AEROSPACE STANDARD	AS8006	REV. A
	Issued 1988-04 Revised 2015-08 Superseding AS8006	

(R) Minimum Performance Standard for Pitot and Pitot-Static Probes

RATIONALE

This standard is being revised to: update the in-flight icing conditions Pitot and Pitot-static probes may experience in service; update certain design requirements so they apply to all probes meeting this standard; and update the environmental test requirements to include those of ED-14G / RTCA DO-160G as they apply to Pitot and Pitot-static probes.

1. SCOPE

This SAE Aerospace Standard (AS) covers the following basic types:

Type I - Pitot pressure, straight and L-shaped, electrically heated.

Type II - Pitot and static pressures, straight and L-shaped, electrically heated.

1.1 Purpose

This standard establishes the minimum design and performance requirements for electrically heated Pitot (total pressure) probes and for Pitot-static pressure probes for subsonic aircraft.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS5562 Ice and Rain Minimum Qualification Standards for Pitot and Pitot-static Probes

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
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SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AS8006A

2.1.2 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO-160G Environmental Conditions and Test Procedures for Airborne Equipment

2.1.3 EUROCAE Publications

Available from EUROCAE, 102, rue Etienne Dolet, 92240 Malakoff, France, Tel: +33.1.40.92.79.30, www.eurocae.net.

2.1.4 EUROCAE ED-14G Environmental Conditions and Test Procedures for Airborne Equipment

2.2 Glossary of Terms

2.2.1 COMPENSATED PITOT-STATIC PROBE

A compensated Pitot-static probe is a probe that incorporates aerodynamic compensation features. Aerodynamic compensation involves understanding the pressure distribution at the probe mounting location as a function of Mach number and angle of attack and using the probe's head contour and static port location to induce an opposite correcting characteristic in the Pitot-static probe. Once the probe is mounted on the aircraft the resultant static pressure outputs will be close to the true static pressure over the flight envelope of the aircraft.

2.2.2 The term q_c

Impact pressure is the difference between Pitot and static pressures, either subsonically or supersonically. Subsonically it is commonly referred to as the compressible dynamic pressure, q_c.

2.2.3 CALIBRATED STANDARD PROBE

The calibrated standard probe is a duplicate of the Pitot or Pitot-static probe that has been flight tested on the aircraft and the performance approved by the cognizant authority. In lieu of a calibrated standard, the Pitot and static pressure outputs may be specified from available wind tunnel calibration data as a function of angle of attack and Mach number or airspeeds.

2.2.4 PRODUCTION CALIBRATED STANDARD PROBE

The production calibrated standard probe's Pitot and static pressure outputs shall be representative of the nominal outputs at zero probe angle over the Mach number range for which the probe was designed. This unit shall also pass the requirements of 5.3 at zero probe angle.

2.2.5 SHALL

The word "shall" is used in this document to express an essential requirement where compliance is mandatory.

2.2.6 SHOULD

The word "should" is used in this document to express a recommendation. Deviation from the specified recommendation shall require justification.

2.2.7 MUST

The word "must" is used in this document to express an essential (mandatory) requirement that is required by a specific regulation.

3. GENERAL REQUIREMENTS

3.1 Function

When installed in accordance with the aircraft manufacturer's and/or probe manufacturer's instructions; the electrically heated probe shall sense pneumatic Pitot pressure or pneumatic Pitot and static pressures for transmission to instruments or associated equipment, or both. The electric heater function is defined as starting with the aircraft interface (connector). The pneumatic pressure function is defined as starting with the pressure transducer interface if it is integrated with the probe or starting with the aircraft interface if the pressure transducer is separated from the probe.

3.2 Preproduction

This standard requires the preproduction testing stated in Section 5.

3.3 Materials

The suitability and durability of materials shall be established on the basis of experience or tests. In order to satisfy this requirement by use of experience, the user shall show that the materials used in the construction of the probe have performed satisfactorily in service under conditions consistent with its intended use. Materials shall conform to specifications (such as industry or military specifications), or be developed by tests that ensure they have the strength and other properties assumed in the design data. Materials shall be corrosion resistant or suitably treated to resist corrosion when taking into account the effects of environmental conditions expected in service. The compatibility of materials used in the construction of the probe shall be shown not to have detrimental effects on the life or performance of the probe.

3.4 Design and Construction

The probe shall be designed to sense Pitot pressure or Pitot and static pressures.

3.4.1 Construction

The probe shall be so constructed that no parts will work loose while in service. It shall be built to withstand the strains, shocks, vibrations, and other conditions incident to shipping, storage, installation, and service.

3.4.2 Particle Separation Features

The probe shall be designed with baffling or a Pitot settling chamber, or both, to minimize the entry of liquid or solid particles into the tubing connecting the probe to the aircraft instruments. There shall be at least one drain hole to discharge or scavenge entrained liquid, such as rain or melted ice water. The probe design should consider the effects of ingested solid particles such as ice, sand and dust.

3.4.3 Misinstallation

The probe should incorporate design features to minimize the potential for misinstallation on the aircraft. For example, in the case where the probe contains multiple pneumatic or electrical connections these features may include the incorporation of different pneumatic fitting sizes or types, or different electrical connector keying.

3.4.4 Interchangeability

Instruments and components which are identified with the same manufacturing part number shall be directly and completely interchangeable.

3.4.5 Pneumatic Interface

The pneumatic interface shall be specified on the probe's specification drawing or installation manual.

3.4.6 Electrical Interface

The electrical interface shall be specified on the probe's specification drawing or installation manual.

3.4.7 Repeatability

The Pitot or Pitot-static probe shall have a Pitot pressure reproducibility of ±0.005 q_c and a static pressure reproducibility of ±0.002 q_c when compared to a production calibrated standard probe during individual performance testing.

3.4.8 Heaters

Power shall be distributed throughout the probe, including the mounting strut, such that the probe shall deice and remain ice free to the extent that Pitot and static pressure indications from the probe remain within the tolerances specified in AS5562.

3.4.9 Heater Circuitry Sealing

The heater circuit portion of the probe shall be electrically isolated from the action of any atmosphere to which the probe may be subjected.

3.4.10 Heater Induced Probe Distortion

There shall be no distortion of the probe body or strut as a result of extended heater operation that prevents the probe from meeting the requirements of its specification drawing.

3.4.11 Finishes

Protective coatings and finishes utilized in the construction of the probe should not crack, chip, or scale to the extent that the probe no longer meets the aerodynamic accuracy requirements when exposed to the qualification test requirements of this standard.

3.5 Performance

The probe shall meet the detailed performance requirements specified in Section 4 and 5 under the following conditions:

3.5.1 Individual Performance Test Requirements

Section 4 contains the minimum number of individual performance tests that will be conducted on each probe as part of production acceptance testing. These tests will also be completed following each of the respective qualification tests of Section 5 as a means to determine acceptable performance of the probe. As a minimum the following individual tests shall be conducted: Examination of Product, Dielectric, Insulation Resistance, Pressure Leakage, Power Consumption, and Aerodynamic Tests.

3.5.2 Qualification Test Requirements

Section 5 contains the minimum required qualification tests to verify the probe has met its design objectives. When a specific qualification test calls out the use of ED-14 / RTCA DO-160, Revision G of each shall be utilized.

3.5.2.1 Qualification Test Point Customization

If the qualification tests are to be modified the following shall apply:

1. The specific test condition shall be as severe as that called out in this specification.

2. The modified test condition shall be documented in the test report.

NOTE: It is the responsibility of the probe installer to verify that the design and qualification of the probe are consistent with the installation requirements of its intended use.

3.5.2.2 Qualification Test Data Collection

Qualification tests calling out the use of ED-14 / RTCA DO-160 shall use the data collection, accuracy, and tolerance requirements specified in ED-14 / RTCA DO-160. For all other tests the following environmental conditions apply:

a. Atmospheric Pressure: normal ground (900 to 1100 hPa)

b. Temperature: room ambient (25 °C ± 10 °C)

c. Vibration – no intentional input

d. Humidity – room ambient up to 90% relative humidity

e. Airspeed – none

3.5.2.3 Qualification Test Reporting

A qualification test report shall be developed and maintained so that upon request it can be made available to an installer to support installation approval. As a minimum the qualification test report will contain the following information in sufficient detail to allow reproduction of the stated test requirements:

a. Model number and serial number of the unit(s) tested

b. Measurement equipment calibration statement

c. Qualification test procedure

d. Test condition modifications, if applicable

e. Date and place of each test

f. Test results

g. Test witnesses (if any)

3.5.3 Integrated Probe Functions

If the Pitot or Pitot-static probe is integrated into a more complex product that includes additional functions not covered by this standard such as:

a. Angle of attack measurement

b. Temperature measurement

c. Heater monitoring and control

d. Air data computer (ADC) function

Then performance of the probe during all qualification tests requiring operation of the probe heater shall be met with these additional functions active and operational.

NOTE: A failure of the functions not required by this standard does not constitute a failure of the Pitot or Pitot-static probe, unless the failures of those functions interfere with the proper operation of the probe. The performance of these functions should be verified by separate testing to their respective specifications.

3.5.4 Identification of Production

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

a. name of instrument,

b. rated voltage,

c. manufacturer's part number,

d. weight,

e. manufacturer's serial number,

f. date of manufacture, and

g. manufacturer's name or trademark, or both.

3.6 Other Markings

Identify Pitot pressure and static pressure probe lines by the letters "P" and "S" respectively. Stamp, etch or engrave the letters on the lines or fittings. If the probe does not contain pressure lines or air fittings, then the Pitot and static openings shall be identified on the probes specification drawing or installation manual.

3.7 Workmanship

The probe should be constructed and finished to the standards of best commercial practice. Particular attention should be given to the neatness, thoroughness of soldering, wiring, marking of parts and assemblies, welding and brazing, painting, riveting, machine-screw assemblies, and freedom of parts from burrs and sharp edges, except for static pressure ports and Pitot openings when these openings shall be sharp to guarantee aerodynamic performance.

4. INDIVIDUAL PERFORMANCE TESTS

Each probe shall be subjected to whatever tests the manufacturer deems necessary to demonstrate specific compliance with requirements of this specification, but shall include the following requirements as a minimum:

4.1 Examination of Product

The probe shall be carefully examined to determine compliance with the applicable specification drawing, and with respect to material, finish, weight, markings, and workmanship per this standard.

4.2 Dielectric

The probe shall be placed in a chamber and evacuated to a minimum pressure altitude of 46 000 feet for a minimum period of 2 hours. At the end of the 2 hour-period, and while at a pressure altitude of 48 000 feet ± 2000 feet, a voltage of 550 VAC RMS shall be applied between one pin of each heater circuit and the outer surface of the probe for a period of 60 seconds with a dielectric tester. An electrical impedance of less than 2 megohms shall be cause for rejection. No damage to wiring or insulation shall result. Note: The intent of this test is to verify the integrity of the probe's heater(s). Any device attached to the probe that invalidates the test results shall not be a part of the test circuit.

4.3 Insulation Resistance

A voltage potential of 250 VDC ± 10 VDC shall be applied between one pin of the each heater circuit and the probe body. After 2 minutes, the insulation resistance shall not be less than 100 megohms. No damage to wiring or insulation shall result.

NOTE: The intent of this test is to verify the integrity of the probe's heater(s). Any device attached to the probe that invalidates the test results shall not be a part of the test circuit.

4.4 Pressure Leakage

With the Pitot and static orifices and with drain holes sealed, a minimum pressure differential of 50 inches (1270 mm) of mercury shall be applied individually to each of the pressure lines. With the source of pressure isolated, using a volume not to exceed 10 cubic inches, the trapped pressure drop after 1 minute shall not exceed 0.03 inches (0.8 mm) of mercury.

4.5 Power Consumption

At an ambient temperature of between 20 and 30 °C, rated voltage shall be applied to the electrical connector pins of the probe for operation of the heater(s) for a period of 5 minutes. After the 5 minute period, the power dissipated shall be measured. The heater shall operate according to the conditions specified on the probe's specification control drawing.

4.6 Aerodynamic Tests

The probe shall be subjected to uniform air flow with the probe head centerline aligned with the airflow within ±0.5 degree. The airflow rate shall be adjusted to provide a minimum airspeed of 85 knots, and both the Pitot and static pressure readings shall be taken at this airspeed. The vendor shall have available at least one production calibrated standard probe to be used to compare to the test sample. Upon comparison of the data taken from the test unit and that of the calibrated standard, the difference in static pressure shall not be greater than ±0.002 q_c. Any errors greater than ±0.002 q_c shall be cause for rejection. The Pitot pressure difference shall not be greater than ±0.005 q_c, and any errors greater than ±0.005 q_c shall be cause for rejection.

Other means can be used to demonstrate compliance with this requirement provided there is evidence they are equivalent or better than the specified test.

5. QUALIFICATION TESTS

Manufacturers shall subject production samples to whatever tests they deem necessary to demonstrate compliance with this specification. As a minimum they shall include the following tests:

5.1 Heater Cycling

At an ambient temperature of between 20 and 30 °C, rated voltage shall be applied for an uninterrupted period of 60 minutes, and then removed for 15 minutes. The test shall be repeated 50 consecutive cycles. Corrosion resistance and proper operation of the probe shall not be affected. The probe shall be checked dimensionally to determine compliance with the applicable specification drawing. The pressure leakage, the insulation and the aerodynamic tests shall be repeated.

5.2 Vibration

The probe shall be subjected to the vibration test of EUROCAE ED-14G / RTCA DO-160G Section 8, Category R, using curve C for the performance (standard) portion and curve C1 for the endurance (robust) portion. The test shall be performed along each of the probe's three major orthogonal axes. The probe's heater(s) shall be operated during the test and be continuously monitored for proper operation. The probe shall meet all of the individual performance tests after completion of the vibration tests.

5.3 Pitot and Static Pressure Accuracy

5.3.1 Test Points for Compensated and Uncompensated Probes

When mounted in a calibrated wind tunnel, the Pitot pressure and the static pressure from the probe shall be measured over the Mach number and angle of attack ranges of the class for which the probe was designed. These values are listed in Table 1. At each test Mach number, the angle of attack for the probe shall be varied in 2-degree increments from 0 degrees to the maximum negative and maximum positive angles of attack for the class.

If a probe is designed for other Mach number or angle of attack limits within these classes, those values shall be recorded in the test report.

5.3.2 Accuracy Requirements

5.3.2.1 Uncompensated Probes

The Pitot and static pressures shall be within the limits shown in the Table 2 for the Mach number and angle of attack ranges of the class for which the probe was designed. If a probe is designed for other Mach number or angle of attack limits within these classes, those values shall be recorded in the test report

5.3.2.2 Compensated Probes

The difference in static pressure taken from the test unit and that of the calibrated standard shall be no greater than ±0.005 q_c at 0 degrees angle of attack. The Pitot pressure difference shall also be no greater than ±0.005 q_c, at 0 degrees angle of attack. The additional differences at other angles of attack for both Pitot and static pressures shall not exceed 0.05% of impact pressure (0.0005 q_c) multiplied by the absolute value of angle of attack in degrees.

5.4 In-Flight Ice and Rain

The probe shall meet the ice and rain requirements of AS5562 for the intended probe class.

5.5 Shock

The probe shall be subjected to the shock test of EUROCAE ED-14G / RTCA DO-160G Section 7, Category B using the fixed-wing transport values for the sustained crash shock test. The test shall be performed along each of the probe's three major orthogonal axes. The probe's heater shall be operated during the test and be continuously monitored for proper operation. The probe shall meet all of the individual performance tests after completion of the shock tests. Following the sustained crash test, bending and distortion is permitted but there shall be no failure of the mounting attachment of the probe.

5.6 Salt Fog

The probe shall be subjected to the salt fog test of EUROCAE ED-14G / RTCA DO-160G Section 14, Category S. The probe shall meet all of the individual performance tests after completion of the salt spray test.

5.7 Sand and Dust

The probe shall be tested for compliance to sand and dust tests in accordance with EUROCAE ED-14G / RTCA DO-160G Section 12, Categories S and D using the following customized procedures and acceptance criteria.

5.7.1 Category S Test Procedure

a. Seal the probe's Pitot pressure fitting so the only flow through the probe will be in through the Pitot inlet and out through the Pitot drain hole(s).

b. Measure the volumetric flow rate through the probe when the gage pressure at the Pitot inlet is 66.34 millibars.

c. Record the volumetric flow rate through the probe with no ingested sand.

d. Calculate W_s, the mass of sand to be ingested:

$$W_s = 0.3370\ (d)^2$$

where:

W_s is the mass of ingested sand in milligrams

d is the sand capturing diameter of the probe inlet in millimeters (see Figure 1)

e. Pour the calculated mass of sand into Pitot inlet

f. With the Pitot inlet temporarily sealed, laterally shake the probe for a minimum of five seconds while holding the probe in a general orientation where the drain hole, or at least one the drain holes if the probe has more than one, points down.

g. Repeat steps a and b.

h. Record the volumetric flow rate through the probe with ingested sand.

i. Remove any sand remaining in the probe using any suitable means

j. Repeat steps a, e, f, b, h, and i two additional times using the same calculated mass of sand.

k. Calculate the average flow rate through the probe after sand has been ingested from the three tests.

5.7.2 Category S Acceptance Criteria

The average of the three flow rates through the test probe after sand has been ingested shall not be less than 50% of the flow rate through the test probe before sand was ingested.

5.7.3 Category D Test Procedure

a. Seal the probe's Pitot pressure fitting so the only flow through the probe will be in through the Pitot inlet and out through the Pitot drain hole(s).

b. Measure the volumetric flow rate through the probe when the gage pressure at the Pitot inlet is 66.34 millibars.

c. Record the volumetric flow rate through the probe with no ingested dust.

d. Calculate W_d, the mass of dust to be ingested:

$$W_d = 3.0380\ (d)^2$$

where:

W_d is the mass of ingested dust in milligrams

d is the dust capturing diameter of the probe inlet in millimeters (see the figure below)

e. Pour the calculated mass dust into Pitot inlet.

f. With the Pitot inlet temporarily sealed, laterally shake the probe for a minimum of five seconds while holding the probe in a general orientation where the drain hole, or at least one the drain holes if the probe has more than one, points down.

g. Repeat steps a and b.

h. Record the volumetric flow rate through the probe with ingested dust.

i. Remove any dust remaining in the probe using any suitable means

j. Repeat steps a, e, f, b, h, and i two additional times using the same calculated mass of dust.

k. Calculate the average flow rate through the probe after dust has been ingested from the three tests.

5.7.4 Category D Acceptance Criteria

The average of the three flow rates through the test probe after dust has been ingested shall not be less than 50% of the flow rate through the test probe before dust was ingested

5.8 Humidity

The probe shall be subjected to the humidity test of EUROCAE ED-14G / RTCA DO-160G Section 6, Category C. The probe shall meet all of the individual performance tests after completion of the humidity test.

5.9 Magnetic Effect

The magnetic effect of the probe shall be determined in terms of the deflection of a free magnet approximately 1.5 inches long in a magnetic field with a horizontal intensity of 0.18 gauss ± 0.01 gauss, when the probe is held in various positions and with rated voltage applied on an east-west line with its nearest part 12 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 free magnet shall not exceed 5 degrees from any indication or reference position.

5.10 Temperature and Altitude

The probe shall be subjected to the temperature and altitude tests in accordance with EUROCAE ED-14G / RTCA DO-160G Section 4, Category F2. The probe will be considered operating when its heater(s) are operating. After completion of temperature and altitude tests, the probe shall meet all the individual performance tests. This test can be combined with EUROCAE ED-14G / DO-160G Section 5 tests.

5.11 Temperature Variation

The probe shall be subjected to the temperature variation tests in accordance with EUROCAE ED-14G / RTCA DO-160G Section 5, Category A. After completion of the temperature variation tests, the probe shall meet all the individual performance tests. This test can be combined with EUROCAE ED-14G / DO-160G Section 4 tests.

5.12 Explosive Atmosphere

Compliance to the explosive atmosphere tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 9.

5.13 Waterproofness

The probe shall be subjected to waterproofness tests in accordance with EUROCAE ED-14 G / RTCA DO-160G Section 10, Category S. After completion of the waterproofness test, the probe shall meet all the individual performance tests. It is not necessary to retain any ingested water within the probe prior to performing these tests unless that water is within a cavity designed to be hermetically sealed or a cavity sealed by resilient gaskets.

5.14 Fluids Susceptibility

The probe shall be subjected to fluids susceptibility tests in accordance with EUROCAE ED-14G / RTCA DO-160G Section 11, Category F for probe parts external to fuselage. Only tests with de-icing fluids are required. Tests with other fluids may be required by the aircraft manufacturer depending on their probe installation. After completion of the fluids susceptibility tests, the probe shall meet all the individual performance tests.

5.15 Power Input

Compliance to the power input tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 16.

5.16 Audio Frequency Conducted Susceptibility

Compliance to the audio frequency conducted susceptibility tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 18.

5.17 Fungus Resistance

The probe shall be subjected to the fungus resistance test in accordance with EUROCAE ED-14G / RTCA DO-160G Section 13, Category F. The probe shall meet all of the individual performance tests after completion of the fungus resistance test.

5.18 Voltage Spike

The probe shall be subjected to the voltage spike test in accordance with EUROCAE ED-14G / RTCA DO-160G Section 17, Category B. The spike shall be based on the nominal rated voltage of the probe. The probe shall meet all of the individual performance tests after completion of the voltage spike test.

5.19 Induced Signal Susceptibility

Compliance to the induced signal susceptibility tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 19.

5.20 Radio Frequency Susceptibility

Compliance to the radio frequency susceptibility tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 20.

5.21 Emission of Radio Frequency Energy

Compliance to the emission of radio frequency energy tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 21.

5.22 Lightning Induced Susceptibility

Compliance to the lightning induced susceptibility tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 22.

5.23 Lightning Direct Effects

Compliance to the lightning direct effects tests could be required by the aircraft manufacturer. These tests are not included in this minimum performance standard because the details of the specific aircraft installation are a critical part of performing these tests. The tests could be based on EUROCAE ED-14G / RTCA DO-160G Section 23.