**GOVERNMENT/INDUSTRY AERONAUTICAL CHARTING FORUM**
**Instrument Procedures Group**
**(Transcribed/Re-Formatted)**
**HISTORY RECORD**

**FAA Control # 94-02-136**

**SUBJECT:** Publish True vs. Magnetic on GPS Procedures

**BACKGROUND/DISCUSSION:** Minimum Operational Performance Standards (MOPS) for Global Positioning System (GPS) equipment requires that course information be presented to the pilot in degrees magnetic. This is in keeping with the traditional format for display of such information - a format which dates back to the earliest days of cockpit instrumentation. To support this tradition requires extraordinary effort on the part of equipment manufacturers since GPS equipment actually computes such data in degrees true, and then, internally converts from true to magnetic for display. Unfortunately, the means by which this information is converted from true to magnetic is not standardized; rather it is up to the individual manufacturer to choose its own method. The result is, therefore, that vital course information, which should be highly accurate (as should be expected), varies not only from manufacturer to manufacturer, and aircraft to aircraft, but also varies from that computed by the original procedure designer.

Instrument procedure design methodologies are virtually the same for all states. For example, the procedure designer knows, either exactly or generally, the intended/desired ground track the aircraft is to follow over the ground. The procedure designer then evaluates a specific area around that intended ground track, according to strict criteria, for the highest obstacle or terrain, to which is added a required obstacle clearance or allowance to meet airspace requirements. The result is the minimum altitude to which the aircraft is authorized to descend to, or operate at, within that procedure segment. That altitude, along with the magnetic course information relative to that segment, is then published by the state and/or by a charting agency contracted by that state. The track information, in all cases, was initially developed by the specialist in degrees true as determined between points on the chart, or computed point-to-point between sets of coordinates.

In the United States, for instrument approach procedure design, the national policy is to then use the magnetic variation of the airport of intended landing as the factor for converting from true to magnetic courses for publication. However, GPS equipment manufacturers are free to program any algorithm they wish into the GPS equipment to use in the process of internal conversion to magnetic. For instance, one manufacturer uses an algorithm that computes the actual, instantaneous magnetic variation for any location, and applies the resultant value to the internally computed true course between waypoints. Another manufacturer computes the magnetic variation for each end of a particular GPS leg and then applies the average of the two values for converting true values to magnetic course information. Yet another makes a broad assumption as to the expected life of the airframe, 20 years for example, then determines the magnetic variation for the point in time halfway through that life cycle, 10 years in the future in this case, and then applies this constant value in all conversion computations from true to magnetic. It is very probable, therefore, that by whichever means the manufacturers may choose, the magnetic course information computed for display to the pilot is different from that which is utilized by the procedure designer and published by the state. This discrepancy can become a confusion factor to the pilot; adversely affect the pilot's

situational awareness; and, in certain conditions, cause the aircraft to approach or exceed the lateral limits of the area evaluated for obstacle clearance.

When such discrepancies exist between displayed and published course information, the question must arise as to the necessity for magnetic information in the first place. As stated above, the publication of magnetic course information is traditional in most states, and relates to some degree to the existence of the magnetic compass (the "whiskey compass"). But is magnetic course information really necessary in today's world of GPS? Many believe that it decidedly is not! The belief is that the traditional display format is a thing of the past; that use of magnetic course information ignores the inherent nature and capability of GPS equipment: and that continued publication of magnetic course information represents an unnecessary expenditure of state funds.

When magnetic variation changes by a certain predetermined amount (an amount established by the individual states) it becomes necessary to update the published instrument procedure, and therefore the GPS database utilized by the airborne equipment, through amendment action. This equates to significant expenditure of funds for the actual process of procedure amendment, for required changes to several state instrument approach publications, and for the issuance and distribution of an updated GPS database from the database manufacturers.

Were GPS course information to be published in degrees true, this significant cost to states and, ultimately borne by the flying community, could be avoided. Course data determined by the procedure designer would be the course data displayed in the cockpit. There would be no confusion factor – no adverse effect on situational awareness. Where GPS is used by the VFR pilot for course guidance, the pilot's job is made easier. The true course plotted on the chart between points is the course displayed in the cockpit for the pilot to fly. The magnetic compass could still be used for backup – the pilot would only refer to the isogonic lines of variation published on the VFR chart in order to convert from the published true value to a magnetic value for correlation with the onboard compass (the same conversion normally used during VFR pre-flight). Where a flux gate directional gyro is used, the pilot need only apply the same conversion in the reverse direction "on the fly" to correlate with the true course information displayed on the onboard GPS equipment. Standard (non-flux gate) directional gyros can be set to the true course value displayed on the onboard GPS equipment with no conversion required. In the latter case, the published true course is not only displayed on the onboard GPS equipment, but also set in the directional gyro. Interestingly, one argument can be used for either side of the discussion: due to winds, the heading displayed on the directional gyro rarely agrees with the published course anyway. However, for GPS application, agreement between displayed course and published information is preferred over the confusion brought about by disagreement.

Although the United States has not established policy for the magnetic variation value for en route application, similar arguments can be made for benefits to be derived for use of true course information. The most obvious benefit is avoidance of confusion and the concomitant loss of situational awareness. The course displayed would agree with the charted course, and is the course to be flown by the aircraft. Of significance to the state, is the cost benefit. Currently, en route charts publish magnetic courses between navigational facilities. These magnetic courses reflect the magnetic variation that is set into the facility (magnetic variation of record, slave variation, etc.) from which the course emanates. It is common for the magnetic variation for neighboring facilities to differ by as much as three to

six degrees. This causes the magnetic course outbound from one facility and the magnetic course outbound from the next facility, both of which define the airway segment, to not be reciprocal (not 180 degrees apart). This causes obvious confusion and prompts numerous queries as to the nature of the discrepancy. At the time when the pilot switches from one facility to the other for course guidance, it is common for the course needle to adjust to the next facility by significant lateral movement, and require course correction by the pilot to re-establish the aircraft on the published airway course line. This problem, of course, would be avoided were the airway course published in degrees true. In such a case, the course published would be the course displayed and flown, with no course correction required due to selection of the other facility (or at least a very small correction due to great circle issue). Because, however, the non-GPS flying community would still have a requirement for magnetic en route course information, both true and magnetic course information between fixes or facilities defining the airway segments would have to be presented to the pilot. This could be accomplished by: publishing both magnetic and true courses; publishing the true course defining the airway segment with magnetic variation symbolized at the each facility: or, publishing the magnetic course defining the airway segment with magnetic variation symbolized at each facility.

**RECOMMENDATION:** GPS Instrument Approach Procedures: That all course information be published in degrees true.

En Route Procedures: That to facilitate use of GPS in the en route environment, all airway course information be published in degrees true, with facility magnetic variation values symbolized at each facility.

**COMMENT:** Unresolved issues: ATC interface (radar vectors and wind in magnetic); Pilot education: conversion from true to magnetic, magnetic to true; government/industry publications for IFR operations; industry guidance on use of equipment; pilot instruction; transitioning from GPS en route to non-GPS terminal procedures (tendency to stay with GPS equipment rather than switching to traditional nav display): Transition period; confusion factor with revised publications; not all publications are changed simultaneously: Equipment; will all equipment have the capability to display course information in degrees true?; will GPS equipment display a single course between points, or continuously update the changing geodetic course?

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**INITIAL DISCUSSION (MEETING 94-02):** Dave Eckles, AVN-220 distributed a draft document on true vs. magnetic heading and led a discussion on the pros and cons of both. Dave stated that his objective was to receive feedback from the group on the paper. The group generally agreed that the concept was attractive but could raise some sticky issues involving the transition from the present magnetic heading system to the true system. The group agreed that feedback on the paper from the certification experts on the Satellite Operational Implementation Team

(SOIT) would be useful. Ray Nicklaus volunteered to distribute the paper at the next SOIT meeting in early November, 1994. **Action:** None – Discussion item only.

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**MEETING 95-01:** The group agreed to close this item. **Status:** Item closed.