whichever is greater, above the reference track and throughout the 10 dB-down time interval.

K7.9 The tiltrotor altitude must not vary during each flyover by more than ±30 ft (±9 m) from the reference altitude throughout the 10 dB-down time interval.

K7.10 During the approach procedure, the tiltrotor must establish a stabilized constant speed approach and fly between approach angles of 5.5 degrees and 6.5 degrees throughout the 10 dB-down time interval.

K7.11 During all test procedures, the tiltrotor weight (mass) must not be less than 90 percent and not more than 105 percent of the maximum certificated weight (mass). For each of the test procedures, complete at least one test at or above this maximum certificated weight (mass).

K7.12 A tiltrotor capable of carrying external loads or external equipment must be noise certificated without such loads or equipment fitted

K7.13 The value of V_{CON} used for noise certification must be included in the approved Flight Manual.

[78 FR 1139, Jan. 8, 2013]

PART 38—AIRPLANE FUEL EFFICIENCY CERTIFICATION

Subpart A—General

Sec.

Subpart B—Determining Fuel Efficiency for Subsonic Airplanes

AUTHORITY: 42 U.S.C. 4321 *et seq.*, 7572; 49 U.S.C. 106(g), 40113, 44701–44702, 44704; 49 CFR 1.83(c)

SOURCE: Docket No. FAA–2022–0241, Amdt. No. 21–107, 89 FR 12654, Feb. 16, 2024, unless otherwise noted.

Subpart A—General

§ 38.1 Applicability.

(a) Except as provided in paragraph (c) of this section, an airplane that is subject to the requirements of 40 CFR part 1030 may not exceed the fuel efficiency limits of this part when original type certification under this title is sought. This part applies to the following airplanes:

(1) A subsonic jet airplane that has—

(i) Either—

(A) A type-certificated maximum passenger seating capacity of 20 seats or more;

(B) A maximum takeoff mass (MTOM) greater than 5,700 kg; and

(C) An application for original type certification that is submitted on or after January 11, 2021;

(ii) Or—

(A) A type-certificated maximum passenger seating capacity of 19 seats or fewer;

(B) A MTOM greater than 60,000 kg; and

(C) An application for original type certification that is submitted on or after January 11, 2021.

(2) A subsonic jet airplane that has—

(i) A type-certificated maximum passenger seating capacity of 19 seats or fewer;

(ii) A MTOM greater than 5,700 kg, but not greater than 60,000 kg; and

(iii) An application for original type certification that is submitted on or after January 1, 2023.

(3) A propeller-driven airplane that has—

(i) A MTOM greater than 8,618 kg; and

(ii) An application for original type certification that is submitted on or after January 11, 2021.

(4) A subsonic jet airplane—

(i) That is a modified version of an airplane whose type design was not certificated under this part;

(ii) That has a MTOM greater than 5,700 kg;

(iii) For which an application by the type certificate holder for a type design change is submitted on or after January 1, 2023; and

(iv) For which the first certificate of airworthiness is issued with the modified type design.

(5) A propeller-driven airplane—

(i) That is a modified version of an airplane whose type design was not certificated under this part;

(ii) That has a MTOM greater than 8,618 kg;

(iii) For which an application by the type certificate holder for a type design change is submitted on or after January 1, 2023; and

(iv) For which the first certificate of airworthiness is issued with the modified type design.

(6) A subsonic jet airplane that has—

(i) A MTOM greater than 5,700 kg; and

(ii) Its first certificate of airworthiness issued on or after January 1, 2028.

(7) A propeller-driven airplane that has—

(i) A MTOM greater than 8,618 kg; and

(ii) Its first certificate of airworthiness issued on or after January 1, 2028.

(b) The requirements of this part apply to an airplane for which an application for a change in type design is submitted that includes a modification that meets the change criteria of §38.19. A modified airplane may not exceed the applicable fuel efficiency limit of this part when certification under this chapter is sought. A modified airplane is subject to the same fuel efficiency limit of §38.17 as the airplane was certificated to prior to modification.

(c) The requirements of this part do not apply to:

(1) Subsonic jet airplanes having a MTOM at or below 5,700 kg.

(2) Propeller-driven airplanes having a MTOM at or below 8,618 kg.

(3) Amphibious airplanes.

(4) Airplanes initially designed, or modified and used, for specialized operations. These airplane designs may include characteristics or configurations necessary to conduct specialized operations that the FAA and the United States Environmental Protection Agency (EPA) have determined may cause a significant increase in the fuel efficiency metric value.

(5) Airplanes designed with a reference geometric factor of zero.

(6) Airplanes designed for, or modified and used for, firefighting.

(7) Airplanes powered by reciprocating engines.

§ 38.3 Definitions.

For the purpose of showing compliance with this part, the following terms have the specified meanings:

Amphibious airplane means an airplane that is capable of takeoff and landing on both land and water. Such an airplane uses its hull or floats attached to the landing gear for takeoff and landing on water, and either extendable or fixed landing gear for takeoff and landing on land.

ICAO Annex 16, Volume III means Volume III of Annex 16 to the Convention on International Civil Aviation.

Maximum takeoff mass (MTOM) is the maximum certified takeoff mass, expressed in kilograms, for an airplane type design.

Performance model is an analytical tool (or a method) validated using corrected flight test data that can be used to determine the specific air range values for calculating the fuel efficiency metric value.

Reference geometric factor (RGF) is a non-dimensional number derived from a two-dimensional projection of the fuselage.

Specific air range (SAR) is the distance an airplane travels per unit of fuel consumed. Specific air range is expressed in kilometers per kilogram of fuel.

Subsonic means an airplane that has not been certificated under this title to exceed Mach 1 in normal operation.

Type certificated maximum passenger seating capacity means the maximum number of passenger seats that may be installed on an airplane as listed on its type certificate data sheet, regardless of the actual number of seats installed on an individual airplane.

§ 38.4 Compatibility with airworthiness requirements.

Unless otherwise approved by the FAA, an airplane used to demonstrate compliance with this part must meet all of the airworthiness requirements of this chapter required to establish the type certification basis of the airplane, for any condition under which compliance with this part is being demonstrated. Any procedure used to demonstrate compliance, and any flight crew information developed for demonstrating compliance with this part, must be consistent with the airworthiness requirements of this chapter that constitute the type certification basis of the airplane.

§ 38.5 Exemptions.

A petition for exemption from any requirement of this part must be submitted to the Administrator in accordance with and meet the requirements of part 11 of this chapter. The FAA will consult with the EPA on each exemption petition before taking action.

§ 38.7 Incorporation by reference.

The ICAO Doc 7488/3, *Manual of the ICAO Standard Atmosphere (extended to 80 kilometres (262 500 feet))* (1993), referenced in sections A38.2.1.3.1, A38.5.2.2.1.9, and A38.5.2.2.1.10 of appendix A to this part, is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. All approved material is available for inspection at the FAA and at the National Archives and Records Administration (NARA). Contact FAA at: Office of Rulemaking (ARM–1), 800 Independence Avenue SW, Washington, DC 20590 (telephone 202–267–9677). For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations.html* or email *fr.inspection@nara.gov*. The ICAO Doc 7488/3 is available for purchase from the ICAO Store at 999 Robert-Bourassa Boulevard Montréal (Quebec) Canada H3C 5H7, (*https://store.icao.int/*).

§ 38.9 Relationship to other regulations.

In accordance with certain provisions of the Clean Air Act Amendments of 1970 (CAA) (42 U.S.C. 7571 *et seq.*), the United States Environmental Protection Agency (EPA) is authorized to set standards for aircraft engine emissions in the United States, while the FAA is authorized to ensure compliance with those standards under a delegation from the Secretary of Transportation (49 CFR 1.83). The fuel efficiency limits in § 38.17 are intended to be the same as that promulgated by the EPA in 40 CFR part 1030. Accordingly, if the EPA changes any regulation in 40 CFR part 1030 that corresponds with a regulation in this part, a certification applicant may request a waiver of those provisions as they appear in this part in order to comply with part 1030. In addition, unless otherwise specified in this part, all terminology and abbreviations in this part that are defined in 40 CFR part 1030 have the meaning specified in part 1030.

Subpart B—Determining Fuel Efficiency for Subsonic Airplanes

§ 38.11 Fuel efficiency metric.

For each airplane subject to this part, or to determine whether a modification makes an airplane subject to this part under the change criteria of § 38.19, a fuel efficiency metric value must be calculated, using the following equation, rounded to three decimal places:

$$Fuel\ Efficiency\ \text{metric}\ value = \frac{\left(\frac{1}{SAR}\right)_{avg}}{RGF^{0.24}}$$

Where:

The SAR is determined in accordance with § 38.13, and the RGF is determined in accordance with § 38.15. The fuel efficiency metric value is expressed in units of kilograms of fuel consumed per kilometer.

§ 38.13 Specific air range.

(a) For each airplane subject to this part, the SAR of an airplane must be determined by either:

(1) Direct flight test measurements; or

(2) Using a performance model that is:

(i) Validated by actual SAR flight test data; and

(ii) Approved by the FAA before any SAR calculations are submitted.

(b) For the airplane model, establish a 1/SAR value at each of the following reference airplane masses:

(1) High gross mass: 92 percent MTOM.

(2) Low gross mass: (0.45 * MTOM) + (0.63 * (MTOM^0.924)).

(3) Mid gross mass: simple arithmetic average of high gross mass and low gross mass.

(c) To obtain $(1/SAR)_{avg}$ as required to determine the fuel efficiency metric value described in §38.11, calculate the average of the three 1/SAR values described in paragraph (b) of this section. Do not include auxiliary power units in any 1/SAR calculation.

(d) All determinations made under this section must be made in accordance with the procedures applicable to SAR as described in appendix A to this part.

§ 38.15 Reference geometric factor.

For each airplane subject to this part, determine the airplane's non-dimensional RGF for the fuselage size of each airplane model, calculated as follows:

(a) For an airplane with a single deck, determine the area of a surface (expressed in m^2) bounded by the maximum width of the fuselage outer mold line projected to a flat plane parallel with the main deck floor and the forward and aft pressure bulkheads except for the crew flight deck zone.

(b) For an airplane with more than one deck, determine the sum of the areas (expressed in m^2) as follows:

(1) The maximum width of the fuselage outer mold line, projected to a flat plane parallel with the main deck floor by the forward and aft pressure bulkheads except for any crew flight deck zone.

(2) The maximum width of the fuselage outer mold line at or above each other deck floor, projected to a flat plane parallel with the additional deck floor by the forward and aft pressure bulkheads except for any crew flight deck zone.

(c) Determine the non-dimensional RGF by dividing the area defined in paragraph (a) or (b) of this section by 1 m^2.

(d) All measurements and calculations used to determine the RGF of an airplane must be made in accordance with the procedures for determining RGF in section A38.3 of appendix A to this part.

§ 38.17 Fuel efficiency limits.

(a) The fuel efficiency limits in this section are expressed as maximum permitted fuel efficiency metric values, as calculated under §38.11.

(b) The fuel efficiency metric value of an airplane subject to this part may not exceed the following, rounded to three decimal places:

For airplanes described in...	With a MTOM...	The maximum permitted fuel efficiency metric value is...
(1) Section 38.1(a)(1) and (2)	5,700 < MTOM ≤ 60,000 kg	$10^{(-2.73780 + (0.681310 * \log_{10}(MTOM)) + (-0.0277861 * (\log_{10}(MTOM))\hat{}2))}$
(2) Section 38.1(a)(3)	8,618 < MTOM ≤ 60,000 kg	$10^{(-2.73780 + (0.681310 * \log_{10}(MTOM)) + (-0.0277861 * (\log_{10}(MTOM))\hat{}2))}$
(3) Section 38.1(a)(1) and (3)	60,000 < MTOM ≤ 70,395 kg	0.764
(4) Section 38.1(a)(1) and (3)	MTOM > 70,395 kg	$10^{(-1.412742 + (-0.020517 * \log_{10}(MTOM)) + (0.0593831 * (\log_{10}(MTOM))\hat{}2))}$
(5) Section 38.1(a)(4) and (6)	5,700 < MTOM ≤ 60,000 kg	$10^{(-2.57535 + (0.609766 * \log_{10}(MTOM)) + (-0.0191302 * (\log_{10}(MTOM))\hat{}2))}$
(6) Section 38.1(a)(5) and (7)	8,618 < MTOM ≤ 60,000 kg	$10^{(-2.57535 + (0.609766 * \log_{10}(MTOM)) + (-0.0191302 * (\log_{10}(MTOM))\hat{}2))}$
(7) Section 38.1(a)(4) through (7)	60,000 < MTOM ≤ 70,107 kg	0.797
(8) Section 38.1(a)(4) through (7)	MTOM > 70,107 kg	$10^{(-1.39353 + (-0.020517 * \log_{10}(MTOM)) + (0.0593831 * (\log_{10}(MTOM))\hat{}2))}$

§ 38.19 Change criteria.

(a) For an airplane that has been shown to comply with § 38.17, any subsequent version of that airplane must demonstrate compliance with § 38.17 if the subsequent version incorporates a modification that either increases:

(1) The maximum takeoff mass; or

(2) The fuel efficiency metric value by a percentage that is more than the following calculated thresholds.

(i) For airplanes with a MTOM greater than or equal to 5,700 kg, the threshold decreases linearly from 1.35 percent for an airplane with a MTOM of 5,700 kg to 0.75 percent for an airplane with a MTOM of 60,000 kg.

(ii) For airplanes with a MTOM greater than or equal to 60,000 kg, the threshold decreases linearly from 0.75 percent for an airplane with a MTOM of 60,000 kg to 0.70 percent for airplanes with a MTOM of 600,000 kg.

(iii) For airplanes with a MTOM greater than or equal to 600,000 kg, the threshold is 0.70 percent.

(b) For an airplane that has been shown to comply with § 38.17, and for any subsequent version of that airplane that incorporates modifications that do not increase the MTOM or the fuel efficiency metric value in excess of the levels shown in paragraph (a) of this section, the fuel efficiency metric value of the modified airplane may be reported to be the same as the value prior to modification.

(c) For an airplane that meets the criteria of § 38.1(a)(4) or (5), on or after January 1, 2023, and before January 1, 2028, the airplane must demonstrate compliance with § 38.17 if it incorporates any modification that increases the fuel efficiency metric value of the airplane prior to modification by more than 1.5 percent.

§ 38.21 Approval before compliance testing.

All procedures, weights, configurations, and other information or data that are used to establish a fuel efficiency level required by this part or in any appendix to this part (including any equivalent procedures) must be approved by the FAA prior to use in certification tests intended to demonstrate compliance with this part.

§ 38.23 Manual information and limitations.

(a) *Information in manuals.* The following information must be included in any FAA-approved section of a FAA-approved Airplane Flight Manual or combination of approved manual material:

(1) Fuel efficiency level established as required by this part; and

(2) Maximum takeoff mass at which fuel efficiency level was established.

(b) *Limitation.* If the fuel efficiency of an airplane is established at a weight (mass) that is less than the maximum certificated takeoff weight (mass) used to establish the airworthiness of the airplane under this chapter, the lower weight (mass) becomes an operating limitation of the airplane and that limitation must be included in the limitations section of any FAA-approved manual.

APPENDIX A TO PART 38—DETERMINATION OF AIRPLANE FUEL EFFICIENCY METRIC VALUE

A38.1 INTRODUCTION

A38.1.1 This appendix describes the processes and procedures for determining the fuel efficiency metric value for an airplane subject to this part.

A38.1.2 Methods for Determining Specific Air Range (SAR)

A38.1.2.1 SAR may be determined by either—

A38.1.2.1.1 Direct flight test measurement at the SAR test points, including any corrections of test data to reference specifications; or

A38.1.2.1.2 Use of a performance model.

A38.1.2.2 For any determination made under section A38.1.2.1.1 of this appendix, the SAR flight test data must have been acquired in accordance with the procedures defined in this appendix and approved by the FAA.

A38.1.2.3 For any determination made under section A38.1.2.1.2 of this appendix, the performance model must:

A38.1.2.3.1 Be verified that the model produces the values that are the same as FAA-approved SAR flight test data;

A38.1.2.3.2 Include a detailed description of any test and analysis method and any algorithm used so as to allow evaluation by the FAA; and

A38.1.2.3.3 Be approved by the FAA before use.

A38.2 REFERENCE SPECIFICATIONS FOR SAR FLIGHT TESTS

A38.2.1 The following reference specifications must be established when determining SAR values for an airplane. No reference specification may exceed any airworthiness limit approved for the airplane under this chapter. See section A38.5 of this appendix for further information.

A38.2.1.1 Reference specifications at the airplane level:

A38.2.1.1.1 Airplane at the reference masses listed in § 38.13(b);

A38.2.1.1.2 A combination of altitude and airspeed selected by the applicant;

A38.2.1.1.3 Airplane in steady, unaccelerated, straight and level flight;

A38.2.1.1.4 Airplane in longitudinal and lateral trim;

A38.2.1.1.5 Airplane gravitational acceleration when travelling in the direction of true North in still air at the reference altitude and a geodetic latitude of 45.5 degrees, based on g_0 (g_0 is 9.80665 m/s^2, which is the standard acceleration due to gravity at sea level and a geodetic latitude of 45.5 degrees);

A38.2.1.1.6 A reference airplane center of gravity (CG) position selected by the applicant to be representative of the mid-CG point relevant to design cruise performance at each of the three reference airplane masses; and

A38.2.1.1.7 A wing structural loading condition defined by the applicant that is representative of operations conducted in accordance with the airplane's maximum payload capability.

A38.2.1.2 Reference specifications at the engine level:

A38.2.1.2.1 Electrical and mechanical power extraction and bleed flow relevant to design cruise performance, as selected by the applicant;

Note 1 to A38.2.1.2.1—Power extraction and bleed flow attributable to the use of optional equipment such as passenger entertainment systems need not be included.

A38.2.1.2.2 Engine stability bleeds operating according to the manufacturer's normal schedule for the engine; and

A38.2.1.2.3 Engines with at least 15 cycles or 50 engine flight hours.

A38.2.1.3 Other reference specifications:

A38.2.1.3.1 ICAO standard day atmosphere (Doc 7488/3, 3rd edition 1993, titled ''Manual of the ICAO Standard Atmosphere (extended to 80 kilometres (262 500 feet))'') (incorporated by reference, see § 38.7); and

A38.2.1.3.2 Fuel lower heating value equal to 43.217 MJ/kg (18, – 580 BTU/lb).

A38.2.2 If any test conditions are not the same as the reference specifications of this appendix, the test conditions must be corrected to the reference specifications as described in section A38.5 of this appendix.

A38.3 Determination of Reference Geometric Factor (RGF)

A38.3.1 This section provides additional information for determining the RGF, as required by § 38.15.

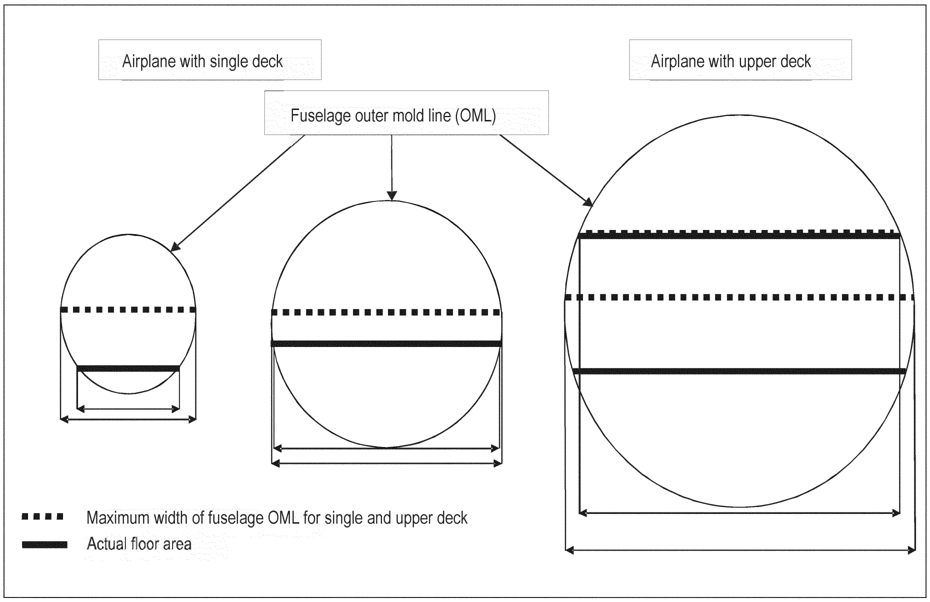
A38.3.2 The area that defines RGF includes all pressurized space on a single or multiple decks including aisles, assist spaces, passageways, stairwells and areas that can accommodate cargo or auxiliary fuel containers. It does not include permanent integrated fuel tanks within the cabin, or any unpressurized fairings, crew rest or work areas, or cargo areas that are not on the main or upper deck (*e.g.*, 'loft' or under floor areas). RGF does not include the flight deck crew zone.

A38.3.3 The aft boundary to be used for calculating RGF is the aft pressure bulkhead. The forward boundary is the forward pressure bulkhead, not including the flight deck crew zone.

A38.3.4 Areas that are accessible to both crew and passengers are not considered part of the flight deck crew zone. For an airplane that has a flight deck door, the aft boundary of the flight deck crew zone is the plane of the flight deck door. For an airplane that has no flight deck door or has optional interior configurations that include different locations of the flight deck door, the aft boundary is determined by the configuration that provides the smallest available flight deck crew zone. For airplanes certificated for single-pilot operation, the flight deck crew zone is measured as half the width of the flight deck.

A38.3.5 Figures A38–1 and A38–2 of this appendix provide a notional view of the RGF boundary conditions.

Figure A38-1 to Appendix A to Part 38—Cross-sectional view



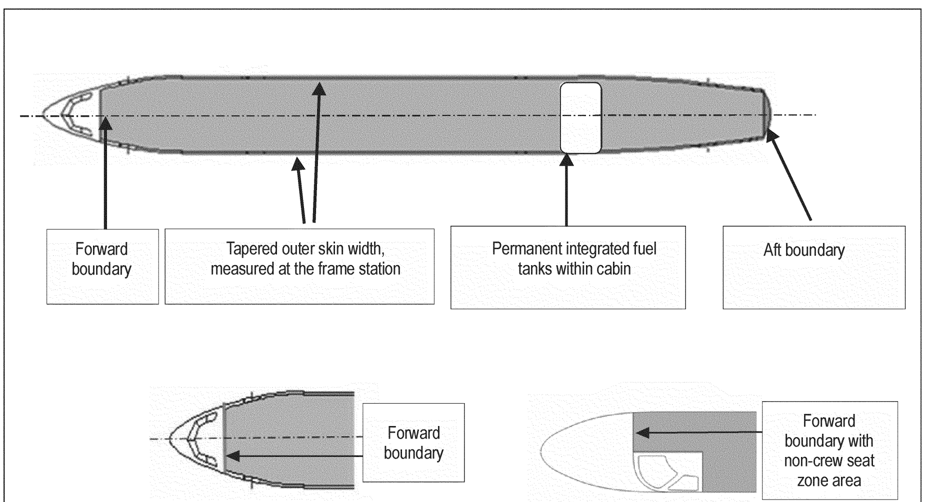


Figure A38-2 to Appendix A to Part 38. Longitudinal view

A38.4 CERTIFICATION TEST SPECIFICATIONS

A38.4.1 Certification Test Specifications. This section prescribes the specifications under which an applicant must conduct SAR certification tests.

A38.4.2 Flight Test Procedures

A38.4.2.1 Before a Test Flight. The test flight procedures must include the following elements and must be approved by the FAA before any test flight is conducted:

A38.4.2.1.1 *Airplane conformity*. The test airplane must conform to the critical configuration of the type design for which certification is sought.

A38.4.2.1.2 *Airplane weight*. The test airplane must be weighed. Any change in mass after the weighing and prior to the test flight must be accounted for.

A38.4.2.1.3 *Fuel*. The fuel used for each flight test must meet the specification defined in either ASTM D1655–15 (titled ''Standard Specification for Aviation Turbine Fuels''), UK MoD Defense Standard 91–91, Issue 7, Amendment 3 (titled ''Turbine Fuel, Kerosene Type, Jet A–1, NATO Code F–35; Join Services Designation; AVTUR''), or as approved by FAA.

A38.4.2.1.4 *Fuel lower heating value*. The lower heating value of the fuel used on a test flight must be determined from a sample of fuel used for the test flight. The lower heating value of the fuel sample must be used to correct measured data to reference specifications. The determination of lower heating value and the correction to reference specifications are subject to approval by the FAA.

A38.4.2.1.4.1 The fuel lower heating value may be determined in accordance with ASTM D4809–13 ''Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)'', or as approved by the FAA.

A38.4.2.1.4.2 The fuel sample may be representative of the fuel used for each flight test and should not have errors or variations due to fuel being uplifted from multiple sources, fuel tank selection, or fuel layering in a tank.

A38.4.2.1.5 *Fuel specific gravity and viscosity*. When volumetric fuel flow meters are used, the specific gravity and viscosity of the fuel used on a test flight must be determined from a sample of fuel used for the test flight.

A38.4.2.1.5.1 The fuel specific gravity may be determined in accordance with ASTM D4052–11 ''Standard Test Method for Density, Relative Density, and API Gravity of Liquids'', or as approved by FAA.

A38.4.2.1.5.2 The fuel kinematic viscosity may be determined in accordance with ASTM D445–15 (titled ''Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)''), or as approved by FAA.

A38.4.2.2 Flight Test Procedures and Test Condition Stability. An applicant must conduct each flight test in accordance with the flight test procedures and the stability conditions as follows:

A38.4.2.2.1 Flight Test Procedure. The following procedures must be maintained during each flight used to gather data for determining SAR values:

A38.4.2.2.1.1 To the extent that is practicable, the airplane is flown at constant pressure altitude and constant heading along isobars;

A38.4.2.2.1.2 The engine thrust/power setting is stable for unaccelerated level flight;

A38.4.2.2.1.3 The airplane is flown as close as practicable to the reference specifications to minimize the magnitude of any correction;

A38.4.2.2.1.4 Changes in trim or engine power/thrust settings, engine stability and handling bleeds, or electrical and mechanical power extraction (including bleed flow) are avoided or minimized as practicable; and

A38.4.2.2.1.5 There is no unnecessary movement of on-board personnel.

A38.4.2.2.2 Test Condition Stability. To obtain a valid SAR measurement, the following conditions must be maintained during each test flight, including the indicated tolerances for at least 1 minute while SAR data is acquired:

A38.4.2.2.2.1 Mach number within ±0.005;

A38.4.2.2.2.2 Ambient temperature within ±1 °C;

A38.4.2.2.2.3 Heading within ±3 degrees;

A38.4.2.2.2.4 Track within ±3 degrees;

A38.4.2.2.2.5 Drift angle less than 3 degrees;

A38.4.2.2.2.6 Ground speed within ±3.7 km/h (±2 kt);

A38.4.2.2.2.7 Difference in ground speed at the beginning of the SAR measurement from the ground speed at the end of the SAR measurement within ±2.8 km/h/min (±1.5 kt/min); and

A38.4.2.2.2.8 Pressure altitude within ±23 m (±75 ft).

A38.4.2.2.3 Alternatives to the stable test condition criteria of section A38.4.2.2.2 of this appendix may be used provided that stability is sufficiently demonstrated to the FAA.

A38.4.2.2.4 Data obtained at test points that do not meet the stability criteria of section A38.4.2.2.2 may be acceptable as an equivalent procedure, subject to FAA approval.

A38.4.2.2.5 SAR measurements at the test points must be separated by either:

A38.4.2.2.5.1 Two minutes; or

A38.4.2.2.5.2 An exceedance of one or more of the stability criteria limits described in A38.4.2.2.2.

A38.4.2.3 Verification of Airplane Mass at Test Conditions

A38.4.2.3.1 The procedure for determining the mass of the airplane at each test condition must be approved by the FAA.

A38.4.2.3.2 The mass of the airplane during a flight test is determined by subtracting the fuel used from the mass of the airplane at the start of the test flight. The accuracy of the determination of the fuel used must be verified by:

A38.4.2.3.2.1 Weighing the test airplane on calibrated scales before and after the SAR test flight;

A38.4.2.3.2.2 Weighing the test airplane before and after another test flight that included a cruise segment, provided that flight occurs within one week or 50 flight hours (at the option of the applicant) of the SAR test flight and using the same, unaltered fuel flow meters; or

A38.4.2.3.2.3 Other methods as approved by the FAA.

A38.5 MEASUREMENT OF SPECIFIC AIR RANGE

A38.5.1 Measurement System

A38.5.1.1 The following parameters must be recorded at a minimum sampling rate of 1 Hertz (cycle per second):

A38.5.1.1.1 Airspeed;

A38.5.1.1.2 Ground speed;

A38.5.1.1.3 True airspeed;

A38.5.1.1.4 Fuel flow;

A38.5.1.1.5 Engine power setting;

A38.5.1.1.6 Pressure altitude;

A38.5.1.1.7 Temperature;

A38.5.1.1.8 Heading;

A38.5.1.1.9 Track; and

A38.5.1.1.10 Fuel used (for the determination of gross mass and CG position).

A38.5.1.2 The following parameters must be recorded:

A38.5.1.2.1 Latitude;

A38.5.1.2.2 Engine bleed positions and power off-takes; and

A38.5.1.2.3 Power extraction (electrical and mechanical load).

A38.5.1.3 The value of each parameter used for the determination of SAR (except for ground speed) is the simple arithmetic average of the measured values for that parameter obtained throughout the stable test condition described in section A38.4.2.2.2 of this appendix.

A38.5.1.4 For ground speed, the value is the rate of change of ground speed during the SAR test measurement. The rate of change of ground speed during the SAR measurement must be used to evaluate and correct any acceleration or deceleration that might occur during the SAR measurement.

A38.5.1.5 Each measurement device must have sufficient resolution to determine that the stability of a parameter defined in section A38.4.2.2.2 of this appendix is maintained during SAR measurement.

A38.5.1.6 The SAR measurement system consists of the combined instruments and devices, and any associated procedures, used to acquire the following parameters necessary to determine SAR:

A38.5.1.6.1 Fuel flow;

A38.5.1.6.2 Mach number;

A38.5.1.6.3 Altitude;

A38.5.1.6.4 Airplane mass;

A38.5.1.6.5 Ground speed;

A38.5.1.6.6 Outside air temperature;

A38.5.1.6.7 Fuel lower heating value; and

A38.5.1.6.8 CG.

A38.5.1.7 The SAR value is affected by the accuracy of each element that comprises the SAR measurement system. The cumulative error associated with the SAR measurement system is defined as the root sum of squares (RSS) of the individual accuracies.

A38.5.1.8 If the absolute value of the cumulative error of the overall SAR measurement system is greater than 1.5 percent, a penalty equal to the amount that the RSS value exceeds 1.5 percent must be applied to the SAR value that has been corrected to reference specifications (see section A38.5.2 of this appendix). If the absolute value of the cumulative error of the overall SAR measurement system is less than or equal to 1.5 percent, no penalty will be applied.

A38.5.2 Calculation of Specific Air Range from Measured Data

A38.5.2.1 Calculating SAR. SAR must be calculated using the following equation:

$$SAR = TAS/W_f$$

Where:

TAS is the true airspeed and W_f is total airplane fuel flow.

A38.5.2.2 Correcting Measured SAR Values to Reference Specifications

A38.5.2.2.1 The measured SAR values must be corrected to the reference specifications listed in A38.2 of this appendix. Unless otherwise approved by the FAA, corrections to reference specifications must be applied for each of the following measured parameters:

A38.5.2.2.1.1 *Acceleration/deceleration (energy).* Drag determination is based on an assumption of steady, unaccelerated flight. Acceleration or deceleration occurring during a test condition affects the assessed drag level. The reference specification is in section A38.2.1.1.3 of this appendix.

A38.5.2.2.1.2 *Aeroelastics.* Wing aeroelasticity may cause a variation in drag as a function of airplane wing mass distribution. Airplane wing mass distribution will be affected by the fuel load distribution in the wings and the presence of any external stores. The reference specification is in section A38.2.1.1.7 of this appendix.

A38.5.2.2.1.3 *Altitude.* The altitude at which the airplane is flown affects the fuel flow. The reference specification is in section A38.2.1.1.2 of this appendix.

A38.5.2.2.1.4 *Apparent gravity.* Acceleration, caused by the local effect of gravity, and inertia, affect the test weight of the airplane. The apparent gravity at the test conditions varies with latitude, altitude, ground speed, and direction of motion relative to the Earth's axis. The reference gravitational acceleration is the gravitational acceleration for the airplane travelling in the direction of true North in still air at the reference altitude, a geodetic latitude of 45.5 degrees, and based on g_0 (see section A38.2.1.1.5 of this appendix).

A38.5.2.2.1.5 *CG position.* The position of the airplane CG affects the drag due to longitudinal trim. The reference specification is in section A38.2.1.1.6 of this appendix.

A38.5.2.2.1.6 *Electrical and mechanical power extraction and bleed flow*. Electrical and mechanical power extraction, and bleed flow affect the fuel flow. The reference specifications are in sections A38.2.1.2.1 and A38.2.1.2.2 of this appendix.

A38.5.2.2.1.7 *Engine deterioration level*. The requirement in section A38.2.1.2.3 of this appendix addresses the minimum deterioration of an engine that is used to determine SAR. Since engine deterioration is rapid when an engine is new, when used for SAR determination:

A38.5.2.2.1.7.1 Subject to FAA approval, an engine having less deterioration than the reference deterioration level in section A38.2.1.2.3 of this appendix must correct the fuel flow to the reference deterioration using an approved method.

A38.5.2.2.1.7.2 An engine with greater deterioration than the reference deterioration level in section A38.2.1.2.3 of this appendix may be used, and no correction is permitted.

A38.5.2.2.1.8 *Fuel lower heating value*. The fuel lower heating value defines the energy content of the fuel. The lower heating value directly affects the fuel flow at a given test condition. The reference specification is in section A38.2.1.3.2 of this appendix.

A38.5.2.2.1.9 *Reynolds number*. The Reynolds number affects airplane drag. For a given test condition the Reynolds number is a function of the density and viscosity of air at the test altitude and temperature. The reference Reynolds number is derived from the density and viscosity of air from the ICAO standard atmosphere at the reference altitude (see sections A38.2.1.1.2 and A38.2.1.3.1 of this appendix, incorporated by reference see §38.7).

A38.5.2.2.1.10 *Temperature*. The ambient temperature affects the fuel flow. The reference temperature is the standard day temperature from the ICAO standard atmosphere at the reference altitude (see section A38.2.1.3.1 of this appendix, incorporated by reference see §38.7).

Note 2 to A38.5.2.2.1.10—Post-flight data analysis includes the correction of measured data for data acquisition hardware response characteristics (*e.g.*, system latency, lag, offset, buffering, etc.).

A38.5.2.2.2 Correction methods are subject to the approval of the FAA.

A38.5.2.3 Using Specific Air Range to Determine the Fuel Efficiency Metric Value

A38.5.2.3.1 Calculate the SAR values for each of the three reference masses as described in §38.13, including any corrections to reference specifications, as required under this part. The final SAR value for each reference mass is the simple arithmetic average of all valid test points at the appropriate gross mass, or derived from a validated performance model. No data acquired from a valid test point may be omitted unless approved by the FAA.

A38.5.2.3.2 When an FAA-approved performance model is used, extrapolations to aircraft masses other than those tested may be approved when such extrapolations are consistent with accepted airworthiness practices. Since a performance model must be based on data covering an adequate range of lift coefficient, Mach number, and thrust specific fuel consumption, no extrapolation of those parameters is permitted.

A38.5.3 Validity of Results

A38.5.3.1 A 90 percent confidence interval must be calculated for each of the SAR values at the three reference masses.

A38.5.3.2 If the 90 percent confidence interval of the SAR value at any of the three reference airplane masses—

A38.5.3.2.1 Is less than or equal to ±1.5 percent, the SAR value may be used.

A38.5.3.2.2 Exceeds ±1.5 percent, a penalty equal to the amount that the 90 percent confidence interval exceeds ±1.5 percent must be applied to the SAR value, as approved by the FAA.

A38.5.3.3 If clustered data is acquired separately for each of the three gross mass reference points, the minimum sample size acceptable for each of the three gross mass SAR values is six.

A38.5.3.4 If SAR data is collected over a range of masses, the minimum sample size is 12 and the 90 percent confidence interval is calculated for the mean regression line through the data.

A38.6 SUBMISSION OF CERTIFICATION DATA TO THE FAA

The following information must be provided to the FAA in the certification reports for each airplane type and model for which fuel efficiency certification under this part is sought.

A38.6.1 General Information

A38.6.1.1 Designation of the airplane type and model:

A38.6.1.2 Configuration of the airplane, including CG range, number and type designation of engines and, if fitted, propellers, and any modifications or non-standard equipment expected to affect the fuel efficiency characteristics;

A38.6.1.3 MTOM used for certification under this part;

A38.6.1.4 All dimensions needed for calculation of RGF; and

A38.6.1.5 Serial number of each airplane used to establish fuel efficiency certification in accordance with this part.

A38.6.2 Reference Specifications. The reference specifications used to determine any SAR value as described in section A38.2 of this appendix.

A38.6.3 Test Data. The following measured test data, including any corrections for instrumentation characteristics, must be provided for each of the test measurement points used to calculate the SAR values for each of the reference masses defined in § 38.13(b):

A38.6.3.1 Airspeed, ground speed and true airspeed;

A38.6.3.2 Fuel flow;

A38.6.3.3 Pressure altitude;

A38.6.3.4 Static air temperature;

A38.6.3.5 Airplane gross mass and CG for each test point;

A38.6.3.6 Levels of electrical and mechanical power extraction and bleed flow;

A38.6.3.7 Engine performance;

A38.6.3.7.1 For jet airplanes, engine power setting; or

A38.6.3.7.2 For propeller-driven airplanes, shaft horsepower or engine torque, and propeller rotational speed;

A38.6.3.8 Fuel lower heating value;

A38.6.3.9 When volumetric fuel flow meters are used, fuel specific gravity and kinematic viscosity (see section A38.4.2.1.5. of this appendix);

A38.6.3.10 The cumulative error (RSS) of the overall measurement system (see section A38.5.1.7 of this appendix);

A38.6.3.11 Heading, track and latitude;

A38.6.3.12 Stability criteria (see section A38.4.2.2.2 of this appendix); and

A38.6.3.13 Description of the instruments and devices used to acquire the data needed for the determination of SAR, and the individual accuracies of the equipment relevant to their effect on SAR (see sections A38.5.1.6 and A38.5.1.7 of this appendix).

A38.6.4 Calculations and Corrections of SAR Test Data to Reference Specifications. The measured SAR test data, all corrections of the measured data to the reference specifications, and the SAR values calculated from the corrected data must be provided for each of the test measurement points.

A38.6.5 Calculated Values. The following values must be provided for each airplane used to establish fuel efficiency certification in accordance with this part:

A38.6.5.1 SAR (km/kg) for each reference airplane mass and the associated 90 percent confidence interval;

A38.6.5.2 Average of the 1/SAR values;

A38.6.5.3 RGF; and

A38.6.5.4 Fuel efficiency metric value.

PART 39—AIRWORTHINESS DIRECTIVES

Sec.

AUTHORITY: 49 U.S.C. 106(g), 40113, 44701.

SOURCE: Docket No. FAA–2000–8460, 67 FR 48003, July 22, 2002, unless otherwise noted.

§ 39.1 Purpose of this regulation.

The regulations in this part provide a legal framework for FAA's system of Airworthiness Directives.

§ 39.3 Definition of airworthiness directives.

FAA's airworthiness directives are legally enforceable rules that apply to the following products: aircraft, aircraft engines, propellers, and appliances.

§ 39.5 When does FAA issue airworthiness directives?

FAA issues an airworthiness directive addressing a product when we find that:

(a) An unsafe condition exists in the product; and

(b) The condition is likely to exist or develop in other products of the same type design.

§ 39.7 What is the legal effect of failing to comply with an airworthiness directive?

Anyone who operates a product that does not meet the requirements of an applicable airworthiness directive is in violation of this section.