder and Elevator	2024-T651	Anodize	Wear, weight	No reported problems
Parker Aerospace	E-2C	Outboard Rudder and Aileron	2024-T651	Anodize	Wear, weight	No reported problems
Parker Aerospace	E3A/KC135R	Rudder	Al-Ni Bronze	Bare	Wear	
Moog	KC-10	Refueling Boom, Aerodynamic Controls	7075-T652	Hard anodize	Weight, cost	
Parker Aerospace	S-3A	Rudder, Aileron, Elevator	Al Bronze (output end) 2024-T85 (center), 17-4PH CRES (tail end)	Bare Alodine Bare	Wear Cost weight Wear	

TABLE 4A - CATEGORY - FIGHTERS/BOMBERS - CYLINDER

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Parker Aerospace	AV-8B	Rudder	7075-T73 4130 Steel, 150 ksi liner	Anodize Bare		
Smiths Aerospace	B-1B	Flight Spoiler	HP4-9-30 Steel, 220-240 ksi	Bare	Customer design	
Smiths Aerospace	B-1B	YAW SCAS	2219-T852 Al Alloy	Hard anodize	Customer design	
Moog	B-2	All Surfaces	15-5PH CRES, H1025	Hard chrome	Wear	
Moog	B-58	Elevon	4140 Steel, 140-160 ksi	Hard Chrome	Wear, fatigue	No reported failures or wear-out
Moog	B-58	Rudder	4140 Steel, 140-160 ksi	Hard Chrome	Wear, fatigue	No reported failures or wear-out
HR Textron	F/A-18 E/F	Aileron, Rudder	15-5PH CRES, H-1025 with Carbon-epoxy overwrap	Thin dense chrome	Wear, strength, corrosion resistance	Composite-wrapped OD for weight savings
Moog	F/A-18 E/F	LEX Spoilers	15-5PH CRES, H1025	Bare		
Moog	F-111	Horizontal Tail	D6AC Steel, 150-170 ksi	Hard Chrome	Customer preference	No reported failures or wear-out. Some fatigue failures after 15 years service.
Moog	F-111	Rudder	D6AC Steel, 200-220 ksi	Hard Chrome	Wear	No reported failures or wear-out. Some fatigue failures after 15 years service.
Moog	F-111	Spoiler	6Al-4V Titan., 130 ksi min.	Ti-cote	Weight	No reported failures or wear-out. Some fatigue failures after 15 years service.
Parker Aerospace	F-117/F-16	Horizontal Tail/ Flaperon, Rudder	15-5PH CRES, H1025	Chrome		
Moog	F-14	Horizontal Tail	4330 Steel, 220-240 ksi	Hard Chrome	Weight, wear, fatigue strength	No reported failures or wear-out
Moog	F-14	Rudder	4330 Steel, 160-180 ksi	Hard Chrome	Weight, wear, fatigue strength	No reported failures or wear-out
Smiths Aerospace	F-15	Rudder	17-4PH CRES, H1025	Nitride	Corrosion resistance wear	Rotary vane
Parker Aerospace	F-15	Stabilator	4340 Steel, RC 40/43	Bare	Weight, cost	Excellent life Mild scratches
Parker Aerospace	F-16	All Primary Surfaces	15-5PH CRES, H1025	Hard chrome	Wear	Excellent life
Smiths Aerospace	F-18	Rudder	15-5PH CRES, H1025	Bare	Corrosion resistance wear	
HR Textron	F-18	Aileron	15-5PH CRES, H1025	Hard chrome	Strength, wear	No reported failures or wear-out
Parker Aerospace	F-18	Stabilator	15-5PH CRES, H1025	Bare	Cost	Excellent life
Parker Aerospace	F-18	Trailing Edge Flap	4340 Steel, 180 ksi	Bare	Strength, wear	
Parker Aerospace	F-18 E/F	TEF	4340 Steel	Bare		
Parker Aerospace	F-18 E/F	Stabilator	13-8 MO Steel	Bare		
Parker Aerospace	F-22	Horizontal Tail, Rudder, Aileron, Flaperon	15-5PH CRES, H1025	Bare		
Parker Aerospace	F-4	Rudder	2014-T6	Anodize	Part of body	

Parker Aerospace	F-4 Air Force	Rudder	7075-T73 with 4130 Steel, 150 ksi liner	Anodize Bare	Part of body, better MTBF	
Smiths Aerospace	F-5	All Surfaces and Stab. Augmentation	2014-T6 with 4130 sleeve 130-150 ksi	Anodize, bare	Customer design	
Moog	IDF	All Primary Surfaces	15-5PH CRES, H1025	Hard chrome	Wear	
Moog	JAS-39	Wing, Rudder, Canard	15-5PH CRES, H1025	Hard chrome	Wear, corrosion resistance	
Moog	LAVI	Elevon, Rudder Canard	17-4PH CRES, H1025	Hard chrome	Wear, corrosion resistance	
Liebherr Aerospace	Typhoon	Rudder	13-8MO H1000	Bore: Chrome Plate		
Microtecnica	Typhoon	Outbd. Flaperon	PH13-8MO H1000	Hard Chrome	Wear	
Smiths Aerospace	Typhoon	Inbd. Flaperon	PH13-8MO H1000	Hard Chrome	Wear	

TABLE 4B - CATEGORY - FIGHTERS/BOMBERS - PISTON

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Parker Aerospace	AV-8B	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Smiths Aerospace	B-1B	Flight Spoiler	HP 4-9-30 Steel, 220-240 ksi	Hard chrome	Customer design	
Smiths Aerospace	B-1B	YAW SCAS	HP 4-9-30 Steel, 220-240 ksi	Hard anodize	Customer design	
Moog	B-2	All Surfaces	15-5PH H1025	Piston Head: Bare Piston Rod: Hard chrome	Wear, corrosion resistance	
Moog	B-58	Elevon	4130 Steel, 140-160 ksi	Hard chrome and tungsten carbide	Wear	No reported failures or wear-out
Moog	B-58	Rudder	4130 Steel, 140-160 ksi	Hard chrome	Wear	No reported failures or wear-out
Moog	F-111	Horizontal Tail	D6AC Steel, 220-240 ksi	Hard chrome	Wear, weight, customer preference	No reported failures or wear-out
Moog	F-111	Rudder	17-4PH, 180 ksi min.	Hard chrome	Wear, weight, customer preference	No reported failures or wear-out
Moog	F-111	Spoiler	D6AC Steel, 220-240 ksi (alt. D6AC, 220-270 ksi)	Hard chrome	Wear, weight, customer preference	No reported failures or wear-out
Parker Aerospace	F-117/ F-16	Horizontal Tail/ Flaperon, Rudder	D6AC	Rod: Chrome Head: Bare	Rod sealing surface requires hard smooth surface; Balanced piston does not allow piston contact with cylinder	
Moog	F-14	Horizontal Tail, Rudder	4330M Steel, 220-240 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Smiths Aerospace	F-15	Rudder	17-4PH CRES, H1025	Nitride	Corrosion resistance wear	Rotary vane
Parker Aerospace	F-15	Stabilator	D6AC Steel	Hard chrome	Weight, cost	Mild scratches
Parker Aerospace	F-16	All Primary Surfaces	D6AC Steel	Hard chrome	Wear	Excellent
Smiths Aerospace	F-18	Rudder	PH13-8MO CRES, H1000	Hard chrome	Corrosion resistance wear, strength	
HR Textron	F-18	Aileron	15-5PH CRES, H1025	Hard chrome rod & alum. bronze head	Wear, corrosion resistance, strength	No reported failures or wear-out
Parker Aerospace	F-18	Stabilator	15-5PH CRES, H1025	Hard chrome	Cost	Excellent
Parker Aerospace	F-18	Trailing Edge Flap	PH13-8MO CRES, H1000	Hard chrome	Wear, strength, corrosion resistance	
Parker Aerospace	F-18 E/F	TEF	13-8MO	Rod: Tungsten Carbide Head: Tribaloy	Rod sealing surface requires hard smooth surface; head requires galling protection due to unbalanced piston	

Parker Aerospace	F-18 E/F	Stabilator	13-8MO	Rod: Tungsten Carbide Head: Copper Nickel Indium	Rod sealing surface requires hard smoothh surface; head requires galling protection due to unbalanced piston	
Parker Aerospace	F-22	Horizontal Tail, Rudder, Aileron, Flaperon	15-5PH CRES, H1025	Rod: Tungsten Carbide Head: Tribaloy	Rod sealing surface requires hard smooth surface; head requires galling protection due to unbalanced piston	Have switched to Tungsten Carbide with added chrome for additional corrosion resistance.
Parker Aerospace	F-4 (All)	Rudder	4130 Steel, 150 ksi	Hard chrome	Wear, strength	
Smiths Aerospace	F-5	All Surfaces and Stab. Augmentation	4130 Steel, 160-180 ksi	Hard chrome	Customer design	
HR Textron	F/A-18 E/F	Aileron	15-5PH CRES, H1025	Hard Chrome		
HR Textron	F/A-18 E/F	Rudder	PH13-8MO CRES, H1000	Hard Chrome	Strength	
Moog	F/A-18 E/F	LEX Spoilers	13-8PH CRES, H1000	Rod: Tungsten Head: Bronze Plated	Wear and corrosion protection	
Moog	IDF	All Primary Surfaces	15-5PH CRES, H1025	Hard chrome	Wear	
Moog	JAS-39	Wing, Rudder Canard	15-5PH CRES, H1025	Hard chrome	Wear, corrosion resistance	
Moog	LAVI	Elevon, Rudder Canard	17-4PH CRES, H1075	Hard chrome	Wear, corrosion resistance	
Liebherr Aerospace	Typhoon	Rudder	13-8MO H1000	Rod: Chrome Plate Head: none		
Microtecnica	Typhoon	Outbd. Flaperon	13-8MO H1000	Hard Chrome	Wear	
Smiths Aerospace	Typhoon	Inbd. Flaperon	13-8MO H1000	Hard Chrome	Wear	

TABLE 4C - CATEGORY - FIGHTERS/BOMBERS - GLANDS

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
Parker Aerospace	AV-8B	Rudder	7075-T73 (tail end) Al-Ni Bronze (output end)	Hard anodize	Weight, cost	
Smiths Aerospace	B-1B	YAW SCAS, Flight Spoilers & Structural Mode Control	2024-T851 Al. Alloy	Hard anodize	Customer design	
Moog	B-2	Gust Load Alleviation Inboard Elevon Middle Elevon	Aft gland: Al-Ni Bronze Fwd gland: 6061 alu	Bare Hard anodize	Wear	Balanced area pistons
Moog	B-2	Outboard Elevon Upper Rudder	Al-Ni Bronze	Bare	Wear	Unbalanced area pistons
Moog	B-2	Lower Rudder	7075 Alum	Hard anodize	Side bearing load	Unbalanced area pistons, high side loads
Moog	B-58	Elevon	440C SS, Rc 57 min.	Fabroid	Wear	No reported failures or wear-out
Moog	B-58	Rudder	4140 Steel, 140-160 ksi	Silver	Wear	No reported failures or wear-out
Moog	F-111	Horizontal Tail	4130 Steel, 140-160 ksi	Fabroid	Wear	No reported failures or wear-out
Moog	F-111	Rudder	2024-T251	Fabroid	Wear	No reported failures or wear-out
Moog	F-111	Spoiler	6Al-4V Titan. 17-4PH CRES 180 ksi min.	Fabriloid	Wear	No reported failures or wear-out
Parker Aerospace	F-117/ F-16	Horizontal Tail/ Flaperon, Rudder	7075-T7351	Middle: Hard Anodize Ends: TFE Woven Fabric Liner		
Moog	F-14	Horizontal Tail	6Al-4V Titan.	Fabriloid	Wear	No reported failures or wear-out
Moog	F-14	Rudder	7075-T73	Fabriloid		
Smiths Aerospace	F-15	Rudder	17-4PH CRES, H1025	Nitride	Corrosion resistance wear	Rotary vane
Parker Aerospace	F-15	Stabilator	4340 Steel	Microseal	Wear	Excellent
Parker Aerospace	F-16	All Primary Surfaces	7075-T7351	TFE fiber woven fabric	Wear	Excellent
Smiths Aerospace	F-18	Rudder	15-5PH CRES, H1025	Bare	Corrosion resistance wear	
HR Textron	F-18	Aileron	Beryllium copper	Bare	Wear	No reported failures or wear-out
Parker Aerospace	F-18	Stabilator	15-5PH CRES, H1025	Bare	Wear	Excellent
Parker Aerospace	F-18	Trailing Edge Flap	6061-T651	Hard anodize	Weight, cost	
Parker Aerospace	F-18 E/F	TEF	7075-T73511	Hard anodize		
Parker Aerospace	F-18 E/F	Stabilator	Al-Ni Bronze	Bare		
Parker Aerospace	F-22	Horizontal Tail, Rudder, Aileron, Flaperon	7075-T73	Hard anodize		
Parker Aerospace	F-4	Rudder	2014-T6 (tail end)	Hard anodize	Weight, cost	No reported failures or wear-out

Parker Aerospace	F-4 Air Force	Rudder	Al-Ni Bronze (output end)	Bare	Weight, cost	No reported failures or wear-out
Smiths Aerospace	F-5	All Primary Surfaces	2024-T42; 2024-T351 or 7075-T6	Hard anodize	Customer design	
Smiths Aerospace	F-5	Stability Augmentation	Naval brass	Bare	Customer design	
Moog	F/A-18 E/F	LEX Spoilers	15-5PH CRES, H1025	Bare		Integral part of cylinder
HR Textron	F/A-18 E/F	Aileron, Rudder	Al MMC w Be Cu insert	None	Wear, low weight	
Moog	IDF	All Primary Surfaces	15-5PH CRES, H1025	Bare	Wear	
Moog	JAS-39	Wing, Rudder, Canard	15-5PH CRES	Al Bronze		
Moog	LAVI	Elevon, Rudder Canard	7075-T6	Hard anodize	Wear, weight	
Liebherr Aerospace	Typhoon	Rudder	7075-T7351	Hard anodize		
Microtecnica	Typhoon	Outbd. Flaperon	7075-T7351	Hard anodize	Wear, low weight	
Smiths Aerospace	Typhoon	Inbd. Flaperon	7075-T7351	Hard anodize	Wear, low weight	

TABLE 5A - CATEGORY - HELICOPTERS - CYLINDER

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
HR Textron	206	Main Rotor	7075-T73	Hard anodize	Wear, cost	No reported failures or wear-out, original design was regular anodize and wore out
Tactair	206B	All Primary Controls	7075-T73	Thin hard anodize	Weight	Slight wear area near neutral position
Tactair	206L	All Primary Controls	7075-T73	Thin hard anodize	Weight	Slight wear area near neutral position
HR Textron	214ST	Main Rotor	15-5PH CRES, 175 ksi min.	Hard chrome	Wear, cost	No reported failures or wear-out
HR Textron	214ST	Tail Rotor	7075-T73	Hard anodize	Weight, wear	No reported failures or wear-out
Parker Aerospace	AH-64 Phase 1	All 4 Primary Controls	7075-T73	Hard anodize	Part of body, weight cost	
Parker Aerospace	AH-64 Phase 2	All 4 Primary Controls	4340 ESR Steel, RC 54-57	Bare	Ballistic resistance lower overall weight	
Parker Aerospace	AH-64 Phase 3	All 4 Primary Controls	4340 ESR Steel, RC 54-57	Bare	Ballistic resistance lower overall weight	
Moog	222/230	All Primary Controls	7075-T73	Sulfuric Acid Anodize	Weight, cost	No reported wear
HR Textron	407/427	MRA & TRA	Alum Ally, 7075-T73 Forging	Hard Anodized, Shot Peened	Wear	
Smiths Aerospace	BA-609	Collective, Longitudinal & Lateral	15-5PH CRES, H1025	Thin Dense Chrome	Wear	Good performance
Smiths Aerospace	BA-609	Flaperon & Elevator	15-5PH CRES, H1025	Hard Chrome	Wear	Good performance
Smiths Aerospace	CH-47	ILCA	7075-T73 Al	Bore: Chrome Plate Remainder: Anodize		
Smiths/Ozone	CH-47	Upper Boost	4340 Steel, HT 150-170 ksi	Bore: Chrome Plate External Cad Plate		
Parker Aerospace	CH-53	Tail Rotor	15-5PH CRES, H1025	Hard chrome	Wear, cost	Excellent life
United Aircraft - Sikorsky	CH-53E	Main Rotor	4340 Steel, 180 ksi	Hard chrome		
Liebherr Aerospace	NH90	Tail Rotor Actuator	7075-T7351	Bare		
Parker Aerospace	OH-6A	Main Rotor	7075-T7351	Bare	Part of body, weight cost	
Moog	RAH-66 Comanche	Main Rotor	Aeromet 100	Bare	Ballistic	
Moog	RAH-66 Comanche	Fan Tail	Aeromet 100	Bare	Ballistic	

HR Textron	S-76	Main Rotor	15-5PH CRES, 175 ksi min.	Hard chrome	Wear, cost	No reported failures or wear-out
HR Textron	S-76	Tail Rotor	17-4PH CRES, H1025	Hard chrome	Wear, cost	No reported failures or wear-out
Parker Aerospace	S-92	Main Rotor, Tail Rotor	15-5PH CRES, H1025	Bare		
HR Textron	UH-1Y/ AH-1Z	MRA & TRA	15-5PH CRES, H1025	Hard chrome	Wear, strength, corrosion resistance	
Parker Aerospace	UH-60A	Boost	4340 ESR Steel, 260 ksi	Electrolize chrome	Ballistic resistance	
Parker Aerospace	UH-60A	Main Rotor	15-5PH CRES, H1025	Hard chrome	Strength, wear ballistic tolerance	
Smiths Aerospace	V-22	Rudder	PH13-8 CRES, H1050	-	Wear, strength, pressure	
Moog	V-22	Elevator	15-5PH CRES, H1025	Bare	Cost	
Moog	V-22	Flaperon	15-5PH CRES, H1025	Hard chrome	Wear	
Moog	V-22	Swashplate	FWD Barrel: 15-5PH CRES, 150-170 ksi	Hard chrome	Wear	Good performance
			AFT Barrel: 4340 ESR Steel	Hard chrome	Wear, ballistic reason	Good performance

TABLE 5B - CATEGORY - HELICOPTERS - PISTON

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
HR Textron	206	Main Rotor	15-5PH CRES, 175 ksi	Hard chrome	Wear, cost	No reported failures or wear-out
Tactair	206B	All Primary Controls	17-4PH CRES, 150 ksi	Hard chrome	Wear	No reported failures or wear-out
Tactair	206L	All Primary Controls	15-5PH CRES, 150 ksi	Hard chrome	Wear	Excellent
HR Textron	214ST	Main Rotor	15-5PH CRES, 175 ksi	Hard chrome	Wear, cost	No reported wear
HR Textron	214ST	Tail Rotor	15-5PH CRES, 175 ksi	Hard chrome	Wear, cost	No reported failures or wear-out
Moog	222/230	All Primary Controls	4330V Steel, 220-240 ksi	Chrome plated rod/ bare piston head. (Main Rotor Urgent & Tail Rotor) Chrome plated rod & head (Main Rotor rod end)	Stress, wear	No reported wear
HR Textron	407/427	MRA and TRA	15-5PH CRES, H1025	Hard chrome	Wear, strength, corrosion resistance	
Parker Aerospace	AH-64 Phase 1	All 4 Primary Controls	17-4PH CRES, H1025	Hard chrome	Wear, strength, corrosion resistance	
Parker Aerospace	AH-64 Phase 2	All 4 Primary Controls	4340 ESR Steel, 180 ksi (output), RC 54-57 (tail)	Hard chrome	Ballistic resistance	Had hyd. embrittlement on test specimen, no actual problem after HT lowered to 180 ksi
Parker Aerospace	AH-64 Phase 3	All 4 Primary Controls	4340 ESR Steel, 180 ksi (output) RC 54-57 (tail)	Hard chrome	Ballistic resistance	Had hyd. embrittlement on test specimen, no actual problem after HT lowered to 180 ksi
Smiths Aerospace	BA-609	Collective, Longitudinal, Lateral, Flaperon & Elevator	15-5PH CRES, H1025	Hard chrome	Wear	Good performance
Smiths Aerospace	CH-47	ILCA	4340 Steel, HT 180-200 ksi	Rod: Chrome Plate-OD, CAD Plate-ID Head: Plasma Spray		
Smiths/Ozone	CH-47	Upper Boost	410 CRES, HT R_c 40-42 (180-194 ksi)	Rod: Chrome Plate Head: Plasma Spray		Brazed plasma spray: 90% copper, 10% Al
Parker Aerospace	CH-53	Tail Rotor	15-5PH CRES, H1025	Hard chrome	Wear	Excellent

United Aircraft - Sikorsky	CH-53E	Main Rotor, original	4340 Steel, 180 ksi	Hard chrome + black chrome	Corrosion	
		Main Rotor, current	15-5PH	Hard chrome	No corrosion	
Liebherr Aerospace	NH90	Tail Rotor Actuator	15-5PH H1025	Rod: tungsten carbide	Wear	
Parker Aerospace	OH-6A	Main Rotor	7075-T73	Hard chrome	Cost, weight	
Moog	RAH-66 Comanche	Main Rotor	Aeromet 100	Tungsten	Aeromet for ballistics tungsten for wear and corrosion protection	
Moog	RAH-66 Comanche	Fan Tail	Aft Piston: 15-5PH H1025	Tungsten	15-5 for cost and Aeromet for ballistics	
			Fwd Piston Aeromet 100	Tungsten	Tungsten for wear and corrosion protection	
HR Textron	S-76	Main Rotor	15-5PH CRES, 175 ksi	Hard chrome	Wear, cost	No reported failures or wear-out
HR Textron	S-76	Tail Rotor	15-5PH CRES, 175 ksi	Hard chrome	Wear, cost	No wear-out, some piston fractures early in program
Parker Aerospace	S-92	Main Rotor, Tail Rotor	15-5PH CRES, H1025	Rod: Tungsten Carbide Head: Tribaloy	Rod sealing surface requires hard smooth surface	
HR Textron	UH-1Y/ AH-1Z	MRA	PH13-8MO CRES, H1000	Hard Chrome	Wear, strength, corrosion resistance	
HR Textron	UH-1Y/ AH-1Z	TRA	15-5PH CRES, H1025	Hard Chrome	Wear, strength, corrosion resistance	
Parker Aerospace	UH-60A	Boost	4340 ESR Steel, 260 ksi	Hard chrome	Ballistic resistance	Had hydrogen embrittlement failures
Parker Aerospace	UH-60A	Main Rotor	4340 ESR Steel, 180 ksi (was 260 ksi)	Hard chrome	Ballistic resistance	Had hyd. embrittlement, no problem after HT lowered to 180 ksi
Smiths Aerospace	V-22	Rudder	PH13-8 CRES, H1050	Hard chrome	Wear	
Moog	V-22	Elevator/Flaperon	15-5PH CRES, H1025	Hard chrome	Wear	
Moog	V-22	Swashplate	FWD Piston: 4340 ESR-Outer; 4330M-Inner	Hard chrome	Wear, ballistic reason	Good performance
			AFT Piston: 4330M Steel, 220-240 ksi	Hard chrome	Wear	Good performance

TABLE 5C - CATEGORY - HELICOPTERS - GLANDS

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
HR Textron	206	Main Rotor	Alum. Bronze	Bare	Wear, cost	No reported failures or wear-out
Tactair	206B	All Primary Controls	Alum. Bronze	Bare	Wear	No reported failures or wear-out
Tactair	206L	All Primary Controls	Alum. Bronze	Bare	Wear	No reported failures or wear-out
HR Textron	214ST	Main Rotor	Alum. Bronze	Bare	Wear, cost	No reported failures or wear-out
HR Textron	214ST	Tail Rotor	Alum. Bronze	Bare	Wear, cost	No reported failures or wear-out
HR Textron	407/427	MRA & TRA	Al Bronze	None	Wear, strength	
Parker Aerospace	AH-64 Phase 1	All 4 Primary Controls	7075-T73	Hard anodize	Cost, weight	
Parker Aerospace	AH-64 Phase 2	Collective and Longitudinal	7075-T73	Hard anodize	Cost, weight	
Parker Aerospace	AH-64 Phase 2	Lateral and Directional	Be-Cu (ends); 7049-T73 (center)	Bare Hard anodize	Available space, strength, wear, resistance to crack propagation (ballistic)	
Parker Aerospace	AH-64 Phase 3	All 4 Primary Controls	7075-T73	Hard anodize	Cost, weight	
E-System	222/230	All Primary Controls	7075-T73	Sulfuric Acid Anodized	Weight, cost	No reported wear
Smiths Aerospace	BA-609	Collective, Longitudinal, Lateral, Flaperon & Elevator	Bronze AMS 4640	None	Low friction	Good performance
Smiths Aerospace	CH-47	ILCA	2024-T351 Al	ID: Fluoroloy "C" bonded		
Smiths/Ozone	CH-47	Upper Boost	Al Bronze	Bare		
Parker Aerospace	CH-53	Tail Rotor	Beryllium copper	Bare	Wear	Excellent
United Aircraft - Sikorsky	CH-53E	Main Rotor	Be-Cu	Bare		
Liebherr Aerospace	NH90	Tail Rotor Actuator	7075-T7351	Hard anodize	Low weight	
Parker Aerospace	OH-6A	Main Rotor	2024-T851	Hard anodize	Cost, weight	
Moog	RAH-66 Comanche	Main Rotor	Aft gland: Al-Ni Bronze Fwd gland: 7075 Alum	Bare Hard anodize	Strength, wear Weight, cost	
Moog	RAH-66 Comanche	Fan Tail	Al-Ni Bronze	Bare	Wear, strength	Centerline is heavily side loaded during operation
HR Textron	S-76	Main Rotor	Be-Cu	Bare	Wear, cost, customer preference	No reported failures or wear-out
HR Textron	S-76	Tail Rotor	Alum. Bronze	Bare	Wear, cost	No reported failures or wear-out
Parker Aerospace	S-92	Main Rotor, Tail Rotor	Al-Ni Bronze	Bare		
HR Textron	UH-1Y/ AH-1Z	MRA & TRA	Al Bronze	None	Wear, strength	
Parker Aerospace	UH-60A	Main Rotor Boost	7075-T7351 Plastic liner	Anodize	Cost, weight, ballistic tolerance (frangible)	