GNSS overlay approaches

Pilot's Corner
By Anthony MacKay

In conversations I have regularly with pilots across the country I often encounter questions about GNSS overlay approaches. I wanted to take the opportunity in this column to address some of the common ones. A review of section 3.15.5.2.2 of the Canadian AIM would be helpful before you continue reading further.

Firstly, a GNSS overlay approach is not a RNAV approach.

An overlay approach is a NDB or VOR non-precision approach that has been adapted to allow a standalone GPS receiver or a GPS sensor to provide approach navigation guidance to the FMS. While overlay approaches have GNSS in the approach title, at their core they are still conventional approach procedures because they were designed as conventional procedures. As conventional procedures they are coded using ARINC 424 rules for conventional leg types, which for most NDB and VOR approaches require the use of CF legs, or COURSE TO FIX legs. An RNAV procedure is coded using ARINC 424 rules for RNAV leg types which would be a TF leg, or TRACK TO FIX legs.

TF legs are anchored at both ends by the latitude/longitude of the waypoints starting and ending the leg. CF legs are anchored on the ending fix only. This results in CF legs being very sensitive to magnetic variation discrepancies while TF legs are not affected by magnetic variation at all. TF legs will always tie together while CF legs can be disconnected. The magnitude of the disconnect is driven by the amount of magnetic variation difference between aircraft systems, navigation aids and the airport magnetic variation of record.

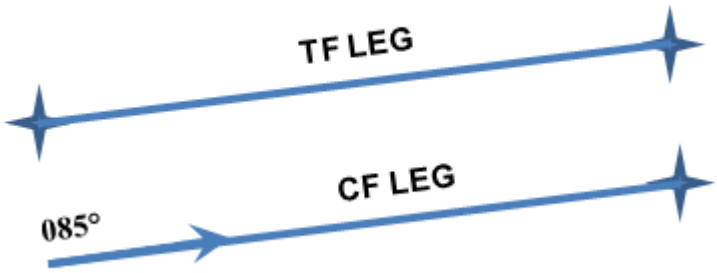


Figure 1: TF Leg vs CF Leg

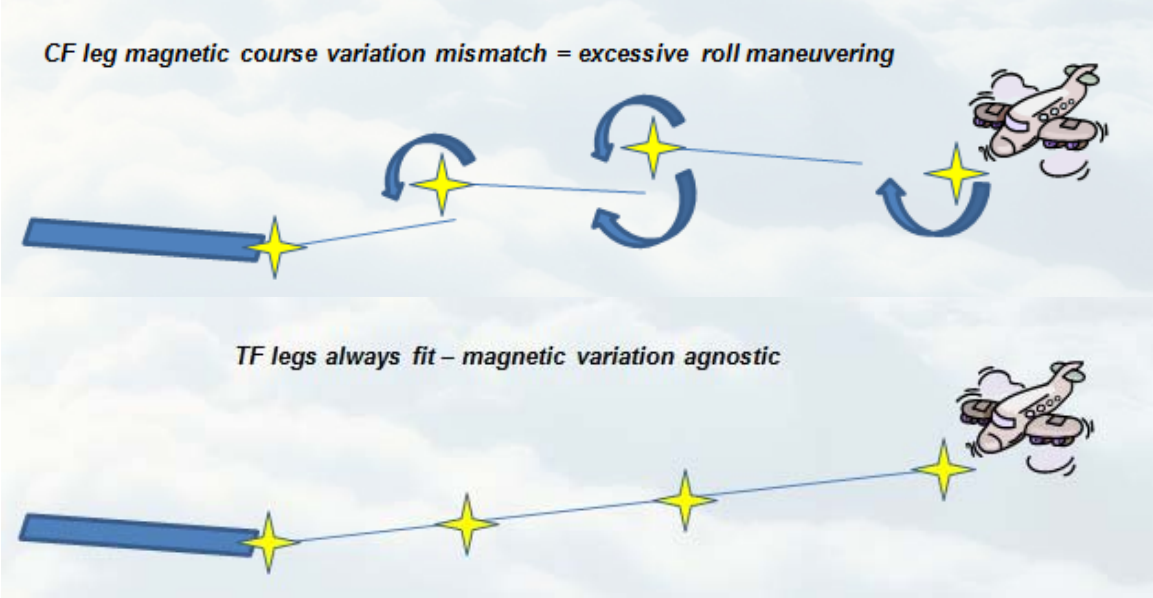
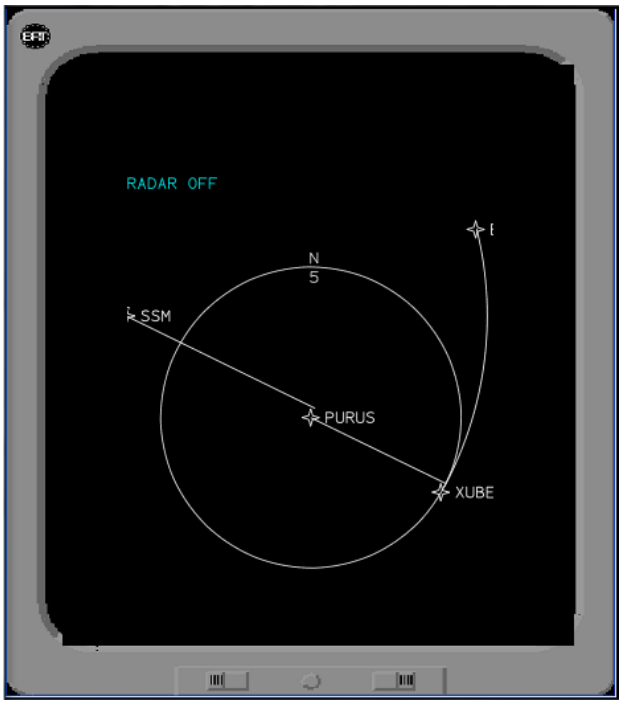


Figure 2: Leg Path Continuity

During the latest review of instrument approach procedures in Canada, NAV CANADA Flight Inspection found issues with excessive roll steering at each transition point of the approach on overlay approaches. In one case, a pilot was complaining about the performance of his autopilot on approach to his home airport. In actual fact the autopilot was just chasing the disconnected CF legs on the approach; the autopilot was just following the guidance provided by the FMS.

Here is an example of what was found on the VOR DME (GNSS) RWY 16 CYAM in the fall of 2013.



As you can see on the multi-function display (MFD), the flight path legs between XUBER, PURUS and SSM are all disconnected. The reaction of the aircraft was to overshoot the transition from the ARC to XUBER, then at PURUS the aircraft initiated a 15° bank turn to the right to regain the track from PURUS to SSM and the same thing happened from SSM to the runway.

Each FMS/GPS handles differences in magnetic variation differently between the onboard aircraft sources when using GPS as the navigator. When the approach is flown with reference to the VOR RADIAL as the primary navigation source, the aircraft is stable. However when it is flown with reference to the GPS as the primary navigator, the aircraft becomes unstable in roll while trying to make good the flight path between disconnected legs.

In Northern domestic airspace (NDA), where navigation aids and airports are referenced to TRUE NORTH, the magnetic variation issue is not a problem because for all intents and purposes the magnetic variation is 0. The issue with overlay approaches in NDA however still relates to conventional leg path terminators and the ARINC 424 rules around them.

For many conventional leg path terminators to be used, a reference VHF navigation aid must be within 45 nm of the approach procedure. For that reason, many of the NDB overlay approaches in NDA do not have the entire procedure coded; only the final approach segment is coded in the FMS. The procedure turn, approach transitions and the missed approach segment may be missing.

In one case, NAV CANADA flight inspection found that the NDB missed approach called for an immediate left turn but the conventional coding used in the overlay had the aircraft track climbing straight ahead until 400’ and then turning. This caused the track to be too close to terrain and as a result the overlay was NOTAM’d as “Not Authorized”. The basic conventional procedure was OK but the overlay coding did not match the approach designer’s intention.

As more RNAV approaches are designed and published, GNSS Overlay Approaches will be discontinued. In the meantime, when NAV CANADA Flight Inspection finds issues with final approach coding during flight check of current GNSS overlay approaches, the GNSS overlay approach must be NOTAM’d out of service.