U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: PROCEDURES FOR DETERMINING ACCEPTABLE FUEL/OIL RATIO AS REQUIRED BY FAR 23.1011(b)

Date: November 14, 1983 **AC No:** 23.1011-1
Initiated by: ACE-100 **Change:**

1. PURPOSE. This Advisory Circular (AC) sets forth acceptable means, but not the only means, of showing compliance with Part 3 of the Civil Air Regulations (CAR) and Part 23 of the Federal Aviation Regulations (FAR) applicable to determining that the engine oil capacity is adequate to assure safe operation with the maximum fuel supply available. This AC does not cover airplanes approved in the acrobatic category.

2. RELATED FAR SECTION. For convenience, the related sections of CAR, Part 3 reference, corresponding to the sections of FAR, Part 23, are shown in parentheses.

a. Section 23.959 (3.437)

b. Section 23.1011(b) (3.561)

3. BACKGROUND. Federal Aviation Regulation (FAR) 23.1011(b) (CAR 3.561) requires that "the usable oil tank capacity may not be less than the product of the endurance of the airplane under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling." This regulation requires a rational analysis to substantiate the fuel/oil supply ratio. It is no longer acceptable to determine the minimum oil capacity or maximum fuel capacity based on a fixed fuel/oil supply ratio. Some problems have occurred because some of the terms used in the regulations describing the condition for a rational fuel/oil analysis are not adequately defined. Therefore, the following definitions are applicable:

a. Usable Oil. The usable quantity of oil is the quantity of oil in the oil tank, or sump in the case of wet sump engines, in excess of the minimum quantity of oil required to keep the oil outlet covered under the most adverse of the following two operating conditions with the aircraft at a zero degree roll angle: (1) the noseup pitch angle required for the sea level best rate-of-climb speed with maximum continuous power, or (2) the nosedown pitch angle required for the 1.3 V_{SO} power-off landing configuration. For most wet sump engines, the usable oil quantity for various pitch angles is listed on the appropriate Federal Aviation Administration (FAA) Engine Type Certificate Data Sheet, and this quantity may be used in lieu of a determination of usable oil as described above. If the usable quantity is not listed, it may be determined by contacting the engine manufacturer or conducting a usable oil test with the critical operating conditions. In addition:

(1) For a conventional oil system (no transfer system provided), only the usable oil tank or sump capacity should be considered in the determination of the usable oil supply. The quantity of oil in the engine oil lines, in the oil radiator, and/or in a propeller feathering reserve, should not be included. If the airplane manufacturer elects to operate the engine with less than total oil tank capacity, the lower oil level should be used for rational fuel/oil analysis.

(2) When an oil reserve system is installed and its transfer pump is so located that it can pump some of the oil in the transfer lines into the main engine oil tanks, the quantity of oil in these lines which can be pumped by the transfer pump may be considered in the determination of the usable oil supply, in addition to the usable oil in the reserve tank.

b. Usable Fuel. The usable quantity of fuel is the total quantity of fuel in all fuel tanks less the fuel quantity necessary to establish compliance with the unusable fuel quantity per section 23.959 (3.437).

c. Oil Consumption Rate. The maximum oil consumption rates established for reciprocating or turbine engines are the values substantiated by the engine manufacturers. If no substantiated oil consumption rates are available, a maximum oil consumption of 0.012 pounds per b.hp. per hour may be used for reciprocating engines. No similar maximum oil consumption rate is available for turbine engines. A lower rate is acceptable when substantiated either by tests under conditions acceptable to the FAA or by statistical analysis of actual consumption rates based on service experience. Tests for a lower oil consumption rate should include:

(1) A positive demonstration that a lower oil consumption rate will not jeopardize the airworthiness of the engine.

(2) A statistical analysis should include observed data on the actual oil consumption from a number of engines of the same model. These data should be obtained from engines with high time or high oil consumption just prior to removal for overhaul.

d. System Circulation and Cooling. A suitable oil quantity margin for system circulation is necessary for either reciprocating engine or turbine engine installations. It should be determined that the oil system is capable of maintaining the engine within its operating limitations; i.e., oil temperature with the minimum oil quantity provided for circulation. It is not intended that cooling tests be performed with a low usable oil supply unless it is determined the cooling capabilities of the engine are not adequate to assure oil cooling between full oil supply and the point of near exhaustion of the usable oil.

e. Specific Fuel Consumption (SFC). The fuel consumption established for the engine based on available engine power expressed in pounds per brake horsepower per hour (lbs/b.hp/hr).

f. Specific Oil Consumption (SOC). The maximum oil consumption established for the engine determined during engine certification expressed in pounds per brake horsepower per hour (lbs/b.hp/hr).

4. ACCEPTABLE MEANS OF COMPLIANCE.

a. The minimum allowable usable oil capacity can be determined from the endurance and the maximum allowable oil consumption. For either wet or dry sump engines, the maximum allowable usable fuel/oil supply ratio is equal to the minimum obtainable fuel/oil consumption ratio. This is expressed mathematically as follows:

$$\frac{\text{Maximum Allowable Usable Fuel Capacity (LBS)}}{\text{Minimum Allowable Usable Oil Capacity (LBS)}} \leq \frac{\text{Minimum Obtainable SFC}}{\text{Maximum Allowable SOC}}$$

Therefore, for both wet and dry sump engines, fuel/oil supply ratios equal to or less than the minimum obtainable fuel/oil consumption ratios are considered acceptable.

b. Multiengine Installations. Unless an adequate oil reserve is provided, the endurance of a multiengine airplane employing a fuel crossfeed system or common fuel tank should be established on the basis that 50 percent of the specified total initial fuel capacity provided for a shutdown engine will be available to the other engine(s). The engine power levels to be considered for a multiengine airplane having a crossfeed system are those that will allow maximum published endurance with all engines operating and adjusted as necessary (including mixture setting) to complete safely the flight with one engine inoperative after 50 percent of the fuel supply is consumed.

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