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

AERONAUTICAL STANDARD AS413

TEMPERATURE INDICATOR

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Revised

1. PURPOSE: To specify minimum requirements for electrical type of temperature indicators for use in aircraft, the operation of which may subject the instrument to the environmental conditions specified in Section 3.3.

2. SCOPE: This specification covers two types of instruments. These instruments are for the purpose of measuring temperature, such as those of oil coolant, carburetor air, free air and cylinder head.

Type I - Ratiometer type actuated by changes of electrical resistance of a temperature sensing electrical resistance element; the resistance changes being obtained by temperature changes of the temperature sensing resistance element.

Type II - Millivoltmeter type, operated and actuated by varying e.m.f. output of a thermocouple, the varying e.m.f. input to the instrument being obtained by temperature changes of the temperature sensing thermocouple.

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 instrument
(b) SAE Specification AS413
(c) Rating (nominal voltage or thermocouple material as applicable)
(d) Manufacturer's part number
(e) Manufacturer's serial number
(f) Manufacturer's name or trademark

3.3 Environmental Conditions: The following are 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 from -30 C to 50 C. It shall not be adversely affected by exposure to temperature of -65 C and 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 approximately 32 C.

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

3.3.4 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 not more than 0.010 inch at a frequency from 500 to 3000 cycles per minute *or of not more than 1.3 g. When specified by the purchaser for use in rotary wing aircraft, the frequency range shall be 150-3000 cycles per minute.

*NOTE: It is understood that the unit shall withstand vibrations at higher frequencies, but the acceleration values need not exceed those shown above.

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 sets installed in the same aircraft as the instrument.

4. DETAIL REQUIREMENTS:

4.1 Resistance vs Temperature Equivalents: Unless otherwise specified, Type I instruments shall be calibrated to indicate temperature in accordance with the temperature versus resistance values in Table I.

4.2 E.m.f. versus Temperature Equivalents: Unless otherwise specified, Type II instruments shall be calibrated to indicate temperature in accordance with the emf versus temperature values as established by the National Bureau of Standards for Iron Constantan, Copper Constantan, and Chromel Alumel Thermocouples.

4.3 Indicating Method: Type I and Type II instruments shall indicate temperature by means of a pointer moving over a fixed dial. Clockwise motion of single pointers or upward motion of dual pointers shall indicate rising temperature.

4.4 Visibility: The pointer and all significant dial markings shall be readable 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 0.250 of an inch.

4.5 Adjustment: When provided, the zero adjustment shall have sufficient friction so that it will not change its adjustment due to vibration encountered in service within the tolerances specified herein for scale error tests.

4.6 Case Markings: Type II instrument terminal posts shall be of different sizes and shall be distinctly marked to indicate plus for either the iron wire, copper wire, or chromel wire connections, and minus for either the constantan or alumel wire connections. External resistance of the lead and thermoooouple shall be plainly marked.

4.7 Dial Markings:

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

4.7.2 Numerals and Graduations: Sufficient numerals and graduations shall be marked to positively and quickly identify temperature indications. Numerals shall distinctly indicate the graduation to which each applies.

4.7.3 Instrument Name: The appropriate word or words, such as "Oil", "Carb. Air", "Free Air", "Cyl. Head", may be marked on either the dial or mask covering moving parts, and may be the same finish as the numerals.

4.7.4 Temperature: The inscription "°C" or "°F", as appropriate, shall appear on the dial. The inscription "X100" may appear, if appropriate.

4.8 Limitation or Pointer Travel: The pointer shall be free to move a minimum of two angular degrees beyond the ends of the scale travel and may be limited by stops.

5. TEST CONDITIONS:

5.1 Atmospheric Conditions: Unless otherwise specified, all tests required by this specification shall be made at an atmospheric pressure of approximately 29.92 inches of mercury, and at an ambient temperature of approximately 22°C. When tests are made 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 made with the instrument subjected to a vibration of 0.002 to 0.005 inch amplitude at a frequency of 1500 to 2000 cycles per minute. The term amplitude as used herein, indicates the total displacement from positive maximum to negative maximum.

5.3 Test Voltage: Unless otherwise specified, all tests for performance shall be conducted at the power rating recommended by the manufacturer.

5.4 Test Position: Unless otherwise specified, all tests shall be made with the indicator mounted in its normal operating position.

5.5 Vibration Stand: For vibration tests, a stand shall be used which will vibrate at any desired frequency between 500 and 3000 cycles per minute and shall subject the instrument to vibration such that a point on the instrument case will describe, in a plane inclined 45 degrees to the horizontal plane, a circle the diameter of which is equal to the amplitude specified herein.

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 specification, including the following requirements, where applicable.

6.1 Type I Position Error:

6.1.1 No Voltage: With no voltage applied to Type I instruments, and when the instrument is tipped from the normal operating position to a position with the plane of the dial horizontal or 90 degrees to the right or left, the pointer shall remain slightly off scale at the low temperature end.

6.1.2 Voltage: The test specified for "no voltage", shall be repeated on Type I instruments with the test voltage applied. This test may be performed at any indication. The change in pointer indication shall not exceed 2% of the total scale span in temperature degrees. When the power to the indicator is cut off, the pointer shall return to the no voltage position.

6.2 Type II Position Error: Type II indicators of the unsuppressed type shall be tested on open circuit, and the reading of the indicator observed in the normal operating position with the dial in the vertical plane. The indicator shall then be rotated through angles of 90 degrees to the right and left, and also tipped to a position with the dial horizontal. The readings shall be noted in all positions. The maximum change in reading shall not exceed 2 percent of total scale span in temperature degrees.

6.2.1 Indicators of the suppressed type shall be tested with the pointer set to a major graduation at approximately mid-scale by means of an appropriate millivoltage applied to the terminals through the specified external resistance in series with the indicator. This indicator shall then be rotated through angles of 90 degrees to the right and left and also tipped to a position with the dial horizontal. The readings shall be noted in all positions. The maximum change in readings shall not exceed 2 percent of total scale span including the amount suppressed, in temperature degrees.

6.3 Friction:

6.3.1 Type I Indicators: The difference in readings of Type I indicators shall be noted after a slow change in indication before and after tapping or vibrating. This test may be performed at any point on the scale. The change in pointer indication shall not exceed 2% of total scale span in temperature degrees.

6.3.2 Type II Indicators: The friction test on Type II indicators may be conducted in conjunction with the scale error test. The voltage shall be slowly increased up to each test point. The indicator reading shall be noted before and after the indicator is lightly vibrated and the friction shall not exceed 4 percent of total scale span including any amount suppressed in temperature degrees. The procedure shall be repeated for decreasing voltage values. The movement of the pointer shall be smooth when the applied voltage is varied uniformly.

6.4 Scale Error at Room Temperature:

6.4.1 Type I indicators shall have connected to the resistance bulb terminals the appropriate resistance of the temperature versus resistance curve. A fixed resistance of 0.16 ohms shall be added to these resistance values to represent the average lead resistance. When the test voltage is applied, the scale errors shall be determined at a minimum of five test points for the indicator under test. The scale errors shall not exceed 2 percent of the

total scale span in temperature degrees.

6.4.2 Type II Indicators: Type II indicators shall be subjected to a constant room temperature for a period of not less than one hour. On indicators of the unsuppressed type, the pointer shall be set to read this temperature while the indicator is on open circuit. Specified voltages for the prevailing ambient temperature shall be applied to the terminals of the indicator through the specified external resistance in series with the indicator.

6.4.2.1 On indicators of the suppressed type, the pointer shall be set to read a temperature at approximately mid-scale when a millivoltage appropriate for that temperature is applied to the terminals through the specified external resistance in series with the indicator.

6.4.2.2 Indicator readings shall be taken at a minimum of 5 test points. The errors shall not exceed 2 percent of total scale span, including the amount suppressed, in temperature degrees.

6.5 Dielectric: The insulation shall be subjected to a dielectric test with an R.M.S. voltage at a commercial frequency applied for a period of five seconds equivalent to five times normal circuit operating voltage, except where circuits include components for which such a test would be inappropriate the test voltage shall be 1.25 times normal circuit operating voltage. The insulation resistance shall not be less than 5 megohms at that voltage.

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 manufacturers recommendations.

7.1 Reduced Voltage Operation: The Type I indicator shall be tested with 80% of test voltage. The indications at the reduced voltages shall not differ from the indications at test voltage by more than 2 percent of scale span in temperature degrees.

7.2 Indicator Scale Error Tests at High and Low Temperatures: The indicator shall be subjected successively to temperatures of -30C for 3 hours and +50C for 3 hours. While the indicator is held at each of the above temperatures, resistance and/or voltage shall be applied as specified for Scale Error at Room Temperature (6.4). The scale errors shall not exceed plus or minus 5 percent of the total scale span, including the amount suppressed in temperature degrees.

7.3 Vibration Tests: The indicator shall be subjected to vibration for a two hour period on a vibration stand. The amplitude of the vibration shall be between .009 and .011 inch (total excursion). The vibration frequency shall be varied between 500 and 3000 cycles per minute.

This test may be conducted at any indicator indication. The pointer oscillation and change in the indication shall be observed throughout range of the indicator. After these observations have been made, the stand shall be set to an amplitude of vibration between .018 and .020 inch total excursion, and to 2000 cycles per minute and operated for the remainder of the two hour period with the pointer position changed every 20 to 30 minutes. Following the two hour vibration period, the test specified for, "Scale