



DRAFT Advisory Circular

AC 43-17(0)

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CALIBRATION OF AIRCRAFT COMPASSES

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1. REFERENCES

1	Civil Aviation Safety Regulation (CASR) 43.050.
1	CAANZ Advisory Circular 43-7. Calibration of compasses and surveying compass swing sites.
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2. PURPOSE

3	This Advisory Circular (AC) provides information on methods, techniques, and practices for the calibration of aircraft compasses.
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3. STATUS OF THIS AC

6	This is the first AC to be issued on this subject.
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Advisory Circulars are intended to provide recommendations and guidance to illustrate a means but not necessarily the only means of complying with the Regulations, or to explain certain regulatory requirements by providing interpretative and explanatory material.

Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.

ACs should always be read in conjunction with the referenced regulations

4. DEFINITIONS

For the purpose of this AC the following definitions are used:

Air-swing: means to perform the calibration of a compass during a flight detailed for this purpose.

Calibration: means the measurement of residual deviations of a compass installed in an aircraft, any necessary compensation of this deviation, and the recording of the residual deviation.

Compass Swing Site: means a prepared area with minimum magnetic abnormalities on which an aircraft may be oriented or swung to various headings for the purpose of checking the aircraft on-board compass systems and the standby compass.

Compensation: means the correction of deviations resulting from magnetism in an aircraft.

Deviation: means the angle required to be added algebraically to a compass reading to obtain the aircraft magnetic heading.

Direct reading compass: means a compass having the magnetic sensing element and heading indication located in the one instrument.

Remote indicating compass (non-stabilised): means a remote indicating compass without gyroscopic means of stabilisation or smoothing (e.g. Magnesyn compass).

Remote indicating compass (stabilised): means a compass system which has the magnetic sensing element located remotely from the indicator(s) together with gyroscopic means to stabilise or smooth the heading indications.

Standby compass: means a direct reading compass which is not used as the primary heading reference.

5. GENERAL

5.1 This Advisory Circular provides helpful information with regard to calibration of aircraft compasses when addressing the requirements of CASR 43.050. Under this regulation a person carrying out maintenance must use:

- (a) the methods, techniques and practices set out in:
 - (i) the manufacturer's maintenance manual for the aircraft or aeronautical product concerned; or
 - (ii) the Instructions for Continued Airworthiness issued by the manufacturer of the aircraft or product; or
- (b) another method, technique or practice acceptable to an AAR or CASA.

The following information describes a method that may be used to perform calibration of aircraft compasses to meet the requirement of CASR 43.050(1)(b).

5.2 Aircraft compass calibration may be conducted by using approved compass calibration equipment or by aligning an aircraft on known magnetic headings for the purpose of determining and compensating the degree of error in the compass system(s) and the magnetic standby compass. This procedure should only be conducted at a suitable compass swing site that is level and free from magnetic disturbances. When conducting a compass swing, manufacturer's procedures should be followed. Where no manufacturer's procedures are available the procedures in this Advisory Circular provide information on compass calibration procedures.

6. OCCASIONS FOR CALIBRATION

6.1 Each installed compass or compass system should be calibrated:

- (a) prior to the issue of an initial Certificate of Airworthiness; or
- (b) at intervals specified in the aircraft's Maintenance Program.

6.2 Each compass or compass system should also be calibrated:

- (a) when initially installed or reinstalled in an aircraft;
- (b) when permanently locating an aircraft from northern hemisphere operations to southern hemisphere operations;
- (c) after an engine change, unless the aircraft manufacturer prescribes otherwise;
- (d) whenever a magnetic sensing element has been changed or relocated;
- (e) after modification of an electrical or avionic system installation of the aircraft, unless the certifying engineer is satisfied that the modification will not affect the compass;
- (f) after a suspected lightning strike, unless an in-flight comparison on at least four headings, checked 90 degrees apart proves that no change of deviation has occurred between the standby compass and compass system(s) installed on the aircraft;

Note: A heading check may only be made during the flight on which a suspected strike has occurred if this procedure is documented in the appropriate aircraft flight manual.

- (g) after any maintenance involving the addition, removal, or relocation of magnetic materials likely to influence compass deviation;

Note: Manufacturers maintenance manuals may indicate the components that, if changed, would require the compass to be swung.

- (h) following any operational occurrence, such as an accident, or heavy landing, that is likely to affect compass deviation; and
- (i) after long-term storage of the aircraft whenever there is reason to suspect that a change of deviation may have occurred.

7. COMPASS CALIBRATION

7.1 Compass calibration should be conducted using approved compass calibration equipment by aligning the fore and aft axis of the aircraft with each cardinal and 30 degrees magnetic heading intervals. The deviation is determined at each magnetic heading with all equipment positioned and operating so that the magnetic effects of the aircraft as sensed by the compass(es) are as near as is practicable to those of straight and level flight. The deviation at any heading should not exceed:

- (a) 2 degrees for a remote indicating compass (stabilised);
- (b) 5 degrees for a remote indicating compass (non-stabilised);
- (c) 5 degrees for a direct reading compass used as the primary compass; and
- (d) 10 degrees for a standby compass.

Note 1: Some aircraft manufacturers may only have a requirement in their maintenance manual for a swing to be accomplished on 8 headings at 45 degree intervals. In this circumstance the four main cardinal points, North, East, South, West and the four intermediate points, Northeast, Southeast, Southwest and Northwest are the headings to be used.

Note 2: An acceptable procedure for compass calibration is described in paragraph 13 of this Advisory Circular.

7.2 Any practical combination of aircraft systems, that are positioned, operated or loaded within their operating limits should not vary the compass deviations existing under the conditions specified in paragraph 7.1 in excess of:

- (a) 2 degrees for a remote indicating compass (stabilised);
- (b) 4 degrees for a remote indicating compass (non-stabilised);
- (c) 5 degrees for a direct reading compass used as the primary compass; and
- (d) 8 degrees for a standby compass except that in specific circumstances, magnetic interference to a standby compass may exceed 8 degrees provided that details of these circumstances are stated in the operations or flight manuals and placarded adjacent to the compass;

except that magnetic interference that occurs only occasionally and for short periods may be ignored.

8. COMPASS COMPENSATION

8.1 Compasses need to be compensated when the result of the compass calibration discloses:

- (a) a deviation which differs by 3 degrees or more from that anticipated by virtue of a previous calibration; or
- (b) a deviation in excess of the limits specified in paragraph 7.1 on any heading.

8.2 Compass compensation is performed by aligning the fore and aft axis of the aircraft with each of the cardinal and 30 degree magnetic headings and:

- (a) determining the compass deviations;
- (a) compensating the compass for coefficients. A, B and C if they exceed 2 degrees.

Note: Acceptable procedures for compass compensation are described in paragraph 13 of this Advisory Circular.

9. DE-MAGNETISATION

9.1 Aircraft compass calibration can be affected by the magnetisation of the aircraft and its components. This magnetisation may be a result of residual magnetism of installed aircraft components or as result of a lightning strike. In the case of a lightning strike the disturbance can be very high and any de-magnetisation should not be attempted until the aircraft is magnetically stable. Stabilisation can take several days.

9.2 If after a suspected lightning strike, an in-flight comparison check performed on at least four headings, checked 90 degrees apart indicates that deviation has occurred between the standby compass and compass system(s) installed on the aircraft the aircraft should be de-magnetised and a compass swing carried out.

9.3 De-magnetisation should be accomplished in accordance with the manufacturer's recommendations.

9.4 After de-magnetisation the aircraft should be flown twice, each flight for at least one hour, performing figure of eight manoeuvres on each of the main compass headings to stabilise the magnetism. The deviations should be calculated during these flights to determine the effectiveness of the de-magnetisation process. The aircraft compass(es) should be re-swung two months after the de-magnetisation to ensure that the aircraft is magnetically stable.

10. PREPARATION FOR COMPASS SWING

10.1 Prior to swinging a compass the preparations outlined in subparagraphs (1), (2), (3) and (4) of this paragraph should be completed.

- (1) The serviceability of the compass should be checked in accordance with the compass manufacturer's specifications. In lieu of the manufacturer's specifications a direct reading compass may be established as complying with the following:
 - (a) Prior to calibration the compass should be checked for general serviceability and it should be verified that:
 - (i) there are no signs of leakage of the liquid;
 - (ii) bubbles, excessive sediment and discolouration shall not be present in the liquid.

Note: In-service refilling or topping up of compass fluid is not permitted as manufacturers requirements call for the use of isobaric or vacuum chambers for de-aerating the compass fluid during the filling process.

- (b) the pivot friction should not exceed the compass manufacturer's tolerance except that where those tolerances are not known the pivot friction shall be determined by deflecting the compass through 10 degrees then removing the deflecting force after which the compass shall return to within 2 degrees of its original indication; and
 - (c) the compass mounting should be sound and serviceable.
- (2) All equipment not normally carried in the aircraft should be removed;
 - (3) All equipment normally carried in the aircraft is stowed in its usual position.
 - (4) The flight controls are in their normal position for straight and level flight.

Note: Direct reading compasses should be checked prior to installation to ensure that the compass element is balanced correctly.

11. AIR-SWINGS

11.1 For aircraft equipped with Global Positioning Systems (GPS), Inertial Reference Navigation Systems (INS) or Attitude and Heading Reference Systems (AHRS) an air-swing may be conducted to ensure the serviceability of compasses. An air-swing involves flying the aircraft on twelve headings; north, north north east, north east, east, south east, south south east, south, south southwest, south west, west, north west and north north west, established from the GPS, INS or AHRS and checking the aircraft magnetic compass heading against this heading. A flight test checklist should be used that provides for recording the directly read deviations. This checklist should be used to create the compass correction card and be included in the aircraft records.

12. RECORDING

12.1 The results of each compass swing should be recorded in the aircraft records, e.g. an Aircraft Log Book or an alternative maintenance record, whichever is applicable.

12.2 A compass correction card should be compiled for primary and standby compasses in legible form showing:

- (a) the magnetic heading and compass reading necessary to achieve the magnetic heading at the cardinal and intermediate 30 degree headings, unless the deviation under any condition of operation is less than one degree, in which case the card may be endorsed 'ERRORS LESS THAN 1' in lieu of the corrected headings;
- (b) the corrections to be applied where a change in compass deviation within the limits permitted in paragraph 7.2 is found during compass calibration due to the operation of radio or electrical services whose use may be optional depending on operational requirements;
- (c) the date of the compass swing;
- (d) the identification of the aircraft;

- (e) the type and serial number of the compass, and
- (f) the signature of the person authorised to certify for completion of the compass swing.

Note: An additional card may be used if necessary to comply with subparagraph 12.2 (b).

12.3 The compass correction card should be provided with protection against water or other damage, and shall be installed near the compass. in easy view of the flight crew.

13. CALIBRATION AND COMPENSATION OF AIRCRAFT COMPASSES — AN ACCEPTABLE PROCEDURE

13.1 Calibration

- (a) Head the aircraft within 5 degrees of each cardinal and 30 degree magnetic heading. Determine the deviation at each heading. At each cardinal heading check whether a change in deviation occurs when engine(s) electrical or radio equipment is operated. Repeat these checks at each 30 degrees if a change in deviation does occur.
- (b) Compare the results of the calibration with the previous calibration and observe the requirements of paragraphs 7, 8 and 12 of this Advisory Circular.

Note: Compass swings may be carried out in either a clockwise or anti-clockwise direction. Better results may be achieved by adopting a standard direction procedure for the site, taking into account the magnetic anomalies of the site.

13.2 Compensation

13.2.1 Coefficient method

- (a) Set compensator magnets to neutral (where applicable).
- (b) Head the aircraft fore and aft axis within 5 degrees of each magnetic cardinal heading and determine the deviations.

Calculate coefficients A, B and C by the formulae:

$$\text{Coeff A} = \frac{\text{Dev. North} + \text{Dev. East} + \text{Dev. South} + \text{Dev. West}}{4}$$

$$\text{Coeff B} = \frac{\text{Dev. East} - \text{Dev. West}}{2}$$

$$\text{Coeff C} = \frac{\text{Dev. North} - \text{Dev. South}}{2}$$

- (c) With the aircraft on any cardinal magnetic heading add coefficient A algebraically to the compass reading. Rotate the compass or magnetic sensing element until the compass reads the corrected heading. This adjustment, normally, is not applicable to panel mounted compasses.

- (d) Head the aircraft on North within 5 degrees. Add coefficient C algebraically to the compass reading. Adjust the NS compensator to make the compass read the corrected reading.
- (e) Head the aircraft on East within 5 degrees. Add coefficient B algebraically to the compass reading. Adjust the EW compensator to make the compass read the corrected reading.
- (f) Conduct the compass calibration specified in paragraph 13.1 of this Advisory Circular.

Note: Compensation may be made by either the correction of coefficients B and C or by halving the deviations of complementary cardinal headings. The latter method normally is only used for direct reading compasses in aircraft always operated in IFR conditions or for standby compasses.

13.2.2 Simplified method

- (a) Set the compensator magnets to neutral.
 - (b) Determine and remove if applicable any coefficient A as specified in subparagraph 13.2.1 (b) and 13.2.1 (c).
 - (c) Head the aircraft on magnetic North within 5 degrees. Determine the aircraft magnetic heading and adjust the NS compensator to make the compass read the aircraft magnetic heading.
 - (d) Head the aircraft on magnetic East within 5 degrees. Determine the aircraft magnetic heading and adjust the EW compensator to make the compass read the aircraft magnetic heading.
 - (e) Head the aircraft on magnetic South within 5 degrees. Determine the aircraft magnetic heading. Adjust the NS compensator to make the compass read half the difference between the aircraft magnetic heading and the compass reading.
 - (f) Head the aircraft on magnetic West within 5 degrees. Determine the aircraft magnetic heading. Adjust the EW compensator to make the compass read half the difference between the aircraft magnetic heading and the compass reading.
 - (g) Conduct the compass calibration specified in paragraph 13.1 of this Advisory Circular.
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Bill McIntyre
Executive Manager
Aviation Safety Standards