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Oil Systems for Helicopter Powerplants

FOREWORD

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

- a. Engine: The oil system has to enable satisfactory operation within the specified limits (ambient temperature, power, etc.)
- b. Airframe: Integration of the engine and associated oil system components into the airframe without 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 tasks on engine and airframe, e.g.:
 - (1) lubrication fluid
 - (2) fittings
 - (3) filters, etc.

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

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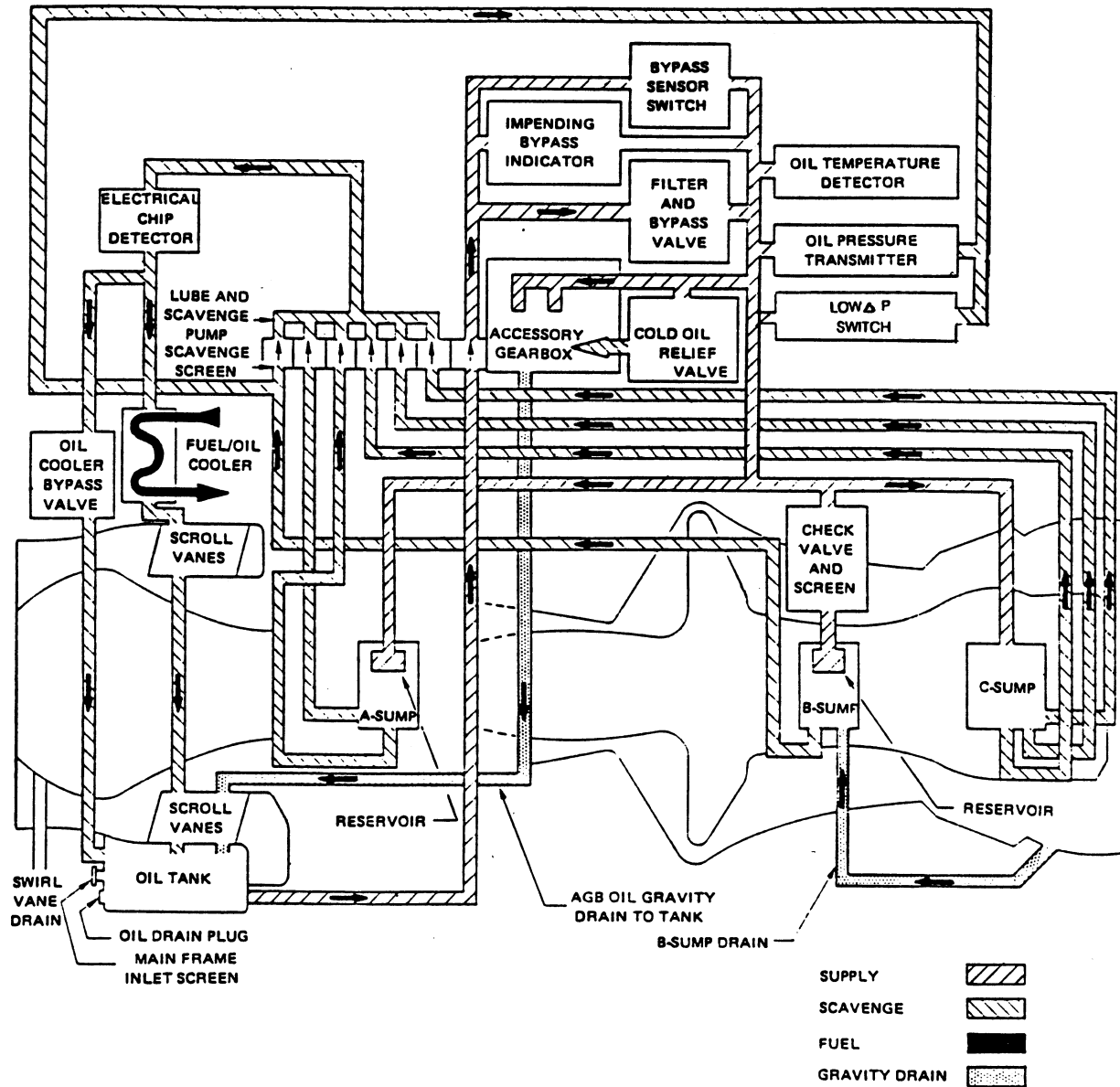


FIGURE 1 - Schematic of a Typical Oil System

1. SCOPE:

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

- a. Cooling/oil supply
- b. Lubrication

While lubrication is an engine internal procedure, cooling and oil supply require more or less design activity on the aircraft side of the engine/airframe interface for proper engine function, depending on the engine type.

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.

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.

2. APPLICABLE DOCUMENTS:

Further information concerning oil system design, operation, installation, and testing is given in the following documents:

2.1 FAA Publications:

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591.

2.1.1 FAR Regulations:

Part 27 - Airworthiness Standards: Normal Category Rotorcraft; Subpart E - Powerplant, paragraphs 27.1011 through 27.1021 (Oil System)

Part 29 - Airworthiness Standards: Transport Category Rotorcraft; Subpart E - Powerplant, paragraphs 29.1011 through 29.1025

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

2.2 Military Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

Military Specification MIL-O-19838 (Aer): Oil Systems, Aircraft, Installation and Test

(It should be noted that this MIL-Spec. provides a general definition for aircraft propulsion.)

2.3 Other Documents:

British Civil Airworthiness Requirements, Section C: Sub-Section C4 - Turbine Engines for Rotorcraft, Chapter C4-2 Design and Construction; paragraph 2.2 Oil System

3. COOLING AND OIL SYSTEM CONCEPTS:

From the point of view of engine/airframe interfaces, three cooling/oil system concepts have to be considered:

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

3.1 Self-Contained Oil System (Figure 2):

A self-contained oil system means that all components necessary for engine oil supply and oil cooling are an integral part of the engine. No provisions are necessary on the airframe.

Oil supply is achieved by an oil tank integrated within the engine structure.

Engine cooling is obtained by engine internal cooling provisions such as:

- a. Fuel cooled oil coolers
- b. Air/oil cooling devices
- c. A combination of both

The fuel cooled oil cooler transfers the heat from the oil to the fuel consumed by the engine.

For air/oil cooling, the heat is transferred to the engine inlet air. In addition, such a system can provide anti-icing functions for certain sections of the engine air inlet structure.

However, consideration should be given to the fact that transfer of heat to the engine intake will cause a performance penalty. For such a system a means should be provided which prevents heated portions of inlet air from entering the core engine.

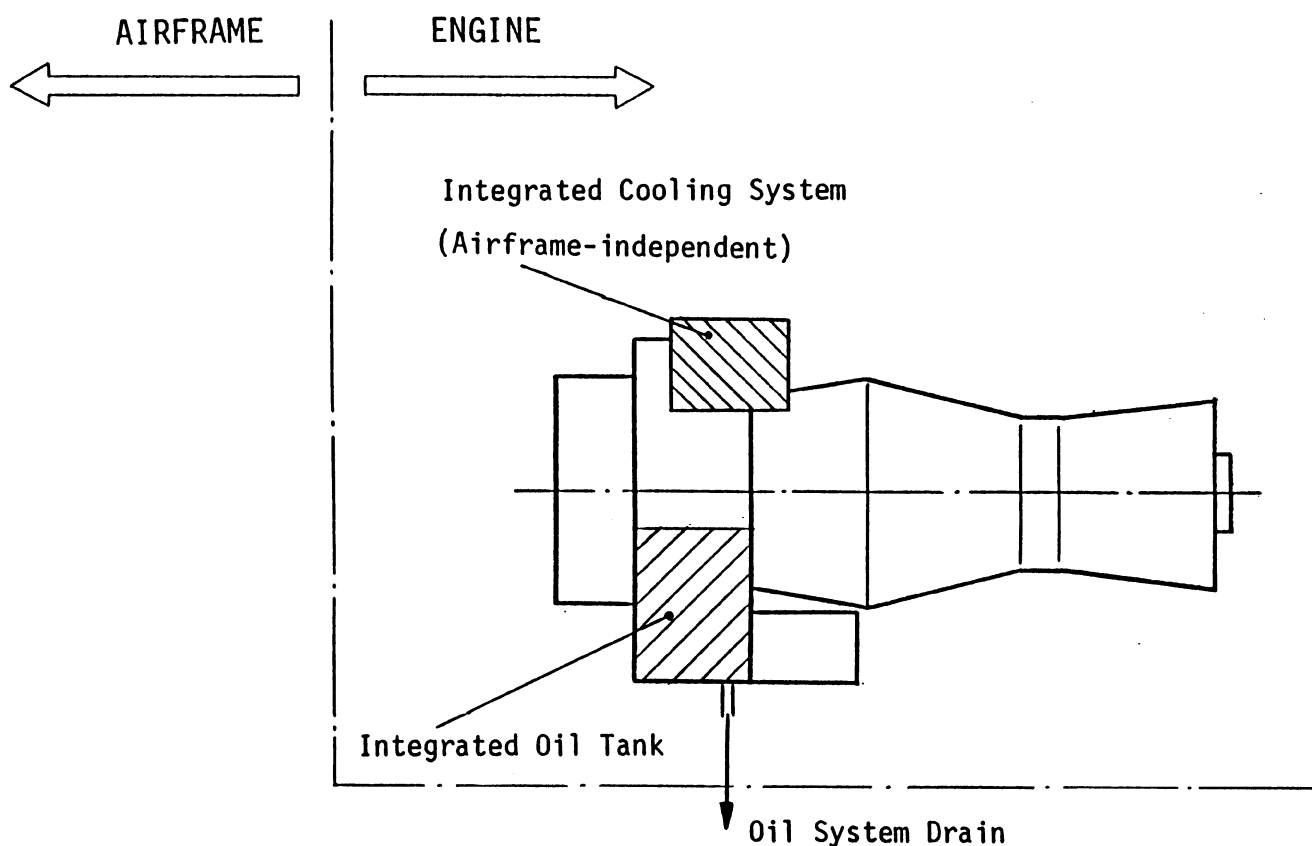


FIGURE 2 - Self-Contained Oil System
(No Vital Interfaces Engine/Airframe)

3.1 (Continued):

A self-contained engine oil system is the simplest solution for integration of an engine into a helicopter. No engine/airframe interfaces are necessary which could adversely affect engine oil system functions.

The responsibility for the complete engine oil system rests with the engine manufacturer.

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

3.2 Partially Self-Contained Oil System (Figure 3):

A partially self-contained oil system does not have all the components necessary for engine oil supply/oil cooling located on the engine. Some components have to be provided on the airframe and, thus, are the responsibility of the helicopter manufacturer. The airframe part of a partially self-contained oil system is generally related to cooling air supply.

The engine is equipped with all components necessary for oil supply, oil conditioning, and oil transport (integrated oil tank, pumps, lines, filter units, etc.). For oil cooling, an air/oil cooling unit is provided on the engine which needs cooling air in addition to the airflow necessary for engine operation. Cooling airflow is usually provided by an engine driven blower (air/oil-cooler and blower may be designed as one common unit).

It is the helicopter manufacturer's responsibility to provide sufficient cooling air supply and a cooling air outlet. For this, corresponding air ducts have to be provided on the airframe.

The airframe/engine-interface for such a configuration will be between the air ducts (inlet and outlet) and the engine's cooling unit.

In order to ensure proper cooling system operation, the engine manufacturer has to specify the cooling system's operating data including worst case conditions (cooling air mass flow, etc., see 4.1). These data are required by the airframe manufacturer for design and dimensioning of the cooling air inlet and outlet ducts.

For structural integration of the cooling system into the airframe, the following interface information has to be provided by the engine manufacturer:

a. Engine cooling system cooling air inlet and outlet connection flange definition:

- (1) location
- (2) shape
- (3) dimensions
- (4) type of connecting device
- (5) maximum allowable connecting loads

b. For cooling system integration:

- (1) the engine cooling system has to be optimized with regard to size, weight, maintainability (e.g., reduction of cooling air duct size; accessibility to connecting devices for the installed engine)
- (2) on the airframe it must be ensured that:
 - (a) the cooling air supply/exhaust-conditions required for the engine cooling system will be met by the air duct design

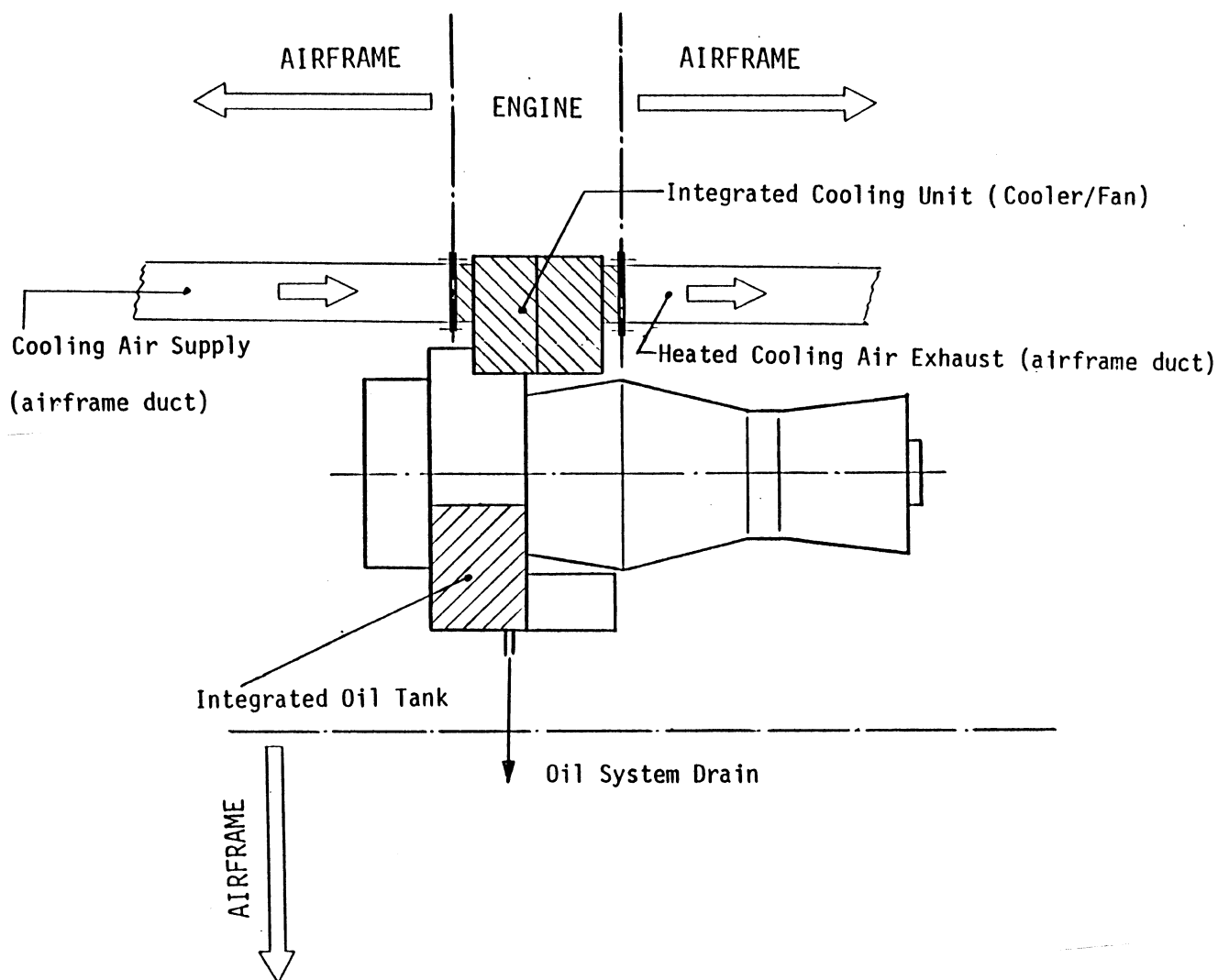


FIGURE 3 - Partially Self-Contained Oil System

3.2 (Continued):

- (b) the supply and outlet ducts are located and routed such that the ingestion of exhausted cooling air or other hot gases (engine exhaust gas) will be avoided
- (c) the cooling air outlet ducts will be routed such that exhausted cooling air cannot be ingested by engine air inlets
- (d) the cooling air inlet opening is protected against ingestion of foreign objects which could clog the supply duct or damage cooling system components (e.g., installation of an inlet screen)