EASTMAN

Skydrol

Specifically formulated to meet the changing needs of the aviation industry

Eastman Aviation Solutions

Airlines can run a best practice hydraulic fluid operation using one or two fluids across a fleet. In some cases one fluid will provide an optimal operation for all aircraft in the fleet. In some cases aircraft might require different fluids for operational peak performance.

Before the invention of Type V fluids, there were only three fluids on the market, and all fluids were approved by all of the manufacturers.

Today the situation is much more complicated, with six phosphate ester products on the market, and some manufacturers indifferent toward the newer Type V fluids. Many airlines are using more than one fluid to meet the needs of their fleet.

The Eastman advantage

- **Sample analysis program**
  Offered at no extra cost to all Skydrol customers (including our distributor's customers).

  Complimentary sample bottle kits ease the process—assure clean, safely transported samples.

  Helpful analysis reports that include recommendations.

- **Technical expertise**
  Our dedicated aviation hydraulic fluid experts are skilled at solving customer problems.

- **Fluid development laboratory**
  Advancing the science of fire-resistant hydraulic fluids.

- **mySkydrol**
  A link on our website, www.skydrol.com, with customer access to their sample data and tools for analysis.

Product selection guide

Product	Features and benefits	Manufacturer approvals
Skydrol 500B-4	**Proven track record**—The longest service history among phosphate ester products **Erosion-resistant**—Contains the same breakthrough anti-erosion additive and acid scavenger found in Skydrol LD-4 **Less irritating**—The only commercially available standard density aviation hydraulic fluid. Favored for its lower irritation potential, and popular for use in ground-based test rig applications	Airbus (excluding A350 and A380) ATR Boeing (excluding B787) Bombardier (excluding Global Express) British Aerospace Cessna Embraer Fokker Gulfstream (excluding G650) Lockheed
Skydrol LD-4	**Trusted**—World's best selling Type IV aviation hydraulic fluid **Erosion-resistant**—A breakthrough product introduced in 1978, solving previous problems of valve erosion and thermal stability **Excellent reliability and performance**—Its overall performance under real world conditions has given LD-4 the reputation as the premier aviation hydraulic fluid, with no change in formulation for over 35 years since its inception	Airbus (excluding A350) Antonov (An-148 and 158) ATR Beriev (Be-200) Boeing (excluding B787) Bombardier British Aerospace Cessna COMAC Embraer Fokker Gulfstream Ilyushin (IL-86 and 96) Lockheed Mitsubishi Sukhoi (Superjet 100) Tupolev (Tu-204 and Tu-214)
Skydrol 5	**Cost savings**—Lowest density fluid available on the market, offering weight reductions, thus saving fuel **Innovation**—The first Type V fluid on the market **Efficacy**—Skydrol 5 offers higher temperature capability than Type IV fluids, the lowest density, and better paint compatibility **Erosion-resistant**—The first aviation hydraulic fluid demonstrating erosion-resistance at higher temperatures	Boeing (excluding B787) Bombardier (C Series only) Cessna Fokker Gulfstream (excluding G650) Lockheed
Skydrol PE-5	**Longest fluid life**—of any phosphate ester fluid available today, even under high moisture conditions **Maximum efficiency**—Excellent low temperature viscosity **Cost savings**—Low density offers weight reductions, thus saving fuel **Erosion-resistant**—Demonstrated protection at 3000 psi and 5000 psi **Fluid compatibility**—Fully compatible with existing Type IV and V fluids	Airbus ATR Boeing (excluding B787) Bombardier (C Series only) COMAC Gulfstream *. . . and more approvals are in progress*

Physical properties

Property	Units	Skydrol PE-5	Skydrol 5	Skydrol LD-4	Skydrol 500B-4	Test method
Viscosity –65°F/–54°C 100°F/38°C 210°F/99°C	cSt	 1076 9.53 3.31	 2085 9.23 3.18	 1185 11.42 3.93	 2765 11.51 3.78	ASTM D445
Pour point	°F °C	<–80 <–62	<–80 <–62	<–80 <–62	<–80 <–62	ASTM D97
Specific gravity @ 25°C		0.996	0.977	1.009	1.057	Eastman 116-B
Density @ 25°C	g/cc lb/gal	0.993 8.28	0.974 8.12	1.006 8.39	1.054 8.79	Eastman 116-B
Acid number	mg KOH/g	0.03	0.03	0.03	0.03	ASTM D974
Moisture content	%w/w	0.07	0.07	0.07	0.07	ASTM D1744
Foaming Sequence 1 2 3	mL, sec	 109, 53 54, 30 157, 59	 79, 30 57, 32 81, 32	 50, 25 10, 5 40, 20	 100, 35 20, 15 110, 40	ASTM D892-63
Particle count		AS4059 Class 7 or better				SAE ARP598
Specific heat 38°C 93°C 120°C 149°C	cal/g/°C	 0.453 — 0.461 —	 0.402 0.437 — 0.472	 0.437 0.472 — 0.507	 0.418 0.453 — 0.487	ASTM D2766
Thermal conductivity 100°F 200°F 300°F	cal/(sec*cm*°C)	 0.000344 0.000289 0.000263	 0.000283 0.000259 0.000246	 0.000326 0.000298 0.000277	 0.000315 0.000299 0.000278	ASTM D2717
Surface tension @ 25°C	dynes/cm	29.4	—	28.2	26.7	Du-Nouy Balance
Heat of combustion	BTU/lb	13,291	13,100	13,700	13,400	ASTM D240
Bulk modulus	psi	235,000	210,000	231,000	242,000	BMS3-11
Four ball wear test 4 kg 10 kg 40 kg	mm	 0.30 0.41 0.65	 0.20 0.46 0.77	 0.33 0.43 0.69	 0.36 0.45 0.68	ASTM D4172

Fire-resistance properties

Property	Units	Skydrol PE-5	Skydrol 5	Skydrol LD-4	Skydrol 500B-4	Test method
Flash point	°F/°C	343/172	318/159	340/171	360/182	ASTM D92
Fire point	°F/°C	376/191	362/183	360/182	410/210	ASTM D92
AIT	°F/°C	812/433	870/466	880/471	945/507	ASTM D2155
Hot manifold drip		Does not burn in tray	Does not burn in tray	Does not burn in tray	Does not burn in tray	AMS 3150C
High-pressure spray		Will not ignite	Will not ignite	Will not ignite	Will not ignite	AMS 3150C
Low-pressure spray		No increase	No increase	No increase	No increase	AMS 3150C
Wick flammability		>40 cycles	>40 cycles	>40 cycles	>40 cycles	AMS 3150C

These data are based on samples tested in the laboratory and are not guaranteed for all samples. Contact us for complete sales specifications. Does not constitute an express warranty. See disclaimer on the back of this bulletin.

Skydrol PE-5

The first name in aviation hydraulic fluid

Type V, fire-resistant hydraulic fluid specifically formulated to meet the changing needs of the aviation industry.

- **Longest fluid life**
  Longest fluid life at normal temperatures
- **Erosion resistance**
  Demonstrated erosion protection at 3000 and 5000 psi
- **Efficiency**
  Ideal combination of density (specific gravity) and low-temperature viscosity
- **Reduced waste**
  Longer fluid life reduces volume for disposal as waste
- **Fully compatible**
  Normal fluid top up for conversion

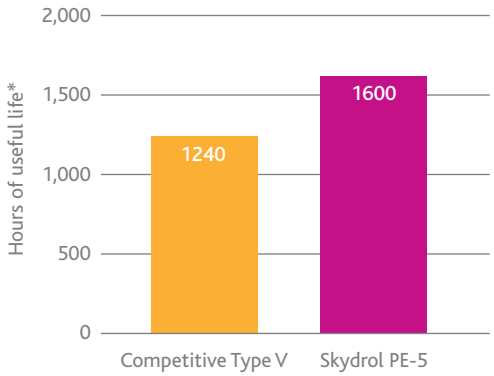
Skydrol PE-5 is specifically formulated to meet and exceed the more demanding harmonized specifications as developed by Boeing, Airbus, and hydraulic fluid manufacturers. Skydrol PE-5 provides the ultimate in performance efficiency. It supplies all the advantages of the longest fluid life at design conditions. Less frequent fluid replacement provides the benefit of reducing disposal volume.

Skydrol PE-5 offers performance benefits when compared with existing Type IV and Type V fluids. Benefits include:

- The longest fluid life of any phosphate ester fluid, under high- and low-moisture conditions. Also under high- and mild-temperature conditions.
- Significant weight savings vs. most Type IV fluids, which deliver fuel savings by making the hydraulic system lighter.
- The lowest –65°F viscosity among phosphate ester fluids, for faster cold starts, highest system efficiency.
- Reduced maintenance expense due to longer fluid life.
- Benefit with reduced waste disposal volumes from extended fluid life.

Longest fluid life

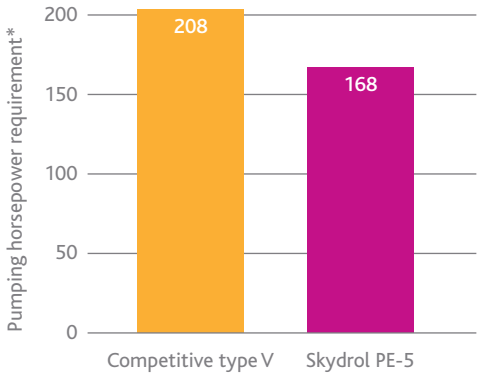
Skydrol PE-5 has the longest life of any phosphate ester fluid available today, even under high-moisture conditions.



*Fluid tested @ 257°F (125°C) and 0.5% H_2O, laboratory conditions

Low-temperature performance

PE-5 users may experience up to 25% better hydraulic system efficiency.



*At –65°F (–54°C) viscosity

Skydrol 5

Lighter-weight hydraulic fluid

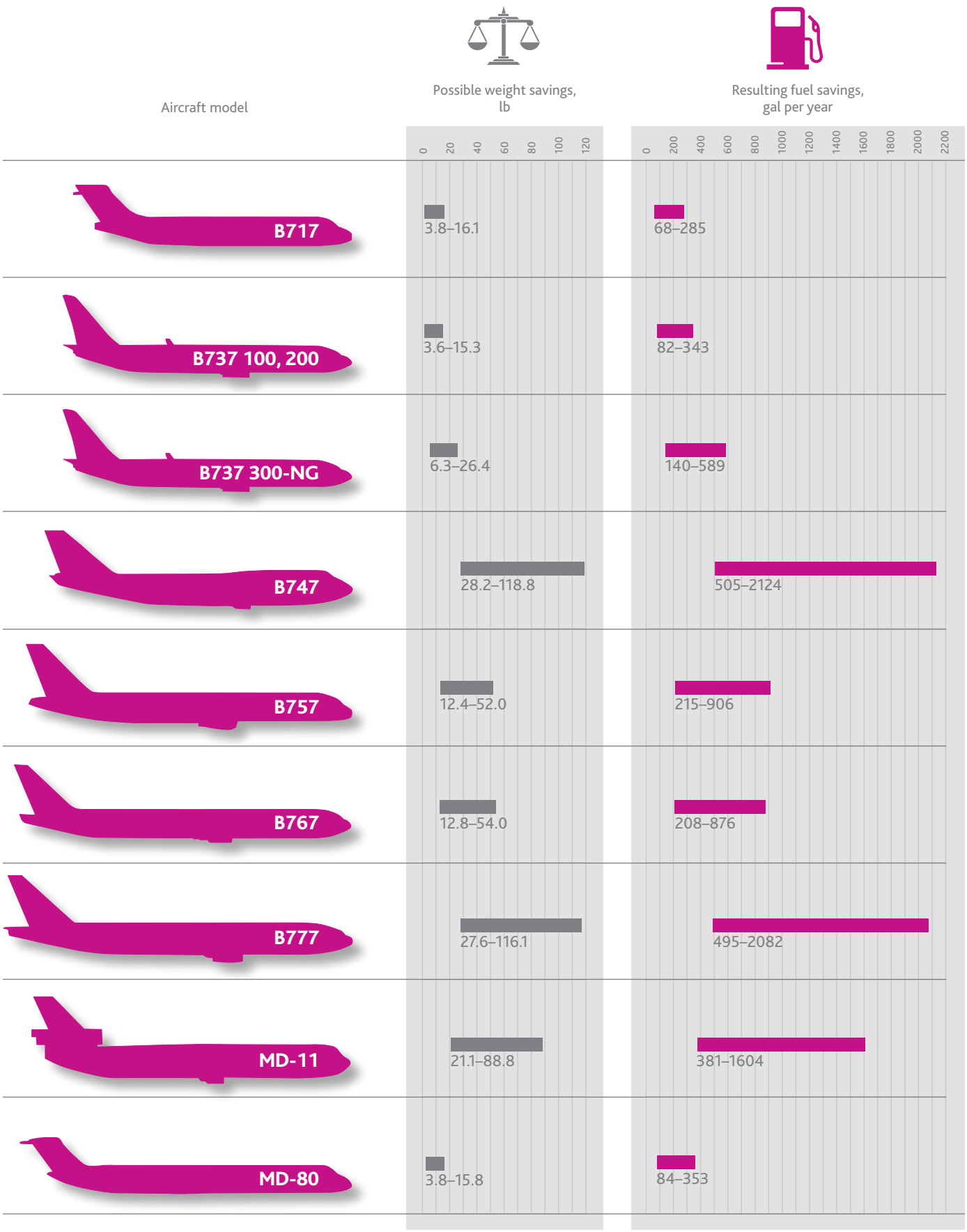
- **Fluid density**
  The lowest density PE hydraulic fluid, which can result in significant fuel savings
- **Thermal stability**
  Higher-temperature capability than Type IV fluids
- **Erosion resistance**
  Maintains erosion resistance at higher temperatures
- **Safety**
  New base stock reduces potential health concerns.
- **Paint compatibility**
  Less aggressive toward aircraft paints
- **Fire resistance**
  Improved fire resistance over Type IV fluids in spray ignition tests

Skydrol 5 has a unique formulation built on a new base stock, triisobutyl phosphate. Most other phosphate ester products use tributyl phosphate as a major ingredient. The difference gives Skydrol 5 the lightest weight of any phosphate ester hydraulic fluid. Weight savings on the plane translate into fuel savings for the bottom line (see graphic table on the following page).

Lower density equates to weight savings

Airframe manufacturers and operators are becoming more conscious of the benefits of weight saving in today's competitive environment. Any weight that can be removed from an aircraft translates to increased payload and/or fuel savings. Skydrol 5 sets a new standard as the lowest density phosphate ester based hydraulic fluid. Typical weight savings per aircraft model are given in the graphic table. The use of Skydrol 5 can translate into 5 to 120 lb of weight savings depending on the aircraft model. This weight saving will lead directly to reduced fuel burn.

Weight and fuel savings with Skydrol 5



Skydrol LD-4 and 500B-4

Skydrol LD-4 and 500B-4 fluids are approved by all airframe manufacturers specifying phosphate ester hydraulic fluids, including:

- Airbus Industrie NSA307110
- Boeing Commercial Airplane Co. BMS3-11
- McDonnell Douglas Corp. DMS2014
- Lockheed Aircraft Corp. LAC C-34-1224
- Society of Automotive Engineer AS1241
- British Aerospace BAC M.333.B
- Fokker
- Embraer
- Bombardier BAMS 564-003

Many business aircraft manufacturers utilize one or more of these material specifications. Business aircraft manufacturers that have designed aircraft models for use with phosphate ester fluids include:

- Westwind
- Cessna
- Gulfstream

Materials used in the hydraulic system and surrounding it must be compatible with the hydraulic fluid. The fluid must not degrade their performance; neither should the materials degrade the fluid. Materials and components used in and near any aircraft hydraulic system are carefully selected by the airframe manufacturer. The aircraft industry uses many synthetic materials—many are resistant to Skydrol fluids and some are not. Many that are not totally resistant require long exposure before damage results. Deviations from the recommended materials should not be made without prior consultation with the airframe manufacturer and the materials components suppliers.

The general rating of compatibility of various materials with Skydrol fluids ratings of compatibility:

- **Excellent resistance**—Material may be used in constant contact with the fluid.
- **Good resistance**—Withstands exposure to the fluid with minimum swell (for plastics and rubber) or loss of integrity
- **Poor resistance**—Should not be used near the fluid
- **No resistance**—Disintegrates in the fluid

All approved phosphate ester hydraulic fluids are miscible and compatible and may be used with each other in any and all proportions. Miscibility and compatibility testing of the phosphate ester fluids is a qualification requirement and ensures the compatibility of all approved fluids in all proportions.

Material compatibility in Skydrol fluids

Material	Excellent	Good	Poor	No
Fabrics				
Acrylic[a]			■	
Cotton, wool, rayon		■		
Fiberglass, nylon, polyester[b]		■		
Carbon (graphite)	■			
Coated fabrics				
Buna N coated cotton or nylon			■	
Butyl coated nylon	■			
Ethylene propylene coated nylon	■			
Chlorosulfonated polyethylene nylon			■	
Neoprene coated nylon, cotton, polyester			■	
Silicone coated fiberglass		■		
Silicone coated polyester		■		
Vinyl coated cotton, nylon, polyester				■
Vinyl coated fiberglass				■
Fluoroelastomer coated nylon		■		
Metals				
Aluminum	■			
Brass		■		
Bronze		■		
Cadmium		■		
Chromium	■			
Copper[c]			■	
Ferrous	■			
Lead[d]		■		
Magnesium[c]		■		
Nickel	■			
Noble (gold, silver)	■			
Stainless steel	■			
Zinc[d]		■		
Titanium[e]		■		
Exotic (Hastelloy™)	■			
Beryllium copper	■			
Conversion coatings				
Anodizing (aluminum)	■			
Dow 7 and 17 (magnesium)	■			

(continued)

Description of ratings

Excellent—Suitable for use inside and outside the hydraulic system

Good—For metals, corrosion rates are higher than that of "excellent" materials but still may be useful in some applications. For plastics and elastomers, suitable for use outside the hydraulic system but not for constant immersion in liquid.

Poor—Not recommended for use, except for limited duration

No—Will dissolve in liquid Skydrol fairly quickly

Material compatibility in Skydrol fluids *(continued)*

Material	Excellent	Good	Poor	No
Paint finishes				
Alkyd[f]			■	
Acrylic				■
Asphaltic				■
Cellulosic lacquer				■
Epoxy	■			
Epoxy-amide	■			
Heat-resistant aluminized				■
Latex			■	
Polyurethane		■		
Linseed oil			■	
Shellac			■	
Silicone		■		
Urethane		■		
Varnish			■	
Vinyl			■	
Thermoplastics				
ABS			■	
Acetal			■	
Acrylic			■	
Cellulosic			■	
ETFE copolymer[g]	■			
FEP (fluorocarbon)	■			
Nylon	■			
Polycarbonate[h]			■	
Polyetheretherketone (PEEK)		■		
Polyetherketone (PEK)		■		
Polyethylene	■			
Polyphenylene oxide (PPO)			■	
Polyphenylene sulfide (PPS)		■		
Polypropylene	■			
Polystyrene				■
Polyvinyl chloride				■
Polyvinylidene chloride		■		
Polyvinyl fluoride (PVF)[i]	■			
PCTFE	■			
PETG	■			
PTFE	■			
Reinforced TFE	■			
TFE (fluorocarbon)	■			

Material compatibility in Skydrol fluids *(continued)*

Material	Excellent	Good	Poor	No
Thermosets				
Melamine		■		
Polyester		■		
Phenolic		■		
Polyamide	■			
Polyimide	■			
Elastomers				
Butadiene acrylonitrile (Buna N)				■
Chlorosulfonated polyethylene[j]		■		
Epichlorohydrin		■		
Ethylene propylene (EPR, EPDM)	■			
Fluorinated hydrocarbon[k]			■	
Polyacrylic			■	
Polybutadiene			■	
Polychloroprene (neoprene)			■	
Polyisoprene (natural and synthetic rubber)			■	
Polysulfide			■	
Polyurethane				■
Isobutylene isoprene (butyl)		■		
Silicone		■		
Styrene butadiene (Buna S)			■	
Perfluorohydrocarbon[l]	■			
Fluoroethylene (TFE, FEP)	■			
Miscellaneous materials				
Cork			■	
Leather			■	
Vinyl floor tile				■

Based on material from Machine Design, January 21, 1971. Copyright 1971 by Penton IPC Inc., Cleveland, Ohio

[a] *Includes Acrilan, Creslan, Orlon, Zefran*
[b] *Includes Dacron, Fortrel, Kodel*
[c] *Copper and magnesium are not recommended for use in a hydraulic system. Long-term corrosion rates are excessive.*
[d] *Lead and zinc are not recommended for use in a hydraulic system. Their oxidation products can form soaps and cause emulsions.*
[e] *Titanium should not be used at temperatures above 325°F. Hydrogen embrittlement may occur.*
[f] *Includes alkyd-phenolic, alkyd-silicone, and alkyd-urethane finishes.*
[g] *Tefzel™ (DuPont)*
[h] *Lexan™ (General Electric)*
[i] *Tedlar™ (DuPont)*
[j] *Hypalon™ (DuPont)*
[k] *Viton™ (DuPont), Fluorel™ (3M)*
[l] *Kalrez™ (DuPont), Chemraz™ (Greene Tweed)*

To learn more about Skydrol, visit
www.EastmanAviationSolutions.com.

EASTMAN

The results of **insight**™

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