April 22, 2016

Ms. Peggy Gilligan
Associate Administrator for Aviation Safety
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Dear Peggy:

The Performance-based Operations Aviation Rulemaking Committee (PARC) is pleased to submit the recommendations of the MagVar Action Team (AT) in the attached report. The Performance-based Operations Aviation Rulemaking Committee (PARC) requested the MagVar AT reevaluate magnetic variation requirements that cover all ILS categories and any other magnetic variation tolerances that may be expanded beyond current standards. The analysis resulted in specific recommendations that will allow for more efficient management of VOR related systems while not compromising operational availability for the aviation community. The recommendations are all also in line with the recent update to the NAS Performance Based Navigation Strategy.

The Action Team consisted of Subject Matter Experts (SMEs) that resulted in a thorough analysis, leading to their recommendations, which were supported by the PARC Steering Group.

The PARC recommendations to the FAA are summarized below:

1. The PARC recommend to the FAA to modify the VOR MV tolerance to 5 degrees
2. Change FAA documents to indicate 5 degrees.

The PARC appreciates your continued support of our activities and invites you to join us in a discussion of these recommendations at your convenience. Please call me if you have any questions or would like to set up a discussion.

Sincerely,

Mark Bradley
Chairman, PARC

Cc: B. DeCleene
M. Steinbicker
A. Smith
L. Volchansky
T.J. Nichols

Executive Summary

In response to a PARC recommendation, the FAA and aircraft equipment manufacturers studied modifying the Very High Frequency Omni-Directional Range (VOR) magnetic variation (MV) from the current tolerance of 3 degrees to a new tolerance of 5 degrees.

Areas studied by the PARC MV action team include:

- ☐ Terminal or Enroute instrument flight procedures and tracking performance.
- ☐ Flight Management System (FMS) VOR/DME position computation, assuming the VOR Navigation Database (NDB) magnetic declination and actual VOR ground station antenna zero degree orientation with respect to True North remain consistent.
- ☐ Tracking the VOR radial using the Course Deviation Indicator (CDI). Please note that the FMS track computed using GPS corrected or inertial velocities and inertial selected heading will not line up by the difference between the VOR magnetic declination and the inertial magnetic variation on the CDI and Navigation Display (ND).
- ☐ VOR based terminal area procedures and airways using CDI or FMS using LNAV and the MAP.

The study supports and the PARC MV Action Team (AT) recommends adjusting the VOR MV tolerance to 5 degrees.

Background

The Performance-based Operations Aviation Rulemaking Committee (PARC) requested the MV AT to reevaluate magnetic variation requirements that cover all ILS categories and any other magnetic variation tolerances that may be expanded beyond current standards.

FAA Order 8260.19, Flight Procedures and Airspace, defines how magnetic variation is maintained and used. The Order states VORs must be maintained to a tolerance within plus or minus 3 degrees magnetic variation. The Very High Frequency Omni-Directional Range (VOR) is a ground-based electronic system that provides azimuth information for high and low altitude routes and airport approaches. Magnetic variation at its most basic is simply the difference between true North and magnetic North. Variations for NAVAIDs are "assigned" and not the actual variation for the geographic area. For VORs, it means a physical "rotation" of the VOR radials to correspond to the actual variation. When the VOR exceeds the MV tolerance, the applicable Air Traffic Service Area Office initiates a revision to published air traffic procedures; the Technical Operations Service (AJW-0) conducts a facility rotation which requires proper coordination and subsequently, the facility will require flight inspection. Additionally, the charting of the product impacts both Aeronautical Information Services and other chart makers. All magnetic tracks defined by a VOR conventional navigation aids are determined by the application of the station.

Magnetic Variation

The MV AT collaborated on equipage tolerances, certification, and operational conditions. Bi-weekly telecons between the FAA and aircraft equipment manufacturers (participants listed in appendix) researched the interdependencies of the aircraft MagVar table, IRU, and the FMS. The MV AT findings indicate FMS products are unaffected by VOR Mag References or errors. Furthermore, the FMS pulls Mag Declination (Variation) out of the data base for each individual Navaid and corresponding procedure, and thus, the procedure value matches the assigned value used by the Navaid resulting in no error. Neither the FMS nor the Navaid is using the IRS MagVar table, so in this case the IRS MagVar table has no value. Arinc 424 now includes the source (State) provided Procedure Design MV (PDMV) embedded into the procedure.

Areas studied by the MV AT include;

- Terminal or Enroute instrument flight procedures and tracking performance.

- Flight Management System (FMS) VOR/DME position computation, assuming the VOR Navigation Database (NDB) magnetic declination and actual VOR ground station antenna zero degree orientation with respect to True North remain consistent.

- Tracking the VOR radial using the Course Deviation Indicator (CDI). Please note that the FMS track computed using GPS corrected or inertial velocities and inertial selected heading will not line up by the difference between the VOR magnetic declination and the inertial magnetic variation on the CDI and Navigation Display (ND).

- VOR based terminal area procedures and airways using CDI or FMS using LNAV and the MA.

Boeing conducted an operational evaluation of a 5 degree MV VOR tolerance. The data analysis and overall results of this evaluation supports a 5 degree tolerance.

Boeing's findings are below;

- No impact to the ILS capture and tracking performance for any of the current production Boeing models or the more recent out-of-production models

- No impact on Flight Management System (FMS) VOR/DME position computation, assuming the VOR Navigation Database (NDB) magnetic declination and actual VOR ground station antenna zero degree radial orientation with respect to True North remain consistent. That is do not update the VOR assigned magnetic declination in the NDB without re-aligning the VOR ground station antenna or vice versa.

- No impact on tracking the VOR radial using the Course Deviation Indicator (CDI). Please note that VOR radial and the FMS track (to the VOR) computed using GPS corrected or inertial velocities will not line up by the difference between the VOR magnetic declination and the inertial magnetic variation on the CDI and Navigation Display (ND).

- No impact to flying VOR based terminal area procedures and airways using CDI or FMS using LNAV and the MAP.

Garmin's findings are below:

- VOR MV tolerance has no effect on "Fix-to-Fix" operations (theseare the most common).
- "Course-based" operations can be exposed to the difference between VOR Station Declination and Magnetic Variation.
- Based on current population of US VORs, the effective course setting error is currently 6 degrees (95%).
- If implemented, the proposed 5 degree tolerance would actually be an improvement over the status quo.
- Airspace users and managers also need to assess the acceptable tolerance

The entire MV AT accepted this result.

Recommendation

1. The PARC recommend to the FAA to modify the VOR MV tolerance to 5 degrees
2. Change FAA documents to indicate 5 degrees.

Discussion: Some pilots have reported noticeable differences between their RNAV system's displayed magnetic course and the magnetic course as depicted on the corresponding chart.

Each leg of an instrument procedure, regardless of type, is first charted along a desired ground track with reference to true north. The resulting true course is then corrected for magnetic variation in order to determine the magnetic course to be depicted on the IFP plate. The magnetic variation used for this correction, however, may vary somewhat depending on whether the procedure is a "conventional" Navaid-based IFP or a RNAV IFP. As a result, there will often be slight variances in magnetic course between Navaid-based and RNAV IFP legs. RNAV systems are not constrained by charting conventions. Rather, many of these systems will rely on their navigational database for magnetic variation or will calculate it dynamically based on aircraft position. For this reason, it is possible that the magnetic variation applied by the RNAV system will be marginally different than the magnetic variation used by the procedure designer when the IFP chart was created, or last updated. Thus, the magnetic course ***displayed*** by the RNAV system for a particular IFP leg may also slightly vary from the magnetic course ***charted*** on the IFP plate.

There is a cost to both the agency and industry. In today's environment resources are critical. The 5 degrees allows a smart application of the criteria and still maintains safety. The value derived will be in the increased band width to develop more PBN procedures as well as save industry millions of dollars in fuel savings. FAA and Industry need to develop our critical thinking and strategically align our resources to best serve the users of the NAS. Below is the fuel savings for the Florida Metroplex, this is just one example of the efficiencies as well as cost savings with PBN procedures for industry and users of the NAS At this time there are 568 VORs out of tolerance with the change to 5 degrees there will only be 172 out of tolerance. The cost for the agency varies depending on how many procedures are tied to a VOR. A medium VOR project will cost approximately $738,638 per facility to the agency. The fuel savings for Industry are shown in the table below for one location.

Florida Notional Benefits

Estimated Annual Fuel Savings - Fuel Burn (Distance and Profile)	$13.19-40.88M
Estimated Annual Fuel Savings - Cost to Carry	$1.78-4.55M
Total Estimated Annual Fuel Savings (Dollars)	$22.97-53.4M
Total Estimated Annual Fuel Savings (Gallons)	$7.66-17.81M
Total Estimated Annual Fuel Savings (Metric Tons)	$79.5-184.4K

*Based on CY2013 RITA Average Fuel Price of $3.00/gallon

Appendix

PARC MV Action team consisted of subject matter experts covering avionics, flight operations, aeronautical information services (AIS), aircraft and avionics certification, and aircraft equipment manufacturers to include;

- FAA – Sue Crumb, Jon Denton, Rick Dunham, Steve Jackson, and Barbara Clark
- Boeing- James Vandenbrook, Blaney Fisher, Gang Feng, James Lu, Marissa Singleton
- Honeywell – Chris Benich and Dean Wilkens (Industry Co-Chair)
- Garmin – Xin Qi
- Garmin – Bob Gaul
- Rockwell-Collins – Ellen McGaughy, Timothy Geels
- Bombardier – Carlos Branco and Paulo Gregori
- Airbus – Laurent Azoulai
- Embraer – Yan Abreu
- General Aviation Manufacturers' Association – Jens Hennig