AEROSPACE INFORMATION REPORT

AIR5358™ REV. B

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Superseding AIR5358A

(R) Landing Gear Shock Strut Hydraulic Fluid With Extreme Pressure and Anti-Wear Additives

RATIONALE

This document has been updated to provide additional information about the use of landing gear shock strut hydraulic fluids in-service, and to clarify the use of MIL-PRF-6083. In addition, some editorial changes have been made.

TABLE OF CONTENTS

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1. SCOPE

This document describes hydraulic fluids used in landing gear shock struts with extreme high contact pressure and anti-wear additives that have been added for improved lubrication.

1.1 Purpose

The purpose of this document is to describe several hydraulic fluids with an additive package that can be used for the reduction of friction and subsequent reduction of “ladder cracking” in aircraft shock struts (refer to AIR5913).

1.2 Field of Application

The information included herein is for hydraulic fluid in landing gear shock struts. The fluid contains a uniquely colored dye to differentiate it from other fluids used for hydraulic systems.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR1362 Aerospace Hydraulic Fluids Physical Properties

AIR5913 Landing Gear Component Heat Damage

2.2 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

MIL-PRF-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordinance

MIL-PRF-6083 Hydraulic Fluid, Petroleum Base, For Preservation and Operation

MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, Nato Code Number H-537

MIL-PRF-87257 Hydraulic Fluid, Fire Resistant, Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

2.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D92 Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

ASTM D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

ASTM D974 Standard Test Method for Acid and Base Number by Color-Indicator Titration

ASTM D1500 Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)

3. CLASSIFICATION AND EXAMPLE FLUIDS

3.1 Extreme Pressure and Anti-Wear Additives

The following are extreme pressure and anti-wear additives that have been used in landing gear shock strut hydraulic fluid:

- Lubrizol 1395 – This contains zinc dialkyldithiophosphate.
- Methyl oleate – This is a high contact pressure additive.

3.2 Classification of Fluids

Landing gear shock strut hydraulic fluids with extreme pressure and anti-wear additives have been classified as shown in Table 1.

Table 1 - Classification of fluids

Type I	-	Preservative Shock Strut Fluid
Type II	-	In-Service Shock Strut Fluid
Type III	-	In Service Shock Strut Fluid (Synthetic Fire Resistant)

Type I fluids have been based on MIL-PRF-6083, type II fluids have been based on MIL-PRF-5606 and type III fluids have been based on MIL-PRF-87257. MIL-PRF-83282 is another fluid commonly used in landing gear shock struts, however, no variants of this fluids have been used with extreme pressure and anti-wear additives.

Note that in MIL-PRF-6083G the following statement has been added to the scope of the document: “This hydraulic fluid will not be used for aircraft systems, aircraft ground support equipment, or the preservation of aircraft components.” However before revision G the document stated that “The hydraulic fluid is also used as a preservative fluid for aircraft hydraulic systems and components where MIL-H-5606 (OHA) or MIL-PRF-87257 is used as an operational fluid.” There are many examples where MIL-PRF-6083 and derivatives with extreme pressure and anti-wear additives may still be used in landing gear for preservation and storage based on versions of the specification before revision G. MIL-PRF-6083 is also still used as an operational fluid in some aircraft.

3.3 Example Airframer Specifications

Once the extreme pressure and anti-wear additives have been added to the base hydraulic fluids, often along with other additives such as alternative dye, the fluids no longer meet the requirements of the base fluid specification. Therefore, the fluids have to be referenced by a new specification number. There are no international standards to designate these fluids with extreme pressure and anti-wear additives; airframe manufacturer specification numbers are used to designate these fluids.

The list below contains some airframer specifications that have been used to specify these fluids with extreme pressure and anti-wear additives:

- Boeing BMS 3-32 (type I and II fluids)
- McDonnell Douglas DPM6176 (type II fluid)
- McDonnell Douglas DPM6177 (type I fluid)

3.4 Example Landing Gear Shock Strut Hydraulic Fluid with Extreme Pressure and Anti-Wear Additives

The list below shows selected fluids with extreme pressure and anti-wear additives that have been used in landing gear in compliance with some of the airframer specifications listed in 3.3:

- Aeroshell SSF (Shock Strut Fluid) – a type I fluid
- Aeroshell LGF (Landing Gear Fluid) – a type II fluid
- Castrol Aero 35 Yellow – a type I fluid
- Castrol Aero 40 – a type II fluid
- Hydraunycoil FH 5 AW – a type II fluid
- Hydraunycoil FH 6 AW – a type I fluid
- ROYCO SSF (Shock Strut Fluid) – a type I fluid
- ROYCO LGF (Landing Gear Fluid) – a type II fluid

4. EXAMPLE AIRFRAMER REQUIREMENTS

The requirements listed in this section are one example of how landing gear shock strut hydraulic fluid with extreme pressure and anti-wear additives have been specified by an airframer in their specification.

a. The material is clear, homogeneous, and free from solid matter.

b. The material consists of a base fluid premixed with suitable additives in accordance with MIL-PRF-5606, MIL-PRF-6083, or MIL-PRF-87257 as specified. Except that the base fluids shall be formulated without the red dye typically used in MIL-PRF-5606, MIL-PRF-6083, or MIL-PRF-87257.

c. A yellow dye will be used to indicate the presence of the extreme wear additive package.

d. It is desired that extreme pressure/anti-wear additives do not exceed 2.7% by volume.

4.1 Typical Properties

4.1.1 Type I Fluid

The following fluids or combinations of fluids are approved (by the airframer) as type I:

MIL-PRF-6083 fluid base pre-mixed with 1.5% ± 0.1% by volume of Lubrizol 1395 and 1.0% ± 0.1% by volume methyl oleate. Yellow non-fluorescent dye at less than 0.01% by volume is added to the fluid.

4.1.2 Type II Fluid

The following fluids or combinations of fluids are approved (by the airframer) as type II:

MIL-PRF-5606 fluid base pre-mixed with 1.5% ± 0.1% by volume of Lubrizol 1395 and 1.0% ± 0.1% by volume methyl oleate. Yellow non-fluorescent dye at less than 0.01% by volume is added to the fluid.

4.1.3 Type III Fluid

The following fluids or combinations of fluids are approved (by the airframer) as type III:

MIL-PRF-87257 fluid base pre-mixed with 1.5% ± 0.1% by volume of Lubrizol 1395 and 1.0% ± 0.1% by volume methyl oleate. Yellow non-fluorescent dye at less than 0.01% by volume is added to the fluid.

4.1.4 Compatibility

It is not recommended to mix other qualified products with this fluid in landing gear shock struts. Color change from mixing with other base fluids is an indication of mixing.

4.1.5 Physical and Chemical Properties of the Finished Oil

The typical properties for these shock strut fluids are shown in Table 2.

Table 2 - Physical and chemical properties

Property	Requirement	Classes	Test Method
Viscosity, cSt	4.9 min at 100 °C ± 1 °C (1)	Type I & II	ASTM D445
	2.0 min at 100 °C ± 1 °C	Type III	
	13.2 min at 40 °C ± 0.5 °C	Type I & II	
	6.7 min at 40 °C ± 0.5 °C	Type III	
	800 max at -40 °C ± 0.5 °C (2)	Type I & II	
	550 max at -40 °C ± 0.5 °C	Type III	
Total Acid Number (TAN) mg KOH/gm	1.5 to 3.5 (3)	Type I	ASTM D974
	2.3 to 5.0	Type II	
	2.3 to 5.0	Type III	
Flash Point	82 °C minimum	Type I & II	ASTM D92
	170 °C minimum	Type III	
Zn, ppm	1700 ± 300	All	XRF or ICP (4)
Color	pale to straw yellow (1.0-2.0)	All	ASTM D1500

NOTES:

1. MIL-PRF-6083G gives a value of 4.6 min, MIL-PRF-5606J gives a value of 4.9 min.
2. MIL-PRF-6083G gives a value of 700 max, MIL-PRF-5606J gives a value of 600 max.
3. TAN values are high compared to the required base oils due to the zinc dialkyldithiophosphate extreme pressure additive and the corrosion inhibitor additive in type I fluid.
4. X-ray fluorescence or induction coupled plasma spectroscopy or another method with required accuracy.

4.1.6 Modification of Fluids

It is not recommended to mix these fluids or the additives in the field. Premix is the preferred method to use.