Chapter 4 GNSS

4.1 General

The advent of satellite based navigation provides significant improvement in navigation performance which is available to aircraft of all types. While Performance Based Navigation in general is not dependent upon satellite navigation the benefits available within the PBN concept are multiplied by the use of GNSS.

It is not within the scope of this Handbook to cover the basics of GNSS navigation and it is assumed that readers have or will obtain knowledge and training in satellite based navigation principles and practice.

The discussion of satellite navigation will be related to specific elements of satellite based navigation that are relevant to PBN operational approvals.

GNSS systems range from stand-alone receivers, now in general use in general aviation to Flight Management Systems incorporating IRS systems updated by GNSS. Whatever the installation, the navigation capability of GNSS is excellent, and there is little variation in the positioning accuracy across the various types of installation. However there are considerable differences in functionality, cockpit displays, integrity monitoring, alerting and other characteristics that must be considered in the operational approval, depending upon the particular navigation specification.

Les paramètres requis sont manquants ou erronés.

4.2 Monitoring and alerting

An IFR GNSS navigation receiver incorporates by design a system to monitor the positioning performance and to provide an alert to the operating crew when the minimum requirements appropriate to the desired navigation performance is not available. Consequently a GNSS navigation system qualifies as an RNP navigation system as it is able to provide the necessary on board performance monitoring and alerting functions. However, the monitoring and alerting function of the navigation system alone is insufficient for RNP applications, and FTE must also be monitored. A number of aircraft equipped with GNSS fail to meet the monitoring requirements for RNP because of a lack of capability for the crew to monitor cross-track deviation.

Prior to the PBN Manual, many operations utilising GNSS were classified as RNAV operations, such as RNAV (GNSS) approach procedures. In order to be consistent with the PBN Manual definition of RNP, RNAV (GNSS) procedures are now classified as RNP APCH procedures, as they fulfil the on-board performance monitoring and alerting requirements associated with RNP systems.

4.3 GNSS Accuracy

The positioning accuracy of GNSS signal in space is dependent upon the satellite constellation and is generally independent of the aircraft systems. Positioning accuracy is excellent and a significant amount of data has now been accumulated which demonstrates that unaugmented GNSS is able to provide accuracy measured in metres with a high degree of availability over much of the earth's surface.

Whilst PBN Manual navigation specifications may contain an accuracy requirement specified as a 95% probability, when GNSS is used, the underlying accuracy is independent of the navigation specification requirement. An aircraft equipped with GNSS and approved for operations at a particular RNP level e.g. RNP 0.3 is capable of no less accurate navigation when operating to another navigation specification such as RNP 1.

It should be recognised that when GNSS is available navigation position accuracy remains high irrespective of the particular operation. However it should also be noted that accuracy is only one consideration in regard to a PBN operation and other factors may limit the approved operational capability.

4.4 Integrity Monitoring

All IFR lateral navigation systems, both conventional and performance based, are required to meet standards for integrity. Integrity represents the trust that we place in the ability of the system to provide navigation information that is not misleading. Whilst a navigation system may provide accurate guidance, in aviation we require assurance that the guidance is valid under all reasonable circumstances and various means have been implemented to provide that assurance.

Integrity for conventional navigation aids is indicated by the absence of a warning flag on a VOR or ILS indicator, or the presence of the Morse ident when using an ADF. For GNSS systems a loss of integrity availability is indicated by an annunciation (in various forms) displayed to the flight crew.

GNSS systems employ a variety of methods to monitor the integrity of the navigation solution, the most basic being Receiver Autonomous Integrity Monitoring or RAIM. This type of monitoring system is generally associated with (but not limited to) stand-alone general aviation receivers. Other types of integrity monitoring include proprietary hybrid systems which integrate inertial navigation with GNSS positioning to provide high levels of availability of navigation with integrity.

Unfortunately the term RAIM is erroneously used to describe integrity systems in general, and this can lead to some misconceptions of the role and application of integrity monitoring to performance based navigation.