

BANK AND PITCH INSTRUMENTS

(Indicating Stabilized Type)(Gyroscopic Horizon, Attitude Gyro)(Turbine-Powered Subsonic Aircraft)

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Revised

1. **PURPOSE:** This Aerospace Standard establishes the essential minimum safe performance standards for gyroscopically stabilized Bank and Pitch Indicating Instruments primarily for use with turbine-power subsonic transport aircraft, the operation of which may subject the instruments to the environmental conditions specified in Paragraph 3.3.
2. **SCOPE:** This Aerospace Standard covers both direct and remote display instruments.
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 legibly and permanently be marked on the instrument or nameplate attached thereto:
 - (a) Name of instrument
 - (b) SAE AS 441
 - (c) Manufacturer's part number
 - (d) Manufacturer's serial number or date of manufacture
 - (e) Manufacturer's name and/or trademark
 - (f) Rating (electrical, vacuum, etc.)
 - (g) Explosion (Category)
 - 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 instruments shall function over the range of ambient temperatures as listed in Column A below and shall not be adversely affected by exposure to the temperature shown in Column B below.

Instrument Location:

Pressurized Areas

Non-Pressurized or External Areas

A

-30 to +70 C

-55 to +70 C

B

-65 to +70 C

-65 to +70 C

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 liability for infringement of patents."

- 2 -

- 3.3.2 Altitude: When installed in accordance with the instrument manufacturer's instructions, the instruments shall function from sea level up to the altitudes and temperatures listed below. Altitude pressures are per NACA Report 1235.

The instrument shall not be adversely affected following exposure to extremes in ambient pressure of 50 and 3 inches Hg absolute respectively.

<u>Instrument Location</u>	<u>Alt. Ft.</u>	<u>Temp. C</u>
Pressurized Areas	15,000	50
Non-Pressurized or External Areas	60,000	40

- 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.

<u>Instrument Location</u>	<u>Frequency (cps)</u>	<u>Maximum Double Amplitude (inches)</u>	<u>Maximum Acceleration (g)</u>
Nacelle, Nacelle Mounts, Wings, Empennage and Wheel Wells	5-1000	0.036	10
Fuselage			
Forward of Spar Area	5-500	0.036	2
Center of Spar Area	5-1000	0.036	4
Aft of Spar Area	5-500	0.036	7
	500-1000	---	5
Vibration Isolated Rack	5-1000	0.030	1
Instrument Panel	5-30	0.020	--
	30-1000	---	0.25

- 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 70 C.

- 3.4 Explosion Category: The instrument component, when intended for installation either in the uninhabited areas of non-pressurized aircraft or in the 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:

- 3 -

<u>Category</u>	<u>Definition</u>	<u>Requirements</u>
I	Explosion Proofed; case not designed to prevent flame or explosion propagation.	Test per Para. 7.4.1.1
II	Explosion Proofed; case designed to prevent flame or explosion propagation.	Test per Para. 7.4.1.2
III	Hermetically Sealed	Test per Para. 7.7
IV	Instrument not capable of causing an explosion	Shall not be capable of producing a spark with more than 1.0 millijoules 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 20 C 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 affect 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 Hg 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 Graduations: The graduations shall be arranged to provide the maximum of readability consistent with the accuracy of the instrument.

- 4 -

- 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 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 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 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.
- 4.2 Power Variation: The instrument shall properly function with $\pm 15\%$ variation in d-c voltage and/or $\pm 10\%$ variation in a-c voltage and $\pm 5\%$ variation in frequency.
- 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 tests of this Aerospace Standard.
- 4.5 Synchro Requirements: The synchro requirements shall 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 failure which causes the gyro to be caged shall be indicated in a positive manner.
- 4.7 Operating Range: The instrument shall be operable following maneuvers of 360 degrees in bank and 360 degrees in pitch. Controlled precession may be employed to achieve the 360 degrees in pitch.
- 4.8 Methods of Display: The method of displaying bank and pitch attitude is specified below:

Bank attitude shall be pictorially displayed so that the true relationship between aircraft bank attitude and the actual earth's horizon is clearly presented over the range of indication.

Pitch attitude shall be pictorially displayed so that a change between the aircraft's pitch attitude and the actual earth's horizon is clearly presented in the proper relationship over the range of indication.