

DRAFT
C-141 Magnetic Heading Issues

Background:

The C-141 has had numerous issues concerning mag heading and compasses in general. This is a problem area throughout the AF. The subject is somewhat complicated and causes a lot of confusion. This paper is intended to clarify some of the issues with respect to the C-141 aircraft. I am also recommending the best approach to solve the problems.

Terminology:

This discussion will use the following terms:

Attitude & Heading Reference System (AHRS) – the primary C-141 compass, among other things.

Magnetic Azimuth Detector (MAD) – electronic compass device that can usually be remotely located from the indicator.

Standby Compass (or “Whiskey Compass”) - the C-141 secondary compass.

Variation – the difference between true north and mag north at a geographic location/region based on the geometry of the Earth’s magnetic field. You have to obtain variation from some source to convert true to mag or mag to true. Variation is usually obtained from navigation charts or software (SW). Variation changes some from year to year.

Deviation – compass error caused by the aircraft itself, actually magnetic substances or ferrous metals in the aircraft. Deviation changes with heading and must be corrected by doing a compass swing, which is also called a compass calibration or compensating the compass.

Local Disturbances – errors caused by magnetic disturbances near the aircraft such as underground pipes, underground cables, nearby buildings or natural magnetic formations. Shortcut methods don’t adequately account for this type of error. This error is the reason many bases cannot maintain a certified compass rose.

Old AF Method of Compass Calibration:

Until recently the only “good” method of swinging a compass was the **compass rose method**. (By “good method”, I mean that you can determine that a reasonably small amount of error will occur if done correctly, i.e. systematic.) The compass rose method required the base (AFB) to have a surveyed & certified compass rose. Unfortunately most bases cannot pass survey due to local disturbances. Robins AFB has this problem, for example. The compass rose method also requires you to rotate the aircraft to many headings with some precision.

Since most bases do not have a compass rose, “alternate” or “shortcut” procedures became common throughout the AF. Sometimes these were performed in abbreviated form in magnetically “bad” locations. However most folks had no other option before the compass calibrators were developed. (Also, the shortcut procedures are easier & faster.)

Compass Calibrator Methods:

Compass calibrators like the “MC-2000” have since been developed to solve these problems, and the C-141 incorporated these procedures several years ago. This method is presently the **best method**. It is the most systematic, and it accounts for all of the different types of errors. In addition you do not have to rotate the aircraft to numerous headings. **All bases need to use this method and become good at it. This will reduce problems that might come up in distant regions of the world. If the aircraft are not properly calibrated at home station problems will occur.**

Unfortunately the calibrator method is a little more involved to set up and become familiar with.

Shortcut Methods:

As stated above, various “shortcut” or “alternate” methods were developed throughout the AF. These methods are usually not systematic, do not account for local disturbances and don’t use a good reference for magnetic heading. Most of these methods reference the INS and/or standby compass. I will summarize the problems with these methods below.

Why INS is not a good reference for compass calibration:

- does not account for local magnetic disturbances
- C-141 INS “mag var” tables are 17 years out of date (see INS discussion)
- INS errors (like alignment error) are transferred to the compass - so the INS & AHRS are less independent or redundant
- not a true magnetic reference

Why the standby compass is not a good reference for compass calibration:

- it’s less accurate than AHRS
- does not account for local disturbances - because it is too far from the AHRS MAD on the wing tip.
- it is subject to different (possibly worse) deviation in the cockpit
- you are passing it’s error to the AHRS
- you must question how & when it was calibrated

INS Mag Heading Issues:

The C-141 INS (or INU) derives mag heading from true heading using an internal software model called the “mag var table”. This table provides the INS with a variation for a position (latitude & longitude). Unfortunately the C-141 mag var tables are from 1985 and are out of date. These tables become more inaccurate each year and the error you will see depends on your position (latitude & longitude). Until the mag var tables are updated discrepancies between the AHRS and the INU’s will get worse in many locations. This makes AHRS accuracy even more important ! Here are some examples of differences between the 1985 and the 1995 mag var tables (in Europe and Russia).

Lat	Lon	delta 1985 to 1995
50	-35	1.853
50	-30	1.828
50	-25	1.77
50	-20	1.681
50	-15	1.566
50	-10	1.428
50	-5	1.277
50	0	1.116

Conclusions:

The best solution, from a maintenance point of view, to all these issues is to calibrate both compasses using the compass calibrator method IAW tech data **This must be done as required stateside because it will most likely not be done overseas. If a discrepancy occurs overseas, it will be greatly aggravated if the AHRS was not properly calibrated when it arrived. It will be impossible to determine how much error lies with the AHRS, INS or with local disturbances. As a result the pilot will be unable to rely on any mag-heading source.**

Please send comments or questions.

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