

**No. 2836**

## **RNAV (GPS) or RNAV (GNSS) Approach Level of Service (LOS) – WAAS/SBAS FMS**

### **Application**

This service letter clarifies how the Level of Service (LOS) is determined for RNAV (GPS) or RNAV (GNSS) approaches. It is recommended reading to all operators of Universal Avionics Systems Corporation (UASC) SBAS capable Flight Management System (FMS), SCNs 1000.0/1100.0 through SCNs 1000.4/1100.4.

### **Description**

#### **RNAV (GPS) or RNAV (GNSS) Approaches**

Aviation authorities publishing RNAV (GPS) or RNAV (GNSS) approach procedures determine the available lines of minima, and whether SBAS-based vertical guidance is approved for that line of minima. Unlike traditional sensor-based approach procedures like VOR, ILS, etc., that require a specific sensor complement to fly an approach, RNAV approach procedures provide a common chart for users that may be using different sensors (SBAS-based or baro-based vertical guidance). Any operator with an IFR-approved (approved for a particular class) GPS receiver can fly an RNAV (GPS) to LNAV MDA minima; and with appropriate equipment, can fly barometric advisory VNAV guidance to the charted LNAV/VNAV DA minima. However, only operators with an approved SBAS system can fly to LPV DA minima.

RNAV (GPS) approaches (FAA), or RNAV (GNSS) (ICAO) approaches, are published with one or more lines of minima such as: LPV, LNAV/VNAV, or LNAV. Some of these minima, or application of temperature restrictions, are determined by the use of a Satellite Based Augmentation System (SBAS). The United States SBAS is called the “Wide Area Augmentation System” (WAAS). The European SBAS, expected to be operational in 2010, is called “European Geostationary Navigation Overlay Service” (EGNOS). The Japanese SBAS is called “Multi-functional Satellite Augmentation System” (MSAS) and is operational. India is planning an SBAS called “GPS Aided Geo Augmented Navigation” (GAGAN).

Because these SBAS systems all meet the same performance standards, SBAS-capable Universal FMS models will work with all of these providers.

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UASC receives aeronautical data that defines the equipment requirements and associated LOSs provided by the regulatory authorities and uses this information to create the approved FMS navigation database. Ultimately, the FMS uses the database, along with performance predictions, to determine if there is a LOS published for an RNAV approach.

LPV minima always require SBAS-derived vertical guidance for the final approach segment. LNAV/VNAV minima may be approved for SBAS or barometric vertical guidance by the governing aviation authority; however, the FMS always uses SBAS-derived vertical guidance for LNAV/VNAV LOS.

RNAV (GPS) or RNAV (GNSS) charts are usually published with several lines of minima, with a typical chart including LPV, LNAV/VNAV and LNAV lines of minima. It is possible for charts to be published with only one or two lines of minima (e.g., KCMA has an LPV and LNAV only approach). The FMS equates charted lines of minima to a specific LOS that is defined in the navigation database. Many countries publish RNAV approach procedures that do not specify a LOS.

During the transition to use of a SBAS, some countries provide a LOS such as LNAV/VNAV on charts, but initially restrict the use of SBAS for vertical guidance. This results in the FMS selecting LNAV even though the chart shows an LNAV/VNAV minimum and the FMS is receiving the SBAS signals. Eventually, it is expected that all ICAO areas that utilize an SBAS will support the use of SBAS vertical guidance.

Users of WAAS will note a reference to a “channel ID” on some RNAV (GPS) charts. In addition to the normal approach selection procedure, if an approach has a channel ID it may be selected. If an RNAV approach provides LPV LOS, the approach is preceded by a “W” on the approach selection page.

**Prediction and Selection of LOS at Approach Arming**

When an RNAV (GPS) or RNAV (GNSS) approach is armed, either manually when within 50 NM of the airport, or automatically by the FMS when within 30 NM of the airport, the FMS performs a prediction of the LOS that will be available for the final approach segment. Based upon this prediction and other system criteria, the FMS automatically selects the appropriate LOS for the approach and announces it to the flight crew; this allows planning and briefing for the approach.

- At initial power up, or after power interruption, it may take up to 5 minutes for the FMS and internal GPS/SBAS receiver to achieve a navigation mode to predict anything higher than LNAV LOS.
- FMS predictions require a valid ETA at the FAF. If the aircraft groundspeed and distance to the FAF produce an invalid ETA or an ETA that is more than an hour ahead

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of the current time, the FMS may predict LNAV LOS even though LPV and/or LNAV/VNAV are charted.

- The FMS will not automatically arm an approach while on the ground. If an approach is manually armed on the ground, the FMS will only predict LNAV LOS.
- The FMS selects the highest (lowest minima) LOS when the approach is armed, but the pilot may manually select any available LOS. These are listed on the **APPR LOS** CDU page.
- If the highest charted LOS is not available at the approach arm prediction, the FMS will present the [<LOS> NOT AVAILABLE] message.
- The FMS does not dynamically update LOS predictions. The pilot can manually cause the FMS to perform a new prediction by re-entering the approach into the flight plan.
- In dual installations, each FMS independently determines its LOS. While uncommon, it is possible for each FMS to select/predict a different LOS for the same approach.

**Second LOS Prediction at Approach Activation**

At approach activation, either manually or automatically, the FMS performs another prediction of LOS for the final approach segment.

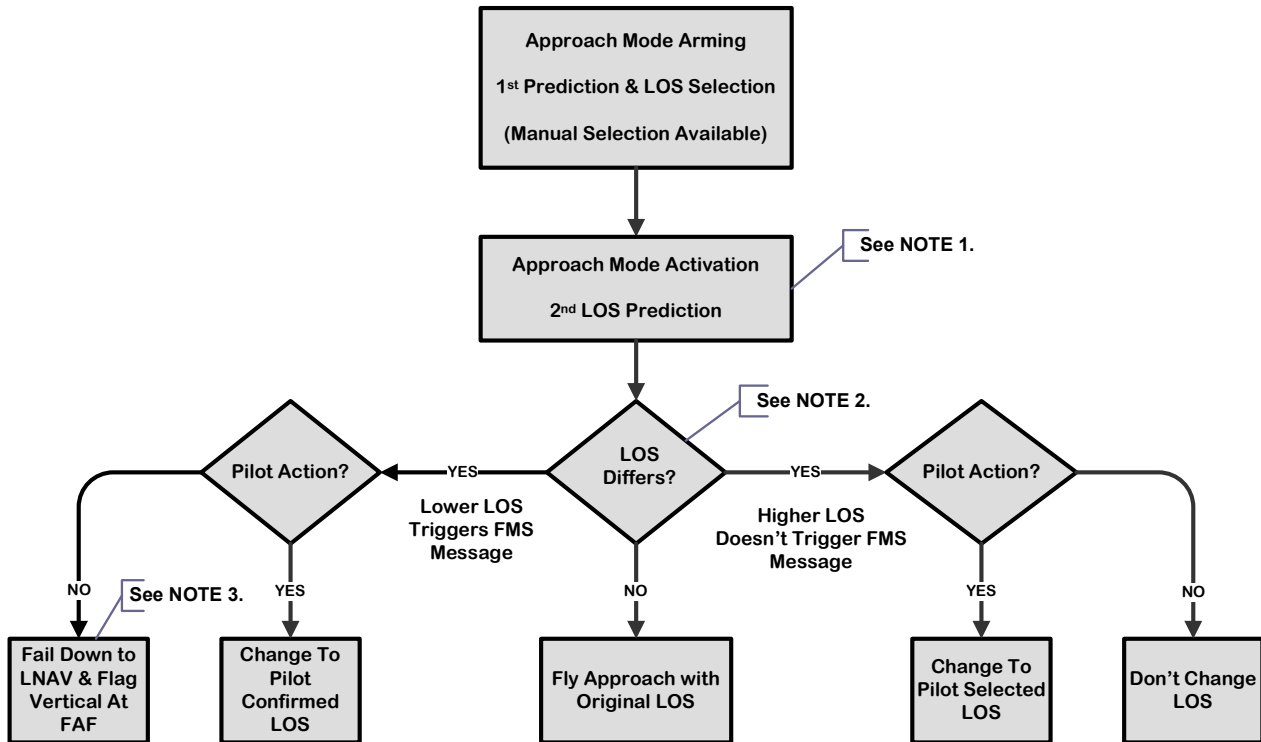
- If the originally selected LOS is still available, there is no change or messaging by the FMS.
- If the selected LOS is no longer available, and the prediction is for a lower (higher minima) LOS, the FMS will present a [<LOS> NOT AVAILABLE] message to the crew. The FMS will provide the option to select a lower LOS, if it is available.
- If a higher LOS is predicted, the FMS does not present any message.

It is possible, although rare, for the FMS approach arm and activation predictions to result in different LOS availability based upon the SBAS and GPS signals in space. The original prediction gives the pilot ample time to decide whether to perform the approach based on the minima supported by the LOS. The design assumption is that if the approach was initiated with any LOS, the pilot is satisfied with the LOS, and there is no need to intervene with messages that the LOS has improved. If desired, the pilot can review the LOS after activation, but prior to the FAF, to determine if there has been an improvement in LOS.

The following flowchart graphically depicts the LOS selection sequence

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**Level of Service (LOS) Selection Flowchart**



**NOTES:**

1. Manual changes can be made prior to approach activation.
2. The 2<sup>nd</sup> LOS prediction can make available different LOSs.
3. Fail Down to LNAV can only occur if LNAV is charted and available.

**Final Approach Segment**

The FMS defines the segment between the FAF and the end of approach (EOA) as the Final Approach Segment (FAS). The FMS has special criteria for selecting, maintaining, and guiding an RNAV (GPS) or RNAV (GNSS) approach on the FAS.

- Lateral and/or vertical guidance is being provided to the annunciated LOS.
- The crew cannot manually change the selected LOS during this segment.
- For LPV and LNAV/VNAV LOS, vertical guidance smoothly transitions from Barometric based to SBAS based.
- LNAV LOS and all other FMS based approaches use barometric-based advisory vertical guidance any time vertical guidance is provided.

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- If the criteria to continue the selected LPV or LNAV/VNAV LOS cannot be maintained, the FMS will automatically fail down to LNAV LOS (if published).
- In all fail down cases, vertical guidance will be discontinued and/or flagged.
- If the criteria for LNAV LOS cannot be maintained, lateral guidance will be discontinued and/or flagged.
- If FMS lateral guidance is flagged, regaining lateral guidance may be achieved by selecting Missed Approach (CDU prompt or TOGA input).

**Barometric vs. GNSS Based Approach Vertical Guidance**

There are two types of approach vertical guidance, approved and advisory. Approved vertical guidance is an actual vertical path deviation guidance indication for approaches generated for procedures that contain an approved and protected glide path (e.g., ILS, LPV or LNAV/VNAV). Advisory vertical guidance is a vertical path deviation guidance indication for non-precision approaches that is provided to aid the pilot in meeting altitude restrictions (e.g., LNAV minima for RNAV procedures, a Minimum Descent Altitude (MDA) associated with VOR, VOR/DME, LOC, B/C and NDB approaches, etc.).

The FMS uses Barometric VNAV to provide advisory vertical guidance under all circumstances with two specific exceptions, LPV and LNAV/VNAV LOS.

During LPV and LNAV/VNAV approaches, the FMS smoothly transitions from barometric-based advisory vertical guidance to SBAS-based approved vertical guidance upon reaching the FAS. This SBAS-based approved vertical guidance is maintained as long as LPV or LNAV/VNAV LOS continues to the EOA.

If the FMS fails down from LPV or LNAV/VNAV to LNAV while on the FAS, the FMS will flag the vertical guidance.

Universal Avionics Service Letter No. 2817, *Dissimilar Level of Service During an SBAS Approach*, provides additional information (available at the Service Bulletins & Letters link in the UniNet portion of the UASC website – [www.uasc.com](http://www.uasc.com)).

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