SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS420

REV. B

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Flight Directors
(Reciprocating Engine Powered Aircraft)

FOREWORD

This document has been declared “NONCURRENT”. It is recommended, therefore, that this document not be specified for new designs. “NONCURRENT” refers to those documents which have previously been widely referenced and may continue to be required on some existing designs. “NONCURRENT” documents are available from SAE upon request.

1. PURPOSE:

   This Aerospace Standard establishes essential minimum safe performance standards for Flight Director instruments primarily for use with reciprocating engine powered 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 Flight Directors for use on aircraft to indicate to the pilot, by visual means, the correct control application for the operation of an aircraft in accordance with a pre-selected flight plan.

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.

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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 AS420B.
c. Manufacturer's part number.
d. Manufacturer's serial number or date of manufacture.
e. Manufacturer's name and/or trademark.

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 shown in Column A below, and shall not be adversely affected by exposure to the temperatures shown in Column B below:

Instrument Location	A	B
Heated Areas (Temperature Controlled)	-30 to 50 C	-65 to 70 C
Unheated Areas (Temperature Uncontrolled)	-55 to 70 C	-65 to 70 C

3.3.2 Altitude: 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 mercury absolute.

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:

Instrument Location in Airframe	Cycles Per Sec.	Max. Double Amplitude (Inches)	Max. Acceleration
Fuselage	5 - 500	0.036	5g
Panel or Rack (Vibration Isolated)	5 - 50	0.020	1.5g

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 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 feedback, in electronic equipment installed in the same aircraft as the instrument.

3.5 Magnetic Effect:

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

4. DETAIL REQUIREMENTS:

4.1 Indication:

4.1.1 Flight Director Indicator:

4.1.1.1 Lateral Steering Control Indication: When a means of indication for lateral steering control is provided, the sensing of this command presentation should be such that the aircraft is flown toward the indication to satisfy the command (i.e., consistent with “fly to needle” type of instrumentation sensing).

While not limited to the following signals, any one, or combination of these signals, shall produce an indication of the correct control application to maintain flight along a prescribed flight path.

a. Angular displacement of the aircraft about the roll axis.
b. Angular displacement of the aircraft in heading from a reference heading.
c. Lateral displacement of the aircraft with respect to a selected course.

4.1.1.2 Vertical Steering Control Indication: When a means of indication for vertical steering control (pitch command) is provided, the sensing of this command presentation should be such that the aircraft is flown toward the indication to satisfy the command (i.e. consistent with “fly to needle” type of instrumentation sensing).

While not limited to the following signals, any one, or combination of these signals shall produce an indication of correct control application to maintain flight along a prescribed flight path.

a. Angular displacement of the aircraft about the pitch axis from the (reference) Pitch attitude.
b. Vertical displacement of the aircraft with respect to the glide slope.
c. Vertical displacement of the aircraft from an altitude reference, whenever altitude control is provided in the equipment.

4.1.1.3 Attitude Indication: When attitude indication is included in the Flight Director presentation it shall conform to AS396B.

4.1.1.4 Heading Indication: When Heading indication is included in the Flight Director presentation it shall conform to AS399A.

4.1.1.5 Dial Finish: Unless otherwise specified by the user, matte white material shall be applied to major graduations, numbers and pointers. Non-functional surfaces shall be a durable dull black.

4.2 Heading and Course Selectors:

4.2.1 Heading Selector: Means shall be provided to permit setting the desired heading into the Flight Direction System. Indication of the heading selected shall be continuously provided.

4.2.2 Radio Course Selector: If a radio navigation reference is included, means shall be provided to permit setting the desired radio course into the Flight Direction System. Indication of the course selected shall be continuously provided.

4.3 Manual Pitch Kob:

Means shall be provided for manually setting the pitch control pointer to zero reference during climb and descent so as to indicate correct control application to seek and maintain flight at the desired pitch angle. This manual setting feature may be ineffective during approach and constant altitude modes of operation.

4.4 Function Selector(s):

Means shall be provided for selecting the mode of operation (as applicable). The following are examples of possible modes of operation.

a. Hold attitude
b. Hold heading
c. Hold radio course
d. Approach (ILS)
e. Hold airspeed
f. Hold altitude

4.5 Attitude Limiter:

Provisions shall be made to limit, either electrically or visually, the control indications commanded by the system so that a preset maximum value of bank and pitch shall not be exceeded.

4.6 Safety Provisions:

4.6.1 Interlock Provisions: Provisions shall be made to prevent simultaneous applications of control signals which would result in unsafe command indications. As an example, simultaneous application of approach and constant altitude control signals would be considered unsafe.

4.6.2 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 of the phases required for the proper operation of the instrument. The indicating means shall indicate a failure or a malfunction in a positive manner.

4.6.3 Reliability: The design of the instrument shall be such as to preclude (insofar as possible) any hazardous maneuver resulting from malfunction. Where practical an indicating means should be provided to warn against malfunctions.

4.7 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.

5. TEST CONDITIONS:

5.1 Atmospheric Conditions:

Unless otherwise specified herein, all tests required by this Aerospace Standard shall be conducted at an atmospheric pressure of approximately 29.92 inches of mercury and at an ambient temperature of approximately 25C and a relative humidity of not greater than 85%. When tests are conducted 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:

5.2.1 Vibration to Minimize Friction: 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 30 cycles per second. The term double amplitude as used herein indicates the 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 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.

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 methods of inspection listed in paragraph 6.1.1 and 6.1.2.

6.1.1 Insulation Resistance: The insulation resistance measured at 200 volts D.C. 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 the R.M.S. value of five times the maximum circuit voltage or per paragraphs 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 assure proper electrical insulation 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 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.

7. QUALIFICATION TESTS:

As many instruments or components as 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. After completion of all other qualification tests each component shall be tested and shall meet the requirements of Section 6.1 Dielectric.

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 test. (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 test. (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.