

AEROSPACE INFORMATION REPORT

SAE AIR4066

REV.
A

Issued 1987-06
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Superseding AIR4066

Submitted for recognition as an American National Standard

Hydraulic Servoactuator Materials

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 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 alphanumeric 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. He 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.

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PREPARED BY SAE SUBCOMMITTEE A-6D, FLUID POWER 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
FWM	A330/340	Spoilers	15-5PH CRES, H1000	Hard chrome	Wear	
Moog	A330/340	Inboard / Outboard Aileron	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, fatigue	
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
Dowty 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	
E-Systems	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

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TABLE 2A - Category - Commercial Transport - Cylinder (Continued)

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
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	
E-Systems	B777	Wing Tip	15-5PH CRES, H900	Passivate	Wear, corrosion resistance	
Moog	B777	Spoiler	15-5PH CRES, H1025	Bare	Weight, wear	

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TABLE 2A - Category - Commercial Transport - Cylinder (Continued)

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Parker - Bertea	B777	Rudder	15-5PH CRES, H1025	Bare	Customer selected, wear, strength	
Teijin-Seiki	B777	Aileron, Flaperon and Elevator	15-5PH CRES, H1025	Bare	Customer selected wear, strength	
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	
Dowty Aerospace	DHC8	Flight Spoiler	4340 Steel,	Bare	Wear	
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	
E-Systems	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
Dowty 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	
Dowty Aerospace	SAAB 2000	Elevator	4340 Steel, 160-190 ksi	Bare	Wear, corrosion resistance strength	
Dowty Aerospace	SAAB 2000	Rudder	4340 Steel, 160-190 ksi	Bare	Wear, corrosion resistance strength	

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TABLE 2B - Category - Commercial Transport - Piston

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
FWM	A330/340	Spoiler	PH13-8Mo CRES, H1000	Hard chrome	Min. weight, wear	
Moog	A330/340	Inboard / Outboard Aileron	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, fatigue	Good performance
Parker-Bertea	B707	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	B727	Aileron	410 SS, RC 39/44	Bare	Wear	Excellent
Parker-Bertea	B727	Elevator	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	B727	Elevator - Original	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	B727	Flight Spoiler	15-5PH CRES, 180 ksi	Hard chrome	Wear, strength, corrosion resistance	
Parker-Bertea	B727	Rudder - Original	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Dowty Aerospace	B737	Flight Spoiler	17-4PH CRES, 180-200 ksi	Hard chrome	Customer design	
Parker-Bertea	B737	Aileron	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	B737	Elevator	17-4PH CRES, 180 ksi	Hard chrome	Corrosion resistance	
Parker-Bertea	B737	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
E-Systems	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

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TABLE 2B - Category - Commercial Transport - Piston (Continued)

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Moog	B747	Special Inboard Spoiler	4330M Steel, 220-240 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Parker-Bertea	B747	Elevator - Original	4340M Steel, 270 ksi (long) 4340 Steel, 180 ksi (short)	Hard chrome	Wear, Strength	Some corrosion problems were reported
Parker-Bertea	B747	Inboard Elevator	15-5Ph CRES, 180 ksi	Hard chrome	Corrosion resistance, good fatigue	
Parker-Bertea	B747	Outboard Elevator	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	B747	Rudder	17-4PH CRES 190 ksi	Hard chrome	Wear	Excellent
Parker-Bertea	B747-400	Inboard Elevator	15-5PH CRES, 180-200 ksi	Hard chrome	Corrosion resistance, good fatigue	
Parker-Bertea	B747-400	Lower Rudder	15-5PH CRES, 180-200 ksi	Hard chrome	Corrosion resistance, good fatigue	
Parker-Bertea	B747-400	Outboard Elevator	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	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-Bertea	B767	Elevator	4330M Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	B767	Inboard Aileron	4330M Steel, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	B767	Outboard Aileron	4330M Steel, 180 ksi	Hard chrome	Wear, strength	

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TABLE 2B - Category - Commercial Transport - Piston (Continued)

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Parker-Bertea	B767	Rudder	4330M Steel, 180 ksi	Hard chrome	Wear, strength	
E-Systems	B777	AFT Wing Tip	4330V Steel, per BMS 7-122	Bare piston head	Wear, stress	
E-Systems	B777	FWD Wing Tip	15-PH CRES, H-900	Chrome plated rod & head	Wear, corrosion resistance	
Moog	B777	Spoiler	15-5PH CRES, H1025 or PH13-8MO	Hard chrome	Wear, fatigue Wear, strength	
Parker-Bertea	B777	Rudder	15-5PH CRES, H1025	Hard chrome	Wear, strength	
Teijin-Seiki	B777	Aileron, Flaperon Elevator	15-5PH CRES, H1025	Hard chrome	Wear	
Parker-Bertea	DC-10	All Primary Surfaces	4340 Steel, vac. melt, 180 ksi	Hard chrome	Wear, strength	
Parker-Bertea	DHC-7	Flight Spoiler	Cust. 950CRES, H950	Hard chrome	Wear, strength, corrosion resistance	
Parker-Bertea	DHC-7	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Dowty Aerospace	DHC-8	Flight Spoiler	17-4PH CRES, H1075	Hard chrome	Wear, corrosion resistance, strength	
Parker-Bertea	GII	All Surfaces	17-4PH CRES, H925 or H900	Hard chrome	Wear, strength, no interfinish	H900 & H925 are obsolete. No actual problems reported.
Parker-Bertea	GII	Rudder	17-4PH CRES, H925 or H900	Hard chrome	Wear, strength, no interfinish	H900 & H925 are obsolete. No actual problems reported.
Parker-Bertea	GIII	Ground Spoiler	15-5PH CRES, 180 ksi	Hard chrome	Wear, strength, corrosion resistance	
E-Systems	L-1011	Spoiler	4340 Steel, 180-200 ksi	Chrome plated rod/piston head	Wear, stress	No reported war. Corrosion of moisture retaining surfaces.
Parker-Bertea	L-1011	Horizontal Stabilizer	4340 Steel, 180 ksi Output side; 6061-T6 Tail side	Hard anodize	Weight, cost	
Parker-Bertea	L-1011	Inboard Aileron	15-5PH CRES RC 40/45	Hard chrome	Wear	Excellent
Parker-Bertea	L-1011	Outboard Aileron	17-4PH CRES RC 40/45	Hard chrome	Wear	Excellent
Parker-Bertea	L-1011	Rudder	17-4PH CRES RC 40/45	Hard chrome	Wear	Excellent
Dowty Aerospace	MD 90	Elevator	15-5PH CRES 150-170 ksi	Hard chrome	Wear, corrosion resistance	

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TABLE 2B - Category - Commercial Transport - Piston (Continued)

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Parker-Bertea	MD-11	Outboard Aileron	Hy-Tuf Steel 220-250 ksi 4340 Steel, 180-200 ksi	Hard chrome	Wear, strength	
Parker-Bertea	Metro	Landing Gear, Flap	4130 Steel, 140 ksi	Hard chrome	Wear, cost	
Dowty Aerospace	SAAB 2000	Elevator	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosioin resistance	
Dowty Aerospace	SAAB 2000	Rudder	15-5PH CRES, 150-170 ksi	Hard chrome	Wear, corrosion resistance	

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TABLE 2C - Category - Commercial Transport - Glands

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
FWM	A330/340	Spoiler	Al-Ni Bronze	Bare	Wear	
Moog	A330/340	Inboard / Outboard Aileron	Al-Ni Bronze	Bare	Wear	Good performance
Parker-Bertea	B707	Rudder	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	B727	Aileron	420 SS	Bare	Wear	Excellent life
Parker-Bertea	B727	Elevator	Al-Ni Bronze	Bare	Customer preference, wear	Excellent life
Parker-Bertea	B727	Elevator - Original	Al-Ni Bronze	Bare	Customer preference, wear	Excellent life
Parker-Bertea	B727	Flight Spoiler	Al-Ni Bronze	Bare	Customer design, wear	
Parker-Bertea	B727	Rudder	Al-Ni Bronze	Bare	Customer preference, wear	Excellent life
Parker-Bertea	B727	Rudder - Original	Al-Ni Bronze	Bare	Customer preference, wear	Excellent life
Dowty Aerospace	B737	Flight Spoiler	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	B737	Aileron	Al-Ni Bronze	Bare	Customer preference, wear	
Parker-Bertea	B737	Elevator	Al-Ni Bronze	Bare	Customer preference, wear	
Parker-Bertea	B737	Rudder	Al-Ni Bronze	Bare	Customer preference, wear	
E-Systems	B737-200	Leading Edge	Al-Ni Bronze AMS 5659	Bare	Wear	
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

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TABLE 2C - Category - Commercial Transport - Glands (Continued)

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
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-Bertea	B747	Elevator - Original	Al-Ni Bronze	Bare	Customer preference, wear	
Parker-Bertea	B747	Inboard Elevator	Al-Ni Bronze	Bare	Customer preference, wear	
Parker-Bertea	B747	Outboard Elevator	Al-Ni Bronze	Bare	Customer preference, wear	
Parker-Bertea	B747	Rudder	Al-Ni Bronze	Bare	Wear	Excellent
Parker-Bertea	B747-400	Inboard Elevator	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	B747-400	Lower Rudder	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	B747-400	Outboard Elevator	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	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-Bertea	B767	Elevator	7075-T73511 Al-Ni Bronze Liner	Anodize Bare	Cost, weight, customer preference, wear	
Parker-Bertea	B767	Inboard Aileron	7075-T73511 Al-Ni Bronze Liner	Anodize Bare	Cost, weight, customer preference, wear	
Parker-Bertea	B767	Outboard Aileron	7075-T73511	Hard anodize	Cost, weight, no room for liner	
Parker-Bertea	B767	Rudder	7075-T73511 Al-Ni Bronze Liner	Anodize Bare	Cost, weight, customer preference, wear	
E-Systems	B777	Wing Tip	Al-Ni Bronze	Bare	Wear	
Moog	B777	Spoiler	Al-Ni Bronze	Bare	Wear	

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TABLE 2C - Category - Commercial Transport - Glands (Continued)

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
Parker-Bertea	B777	Rudder	Al-Ni Bronze	Bare	Wear	
Teijin-Seiki	B777	Aileron, Flaperon Elevator	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	DC-10	All Primary Surfaces	6061-T6 Alum.	Hard anodize	Weight, cost	No wear-out, some part failed by fatigue
Parker-Bertea	DC-10	Lower Rudder	7075-T73	Hard anodize	Weight, cost	
Parker-Bertea	DHC-7	Flight Spoiler	7075-T7351 and 6061-T6	Hard anodize	Cost, weight	
Parker-Bertea	DHC-7	Rudder	7075-T7351 and 6061-T6	Hard anodize	Cost, weight	
Dowty Aerospace	DHC-8	Flight Spoiler	7075-T651	Anodize	Wear	
Parker-Bertea	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-Bertea	GII	Rudder	Al-Ni Bronze (rod end)	Bare	Wear	
Parker-Bertea	GIII	Ground Spoiler	2024-T4 (center) 7075-T73 (output end)	Bare	Cost, weight	
E-Systems	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	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	L-1011	Inboard Aileron	2024-T4	Alum. Bronze spray coated	Wear	Excellent
Parker-Bertea	L-1011	Outboard Aileron	2024-T4	Anodize	Wear, cost	Excellent
Parker-Bertea	L-1011	Rudder	2024-T4	Alum. Bronze spray coated	Wear	Excellent
Dowty Aerospace	MD-90	Elevator	Al-Ni Bronze	Bare	Wear	
Parker-Bertea	MD-11	Outboard Aileron	7075-T7351	Hard anodize	Weight, wear	
Parker-Bertea	Metro	Landing Gear, Flap	2024-T351	Anodize	Cost, weight	
Dowty Aerospace	SAAB 2000	Elevator	Al-Ni Bronze	Bare	Wear	
Dowty Aerospace	SAAB 2000	Rudder	Al-Ni Bronze	Bare	Wear	

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TABLE 3A - Category - Military Transport - Cylinder

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Kaiser FT	C-130H	All Primary Controls	7075-T73	Anodize	Weight	No failure or wear-out during normal service
Parker-Bertea	C-141	Aileron	2014-T6	Hard anodize	Weight, cost	
Parker-Bertea	C-141	Elevator	2014-T6	Hard anodize	Weight, cost	
Parker-Bertea	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-Bertea	C-17	All Primary Surfaces	Custom 455 CRES, H1000 or PH13-8 MO CRES, H1000	Bare	Strength, wear	
Parker-Bertea	C-5A	All Primary Controls	7075-T73	Hard anodize	Weight, cost	No reported failures or wear-out
E-Systems	C-5B	Spoiler	7075-T73	Sulfuric Acid Anodize	Weight, cost	No service related failures reported
Parker-Bertea	E-2C	Aileron, Rudder Original Elevator; Elevator	2014-T6 2014-T6 15-5PH CRES	Anodize Anodize Bare	Weight, cost Weight, cost Customer prefer., strength	No service failures reported Some fatigue problems No service failures
Parker-Bertea	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-Bertea	S-3A	Rudder, Aileron, Elevator	17-4PH CRES, H1000, Invest. castg	Bare	Strength, cost, wear	

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TABLE 3B - Category - Military Transport - Piston

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

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TABLE 3C - Category - Military Transport - Glands

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

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TABLE 4A - Category - Fighters/Bombers - Cylinder

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Parker-Bertea	AV-8B	Rudder	7075-T73 4130 Steel, 150 ksi liner	Anodize Bare		
Dowty Aerospace	B-1B	Flight Spoiler	HP4-9-30 Steel, 220-240 ksi	Bare	Customer design	
Dowty Aerospace	B-1B	YAW SCAS	2219-T852 Al Alloy	Hard anodize	Customer design	
Moog	B-2	All Primary 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
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.
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
Dowty Aerospace	F-15	Rudder	17-4PH CRES, H1025	Nitride	Corrosion resistance wear	Rotary vane
Parker-Bertea	F-15	Stabilator	4340 Steel, RC 40/43	Bare	Weight, cost	Excellent life Mild scratches
Parker-Bertea	F-16	All Primary Surfaces	15-5PH CRES, H1025	Hard chrome	Wear	Excellent life
Dowty 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-Bertea	F-18	Stabilator	15-5PH CRES, H1025	Bare	Cost	Excellent life

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TABLE 4A - Category - Fighters/Bombers - Cylinder (Continued)

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Parker-Bertea	F-18	Trailing Edge Flap	4340 Steel, 180 ksi	Bare	Strength, wear	
Parker-Bertea	F-4	Rudder	2014-T6	Anodize	Part of body	
Parker-Bertea	F-4 Air Force	Rudder	7075-T73 with 4130 Steel, 150 ksi liner	Anodize Bare	Part of body, better MTBF	
Dowty 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	

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TABLE 4B - Category - Fighters/Bombers - Piston

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Parker-Bertea	AV-8B	Rudder	4340 Steel, 180 ksi	Hard chrome	Wear, strength	
Dowty Aerospace	B-1B	Flight Spoiler	HP 4-9-30 Steel, 220-240 ksi	Hard chrome	Customer design	
Dowty Aerospace	B-1B	YAW SCAS	HP 4-9-30 Steel, 220-240 ksi	Hard anodize	Customer design	
Moog	B-2	All Primary Surfaces	15-5PH CRES, H1025	Hard chrome	Wear	
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
Moog	F-14	Horizontal Tail, Rudder	4330M Steel, 220-240 ksi	Hard chrome	Wear, weight	No reported failures or wear-out
Dowty Aerospace	F-15	Rudder	17-4PH CRES, H1025	Nitride	Corrosion resistance wear	Rotary vane
Parker-Bertea	F-15	Stabilator	D6AC Steel	Hard chrome	Weight, cost	Mild scratches
Parker-Bertea	F-16	All Primary Surfaces	D6AC Steel	Hard chrome	Wear	Excellent
Dowty 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-Bertea	F-18	Stabilator	15-5PH CRES, H1025	Hard chrome	Cost	Excellent
Parker-Bertea	F-18	Trailing Edge Flap	PH13-8MO CRES, H1000	Hard chrome	Wear, strength, corrosion resistance	
Parker-Bertea	F-4 (All)	Rudder	4130 Steel, 150 ksi	Hard chrome	Wear, strength	

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TABLE 4B - Category - Fighters/Bombers - Piston (Continued)

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Dowty Aerospace	F-5	All Surfaces and Stab. Augmentation	4130 Steel, 160-180 ksi	Hard chrome	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, H1075	Hard chrome	Wear, corrosion resistance	

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TABLE 4C - Category - Fighters/Bombers - Glands

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
Parker-Bertea	AV-8B	Rudder	7075-T73 (tail end) Al-Ni Bronze (output end)	Hard anodize	Weight, cost	
Dowty Aerospace	B-1B	YAW SCAS, Flight Spoilers & Structural Mode Control	2024-T851 Al. Alloy	Hard anodize	Customer design	
Moog	B-2	All Primary Surfaces	Al-Ni Bronze	Bare	Wear	
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 6Al-4V Titan.	Fabroid	Wear	No reported failures or wear- out
Moog	F-111	Spoiler	17-4PH CRES 180 ksi min.	Fabriloid	Wear	No reported failures or wear- out
Moog	F-14	Horizontal Tail	6Al-4V Titan.	Fabriloid	Wear	No reported failures or wear- out
Moog	F-14	Rudder	7075-T73	Fabriloid		
Dowty Aerospace	F-15	Rudder	17-4PH CRES, H1025	Nitride	Corrosion resistance wear	Rotary vane
Parker-Bertea	F-15	Stabilator	4340 Steel	Microseal	Wear	Excellent
Parker-Bertea	F-16	All Primary Surfaces	7075-T7351	TFE fiber woven fabric	Wear	Excellent
Dowty 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-Bertea	F-18	Stabilator	15-5PH CRES, H1025	Bare	Wear	Excellent
Parker-Bertea	F-18	Trailing Edge Flap	6061-T651	Hard anodize	Weight, cost	
Parker-Bertea	F-4	Rudder	2014-T6 (tail end)	Hard anodize	Weight, cost	No reported failures or wear- out
Parker-Bertea	F-4 Air Force	Rudder	Al-Ni Bronze (output end)	Bare	Weight, cost	No reported failures or wear- out

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TABLE 4C - Category - Fighters/Bombers - Glands (Continued)

Supplier	Aircraft	Surface	Component - Glands Material	Component - Glands Finish	Component - Glands Reason	Component - Glands Comments
Dowty Aerospace	F-5	All Primary Surfaces	2024-T42; 2024-T351 or 7075-T6	Hard anodize	Customer design	
Dowty Aerospace	F-5	Stability Augmentation	Naval brass	Bare	Customer design	
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	

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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
Kaiser FT	206B	All Primary Controls	7075-T73	Thin hard anodize	Weight	Slight wear area near neutral position
Kaiser FT	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-Bertea	AH-64 Phase 1	All 4 Primary Controls	7075-T73	Hard anodize	Part of body, weight cost	
Parker-Bertea	AH-64 Phase 2	All 4 Primary Controls	4340 ESR Steel, RC 54-57	Bare	Ballistic resistance lower overall weight	
Parker-Bertea	AH-64 Phase 3	All 4 Primary Controls	4340 ESR Steel, RC 54-57	Bare	Ballistic resistance lower overall weight	
E-Systems	222/230	All Primary Controls	7075-T73	Sulfuric Acid Anodize	Weight, cost	No reported wear
Parker-Bertea	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		
Parker-Bertea	OH-6A	Main Rotor	7075-T7351	Bare	Part of body, weight cost	
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-Bertea	UH-60A	Boost	4340 ESR Steel, 260 ksi	Electrolize chrome	Ballistic resistance	
Parker-Bertea	UH-60A	Main Rotor	15-5PH CRES, H1025	Hard chrome	Strength, wear ballistic tolerance	
Dowty Aerospace	V-22	Rudder	PH13-8 CRES, H1050	-	Wear, strength, pressure	
Moog	V-22	Elevator	15-5PH CRES, H1025	Bare	Cost	

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TABLE 5A - Category - Helicopters - Cylinder (Continued)

Supplier	Aircraft	Surface	Component - Cylinder Material	Component - Cylinder Finish	Component - Cylinder Reason	Component - Cylinder Comments
Moog	V-22	Flaperon	15-5PH CRES, H1025	Hard chrome	Wear	
Moog	V-22	Swashplate	FWD Barrel: 15-5PH CRES, 150-170 ksi AFT Barrel: 4340 ESR Steel	Hard chrome	Wear	Good performance
				Hard chrome	Wear, ballistic reason	Good performance

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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
Kaiser FT	206B	All Primary Controls	17-4PH CRES, 150 ksi	Hard chrome	Wear	No reported failures or wear-out
Kaiser FT	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
E-Systems	222/230	All Primary Controls	4330V Steel, 220-240 ksi	Chrome plated rod / bare piston head. (Main Rotor Urgent & Tail Rotor)	Stress, wear	No reported wear
				Chrome plated rod & head (Main Rotor rod end)		
Parker-Bertea	AH-64 Phase 1	All 4 Primary Controls	17-4PH CRES, H1025	Hard chrome	Wear, strength, corrosion resistance	
Parker-Bertea	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-Bertea	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
Parker-Bertea	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	
Parker-Bertea	OH-6A	Main Rotor	7075-T73	Hard chrome	Cost, weight	
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-Bertea	UH-60A	Boost	4340 ESR Steel, 260 ksi	Hard chrome	Ballistic resistance	Had hydrogen embrittlement failures

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TABLE 5B - Category - Helicopters - Piston (Continued)

Supplier	Aircraft	Surface	Component - Piston Material	Component - Piston Finish	Component - Piston Reason	Component - Piston Comments
Parker-Bertea	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
Dowty 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

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