



AEROSPACE INFORMATION REPORT

AIR4281™**REV. A**Issued 1998-11
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Superseding AIR4281

(R) Oil Systems for Helicopter Powerplants

RATIONALE

This SAE Aerospace Information Report (AIR) deals with integration of engine oil systems with the airframe and gives information for both helicopter and engine manufacturers for a better understanding of interface requirements. This document was revised to update the technical content such that it reflects the state-of-the-art understanding on the subject and provide some editorial changes for improved clarity. Minor revisions of this nature were made to most sections. Table 1 was updated with additional oil system examples.

1. SCOPE

Turbine engines installed in helicopters require a highly sophisticated oil system to fulfill two primary tasks:

- a. Cooling/oil supply
- b. Lubrication of rotating components (bearings, shafts, gears, etc.)

While lubrication is an engine internal operation, depending on the engine oil system configuration, cooling and oil supply may require more or less design activity on the aircraft side of the engine/airframe interface for proper engine function. The necessity for engine cooling and oil supply provisions on the airframe can lead to interface problems because the helicopter manufacturer can influence engine related functions due to the design of corresponding oil system components.

2. REFERENCES

2.1 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.

2.1.1 SAE Publications

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

ARP1507 Helicopter Engine/Airframe Interface Document and Checklist

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Full document details: [SAE AIR4281A](http://www.sae.org/standards/content/AIR4281A/)

For more information on this standard, visit
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Documents

Standard, visit Sharing Hub

2.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

- 14 CFR Part 29 Airworthiness Standards: Transport Category Rotorcraft; Subpart E - Powerplant, paragraphs 29.908 (Cooling Fans), 29.1011 through 29.1027 (Oil System), and 29.1183 through 29.1189
- 14 CFR Part 27 Airworthiness Standards: Normal Category Rotorcraft; Subpart E - Powerplant, paragraphs 27.903 (b), 27.1011 through 27.1027 (Oil System), and 27.1183 through 27.1189
- AC 29-2 Certification of Transport Category Rotorcraft; Subpart E - Powerplant, Oil System, 29.1011 (Engines: General)

2.1.3 U.S. Government Publications

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

- MIL-PRF-7808 Performance Specification: Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-148 and O-163
- MIL-PRF-23699 Performance Specification: Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-152, O-154, O-156 and O-167

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Information Report.

2.2.1 SAE Publications

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

- AIR1666 Performance Testing of Lubricant Filter Elements Utilized in Aircraft Power and Propulsion Lubrication Systems
- AIR5433 Lubricating Characteristics and Typical Properties of Lubricants Used in Aviation Propulsion and Drive Systems
- ARP1482 Recommendations for Fuel and Oil System Schematics
- ARP1961 Gearbox - Airframe Mounted Accessory
- AS5780 Specification for Aero and Aero-Derived Gas Turbine Engine Lubricants
- AS18802 Fuel and Oil Lines, Aircraft, Installation of

2.2.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

14 CFR Part 33 Airworthiness Standards: Aircraft Engines; Subpart B - Design and Construction; General, paragraph 33.17 - Fire prevention and Subpart E - Design and Construction; Turbine Aircraft Engines, paragraph 33.71 - Lubrication system

AC 20-24 Approval of Propulsion Fuels, Additives, and Lubricating Oils

AC 33.17-1 Engine Fire Protection § 33.17

2.2.3 U.S. Government Publications

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

MIL-O-19838 Oil Systems, Aircraft, Installation and Test

2.2.4 EASA Publications

Available from European Union Aviation Safety Agency, Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany, Tel: +49 221 8999 000, www.easa.europa.eu.

CS-E 570 Certification Specifications and Acceptable Means of Compliance for Engines, Subpart D - Turbine Engines: Design and Construction, Oil System

2.3 Definitions

SUMP: A chamber surrounded by dry cavity in which shaft supporting bearings are lubricated and pressurized air is fed into to prevent oil past the seals. The accumulating oil and mist in the chamber are discharged via dedicated scavenge and vent lines.

SCREEN: A non-serviceable filter usually without its own bypass provisions and hence usually has a relatively coarse mesh element.

2.4 Symbols and Abbreviations

ACOC	air cooled oil cooler
AGB	accessory gearbox
FCOC	fuel cooled oil cooler
QDM	quantitative debris monitoring
RGB	reduction gearbox
TCDS	type certificate data sheet

3. ENGINE OIL SYSTEM

Oil systems for helicopter powerplants should be optimized with respect to both engine and airframe.

- a. Engine: The oil system must enable satisfactory operation within the specified and/or certified limits (oil temperature, pressure, viscosity, etc.) and operating envelope (ambient temperature, power, altitude, etc.).
- b. Airframe: Integration of the engine and associated oil system components into the airframe should have no adverse effects on helicopter or airframe architecture, reliability, maintainability, performance, etc.

In order to enhance integration and proper operation of the engine, as well as maintainability and reliability of the entire system, the following items should be considered:

- a. Minimization of engine/airframe interfaces
- b. Use of identical components for systems with similar functions on engine and airframe (lubrication fluid, fittings, filters, etc.). However, to reduce risk of undesirable interchangeability of identical parts for different functional interfaces, such parts should preferably have intentional physical differences and be clearly marked to prevent incorrect installation (such as supply in, cooler out, etc.).

A detailed schematic of a typical fuel cooled oil system is shown in Figure 1.

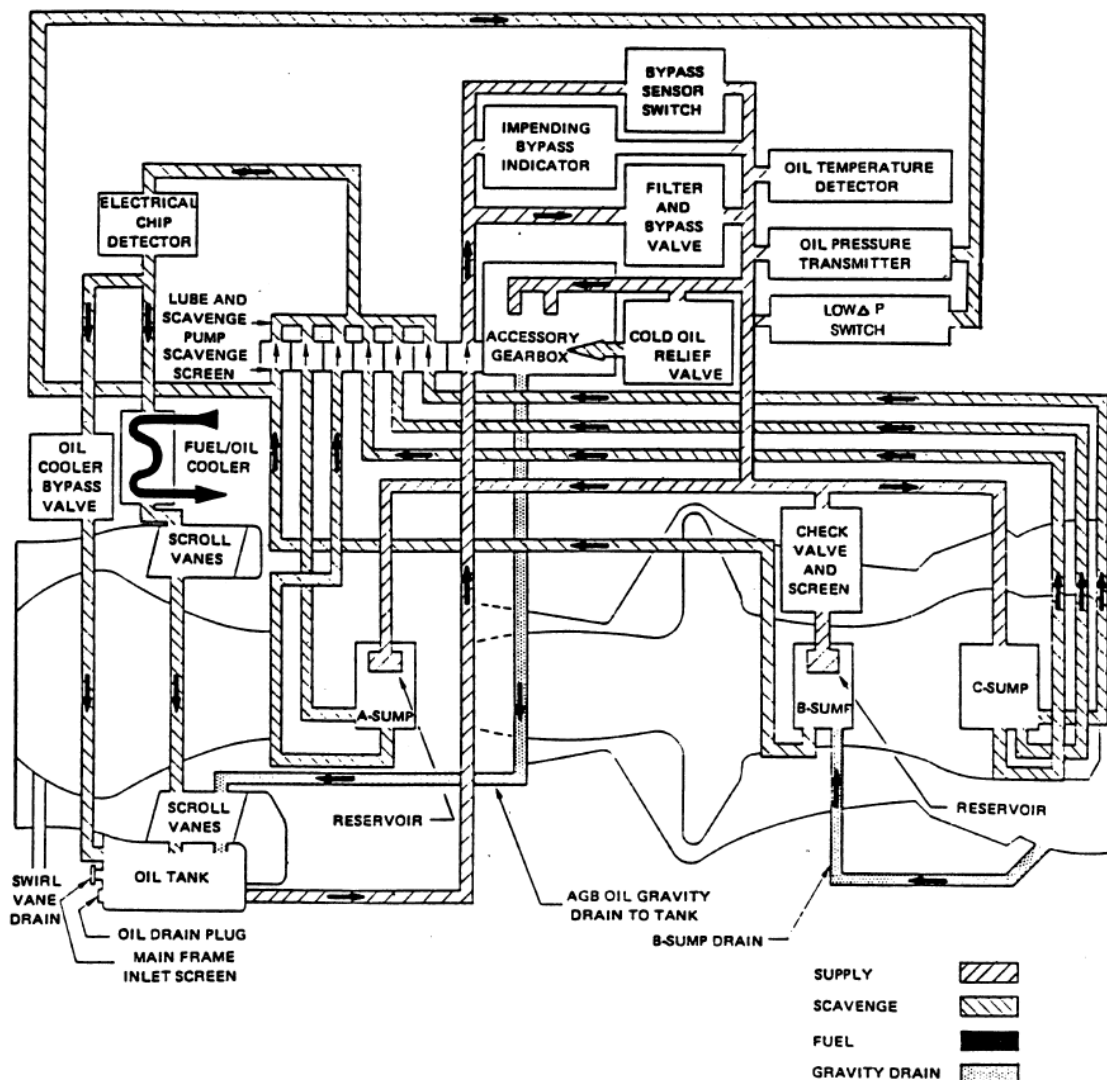


Figure 1 - Schematic of a typical fuel cooled engine oil system



4. OIL SYSTEM CONCEPTS

In terms of engine/airframe interfaces, three cooling/oil system concepts must be considered as per AC 29.1011:

- a. Self-contained oil system
- b. Partially self-contained oil system
- c. Airframe-supported oil system

These systems are generically similar on an overall level, but the requirements drive different constraints and therefore ownership of parts of the system. Some well-known applications for each concept are given in Table 1.

Table 1 - Engine oil system examples

Oil System Cooling Concept	Engine Gearbox Concept	Engine Power kW	Engine Power shp	Engine Oil System Configuration	Engine Name
AS ⁽¹⁾	Integrated RGB	313-485	420-650	No oil tank/cooler	Rolls-Royce M250 series
AS	Integrated RGB	340	456	No oil tank/cooler	Safran Helicopter Engines Arrius 1 Series
AS	Integrated RGB	410	550	No oil tank/cooler	Honeywell (Lycoming) LTS 101-650B-1
AS	Integrated RGB	440	590	No oil cooler	Pratt & Whitney 200 series
AS	Integrated RGB	432-600	580-800	No oil tank/cooler Cooling fan drive pad on some models (see TCDS)	Safran Helicopter Engines ARRIEL 1-2 Series
AS	Integrated RGB	500	670	No oil cooler	Safran Helicopter Engines Arrius 2 Series
AS	Integrated RGB	635	850	No oil tank/cooler	Safran Helicopter Engines TM 333 A
AS	Integrated RGB	745	1000	No oil cooler	Pratt & Whitney PT6B
AS	Integrated RGB	1118	1500	No oil tank/cooler	Honeywell (Lycoming) T53-L-703
AS	No RGB	746-1395	1000-1870	No oil tank	General Electric T58
AS	Integrated RGB	1342-1491	1800-2000	No oil cooler Cooling fan drive pad	Pratt & Whitney PT6T Twin-Pac
AS	No RGB	2387-3282	3200-4400	No oil tank/cooler	General Electric T64
PSC ⁽²⁾	Integrated RGB	596-671	800-900	ACOC & Blower	Pratt & Whitney 210 series
PSC	Integrated RGB	750	1005	ACOC & Blower	Safran Helicopter Engines TM 333 2B2
PSC	Integrated RGB	950	1273	ACOC & Blower	MTU-Safran Helicopter Engines-Rolls-Royce MTR390
PSC	No RGB	986	1320	ACOC & Blower	LHTEC CTS800-4A
SC ⁽³⁾	No RGB	1044-1492	1400-2000	FCOC	General Electric T700/CT7
SC	No RGB	1193-1492	1600-2000	FCOC	Pratt & Whitney PT6C
SC	No RGB	1400	1876	FCOC	Safran Helicopter Engines MAKILA 1-2 Series
SC	No RGB	1566	2100	FCOC	Rolls-Royce/Safran Helicopter Engines RTM322
SC	No RGB	3728-4474	5000-6000	FCOC	Honeywell (Lycoming) T55 Series

⁽¹⁾ Concept AS: Airframe supported oil system; some vital parts of the oil system are provided by the airframe manufacturer (such as oil tank, cooling system, etc.).

⁽²⁾ Concept PSC: Partially self-contained, some devices or arrangements may be provided by the airframe manufacturer.

⁽³⁾ Concept SC: Self-contained, no components, specific device, or arrangement on the airframe side necessary.



4.1 Self-Contained Oil System

A self-contained oil system means that all components necessary for engine oil supply, oil scavenge, and oil cooling are an integral part of the engine (see Figure 2). No supply, scavenge, or cooling provisions are necessary on the airframe. Oil supply is achieved by an oil tank integrated within the engine structure and oil cooling is obtained by engine internal cooling provisions.

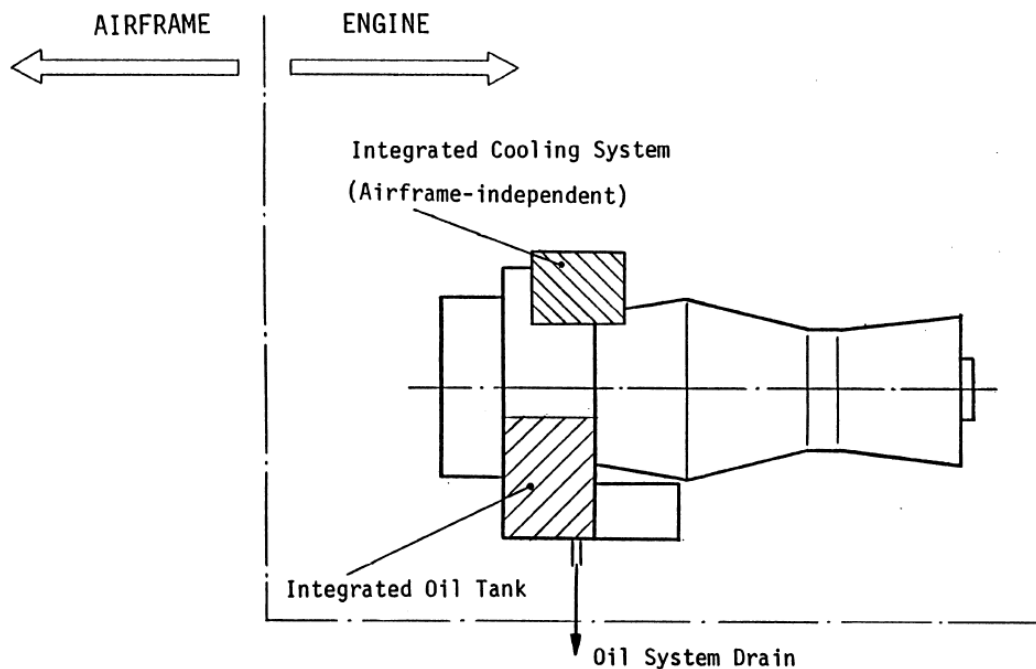


Figure 2 - Self-contained oil system (no vital interfaces engine/airframe)

A self-contained engine oil system is the simplest solution for integration of an engine into a helicopter. No engine/airframe cooling interfaces are necessary which could adversely affect engine oil system functions. The responsibility for the complete engine oil system rests with the engine manufacturer. However, relevant sections of 14 CFR 27/29 are still applicable to overall system design and shall also be complied with by the airframe manufacturer with the support of the engine manufacturer.

This concept can easily be realized for engines which do not have an integrated RGB (generally bigger engines with output power greater than 1000 kW) since this configuration has a reduced amount of engine oil and a reduced heat rejection.