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AEROSPACE STANDARD

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Superseding AS405C

Fuel and Oil Quantity Instruments

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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1. SCOPE:

This Aeronautical Standard covers two basic types of instruments as follows:

Type I - Float Instruments
Type II - Capacitance Instruments

1.1 Purpose:

To specify minimum requirements for Fuel and Oil Quantity Instruments for use in aircraft, the operation of which may subject the instruments to the environmental conditions specified in Paragraph 3.3.

2. REFERENCES:

NACA Report 1235

3. GENERAL REQUIREMENTS:

3.1 Material 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 instrument (Fuel or Oil Quantity Instrument)
b. SAE Aeronautical Standard AS405C
c. Manufacturer's part number
d. Manufacturer's serial number or date of manufacture
e. Manufacturer's name and/or trademark
f. Range
g. Rating

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 instruments shall function over the range of ambient temperatures shown in Column A below and shall not be adversely affected by exposure to the temperatures shown in Column B:

TABLE 1

Instrument Location	"A"	"B"
Heated Areas (Temperature Controlled)	-30 to 50 °C	-65 to 70 °C
Unheated Areas (Temperature Uncontrolled)	-55 to 70 °C	-65 to 70 °C

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

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

TABLE 2

Instrument Location in Airframe	Cycled per Second	Maximum Double Amplitude (Inches)	Maximum Acceleration
Power Plant Mounted	5 - 150	0.100	20 g
Wings & Empennage	5 - 500	0.036	10 g
Fuselage	5 - 500	0.036	5 g
Panel or Rack (with shock-mounts)	5 - 50	0.020	1.5 g

3.3.4 Altitude: The instrument shall function and shall not be adversely affected when subjected to a pressure and temperature range equivalent to -1000 to 40,000 feet standard altitude per NACA Report 1235, except as limited by application of Paragraph 3.3.1. The instrument shall not be adversely affected when subjected to a pressure of 50 inches Hg absolute.

3.3.5 Fire Hazard: The instrument shall be so designed to safeguard against hazards to the aircraft in the event of malfunction or failure, and the maximum operating temperature of surfaces of any sensor component contacted by combustible fuel or vapor shall not exceed 200 °C.

3.3.6 Seal: The tank unit connector head shall be an enclosed compartment designed to prevent fuel or oil leakage.

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 feed-back, in radio equipment installed in the same aircraft as the instrument.

3.5 Magnetic Effect:

The magnetic effect of the instrument shall not adversely affect the operation of other instruments installed in the same aircraft.

4. DETAIL REQUIREMENTS:

4.1 Indicating Methods:

The quantity instrument shall indicate by means of a pointer moving over a fixed dial, and/or by means of a counter.

4.2 Dial Markings:

4.2.1 Finish: Unless otherwise specified by the user, matte white material shall be applied to all major graduations, numerals and indication means. Non-functional surfaces shall be durable dull black.

4.2.2 Graduations: The intervals employed shall be determined by the capacity of the tank and the scale length in order to have a scale having sufficient graduations and numerals for easy reading without overcrowding.

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

4.2.4 Instrument Name: The word “Fuel Quantity” or “Oil Quantity” whichever is applicable may be the same finish as the numerals. The inscription “pounds” or “gallons” or equivalent shall appear on the dial.

4.2.5 Visibility: The indicating means and all markings shall be visible from any point within the frustum of a cone the side of which makes an angle of at least 30 degrees with the perpendicular to the dial and the small diameter of which 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 Power Variation:

All units shall properly function with plus or minus 15 percent variation in DC voltage and/or plus or minus 10 percent variation in AC voltage and plus or minus 5 percent variation in frequency.

4.4 Power Indication:

Either a means shall be provided to permit the operation of a device to indicate whether the instrument is receiving power, or the indicating means shall automatically move off scale at the “empty” and when the electric power to the instrument is “off”.

4.5 Tank Unit Moving Parts:

Where relative motion between parts is expected, the materials used and the design shall be such as to prevent any possibility of “galling” or “binding” due to fuel deposits or temperature changes during service operation.

4.6 Filling Medium:

When hermetically sealed, the case shall be filled with an inert gas of at least 10% helium, of at least 98 percent purity, free of dust particles, and sufficiently dry so that fogging of the indicator glass does not occur during the low temperature tests of this AS.

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 25 °C and at a relative humidity of not greater than 85 percent. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowance shall be made for the variation 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 3.3.3 with the following characteristics:

5.3.1 Linear Motion Vibration: Vibration 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 shall be such that a point on the instrument case will describe, in a plane 45 degrees 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 a power rating recommended by the manufacturer.

5.5 Position:

Unless otherwise specified, all tests shall be conducted with indicators and transmitters mounted in their normal operating position.

5.6 Test Liquid:

If tests are to be conducted with liquid, the liquid shall be the type of fuel or oil for which the instrument is designed or its equivalent. If any tests are to be conducted with the liquid at a temperature and pressure other than that specified in Paragraph 5.1, proper allowances may be made for the resulting variation in the characteristics of the liquid.

6. INDIVIDUAL PERFORMRANCE REQUIREMENTS:

All instruments 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 Error:

The complete fuel or oil quantity gage shall be electrically connected and tested throughout the design range. The “empty” and “full” adjustments shall, if provided, by correctly made and shall not be further adjusted throughout the test. The percent of error at any point in the scale shall not exceed 3 percent of full scale indications for fuel gages and 6 percent for oil gages. The percentage of errors shall be calculated by comparison of readings taken from the design calibration of the system undergoing test.

6.2 Friction:

The indicator shall be tested for friction at the “empty” and “full” points and at three equally spaced intermediate points. The pointer shall be brought up to the desired reading and the input held constant while two readings are being taken. The first reading shall be taken before the indicator has been vibrated and the second one after the indicator has been vibrated. The difference between any two readings for the same point on the scale shall not differ by more than 2 percent of full scale indication in degrees.

6.3 Leak Test:

The tank component shall be securely mounted in a suitable tank fixture. The test pressure of 15 pounds per square inch shall be applied to the seal and there shall be no evidence of leakage.

6.4 Position Error:

The difference in instrument indication between tests in normal position and tests in any other position shall not exceed 2 percent of full scale value.

6.5 Power Variation Test:

The input voltages and frequencies of the gage shall be varied between the limits specified under Paragraph 4.3. The indication at any point on the scale shall not differ by more than 1-1/2 percent of full scale from the indication obtained with rated voltage and frequency.

6.6 Dielectric:

Ungrounded instruments or grounded instruments prior to connection of internal ground wire, shall be tested by either the method of inspection of Paragraph 6.6.1 or 6.6.2.

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

6.6.2 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 five seconds. The RMS value of the sinusoidal voltage applied shall be either five (5) times the maximum instrument operating voltage, or 500 volts, (200 volts for sealed, inert gas filled instruments) whichever is lower.

6.6.2.1 Instruments operated with a permanent internal ground connection shall be tested as follows: The insulation shall withstand without evidence of damage the application of a sinusoidal voltage at a commercial frequency between each electrical circuit and the metal case, for a period of five (5) seconds. The RMS value of the sinusoidal voltage applied shall be 1.25 times the maximum circuit operating voltage obtainable between the test points.

6.7 Maximum Operating Temperatures:

The temperature of surfaces of any tank sensor component shall not exceed 200 °C in air when tested at maximum rated operating power and ambient temperature conditions.

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 recommendation.

7.1 Temperature Characteristics:

7.1.1 Low Temperature: The indicator and interconnected component electrical accessories shall be subjected successively to a temperature of -55 °C, and 70 °C, with the tank unit held at room temperature for a period of not less than four hours each. At the completion of each of these periods the change in fuel gage indication shall not exceed 2 percent (oil gage 4 percent) of full scale indication in degrees from that obtained with all components at room temperature. The above tests shall be repeated with the identical units, except that those units previously subjected to extreme temperature shall be held at room temperature and those units which were at room temperature shall be subjected to the extreme temperature.

7.1.2 High Altitude-Low Temperature: This test may be combined with the low temperature test of Paragraph 7.1.1 by reducing the pressure for any one-hour period of the four-hour soak at -55 °C to the equivalent pressure of 40,000 plus or minus 500 feet. The above test shall be conducted in the same two stages as indicated in Paragraph 7.1.1, first with the indicator and interconnected component electrical accessories at -55 °C and the tank unit at room temperature; then with the tank unit at low temperature and the remaining components at room temperature. At the completion of each of these stages, the changes in fuel gage indication shall not exceed 2 percent (oil gage 4 percent) of the full scale indication from that obtained with all components at room temperature.