Society of Automotive Engineers, Inc.
29 West 39th Street
New York City

AERONAUTICAL STANDARD

AS 407A

FUEL FLOW METERS

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1. PURPOSE: To specify minimum requirements for Fuel Flow Meters for use in aircraft, the operation of which may subject the instruments to the environmental conditions specified in Section 3.3.

2. SCOPE: This aeronautical standard covers two basic types of instruments, or combinations thereof, intended for use in indicating fuel consumption of aircraft engines.

TYPE I - Measure rate of flow of fuel used.

TYPE II - Totalize amount of fuel consumed.

3. GENERAL REQUIREMENTS:

3.1 Materials and Workmanship:

3.1.1 Materials: Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in aircraft instruments.

3.1.2 Workmanship: Workmanship shall be consistent with high-grade aircraft instrument manufacturing practice.

3.2 Identification: The following information shall be legibly and permanently marked on the instrument or attached thereto:

a. Name of component (Fuel Flow Meters)
b. SAE Aeronautical Standard - AS 407
c. Manufacturer's part number
d. Manufacturer's serial number or date of manufacture
e. Manufacturer's name and/or trademark
f. Range (Transmitters only)
g. Rating (electrical - if required)

3.3 Environmental Conditions: The following conditions have been established as design requirements only. Tests shall be conducted as specified in Sections 5, 6 and 7.

3.3.1 Temperature: When installed in accordance with the instrument manufacturer's instructions, the instrument shall function over the range of ambient temperatures indicated in Column "A" below, and shall not be adversely affected by exposure to the range of temperatures shown in Column "B":

Component Location	"A"	"B"
Heated Areas (Temperature Controlled)	-30 to 50C	-65 to 70C
Unheated Areas (Temperature Uncontrolled)	-55 to 70C	-65 to 70C
Power Plant Compartment	-55 to 100C	-65 to 100C
Power Plant Accessory Compartment	-55 to 100C	-65 to 100C

3.3.2 Humidity: The instrument shall function and shall not be adversely affected when exposed to any relative humidity in the range of from 0 to 95% at a temperature of approximately 32C.

3.3.3 Altitude: The instrument shall function and shall not be adversely affected when subjected to a pressure and temperature range equivalent to -1000 feet to +40,000 feet standard altitude, except as limited by the application of paragraph 3.3.1.

3.3.4 Vibration: When installed in accordance with the instrument manufacturer's instructions, the units shall function and shall not be adversely affected when subjected to vibrations of the following characteristics:

Type of Component Mounting	Cycles Per Minute	Maximum Double Amplitude	Maximum Acceleration
Air Frame Structure Mounted	300-30,000	.036"	10 g.
Shock Mounted Panel	300- 3,000	.020"	1.5 g.
Power Plant Mounted	300-30,000	.060"	20 g.

3.4 Radio Interference: The instrument shall not be the source of objectionable interference, under operating conditions at any frequencies used on aircraft either by radiation or feedback, in radio sets installed in the same aircraft as the instrument.

4. DETAIL REQUIREMENTS:

4.1 Indicating Method: One of the following methods of indication shall be employed.

4.1.1 Type I Instruments: Rotating pointer with fixed graduated dial. Clockwise pointer motion shall indicate increasing rate of flow.

4.1.2 Type II Instruments: A counter shall be employed to indicate either the fuel consumed or quantity remaining.

4.2 Dial Markings:

4.2.1 Type I

4.2.1.1 Finish: Unless otherwise specified, luminescent (self-activating) material shall be applied to all major graduations, numerals and pointer.

4.2.1.2 Graduations: Major graduations shall be used at intervals not to exceed 10% of full scale value.

4.2.1.3 Numerals: Sufficient numerals shall be marked to positively and quickly identify all graduations. Numerals shall distinctly indicate the graduations to which each applies.

4.2.2 Type II

4.2.2.1 Counters: Totalizer counters shall be provided to indicate increments no larger than every 10 pounds or 2 gallon increments.

4.2.3 Visibility: The pointer and all dial markings or counters shall be visible from any point within the frustum of a cone whose side makes an angle of not less than 30 degrees with the perpendicular to the dial, and whose small diameter is the aperture of the instrument case. The distance between the dial and the cover glass shall be a practical minimum and shall not exceed 0.25 inch.

4.3 Flow Direction: The direction of flow through the transmitter shall be permanently and legibly marked thereon.

4.4 Fuel Characteristics: Unless otherwise specified, the fuel flowmeter shall be designed to meet the performance requirements included herein when used with 100 octane aviation gasoline with a specific gravity of 0.715 ±.003 at a temperature of 15 to 25C.

4.5 Power Variations: All units shall properly function with ±15% variation in DC voltage and/or ±10% variation in AC voltage and frequency provided the AC voltage and frequency vary in the same direction.

4.6 Safety Provisions: Each transmitter shall provide adequate flow in case of malfunctioning in flight either by means of an automatic by pass or a non-flow restricting mechanism.

5. TEST CONDITIONS:

5.1 Atmospheric Conditions: Unless otherwise specified, all tests required by this aeronautical standard shall be conducted at an atmospheric pressure of approximately 29.92 inches of mercury, and at an ambient temperature of approximately 25C. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowances shall be made for the variations from the specified conditions.

5.2 Vibration: (to minimize friction) Unless otherwise specified, all tests for performance may be conducted with the instrument subjected to a vibration of 0.002 to 0.005 inch double amplitude at a frequency of 1500 to 2000 cycles per minute. The term double amplitude as used herein indicates the total displacement from positive maximum to negative maximum.

5.3 Vibration Equipment: Vibration equipment shall be used which will provide frequencies and amplitudes consistent with the requirements of paragraph 3.3.4 with the following characteristics:

5.3.1 Linear Motion - Vibration: Vibration equipment for airframe structure mounted or power plant mounted instruments or equipment shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the test specimen.

5.3.2 Circular Motion - Vibration: Vibration equipment for shock mounted panel instruments shall be such that a point on the instrument case will describe, in a plane inclined 45° to the horizontal plane, a circle, the diameter of which is equal to the double amplitude specified.

5.4 Power Conditions: Unless otherwise specified, all tests shall be conducted at the power rating recommended by the manufacturer.

5.5 Position: Unless otherwise specified, all tests shall be conducted with the instrument mounted in its normal operating position.

6. INDIVIDUAL PERFORMANCE REQUIREMENTS: All instruments or components of such shall be subjected to whatever tests the manufacturer deems necessary to demonstrate specific compliance with this aeronautical standard including the following requirements where applicable.

6.1 Scale Errors: The instrument scale error shall be determined at all major graduations. This test shall be conducted by subjecting the instrument first with rates of flow increasing, then with rates of flow decreasing. With the rate of flow increasing, the rate shall be brought up to, but shall not exceed, the rate specified to give the desired reading, and with the rate of flow decreasing, the rate shall be brought down to, but shall not fall below, the rate specified to obtain the desired reading. The error at each major graduation shall not exceed 3% of full scale reading. The difference between the reading on increasing rate of flow and the reading on decreasing rate of flow at each major graduation shall not exceed 1% of full scale reading.

6.2 Dielectric: Ungrounded instruments or grounded instruments prior to connection of internal ground wire, shall be tested by either the method of paragraph 6.2.1 or paragraph 6.2.2.

6.2.1 Insulation Resistance: The insulation resistance measured at 500 volts DC (200 volts DC for hermetically sealed, helium filled instruments) between all electrical circuits connected together and the metallic case shall not be less than 20 megohms.

6.2.2 Dielectric Strength: The insulation shall withstand without evidence of damage the application of a sinusoidal voltage at a commercial frequency between all electrical circuits connected together and the metallic case, for a period of 5 seconds. The RMS value of the sinusoidal voltage applied shall be either five times the maximum instrument operating voltage, or 500 volts, whichever is the greater (200 volts for hermetically sealed, helium filled instruments).

6.3 Pressure Drop: The pressure drop within the transmitter when measured with a differential pressure gage connected across the inlet and outlet ports or by any other suitable method, shall not exceed the values tabulated below:

Range Lbs./Hr.	Flow Rate Lbs/Hr.	Pressure Drop (Lbs/Sq.In.) Normal	Blocked Movable Element
100-1000	1000	1-1/4	2-3/4
	2000	2-1/4	3-1/4
100-1500	1500	1-1/2	3
	3000	2-1/2	3-1/2
100-2000	2000	2-1/4	3-1/4
	3000	2-3/4	3-1/2
300-3000	3000	2-3/4	3-1/2
	4500	3	3-3/4

6.4 Leak Test: The Transmitter shall be tested for leaks immediately after the scale error test while the flow chamber is still moist from gasoline, but with all free gasoline drained out. The flow chamber shall be subjected to an air pressure of 40 psi and sealed off. During a five minute period, there shall be no change in pressure indicated on a test gage capable of accurately distinguishing minimum changes of 0.125 psi.

6.5 Position Error: The difference in indicator reading when the indicator is rotated from the normal position to any other position shall not exceed 2-1/2% of full scale reading.

7. QUALIFICATION TESTS:

As many instruments as deemed necessary to demonstrate that all instruments will comply with the requirements of this section shall be tested in accordance with the manufacturer's recommendations.

7.1 Low and High Temperature: The instrument shall be subjected to the applicable low and high temperatures not exceeding 70C as specified in paragraph 3.3.1, column A for 3 hours. The scale errors determined for the indicator with gasoline also at the same temperature shall not exceed 6% of full scale value. Following this test and while still at the same temperature, the leak test of paragraph 6.4 shall be repeated.

7.2 Extreme Temperature Exposure: The instrument shall, after alternate exposures to the applicable low and high temperature specified in paragraph 3.3.1, column B for periods of 24 hours each and a delay of 3 hours at room temperature following completion of the exposure, meet the requirements of paragraph 6.1. There shall be no evidence of damage as a result of exposure to the extreme temperatures specified herein.

7.3 Magnetic Effect: The magnetic effect of the indicator shall be determined in terms of the deflection of a free magnet, approximately 1 1/2 inches long, in a magnetic field with a horizontal intensity of 0.18, plus or minus 0.01 gauss, when the indicator is held in various positions on an east-west line with its nearest part five inches from the center of the magnet. (An aircraft compass with the compensating magnets removed therefrom may be used as the free magnet for this test). The maximum deflection of the magnet shall not exceed one degree for any pointer deflection.

7.4 Humidity: The instrument shall be mounted in its normal operating position in a chamber maintained at a temperature of 70 ±2C and a relative humidity of 95 ±5% for a period of 6 hours. After this period, the heat shall be shut off and the instrument shall be allowed to cool for a period of 18 hours in this atmosphere in which the humidity rises to 100% as the temperature decreases to not more than 38C. This complete cycle shall be conducted:

1. 15 times for instruments located in uncontrolled temperature areas.
2. 1 time for instruments located in controlled temperature areas.

Immediately after cycling the instruments shall be subjected to the scale error at room temperature test of 6.1. The change in reading between this test and the original scale error at room temperature test shall not exceed 2% of full scale reading.

7.5 Vibration: The instrument, while operating with the fuel flow slowly varied throughout the range, shall be subjected to vibrations of all frequencies within the appropriate range specified in paragraph 3.3.4, in order to determine if there exists any natural frequencies, of any parts, that lie within the specified range. The amplitude used may be any convenient value that does not exceed the maximum double amplitude specified in paragraph 3.3.4 and such as not to exceed the maximum acceleration specified in paragraph 3.3.4.