SAE Aerospace
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AEROSPACE STANDARD

SAE AS404

REV. C

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Superseding AS404B

Electric Tachometer: Magnetic Drag (Indicator & Generator)

FOREWORD

Changes in this Revision are format/editorial only.

1. SCOPE:

This Aeronautical Standard covers magnetic drag tachometers with or without built-in synchroscopes.

1.1 Purpose:

To specify minimum requirements for Electric Tachometers primarily for use in reciprocating engine powered civil transport aircraft, the operation of which may subject the instruments to the environmental conditions specified in Section 3.3.

2. REFERENCES:

NACA Report 1235

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.

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3.2 Identification:

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

a. Name of Instrument
b. SAE AS404C
c. Manufacturer's Part Number.
d. Manufacturer's Serial number or date of manufacture.
e. Manufacturer's name and/or trade mark.
f. Range.

3.3 Environmental Conditions:

The following conditions have been established as minimum design requirements. 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 shown in Column A below and shall not be adversely affected by exposure to the range of temperatures shown in Column B below:

TABLE 1

Instrument Location	A	B
Powerplant Accessory Compartment	-30 to 70 °C	-65 to 100 °C
Heated Areas (temperature controlled)	-30 to 50 °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% 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 vibrations of the following characteristics:

TABLE 2

Inst. Location in Airframe	Cycles Per Second	Maximum Double Amplitude (Inches)	Maximum Acceleration
Power Plant Mounted	5-150	.100	20 g
Fuselage	5-500	.036	5 g
Panel or Rack (Vibration Isolated)	5-50	.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 the application of paragraph 3.3.1. The instrument shall not be adversely affected following exposure to an ambient pressure of 50 in Hg absolute.

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 electronic equipment installed in the same aircraft as the instrument.

3.5 Magnetic Effect:

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

4. DETAIL REQUIREMENTS:

4.1 Indicator:

4.1.1 Indication: Engine speed shall be indicated by means of one or more moving pointers or dials. Relative movement of the pointer with respect to the dial shall be clockwise for increasing RPM.

4.1.2 Dial Visibility: The pointers and all dial markings shall be visible from any point within the frustum of a cone whose side makes an angle of not less than 30° 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 0.200 inch.

4.1.3 Dial Markings:

4.1.3.1 Finish: Unless otherwise specified by the user, matte white material should be applied to all major graduations, numerals, and pointers. Non-functional surfaces should be a durable dull black.

4.1.3.2 Graduations: All graduations shall be multiples of 10 RPM. The increment between graduations shall not exceed 2-1/2% of full scale, above 600 RPM.

4.1.3.3 Numerals: Sufficient numerals shall be marked to identify positively and quickly all graduations.

4.1.3.4 Instrument Name: The designation "RPM", plus such other nomenclature as may be necessary, shall be legibly marked on the dial and may be of the same finish as the numerals.

4.1.3.5 Sealing: The indicator case may be either gasket sealed or hermetically sealed.

4.2 Generator:

The generator shall be designed to operate in either direction of rotation and in any position.

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 a relative humidity not greater than 85%. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowances 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 made 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 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 Section 3.3.3 with the following characteristics.

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

5.3.2 Circular Motion Vibration: Vibration equipment for instruments located on the panel or rack (with shockmounts) shall be such that a point on the instrument case will describe a circle, in a plane inclined 45 degrees to the horizontal plane, the diameter of which is equal to the double amplitude specified.

5.4 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 when applicable.

6.1 Scale Error at Room Temperature:

The tachometer indicator shall be connected to its generator and the generator operated at the shaft speeds within the ranges specified in Table 3. The scale error at any speed shall not exceed the values specified in Table 3 with the speed increasing or decreasing. When the speed is held constant at any point on the scale, the pointer shall not oscillate over a range greater than 20 RPM from 600 RPM to full-scale indication.

TABLE 3

Generator Drive Shaft Speed RPM	Correct Indicated Speed RPM	Scale Error Tolerance RPM
300 - 1400	600 - 2800	25
1500 - 2250	3000 - 4500	40

6.2 Dielectric:

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

6.2.1 Insulation Resistance: The insulation resistance measured at 200 volts DC for five seconds between all electrical circuits connected together and the metallic case shall not be less than 5 megohms. Insulation resistance measurements shall not be made to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc., since this measurement is intended only to determine adequacy of insulation.

6.2.2 Overpotential Tests: Equipment shall not be damaged by the application of a test potential between electrical circuits, and between electrical circuits and the metallic case. The test potential shall be a sinusoidal voltage of a commercial frequency with an RMS value of five times the maximum circuit voltage or per paragraphs 6.2.2.1 or 6.2.2.2 whichever applies. The potential shall start from zero and be increased at a uniform rate to its test value. It shall be maintained at this value for five seconds, and then reduced at a uniform rate to zero.

Since these tests are intended to insure proper electrical isolation of the circuit components in question, these tests shall not be applied to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc.

6.2.2.1 Hermetically sealed instruments shall be tested at 200 volts RMS.

6.2.2.2 Circuits that operate at potentials below 15 volts and contain low voltage elements such as transistors, doides, capacitors and special signal generators are not to be subjected to overpotential tests.

6.3 Position Error:

The change in pointer indication with change in instrument position from normal position shall not exceed 25 RPM.

6.4 Sealing:

This test shall apply to hermetically sealed instruments only. The indicator shall be immersed in a suitable liquid, such as water. The absolute pressure of the air above the liquid shall then be reduced to approximately 1 inch of mercury and maintained for 1 minute, or until air bubbles substantially cease to be given off by the liquid, whichever is longer. The absolute pressure shall then be increased to 2-1/2 inches Hg. Any bubbles coming from within the indicator case shall be considered as leakage and shall be cause for rejection. Bubbles which are the result of entrapped air in the various exterior parts of the case shall not be considered as a leak.

A helium leak detector or other means of test, equal or superior in sensitivity to the immersion method described above, may be used. Where a leak detector is employed for conducting the test, the leak rate shall not exceed 1 micro-cubic foot per hour at a pressure differential of approximately 1 atmosphere.

If the indicator incorporates non-hermetically sealed attachments, such as a case extension, these components may be removed prior to the Sealing Test.

7. QUALIFICATION TESTS:

As many instruments as may be 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 Temperature:

The instrument shall be subjected to -30 °C for three hours. The change in indication from the reading obtained at room temperature shall not exceed one percent of full scale. The instrument may be operated at 2000 RPM or half scale, whichever is higher, for a period of 10 minutes before making this scale error test. The force required to turn the generator shaft while and after it has been subjected to a temperature of minus 55 °C for two hours, shall not exceed 8 pound inches. No damage to the generator shall result from this test.

7.2 High Temperature:

The instrument shall be subjected to a temperature of 70 °C for a period of three hours. The change in indication from the readings obtained at room temperature shall not exceed one percent of full scale for the range 600-2800 RPM and shall not exceed one and one-half percent of full scale for the range from 3000 to 4500 RPM.

7.3 Extreme Temperature Exposure:

The instrument shall, after alternate exposure to ambient temperatures specified in Column B of Section 3.3.1 for a period of 24 hours each and a delay of 3 hours at room temperature following completion of the exposure, meet the requirements of Section 6.1. During the high temperature exposure, the generator shall be operating at a shaft speed equivalent to half-scale indicator reading and shall be supplying full-rated electrical load for that speed. There shall be no evidence of damage as a result of exposure to the extreme temperatures specified herein.

7.4 Magnetic Effect:

The magnetic effect of the indictor 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 0.19 ± 0.01 gauss when the indicator is held in various positions on an east-west line with its nearest part 12 inches from the center of the magnet. This test shall first be made with the indicator not operating and then shall be repeated with the indicator in normal operation. The maximum deflection of the free magnet shall not exceed 5 degrees for any pointer or dial position.