

AIRCRAFT INSTRUMENT STANDARDS:
WORDING, TERMINOLOGY, PHRASEOLOGY AND ENVIRONMENTAL
AND DESIGN REQUIREMENTS FOR

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Revised

This AIR is intended to provide the sponsors of Minimum Performance Instrument Standards with standard wording and with Minimum Environmental and Design Requirements for use in the preparation of their documents.

The individual sponsor shall use only those parts of this AIR which apply to his particular document.

The individual sponsor shall expand the standard wording, especially sections 6 and 7, as required for his particular document.

The paragraphs of this AIR shall be used verbatim wherever possible.

Unless otherwise directed by the Committee, cross-referenced documents shall be called out by specific revision letter, e.g. "-----shall be in accordance with AS XXXA.

Title
(Reciprocating Engine Powered Aircraft)
or

Title
(Turbine Powered Subsonic Aircraft)

1. PURPOSE: This Aerospace Standard establishes the essential minimum safe performance standards for _____ Instruments primarily for use with reciprocating engine powered (or turbine powered subsonic, as applicable) transport aircraft, the operation of which may subject the instruments to the environmental conditions specified in Section 3.3.
2. SCOPE: This Aerospace Standard covers _____
or

SCOPE: This Aerospace Standard covers _____ basic types of _____ (no capitals) instruments as follows:

Type I: _____
Type II: _____

Note: Each type number to be followed by a brief description. As many types as required may be used.

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.

Section 8.3 of the SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against infringement of patents."

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 nameplate attached thereto:

- (a) Name of instrument.
- (b) SAE AS _____ (show number and revision letter).
- (c) Manufacturer's part number.
- (d) Manufacturer's serial number or date of manufacture.
- (e) Manufacturer's name and/or trademark.
- (f) Range (If applicable).
- (g) Rating (Electrical, Vacuum, etc.) (if applicable).
- (h) Explosion category (if applicable).

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 temperature shown in Column A below and shall not be adversely affected by exposure to the range of temperature shown in Column B below:

(Reciprocating Engine Powered Aircraft)

<u>Instrument Location</u>	<u>A</u>	<u>B</u>
Power Plant Compartment	-30 to 100 C	-65 to 100 C
Heated Areas (Temperature Controlled)	-30 to 50C	-65 to 70C
Unheated Areas (Temperature Uncontrolled)	-55 to 70C	-65 to 70C

(Turbine Powered Subsonic Aircraft)

<u>Instrument Location</u>	<u>A</u>	<u>B</u>
Power Plant Accessory Compartment	-30 to 150C	-65 to 150 C
Pressurized Areas	-30 to 70C	-65 to 70C
Non-pressurized or External Areas	-55 to 70C	-65 to 70C

3.3.2 Altitude: (Reciprocating Engine Powered Aircraft)

When installed in accordance with the instrument manufacturer's instructions, the instrument shall function and shall not be adversely affected following exposure 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 when subjected to an ambient pressure of 50 inches of Mercury absolute.

Altitude: (Turbine Powered Subsonic Aircraft)

When installed in accordance with the instrument manufacturer's instructions, the instrument shall function from sea level up to the altitudes and temperatures listed below: Altitude pressure values are per NACA Report 1235: The instrument shall not be adversely affected following exposure to extremes in ambient pressure of 50 and 3 inches of mercury absolute respectively.

<u>Instrument Location</u>	<u>Altitude</u>	<u>Temp.</u>
Power Plant Accessory Compartment	60,000 ft.	80C
Pressurized Areas	15,000 ft.	50C
Non-pressurized or External Areas	60,000 ft.	40C

3.3.3 Vibration: (Reciprocating Engine Powered Aircraft)

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:

<u>Instrument Location in Airframe</u>	<u>Cycles Per Sec.</u>	<u>Max. Double Amplitude (In.)</u>	<u>Maximum Acceleration</u>
Power Plant Mounted	5-150	0.100	20g
Wings and Empennage	5-500	0.036	10g
Fuselage	5-500	0.036	5g
Panel or Rack (Vibration Isolated)	5-500	0.020	1.5g

Vibration: (Turbine Powered Subsonic Aircraft)

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:

<u>Instrument Location</u>	<u>Frequency Cycles Per Sec.</u>	<u>Max. Double Amplitude - inches</u>	<u>Maximum Acceleration</u>
Nacelle, Nacelle Mounts, Wings, Empennage and Wheel Wells	5-1000	0.036	10g
Fuselage			
Forward of Spar Area	5-500	0.036	2g
Center or Spar Area	5-1000	0.036	4g
Aft of Spar Area	5-500	0.036	7g
	500-1000	-	5g
Vibration Isolated Rack	5-1000	0.030	1g
Flight Deck Area	5-30	0.020	-
	30-1000	-	0.25g

3.3.4 Humidity: The instrument shall function and shall not be adversely affected following exposure to any relative humidity in the range from 0 to 95% at a temperature of approximately 70C.

3.4 Explosion Category: The instrument component, when intended for installation either in uninhabited areas of non-pressurized aircraft or in non-pressurized areas of pressurized aircraft, shall not cause an explosion when operated in an explosive atmosphere. The component shall meet the requirements applicable to the explosion category below. Specifically, any instrument component which can be an ignition source and is intended for installation in an area in which combustible fluid or vapor may result from abnormal conditions, e.g., fuel line leakage, shall meet the requirements of Category I. If the intended location is an area where combustible fluid or vapor can occur during normal operation, e.g., fuel tank, the instrument component shall meet the requirements of Category II, listed below:

<u>Category</u>	<u>Definition</u>	<u>Requirement</u>
I	Explosion proofed: case not designed to preclude flame or explosion propagation.	Paragraph 7.3.1
II	Explosion proofed: case designed to preclude flame or explosion propagation.	Paragraph 7.3.2
III	Hermetically Sealed	Paragraph 6.2
IV	Instrument not capable of causing an explosion	Shall not be capable of producing a spark of more than 1.0 millijoule of energy and shall not have a short circuit current of more than 100 milliamperes.

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 instrument component contacted by combustible fuel or vapor shall not exceed 200C due to self-heating.

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

3.7 Magnetic Effect: The magnetic effect of the instruments shall not adversely effect the performance of other instruments installed in the same aircraft.

3.8 De-Compression: When installed in accordance with the instrument manufacturer's instructions the instrument shall function and not be adversely affected following exposure to a pressure decrease from 22 to 2 inches of mercury in 2 seconds.

4. DETAIL REQUIREMENTS:

4.1 Display Markings:

- 4.1.1 Finish: Unless otherwise specified by the user, matte white material shall be applied to all graduations, numerals and indication means.

Non-functional surfaces and markings shall be durable dull black.

- 4.1.2 Graduation: The graduations shall be arranged to provide the maximum of readability consistent with the accuracy of the instrument.

- 4.1.3 Numerals: The display shall include sufficient numerals to permit quick and positive identification of each graduation.

Numerals shall distinctly indicate the graduation to which each applies.

- 4.1.4 Instrument Title: The instrument title, when used, shall be of the same approximate size but no larger than the numerals. The title may be of the same finish as the numerals. The units of measure ("PSI x 1000", "Degrees C", "In. Hg. Abs.", as applicable) shall appear on the dial in lettering noticeably smaller than either the numerals or title.

- 4.1.5 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 deg 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.

- 4.2 Power Variation: The instrument shall properly function with plus or minus 15 percent variation in D. C. voltage and/or plus or minus 10 percent variation in A. C. voltage and plus or minus 5 percent variation in frequency, or hydraulic pressure limits of plus or minus 30 percent of rated value.

- 4.3 Power Malfunction Indication: Means shall be incorporated in the instrument to indicate when adequate power (voltage and/or current) is not being made available to all phases required for the proper operation of the instrument. The indicating means shall indicate a failure or a malfunction in a positive manner.

- 4.4 Hermetic Sealing: When hermetically sealed, the case shall be filled with an inert gas, free of dust particles, and sufficiently dry so that fogging of the indicator glass does not occur during the low temperature and fogging tests of this **Aerospace** Standard.

- 4.5 Synchro Requirements: The synchro requirements should be in accordance with the conditions specified in ARP 461A.

- 4.6 Gyro Caging: If a gyro caging means is provided, it shall not be capable of locking the gyro in a caged position. Any malfunction which causes the gyro to remain caged shall be indicated in a positive manner.

5. TEST CONDITIONS:

5.1 Atmospheric Conditions: Unless otherwise specified herein, all tests required by the Aerospace Standard shall be made at an atmospheric pressure of approximately 29.92 inches of mercury, an ambient temperature of approximately 25C and a relative humidity of not greater than 85%. When tests are conducted with the atmospheric pressure or temperature substantially different from these values, allowance shall be made for the variation from the specified conditions.

5.2 Vibration to Minimize Friction (Reciprocating Engine Powered Aircraft): Unless otherwise specified herein, 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 25 to 33 cycles per second. The term double amplitude as used herein, indicates the total displacement from positive maximum to negative maximum.

Vibration to Minimize Friction (Turbine Powered Subsonic Aircraft): Unless otherwise specified herein, all tests for performance may be conducted with the instrument subjected to a maximum vibration of 0.001 inch double amplitude at a frequency of 10 to 60 cycles per second. The term double amplitude, as used herein, indicates the total displacement from positive maximum to negative maximum.

5.3 Vibration Equipment (Reciprocating Engine Powered Aircraft): Vibration equipment shall be used which will provide frequencies and amplitudes consistent with the requirements of Paragraph 3.3.3, with the following characteristics:

Linear Motion Vibration: Vibration equipment shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the instrument.

Circular Motion Vibration: Vibration equipment 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.

Vibration Equipment (Turbine Powered Subsonic Aircraft): Vibration equipment shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the instrument at frequencies and amplitudes consistent with the requirements of Paragraph 3.3.3.

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

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

6. INDIVIDUAL PERFORMANCE REQUIREMENTS: All instruments shall be subjected to tests by the instrument manufacturer to demonstrate specific compliance with this Aerospace Standard, including the following requirements where applicable.

6.1 Dielectric: Each instrument shall be tested by the method of inspection listed in Paragraphs 6.1.1 and 6.1.2

- 6.1.1 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.
- 6.1.2 Overpotential Tests: The instruments 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 R.M.S. value of five times the maximum circuit voltage, or per Paragraph 6.1.2.1 or 6.1.2.2, 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.

- 6.1.2.1 Hermetically sealed instruments shall be tested at five times the maximum circuit voltage up to a maximum of 200 volts R.M.S.
- 6.1.2.2 Circuits that operate at potentials below 15 volts are not to be subjected to overpotential tests.
- 6.2 Sealing: Hermetically sealed components shall be tested for leaks by means of a mass spectrometer type of helium leak detector or equivalent. The leak rate shall not exceed 76 micron cubic feet per hour per cubic foot of filling gas at a pressure differential of one atmosphere.

Note: A micron per hour per cubic foot leak rate is defined as that gas leakage which would change the pressure of a one cubic foot volume by the amount of one micron (one millionth of a meter of mercury) in one hour.

7. QUALIFICATION TESTS: As many instruments or components deemed necessary by the manufacturer to demonstrate that all instruments will comply with the requirements of this section shall be tested in accordance with his recommendations.

7.1 Temperature Characteristics:

- 7.1.1 Low Temperature Operation: The instrument shall be subjected to the applicable low ambient temperature listed in Column A of Paragraph 3.3.1 for a period of five hours without operating. The instrument shall meet, at that temperature, the applicable individual performance tests. (Section 6, except 6.1).
- 7.1.2 High Temperature Operation: The instrument shall be subjected to the applicable high ambient temperature listed in Column A of Paragraph 3.3.1 for a period of five hours without operating. (Electrical equipment shall be energized.) The instrument shall meet, at that temperature, the applicable individual performance tests. (Section 6, except 6.1).

7.1.3 Extreme Temperature Exposure: The instrument shall be exposed to the applicable low and high temperatures listed in Column B of Paragraph 3.3.1 for a period of 24 hours at each extreme temperature, without operating. After a delay of three hours at room temperature, the instrument shall meet the applicable individual performance tests (Section 6, except 6.1) at room temperature. There shall be no evidence of damage as a result of exposure to the extreme temperatures specified.

7.1.4 Altitude (Turbine Powered Subsonic Aircraft): The instrument shall be subjected to the ambient temperature and pressure listed in Paragraph 3.3.2 for a period of three hours while operating. The instrument shall then meet, at the conditions specified, the applicable individual performance tests. (Section 6, except 6.1)

The instrument shall be exposed alternately to 50 inches Hg absolute and three inches Hg absolute, non-operating. The instrument shall meet the applicable individual performance tests (Section 6, except 6.1) at atmospheric pressure following this test.

7.2 Vibration: After the completion of the following vibration tests, no damage shall be evident and the instrument shall meet the applicable individual performance tests. (Section 6, except 6.1)

7.2.1 Resonance: The instrument, while operating, shall be subjected to a resonant frequency survey of the appropriate range specified in Paragraph 3.3.3 in order to determine if there exists any resonant frequencies of the parts. The amplitude used may be any convenient value that does not exceed the maximum double amplitude and the maximum acceleration specified in Paragraph 3.3.3.

The instrument shall then be subjected to vibration at the appropriate maximum double amplitude or maximum acceleration specified in Paragraph 3.3.3 at the resonant frequency for a period of one hour along each axis. If more than one resonant frequency is encountered with vibration applied along any one axis, a test period may be accomplished at the most severe resonance, or the period may be divided among the resonant frequencies, whichever shall be considered most likely to produce failure. The test period shall not be less than one-half hour at any resonant mode. When resonant frequencies are not apparent within the specified frequency range, the instrument shall be vibrated for two hours along each axis in accordance with the vibration requirements schedule (Paragraph 3.3.3) at the maximum double amplitude and frequency to provide the maximum acceleration.

7.2.2 Cycling: The instrument, while operating, shall be tested with the frequency cycled between limits specified in Paragraph 3.3.3 in 15 minute cycles for a period of one hour along each axis at an applied double amplitude specified in Paragraph 3.3.3, or an acceleration specified in Paragraph 3.3.3, whichever is the limiting value or a total of three hours for circular motion vibration, whichever is applicable.

During this test the instrument shall meet the individual accuracy performance requirements as specified in the individual A.S. (The need for and type of performance checks shall be determined by individual A.S. requirements).

7.3 Explosionproof:

The instrument component shall be subjected to whatever requirements are applicable for the specific category listed in Paragraph 3.4. The following requirements cover only two categories.