SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.
485 LEXINGTON AVENUE
NEW YORK 17, N.Y.

AERONAUTICAL STANDARD AS 398A

DIRECTION INSTRUMENT, MAGNETIC, NON-STABILIZED TYPE (Magnetic Compass)

Issued 7-1-47
Revised 7-15-58

1. PURPOSE: To specify minimum requirements for non-stabilized magnetic direction instruments for use in aircraft, the operation of which may subject the instrument to the environmental conditions specified in Paragraph 3.3.

2. SCOPE: This Aeronautical Standard covers two basic types of instruments as follows:

Type I - Direct Reading
Type II - Remote Indicating

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 be legibly and permanently marked on the instrument or attached thereto:

(a) Name of Instrument
(b) Aeronautical Standard AS 398A
(c) Manufacturer's part number
(d) Manufacturer's serial number or date of manufacture
(e) Manufacturer's name and/or trademark
(f) Rating, if applicable (Electrical, Vacuum, etc.)

3.3 Environmental Conditions: The following conditions have been 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 temperature shown in Column A below and shall not be adversely affected by exposure to the range of temperature shown in Column B below:

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

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 a temperature of approximately 32C.

Printed in U. S. A.

3.3.3 Vibration: When installed in accordance with the instrument manufacturer's instructions, the instruments 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
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 (with Shockmounts)	5 - 50	0.020	1.5g

3.3.4 Altitude: The instrument shall function and shall not be adversely affected when subjected to a pressure and temperature range equivalent from -1000 feet to 40,000 feet standard altitude per NACA Report 1235, except as limited by application of Paragraph 3.3.1. The instrument shall not be adversely affected when subjected to a pressure of 50 in. Hg. absolute.

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 equipment installed in the same aircraft as the instrument.

3.5 Magnetic Effect: The magnetic effect of the instrument shall not adversely affect the operation of other instruments installed in the same aircraft.

4. DETAIL REQUIREMENTS:

4.1 Indicating Method: One of the following methods of indication shall be employed:

Method I — Horizontal drum dial with fixed lubber's line. Graduations move to the right for right turns.

Method II — Rotating vertical dial with fixed lubber's line. Dial rotates counter-clockwise for right turns.

Method III — Rotating pointer with fixed graduated dial. Pointer rotates clockwise for right turns. Dial position may be settable.

4.2 Operating Limits: During straight flight the instrument shall indicate magnetic headings, throughout the 360 degree scale range, during dives, climbs or banks up to at least 20 degrees displacement from level flight.

4.3 Dial Markings:

4.3.1 Graduations: The indicators shall be provided with degree graduations at intervals not to exceed 5 degrees, with major graduations every 10 degrees and with numerical markings at intervals not greater than 30 degrees, except that the 0, 90, 180 and 270 degree positions shall be marked N, E, S and W respectively.

4.3.2 Visibility: Index and dial markings shall be visible from any point within the frustum of a cone the side of which makes an angle of 30 degrees with the perpendicular to the dial and the small diameter of which is the aperture of the instrument case. At least two numerals shall be simultaneously visible.

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

4.4 Power Variations: All units shall properly function with ± 15% variation in D.C. voltage and/or ± 10% variation in A.C. voltage and a ± 5% frequency variation.

4.5 Compensation Provisions: Means shall be provided for compensating for semicircular deviation. Compensating effect shall be between 15 and 40 degrees in each direction for each axis when adjusted for maximum effect.

4.6 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.

5. TEST CONDITIONS:

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

5.2 Vibration (to minimize friction): Unless otherwise specified, 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 1500 to 2000 cycles per minute. 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:

5.3.1 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.

5.3.2 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, all tests shall be conducted at the power rating recommended by the manufacturer.

5.5 Position: Unless otherwise specified, all tests shall be made with the instrument (indicators, amplifiers, transmitters, etc.) mounted in their normal operating position.

5.6 Magnetic Field Strength: Unless otherwise specified, all tests required by this Aeronautical Standard shall be made with a horizontal field strength of approximately 0.18 gauss and a vertical field strength of approximately 0.54 gauss, in the direction normal in the northern hemisphere. When tests are made with field strength values substantially different from these values, allowance shall be made for variations from the specified tolerances.

5.7 Compensators: Unless otherwise specified, all tests shall be made with magnetic compensators removed or adjusted to neutral position.

6. INDIVIDUAL PERFORMANCE REQUIREMENTS: All instruments shall be subjected to whatever tests the manufacturer deems necessary to demonstrate specified compliance with this Aeronautical Standard including the following requirements where applicable.

6.1 Leakage: Liquid-filled indicators or transmitters shall not show evidence of leakage after having been placed in a bell jar and subjected to a pressure equivalent to 40,000 feet standard altitude for a period of 1 hour.

6.2 Scale Error: When the magnetic-sensitive unit is placed on magnetic headings at 30 degree intervals starting from North the indicated headings shall correspond to actual magnetic headings within 4 degrees.

6.3 Friction: When the magnetic element has been deflected 5 degrees first to right and then to left, from its equilibrium position and then allowed to come to rest, the difference between the two indicator readings at rest shall not exceed 1 degree.

6.4 Damping: When the magnetic element has been deflected 30 degrees first to the right and to the left, from its equilibrium position, the time required for the indicator dial (or pointer) to pass through the 25 degree angle toward the original indicated heading shall not exceed 5.0 seconds or be less than 1.0 seconds. The maximum overswing past the original indicated heading shall not exceed 15 degrees.

6.5 Heeling Error: When the magnetic-sensitive unit is tilted 20 degrees from the normal level position the magnetic element shall be free to rotate through 360 degrees. When the unit is tilted 10 degrees the indicated heading shall not differ from the indicated heading with the magnetic-sensitive unit in normal level position by more than 4 degrees. The indicator dial (or pointer) shall still be visible as specified in Paragraph 4.3.2.

6.6 Swirl: When the magnetic-sensitive unit is tilted 20 degrees from normal and rotated in azimuth, at a rate of 30 degrees per second, through 360 degrees, stopping at N, S, E and W indication, the overswing of the indicator dial (or pointer) at each of these points shall not exceed 6 degrees.

6.7 Compensation: With the magnetic-sensitive unit on N heading and the compensator adjusted for minimum effect, the scale error with the compensator shall not differ from the scale error without compensator by more than 2 degrees. The maximum adjustable compensation effect shall be between 15 and 40 degrees in each direction for each axis.

When the magnetic-sensitive unit is placed on any cardinal heading and the opposite axis compensator adjusted for maximum effect the indicated heading shall not change more than 2 degrees.

6.8 Dielectric: Ungrounded instruments or grounded instruments prior to connection of internal ground wire, shall be tested by either the method of inspection of Paragraph 6.8.1 and 6.8.2.

6.8.1 Insulation Resistance: The insulation resistance measured at 500 volts D.C. (200 volts for hermetically sealed, inert gas filled instruments) between all electrical circuits connected together and the metallic case shall not be less than 20 megohms.

6.8.2 Dielectric Strength: The insulation shall withstand without evidence of damage the application of a sinusoidal voltage at a commercial frequency between all electrical circuits connected together and the metallic case, for a period of five seconds. The RMS value of the sinusoidal voltage applied shall be either five (5) times the maximum instrument operating voltage, or 500 volts, whichever is lower, except that on hermetically sealed, (inert gas filled instruments) the test voltage shall be 200 volts RMS.

6.8.2.1 Instruments having a permanent internal ground connection shall be tested as follows:

The insulation shall withstand without evidence of damage the application of a sinusoidal voltage at a commercial frequency between each electric circuit and the metallic case, for a period of five (5) seconds. The RMS value of the sinusoidal voltage applied shall be 1.25 times the maximum circuit operating voltage obtainable between the test points.