

Advisory Circular

CALIBRATION OF COMPASS

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- 1 **GENERAL.** Pursuant to paragraph 88B of the Air Navigation Order, the Director-General of the Civil Aviation Authority of Singapore (DGCA) may, from time to time, issue advisory circulars (ACs) on any aspect of safety in civil aviation. This AC contains information about standards, practices and procedures acceptable to CAAS. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.
- 2 **PURPOSE.** This AC is issued to provide information and guidance related to calibration of compass installed on an aircraft. It contains information for interested parties who are performing maintenance to ensure the accuracy of an aircraft compass.
- 3 **APPLICABILITY.** This AC applies to parties involved in maintenance of compasses installed on an aircraft.
- 4 **CANCELLATION.** This is the first AC issued on this subject.
- 5 **EFFECTIVE DATE.** This AC is effective on 31 December 2012.
- 6 **REFERENCES.**
 - Air Navigation Order;
 - Singapore Airworthiness Requirements;
 - Advisory Circular AC43-7 – Calibration of compasses and surveying compass swing sites from Civil Aviation Authority of New Zealand; and
 - Civil Aircraft Airworthiness Information and Procedures Part 8, Leaflet 8-1 – Compass Base Surveying and Leaflet 8-2 – Compasses from Civil Aviation Authority of the United Kingdom.
- 7 **DEFINITIONS.** For the purpose of this Advisory Circular, the following definitions shall apply:-
Calibration means the measurement of residual deviations of a compass installed in an aircraft;
Compensation means the correction of deviations resulting from permanent magnetism in the aircraft;
Deviation means the angle required to be added algebraically to the compass reading to obtain the aircraft magnetic heading;

Direct Reading Compass means a compass which has the magnetic sensing element and heading indication located in one instrument; and

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

8 REQUIREMENT FOR COMPASS CALIBRATION.

8.1 An installed compass on an aircraft should be calibrated every 12 months unless the approved maintenance programme prescribes a different period.

8.2 Each compass should also be calibrated for out-of-phase occurrences, including but not limited to the followings:

- (a) Whenever a magnetic sensing element has been changed or relocated;
- (b) The compass has an deviation that is out of the acceptable limits on any heading;
- (c) Deviations of the compass are in any way different from those on the existing compass deviation card.
- (d) After major overhaul of the aircraft, removal or replacement of any magnetic material which may affect the accuracy of the compass;
- (e) After installation of a new electrical or radio system or major modification of the existing electrical or radio system;
- (f) After installation of geophysical survey equipment or other equipment that likely to have a strong external magnetic field;
- (g) If it is considered likely that the carriage of a specific freight load that has magnetic influence and thereby affect compass readings;
- (h) Whenever a compass has been subjected to shock, e.g. after a heavy landing;
- (i) After the aircraft has passed through a severe electrical storm;
- (j) Whenever the sphere of operation of the aircraft is changed to one of different magnetic latitude; or
- (k) After the aircraft has been in long term storage.

9 PREPARATION FOR COMPASS CALIBRATION.

9.1 To avoid magnetic interference during compass calibration, loose items of equipment or tools not normally carried in the aircraft should be removed. Any person who needs to stay in the aircraft should see that he has no loose tools or equipment that may have magnetic influence.

9.2 The flight controls should be in their normal flying positions – cruise configuration.

9.3 Aircraft systems operating for normal cruise configuration, include; electrical systems, navigation systems, and communication systems.

Note 1 : Communication systems do not have to actually be transmitting or receiving during the calibration.

Note 2 : Manufacturer's procedures should be adopted where prescribed.

10 COMPASS COMPENSATIONS.

- 10.1 Aircraft compass readings accuracy can be affected by the metallic airframe or components installed on the aircraft. The magnetic influence of this nature is known as one cycle errors (deviations). The deviations vary as a function of aircraft headings and the maximum deviations are termed as 'Coefficient B' and 'Coefficient C'. Additionally, the misalignment of a compass in its mounting causes an error known as 'Coefficient A' error. Coefficient A, B and C would have to be calculated and compensated for compass calibration; the methods are normally provided in the aircraft maintenance manual. In the absence of these instructions, the method in paragraph 10.2 can be adopted.
- 10.2 Aircraft is positioned on each of the cardinal headings (East, South, West and North). At each heading the datum compass and the aircraft compass readings are recorded. The difference or the deviation (dev) between the two readings is obtained:

$$\text{dev} = \text{datum heading} - \text{aircraft heading}$$

and the necessary compensations for coefficients A, B and C are calculated;

Calculate coefficient A,B and C by:

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

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

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

- (a) With the aircraft on any cardinal magnetic heading, add Coefficient A algebraically to the compass reading to obtain the corrected reading. Rotate the compass or magnetic sensing element until the compass reads the corrected reading. This adjustment, normally, is not applicable to panel mounted compasses.
- (b) Head the aircraft on North. Add Coefficient C algebraically to the compass reading. Adjust the athwartships adjusters to make the compass read the corrected reading.
- (c) Head the aircraft on East. Add Coefficient B algebraically to the compass reading. Adjust the fore-aft adjusters to make the compass read the corrected reading.
- (d) Carry out the compass calibration and raise the deviation card.

11 CALIBRATION OF COMPASS.

- 11.1 Manufacturer's procedures should be adopted where prescribed. Where no manufacturer's procedures are available, the procedures in this Advisory Circular provide a general compass calibration method.
- 11.2 During the compass calibration the aircraft should be positioned at eight successive points, each 45° apart and including the 4 cardinal points. A landing compass or a similar instrument may be used to establish the magnetic heading of the aircraft.

The aircraft avionics systems should be turned on and the flight controls should be operated through the range permitted for cruising flight, to ensure that there is no significant effect to reading of the compass headings.

When the above procedures are adopted, the deviation at any heading shall not exceed:

- (a) Gyro-stabilised remote indicating compasses - 2 degrees.
- (b) Non Gyro-stabilised remote indicating compasses - 3 degrees.

- (c) Direct reading compasses used as the Primary Compasses - 5 degrees.
- (d) Standby Compasses - 8 degrees.

Note : Interference resulting from transmission of radio signals or electrical services that are only operated intermittently and for short periods may be ignored.

12 CERTIFICATION AND COMPASS DEVIATION CARD.

- 12.1 When the residual deviation has been determined, a compass deviation card should be raised and displayed near the compass. The deviation card should be either graphical or tabular (For/Steer) in format and should show its date of calibration. Details should be given on the back of the card to indicate aircraft type and registration, compass type and serial number.
- 12.2 An aircraft log book entry should be made that includes full details of the calibration, and a release to service should be certified in accordance with SAR Part 145.

13 COMPASS CALIBRATION SITE.

- 13.1 CAAS does not carry out surveys or approve compass bases, but its interest in surveying procedures lies in the fact that the accuracy of a base is a significant factor in meeting Singapore Airworthiness Requirements relevant to the overall accuracy of compasses installed in an aircraft. Surveys may be carried out by an operator.
- 13.2 A compass swinging site should meet the following criteria:

- (a) Pavement type and thickness

The compass calibration site must be level in all directions. Pavement for the site may be of the rigid or flexible type. Whichever may be the type, the thickness of the pavement should be able to support the types of aircraft used. With concrete pavements the joint type and spacing should conform to standard practices except that no magnetic materials are to be used.

- (b) Size

The size of the site should be compatible with the requirements of the types and size of aircraft used.

For very large aircraft, an analysis of the turning area required, the ingress and egress route for the aircraft will be necessary to determine the suitability of the site.

- (c) Location

- (i) Locate the site at least 100 metres from power and communication cables (both above and below ground) or from the aircraft. Locate the site at least 200 metres from large magnetic objects such as buildings, railway tracks, high voltage electrical transmission lines or cables carrying direct current (either above or below ground). Control cables runway and taxiway light bases or sign fixtures, pipelines, duct, grates for drainage and aircraft arresting gear should be avoided when they contain ferrous materials.
- (ii) The site should be located so that its use will not interfere with or hinder the operation of other aircraft using the airport.
- (iii) After tentative selection of a site, make a thorough magnetic survey of the site. This is necessary because many sites which meet all visually applied criteria regarding distances from structures, etc are still unsatisfactory because of locally generated or natural magnetic anomalies.

- (iv) The difference between magnetic and true north must be uniform in the vicinity of the site. Surveys should be undertaken to verify that the angular difference between true and magnetic north (measured at any point) does not differ from the angular difference (measured at any other point) within the site area by more than 0.25° when measured at a height of 1.5 m above the surface of the site.

13.3 Construction of a compass swing site should take the following into consideration:

- (a) Do not use magnetic materials, such as reinforcing steel or ferrous aggregate in the construction of the site or of any pavement within 100 metres radius of the centre of the site. If any drainage pipe is required within 100 metres of the site, use non magnetic or aluminium culvert.
- (b) After all construction work on the site is completed; it is advisable to have the site magnetically re-surveyed to guard against the possibility of objectionable magnetic materials being introduced during the construction.

13.4 Magnetic surveys of existing compass calibration sites should be performed at regular intervals of 5 years or less. Additional surveys should be performed after major construction of utility lines, buildings or any other structures within 200 metres of the centre of the site. It is advisable to paint the date of magnetic survey on the site near the N heading.