NOTICE OF PROPOSED AMENDMENT (NPA) NO 2009-04

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY

Amending Decision No. 2003/12/RM of the Executive Director of the European Aviation Safety Agency of 5 November 2003 on acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »)

Airworthiness Approval and Operational Criteria for onboard equipment related to Area Navigation for Global Navigation Satellite System approach operation to Localiser Precision with Vertical guidance minima using Satellite Based Augmentation System

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A. Explanatory Note

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to envisage amending Decision 2003/12/RM of the Executive Director of 28 November 2003[1] on general acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »). The scope of this rulemaking activity is outlined in Terms of Reference (ToR) 20.006 and is described in more detail below.

2. The European Aviation Safety Agency (hereinafter referred to as the Agency) is directly involved in the rule-shaping process. It assists the Commission in its executive tasks by preparing draft regulations, and amendments thereof, for the implementation of the Basic Regulation[2] which are adopted as "Opinions" (Article 19(1)). It also adopts Certification Specifications (CS), including Airworthiness Codes and Acceptable Means of Compliance (AMC) and Guidance Material (GM) to be used in the certification process (Article 19(2)).

3. When developing rules, the Agency is bound to follow a structured process as required by Article 52(1) of the Basic Regulation. Such process has been adopted by the Agency's Management Board and is referred to as "The Rulemaking Procedure"[3].

4. This rulemaking activity is included in the Agency's Rulemaking Programme for 2009. It implements the rulemaking task 20.006 AMC-20 for Airworthiness Approval and Operational Criteria for LPV (Localiser Performance with Vertical guidance) Approach Operations.

5. The text of this NPA has been developed by the Agency. It is submitted for consultation of all interested parties in accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

II. Consultation

6. To achieve optimal consultation, the Agency is publishing the draft decision of the Executive Director on its internet site. Comments should be provided within 3 months in accordance with Article 6(4) of the Rulemaking Procedure. Comments on this proposal should be submitted by one of the following methods:

CRT: Send your comments using the Comment-Response Tool (CRT) available at **http://hub.easa.europa.eu/crt/**

E-mail: **Only** in case the use of CRT is prevented by technical problems these should be reported to the CRT webmaster and comments sent by email to NPA@easa.europa.eu.

Correspondence: If you do not have access to internet or e-mail you can send your comment by mail to:
Process Support
Rulemaking Directorate
EASA
Postfach 10 12 53
D-50452 Cologne
Germany

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[1] 2003/12/RM of the Executive Director of 28 November 2003 on general acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »). Decision as last amended by Decision 2008/007/R of the Executive Director of the Agency of 29 August 2008.

[2] Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.03.2008, p. 1)

[3] Management Board decision concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material ('Rulemaking Procedure'), EASA MB 08-2007, 13.6.2007

Comments should be submitted **by 23 June 2009**. If received after this deadline they might not be taken into account.

III. Comment response document

7. All comments received in time will be responded to and incorporated in a comment response document (CRD). The CRD will be available on the Agency's website and in the Comment-Response Tool (CRT).

IV. Content of the draft opinion/decision

8. This NPA introduces AMC 20-28, containing the AMC for the Airworthiness Approval and Operational Criteria for Area Navigation (RNAV) for Global Navigation Satellite System (GNSS) approach operation to Localiser Precision with Vertical guidance (LPV) minima using a Satellite Based Augmentation System (SBAS).

It should be noted that the Agency's initial responsibilities for the field of initial airworthiness and continuing airworthiness has already extended to cover the fields of air operations and flight crew licensing. For the implementation of this extension of scope the Agency has issued the following NPAs:

(1) NPA 2009-02 containing implementing rules, AMC and GM as regards air operations and associated authority and management systems requirements;

(2) NPAs 2008-17 and 2008-22 containing implementing rules and associated AMC and GM as regards flight crew licensing and associated authority and management systems requirements;

(3) NPA 2009-01 containing implementing rules and associated AMC and GM as regards the additional certification tasks of the Agency when transferring the former JAA JOEB into the EASA regulatory framework.

A further NPA is expected resulting from rulemaking task OPS.004 for the development of the implementing rules and associated AMC and GM as regards air operations of third country operators.

The references used in this draft AMC may be affected by the final rules resulting from these NPAs. The proposed AMC is using the existing references: EU-OPS 1 as applicable operational requirement for the commercial air transport of aeroplanes and JAR-OPS 3 and national operational requirements which are still applicable for the commercial air transport of helicopters. Depending on the progress of the above mentioned rulemaking tasks, the references and the proposed text for operational considerations may be aligned when the Agency issues the final Executive Director Decision.

The envisaged change to Decision 2003/12/R GENERAL ACCEPTABLE MEANS OF COMPLIANCE FOR AIRWORTHINESS OF PRODUCTS, PARTS AND APPLIANCES is:

9. Introduction of a new AMC 20-28 - Airworthiness Approval and Operational Criteria for RNAV GNSS approach operation to LPV minima using SBAS.

V. Regulatory Impact Assessment

10. Purpose and Intended Effect

a. Issue which the NPA is intended to address

This NPA addresses the certification and operation of RNAV onboard systems with respect to the application of RNAV GNSS approach operations to LPV minima procedures within European airspace.

b. Scale of the issue

The systems affected are restricted to those related to the navigation and operation of an aircraft along a desired flight path when within the coverage area of the required navigation aids, in accordance with the flight instrument procedures published by the Aeronautical Information Service Provider (ANSP).

c. Brief statement of the objectives of the NPA

The objective of this NPA is to establish an EASA AMC for the approval of RNAV onboard systems installations for use in airspace where RNAV GNSS approach operations to LPV minima procedures are implemented. This standard is required to support and facilitate the implementation of area navigation within the context of the European Air Traffic Management Network as described in Regulation EC 552/2004 on the Single European Sky[4].

11. Options

a. The options identified

Option 1: Do nothing

and

Option 2: Rulemaking to provide an AMC for airworthiness and operational approval of onboard equipment required for RNAV-GNSS approach operations to LPV minima.

b. The preferred option selected

Option 2 is the preferred option.

12. Sectors concerned

This NPA concerns airspace users, avionics and airframe manufacturers directly and Air Navigation Service Providers indirectly.

13. Impacts

a. All identified impacts

i. Safety

Option 1 (do nothing): There will be no safety or operational benefits associated with this option.

Option 2 (rulemaking): A clear standard for the approval of RNAV onboard systems capable of RNAV GNSS approach operations to LPV minima will be established. This will facilitate the implementation of RNAV GNSS procedures within European airspace, thus contributing to an enhanced level of safety through the capability to use precision approach procedures to runways that do not have a ground based precision approach system.

ii. Economic

Option 1 (do nothing): No European basis would be provided for the certification of aircraft for RNAV GNSS operation. European manufacturers and operators could be placed at an (economic) disadvantage through the need to comply with regulations developed by non-European organisations.

Option 2 (rulemaking): Compliance with the proposed NPA should result in a positive economic effect to the industry. Approval for operation using RNP procedures will improve the efficiency and capacity of European airspace, which will lead to a reduction in fuel burn. Adoption of this NPA will also ensure that the European position is clearly set out as part of world-wide harmonisation, with respect to RNAV GNSS operations.

[4] Regulation (EC) No 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation), OJ L 96, 31.3.2004, page 26.

iii. Environmental

Option 1 (do nothing): Has no effect on environmental issues

Option 2 (rulemaking): A reduction in fuel gas emission will have a positive benefit.

iv. Social

No impact expected.

v. Other aviation requirements outside EASA scope

No impact expected.

b. Equity and fairness in terms of distribution of positive and negative impacts among concerned sectors.

All applicants wishing to benefit from RNAV GNSS are equally affected. Further, it should be noted that many air transport category aircraft already carry capably RNAV systems, although they are not yet certified for RNAV GNSS operations. Such aircraft would be immediate candidates for certification.

14. Summary and Final Assessment

a. Comparison of the positive and negative impacts for each option evaluated

Maintaining the do nothing option 1 will result in no safety or operational improvements and will have no direct impact on the aviation community. The use of option 2 will enhance the level of safety through the capability to use precision approach procedures to runways that do not have a ground based precision approach system.

b. Final assessment and recommendation of a preferred option

The Agency concludes on the assessment provided above that Option 2 is the preferred option.

B. Draft Decision

The text of the amendment is arranged to show deleted text, new text or new paragraph as shown below:

1. deleted text is shown with a strike through: ~~deleted~~
2. new text is highlighted with grey shading: new
3. ….

   indicates that remaining text is unchanged in front of or following the reflected amendment.

I Draft Decision AMC 20

Decision No.2003/12/RM of the Executive Director of the Agency of 5 November 2003 shall be amended by introducing the following new AMC:

AMC 20-28: Airworthiness Approval and Operational Criteria for RNAV GNSS approach operation to LPV minima using SBAS

AMC 20-28 Airworthiness Approval and Operational Criteria for RNAV GNSS approach operation to LPV minima using SBAS

1. PURPOSE

This AMC provides an acceptable means that can be used to obtain airworthiness approval for an Area Navigation (RNAV) approach system based on Global Navigation Satellite System (GNSS) augmented by a Satellite Based Augmentation System (SBAS) in order to conduct approach operations to Localiser Precision with Vertical guidance (LPV) minima. This AMC also defines the operational criteria necessary to conduct safely such approach operations in designated European airspace.

An applicant may elect to use an alternative means of compliance. However, that means of compliance must meet the objectives of this AMC and be acceptable to the Agency and the competent authority. Compliance with this AMC is not mandatory. Use of the terms *shall* and *must* apply only to an applicant who elects to comply with this AMC in order to obtain airworthiness approval or to demonstrate compliance with the operational criteria.

2. BACKGROUND

This document addresses and defines airworthiness and operational criteria related to an aircraft system based on GNSS augmented by SBAS in order to conduct RNAV GNSS approach operation to LPV minima. It relates to the implementation of area navigation within the context of the Single European Sky[5], in particular in relation to the verification of conformity of the airborne constituents, per Article 5 of EC Regulation 552/2004. It addresses certification considerations of stand-alone and multi-sensor systems onboard an aircraft, including their functional requirements, accuracy, integrity, continuity of function and limitations, together with operational considerations. Operational compliance with these requirements must be addressed through national operational regulations, and may require a specific operational approval in some cases.

RNAV GNSS approaches conducted down to LPV minima are characterised by a Final Approach Segment (FAS). A FAS is the approach path which is defined laterally by the Flight Path Alignment Point (FPAP) and Landing Threshold Point/Fictitious Threshold Point (LTP/FTP) and defined vertically by the Threshold Crossing Height (TCH) and Glide Path Angle (GPA). The FAS of such approaches may be intercepted by an approach transition (e.g. Precision Area Navigation (P-RNAV) or initial and intermediate segments of an RNP APCH approach) or through vectoring (e.g. interception of the extended FAS).

3. SCOPE

This AMC is to be used to show compliance with the applicable Airworthiness Codes and functional criteria as define in paragraph 4.1 and 7.1. These are related to systems based on a stand-alone receiver or multi-sensor systems including at least one GNSS SBAS sensor. It also defines the operational approval criteria for the intended use under Instrument Flight Rules, including Instrument Meteorological Conditions, in designated European airspace.

Section 4.2 of this AMC refers to documents which contribute to the understanding of an RNAV GNSS approach operation to LPV minima using SBAS and which may support an application for approval. However, it is important that an applicant evaluates the aircraft systems and the proposed operational procedures against the criteria of this AMC.

[5] Regulation (EC) No 549/2004 of the European Parliament and of the Council of 10 March 2004 laying down the framework for the creation of the single European sky (the framework Regulation), OJ L 96, 31.3.2004, page 1.

Compliance with this AMC does not, by itself, constitute an operational authorisation to conduct RNAV GNSS approach operation to LPV minima using SBAS. Aircraft operators should apply to their competent authority. Since this AMC has been harmonised with other implementation and operational criteria outside of Europe, i.e. USA/FAA, it is expected to facilitate interoperability and ease the effort in obtaining operational authorisation by operators.

In this AMC, "LPV approach" wording has been used in lieu of "RNAV GNSS approach to LPV minima" for simplification purposes.

This document is only applicable to RNAV GNSS approaches conducted down to LPV minima. It does not address RNP approaches with Authorisation Required (RNP AR APCH) nor Basic RNP approaches (RNP APCH). These types of approaches are addressed by AMC 20-26 and AMC 20-27.

4. REFERENCE DOCUMENTS

4.1 Related Requirements

- CS 25.1301, 25.1302, 25.1307, 25.1309, 25.1316, 25.1321, 25.1322, 25.1329, 25.1431, 25.1581.
- CS 23.1301, 23.1309, 23.1311, 23.1321, 23.1322, 23.1329, 23.1335, 23.1431, 23.1581.
- CS 27.1301, 27.1309, 27.1321, 27.1322, 27.1329, 27.1581.
- CS 29.1301, 29.1307, 29.1309, 29.1321, 29.1322, 29.1329, 29.1431, 29.1581.
- EU-OPS[6] 1.035, 1.220, 1.225, 1.243, 1.290, 1.295, 1.297, 1.400, 1.420, 1.430, 1.845, 1.865, 1.870 and 1.975.
- JAR-OPS 3.243, 3.845, 3.865.
- National operating regulations.

4.2 Related Material

4.2.1. ICAO

Annex 10	International Standards and Recommended Practices- Aeronautical Telecommunications.
Doc 7030/4	Regional Supplementary Procedures.
Doc 9613	Manual on Performance Based Navigation (PBN).
Doc 8168	PANS OPS (Procedures for Air Navigation Services-Aircraft Operations).

4.2.2. EASA

AMC 25-11	Electronic Display Systems.
AMC 20-26	Airworthiness Approval and Operational Criteria for RNP Authorisation Required (RNP AR) Operations.
AMC 20-27	Airworthiness approval and Operational Criteria for RNP APPROACH (RNP APCH) operations Including APV BARO-VNAV Operations.
ETSO- C115( )	Airborne area Navigation Equipment using Multi-sensor Inputs.

[6] Commission Regulation (EC) N° 859/2008 of 20 August 2008 amending Council Regulation (EEC) N° 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane, OJ L 245, 20.9.2008, page 1.

ETSO-C129( )	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS).
ETSO-C145( )	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System.
ETSO-C146( )	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System.
EASA OPINION Nr. 01/2005	Conditions for Issuance of Letters of Acceptance for Navigation Database Suppliers by the Agency (i.e. an EASA Type 2 LoA).

4.2.3. FAA

AC 25-11( )	Electronic Display Systems.
AC 20-138( )	Airworthiness Approval of GNSS equipment.
AC 20-130A	Airworthiness approval of navigation or flight management systems integrating multiple navigation sensors.
AC 23-1309-1C	Equipment, systems, and installation in Part 23 airplanes.
AC 20-153	Acceptance of data processes and associated navigation data bases.
TSO-C115( )	Airborne area Navigation Equipment using Multi-sensor Inputs.
TSO-C129( )	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS).
TSO-C145( )	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System.
TSO-C146( )	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System.

4.2.4. EUROCAE / RTCA and ARINC

ED-76 / DO-200A	Standards for Processing Aeronautical Data.
ED-12( ) / DO-178( )	Software considerations in airborne systems and equipment certification.
ED-77 / DO-201A	Standards for Aeronautical Information.
DO-229( )	Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne equipment.
ARINC 424	Navigation System Data Base.

5. ASSUMPTIONS

Applicants should note that this AMC is based on the following assumptions:

5.1 Navaid infrastructure

GNSS augmented by SBAS is the primary navigation system to support LPV approach operations. The navigation system shall be:

(1) provisioned by a Navigation Service Provider certified according to Article 7 of Regulation 550/2004[7]; or

(2) comply with Annex 10[8] Volume 1 to the Convention on International Civil Aviation (Chicago Convention[9]).

The acceptability of the risk of loss of LPV approach capability for multiple aircraft due to satellite failure or SBAS system failure , loss of the onboard monitoring and alerting function (e.g. RAIM holes) or radiofrequency interference, will be considered by the responsible airspace authority.

5.2 Obstacle clearance

Detailed guidance on obstacle clearance is provided in PANS-OPS (ICAO Doc 8168, Volume II).

Note 1: Missed approach procedure may be supported by either RNAV or conventional (e.g. based on NDB, VOR, DME) segments.

5.3 Publication

All LPV Approach procedures are:

(1) published by an Aeronautical Information Service Provider certified according to Article 7 of Regulation 550/2004; or

(2) consistent with the relevant parts of PANS OPS (ICAO Doc 8168).

The instrument approach chart will identify LPV approach operation as RNAV(GNSS) and will indicate the associated LPV minima.

Charting will follow the standards of Annex 4[10] to the Chicago Convention for the designation of an RNAV procedure where the vertical path is specified by a glide path angle. The charting designation will remain consistent with the current convention and will be promulgated as a LPV OCA(H).

If the missed approach segment is based on conventional means, navaid facilities that are necessary to conduct the approach will be identified in the relevant publications.

The navigation data published in the applicable Aeronautical Information Publication (AIP) for the procedures and supporting navigation aids will meet the requirements of Annex 15[11] and Annex 4 to the Chicago Convention (as appropriate). The chart will provide sufficient data to support navigation database checking by the crew (including waypoint name, track, distance for each segment and vertical path angle).

All procedures will be based upon WGS 84 coordinates.

The LPV FAS will be promulgated using the FAS Data Block process. This specific onboard navigation database element defines the LPV FAS and is called “FAS Data Block”. This FAS Data Block contains the lateral and vertical parameters, which define the approach to

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[7] Regulation (EC) No 550/2004 of the European Parliament and of the Council of 10 March 2004 on the provision of air navigation services in the single European sky (the service provision Regulation), OJ L 96, 31.3.2004, page 10.

[8] Annex 10 to the Convention on International Civil Aviation - Aeronautical Telecommunications - Radio Navigation Aids

[9] The Convention on International Civil Aviation, sign in Chicago on 7 December 1944 (the Chicago Convention)

[10] Annex 4 to the Convention on International Civil Aviation - Aeronautical Charts

[11] Annex 15 to the Convention on International Civil Aviation - Aeronautical Information Services

be flown. Each FAS Data Block ends with a Cyclic Redundancy Check (CRC), which wraps around the approach data.

5.4 Communication and ATS surveillance

RNAV GNSS approach operation to LPV minima using SBAS does not include specific requirements for communication or ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance and operating procedures. Where reliance is placed on the use of radar to assist contingency procedures, its performance will be shown to be adequate for that purpose, and the requirement for a radar service will be identified in the AIP.

RT phraseology appropriate to such approach operations will be promulgated.

The particular hazards of a terminal and approach area and the impact of contingency procedures following multiple loss of aircraft LPV approach capability will be assessed.

6. AIRWORTHINESS CRITERIA

6.1 General

The following airworthiness criteria are applicable to the installation of the airborne system intended for IFR approach operation, certified according to CS-23, -25, -27 and -29.

This AMC is consistent with FAA Advisory Circular AC 20-138A (LPV approach operation airworthiness approval section).

This AMC is to be used to show compliance with the applicable Airworthiness codes and functional criteria.

6.2 Equipment qualification and aircraft installation

6.2.1 GNSS SBAS Stand-alone Navigation system

GNSS SBAS stand-alone equipment should be approved in accordance with E/TSO-C146a (or subsequent version). Application of this standard should guarantee that the equipment is at least compliant with RTCA DO-229C.

The equipment should be a Class Gamma, operational class 3 and the aircraft installation should comply with requirements of sections 6 to 9 of this AMC.

6.2.2 Integrated Navigation system incorporating a GNSS SBAS sensor

The Integrated Navigation system should meet the performance requirements defined in Chapter 2.2 of RTCA DO-229C. The system should also incorporate a GNSS SBAS sensor approved in accordance with E/TSO-C145a (or subsequent versions) Class Beta, operational class 3 and should comply with requirements of sections 6 to 9 of this AMC.

Note 1: Aircraft that have previously been demonstrated to comply with FAA AC 20-130A and ETSO C-115b (or subsequent versions), need only comply with the performance requirements of Chapter 2.3 of RTCA DO-229C.

6.2.3 Approach system incorporating class Delta GNSS SBAS equipment

The equipment should be approved in accordance with E/TSO-C146a (or subsequent version). This standard should guarantee that the equipment is at least compliant with RTCA DO-229C.

The equipment should be a Class Delta 4 and the aircraft installation should comply with requirements of sections 6 to 9 of this AMC.

6.3 Accuracy

The lateral and vertical Total System Error is dependent on the Navigation System Error (NSE), Path Definition Error (PDE) and Flight Technical Error (FTE).

6.3.1. Navigational System Error (NSE)

Navigational System Error should be within the accuracy requirements of Annex 10 volume 1 paragraph 3.7.2.4 to the Chicago Convention (Signal In Space performance requirements).

NSE requirements are fulfilled without any demonstration if the equipment computes the three dimensional position using a linear weighted least square solution in accordance with RTCA DO-229C Appendix J. Equipment compliant with E/TSO-C145a/C146a (or subsequent version) are satisfying the accuracy requirements of Annex 10 to the Chicago Convention.

6.3.2. Flight Technical Error (FTE)

6.3.2.1 Manual flight

For manual control to the approach flight path, the appropriate flight display(s) must provide sufficient information without excessive reference to other cockpit displays, to enable a suitably trained flight crew to maintain the approach path, make alignment with the runway or to go-around.

FTE performance is considered acceptable if the lateral and vertical display full scale deflections are compliant with the Non-Numeric lateral cross-track and vertical deviation requirements of RTCA DO-229C (or subsequent version)

Note 1: FTE is considered to be equivalent to the ILS approach if the angular display to the flight crew is comparable.

Note 2: ⅓ of the full scale deflection for lateral deviation corresponds to 50 microamps and ½ the full scale deflection for vertical deviation corresponds to 75 microamps when a standard display is used (with a full scale deflection of 150 microamps).

6.3.2.2 Flight Guidance System

FTE performance is considered acceptable if the approach mode of the Flight Guidance System is used during such approach. For more information see paragraph 8.5 of this AMC.

6.3.3. Path Definition Error (PDE)

There are no performance or demonstration requirements for PDE. PDE is considered negligible based upon the process of path specification to data specification and associated quality assurance that is included in the FAS Data Block generation process which is a standardised process. The responsibilities for FAS Data Block generation lie with the Air Navigation Service Provider. Operator's responsibilities associated to the navigation database management aspect are described in paragraph 10.4 of this AMC.

6.4 Integrity

Presenting simultaneously, misleading lateral, vertical and distance data, during an LPV approach is considered to be a hazardous failure condition (extremely remote).

Note 1 Probability terms are defined in AMC 25.1309, FAA AC 23.1309-1( ), AC 27-1B or AC 29-2C.

Note 2 Where LPV approach capability is added to an aircraft having ILS capability, the integrity of the existing ILS display(s) or course deviation indicator(s) used for LPV approach operation are considered acceptable.

6.5 Continuity of function

It shall be demonstrated that:

a) the probability of loss of all navigation information is Remote.

b) the probability of non-restorable loss of all navigation and communication functions is Extremely Improbable.

Loss of LPV approach capability is considered a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport. For LPV approach operation at least one system is required.

Note 1: The operator should develop contingency procedure for the loss of the approach capability during the approach.

Note 2: Probability terms are defined in AMC 25.1309, FAA AC 23.1309-1( ), AC 27-1B or AC 29-2C.

7. FUNCTIONAL CRITERIA

Functional criteria provided in this paragraph are those applicable to the LPV approach operation only. These criteria are therefore limited to the LPV Final Approach Segment and to the interception of the extended Final Approach Segment.

If the installed system (e.g. RNAV system) is also able to fly the initial, intermediate and missed approach segments of the approach it must be approved in accordance with the corresponding requirement (e.g. AMC 20-27 RNP APCH).

7.1 Required Functions

Item	Functional Description
1	LPV approach guidance must be continuously displayed on a lateral and vertical deviation display (HSI, EHSI, CDI/VDI) including a failure indicator and must meet the following requirements: 1) This display must be used as primary means of guidance during the approach. 2) The display must be visible to the flight crew and located in the primary field of view (± 15 degrees from the normal line of sight) when looking forward along the flight path. 3) The deviation display must have a suitable full-scale deflection based on the required track keeping accuracy. The lateral and vertical Full Scale Deflections are angular and associated to the lateral and vertical definitions of the FAS contained in the FAS Data Block. Note 1: Where the minimum required flight crew is two, it must be possible for the none flying flight crew member to verify the desired path and the aircraft position relative to the path.
2	Capability to display the GNSS Approach mode (e.g. LPV, LNAV/VNAV, LNAV …) in the primary field of view. Note: This annunciation indicates to the crew the active approach mode in order to correlate it with the corresponding line of minima on the approach chart. It permits also to detect a level of service degradation (e.g. downgrade from LPV to LNAV).
3	Capability to continuously display the distance to the Landing Threshold Point/Fictitious Threshold Point (LTP/FTP). Note: The display must be visible to the flight crew and located in the primary field of view (± 15 degrees from the normal line of sight) when looking forward along the flight path.
4	The navigation database must contain all the necessary data/information to fly the published LPV approach procedure (Final Approach Segment). Although data may be stored or transmitted in different ways, the data has to be organised in data blocks for the purpose of computing the CRC. This format provides integrity protection for the data it contains. Consequently, each Final Approach Segment is defined by a specific “FAS Data block” containing the necessary lateral and vertical parameters depicting the approach to be flown. Once the FAS Data Block has been decoded, the equipment shall apply the CRC to the data block to determine if the data is valid. If the FAS Data Block does not pass the CRC test, the equipment shall not allow activation of the LPV approach operation.
5	Capability to select from the database into the installed system the whole approach procedure to be flown (SBAS channel number and/or approach name).
6	Indication of the Loss Of Integrity (LOI)/Loss of Navigation, of the LPV airborne capability, in the primary field of view, by means of an appropriately located warning annunciator and the removal of all guidance clues.

Item	Functional Description
7	Capability to provide an appropriate output to an installed Terrain Awareness and Warning System (TAWS) enabling the use of the excessive downward deviation from a glideslope function. Note: This is only applicable where operational regulations require the use of a Class A TAWS or a Class A TAWS is installed.
8	Capability to immediately provide track deviation indications relative to the extended final approach segment, in order to facilitate the interception of the extended final approach segment from a radar vector (e.g. Vector To Final (VTF) function).

8. AIRWORTHINESS COMPLIANCE

8.1 General

This section details a means of airworthiness compliance for new or modified installations (Paragraph 8.2) and for existing installations (Paragraph 8.3). It also details specific points that should be considered during these approval processes (Paragraph 8.4 and 8.5).

Relevant documentation demonstrating airworthiness compliance should be available to establish that the aircraft is equipped with an airborne system meeting LPV approach requirements.

8.2 New or Modified Installations

In demonstrating compliance with this AMC, the following specific points should be noted:

The applicant will need to submit, to the Agency, a compliance statement which shows how the criteria of this AMC have been satisfied. The statement should be based on a plan, agreed by the Agency at an early stage of the implementation programme. The plan should identify the certification data to be submitted which should include, as appropriate, a system description together with evidence resulting from the activities defined in the following paragraphs.

Compliance with the airworthiness requirements for intended function and safety may be demonstrated by equipment qualification, system safety analysis, confirmation of appropriate software design assurance level, performance analysis, and a combination of ground and flight tests. To support the approval application, design data will need to be submitted showing that the objectives and criteria of Sections 6 and 7 of this AMC have been satisfied.

8.3 Existing Installations

The applicant will need to submit, to the Agency, a compliance statement which shows how the criteria of this AMC have been complied with for the existing installations. Compliance may be established by inspection of the installed system to confirm the availability of required features and functionality. The performance and integrity criteria of Sections 6 and 7 may be confirmed by reference to statements in the Aircraft Flight Manual or to other applicable approvals and supporting certification data. In the absence of such evidence, supplementary analysis and/or tests may be required.

8.4 Specific Installation criteria

The following points need to be taken into consideration during the airworthiness approval process.

a) Where other conventional navigation/approach systems, apart from the installed system, provide display and/or guidance to a Flight Director/Autopilot, means should be provided for:

- a system source selector as the only means of selection;
- clear annunciation of the selected approach system on or near the display;
- display of guidance information appropriate to the selected approach system; and
- delivery of guidance information to a Flight Director/Autopilot appropriate to the selected approach system.

b) Annunciation for Flight Director, Autopilot and selected approach system should be consistent, and compatible with the original design philosophy of the cockpit.

c) Equipment failure scenarios involving conventional navigation/approach systems and the installed system(s) should be evaluated to demonstrate that:

- adequate alternative means of navigation are available following failure of the installed system, and
- reversionary switching arrangements, e.g. Selection of ILS system 2 or LPV system 2 on HSI#1 in case of dual equipage, do not lead to misleading or unsafe display configurations.

The evaluation should consider also the probability of failures within the switching arrangements.

d) The coupling arrangements between the installed system and the flight director/autopilot should be evaluated to show compatibility and to demonstrate that operating modes, including installed system failure modes, are clearly and unambiguously indicated to the flight crew.

e) The use of the installed system and the manner of presentation of lateral and vertical guidance information to the flight crew should be evaluated to show that the risk of flight crew error has been minimised. The flight crew should be aware, at all times of the system in use for the approach.

f) Controls, displays, operating characteristics and the flight crew interface with the installed system should be assessed in relation to flight crew workload, particularly in the approach environment. Essential design considerations include:

- Minimising reliance on flight crew memory for any system operating procedure or task.
- Developing a clear and unambiguous display of system modes/sub modes and navigational data with emphasis on enhanced situational awareness requirements for any automatic mode changes.
- Use of context sensitive help capability and error messages (e.g. invalid inputs or invalid data entry messages should provide a simple means to determine how to enter “valid” data).
- Placing particular emphasis on the number of steps and minimising the time required to accomplish flight plan modifications to accommodate ATC clearances, holding procedures, runway and instrument approach changes, missed approaches and diversions to alternate destinations.
- Minimising the number of nuisance alerts so the flight crew will recognise and react appropriately when required.

8.5 FTE performance evaluation for LPV approach operation

ILS look alike presentation is detailed in RTCA DO-229C (or subsequent version) in particular the lateral and vertical Full Scale Deflection (FSD) requirements. The deflection may be fully angular with no limitation or angular but bounded at a certain value (e.g. bounded at ±1 Nm in lateral and ±150 m in vertical).

a) For installations where the autopilot has not been modified and the equipment provides ILS look alike deviations, the applicant should conduct several approaches while flying raw data, flight director and coupled to the autopilot, as applicable. The objective of this test is to ensure that the installed equipment interface is compatible with the aircraft; the objective is not to verify approach performance.

b) For installation where the autopilot has been modified, where the autopilot lateral/vertical control channel performance has not been assessed, or where non-

standard deviations are provided (not ILS look alike), then the approach performance will need to comply with CS xx.1329 or equivalent.

c) For manual control to the approach flight path, the appropriate flight display(s) must provide sufficient information to maintain the approach path and make alignment with the runway without excessive reference to other cockpit displays.

d) LPV approach tracking performance should be stable as follows:

- Lateral guidance from 1000 ft HAT to DA(H) should be stable without large deviations (i.e. within ±50 microamps deviation) from the indicated path.
- Vertical guidance from 700 ft HAT to DA(H) should be stable without large deviations (i.e. within ±75 microamps deviation) from the indicated path.

Note 1: Compatibility with ILS display systems can be achieved by converting the lateral and vertical deviation to microamps based upon a Full Scale Display (FSD) at 150 microamps.

8.6 Intermixing of equipment

Simultaneous use of airborne systems with different crew interfaces can be very confusing and can lead to problems when they have conflicting methods of operation and conflicting display formats. For approach operations, simultaneous use of equipment that is not identical or compatible is not permitted.

9. AIRCRAFT FLIGHT MANUAL/PILOT OPERATING HANDBOOK

For new or modified aircraft, the Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, should provide at least the following information:

a) A statement which identifies the equipment and aircraft build or modification standard certificated for RNAV GNSS approach operation to LPV minima using SBAS. This may include a very brief description of the installed system, including the airborne equipment software version, display equipment and a statement that it is suitable for LPV approach operations. A brief introduction to the LPV approach concept may also be included.

b) Appropriate amendments or supplements to cover LPV approach operation in the following sections:

- Limitations - including use of Lateral and Vertical deviations, FD and AP; currency of navigation database; crew verification of navigation data.
- Normal Procedures
- Abnormal Procedures - including actions in response to a Loss of Integrity/Loss of Navigation or in response to a degradation of the GNSS approach mode (e.g. downgrade from LPV to LNAV).

Note 1 This limited set of information assumes that a detailed description of the installed system and related operating instructions and procedures are available in other operating or training manuals.

10. OPERATIONAL CRITERIA

This section describes acceptable operational criteria for an LPV approach, subject to the limitations given below. The operational criteria assume that the corresponding airworthiness approval has been granted by the Agency.

Operational criteria apply to the use of the approach system on any aircraft operated under IFR in accordance with EU legislation or the applicable operational regulations in the fields for which the EU legislation has not yet been established.

Operations of the installed equipment should be in accordance with the AFM or AFM supplement. The operational procedures to be addressed by the operator are detailed in APPENDIX 3. The (Master) Minimum Equipment List (MMEL/MEL) should be amended to identify the minimum equipment necessary to satisfy LPV approach operations using the installed system.

The operator should determine the operational characteristics of the procedure to be flown. It is recommended that the process described in paragraph 10.3 and APPENDIX 2 of this AMC should be followed, to validate its operational use by the crew.

Depending on the aircraft capability, an LPV approach may be conducted with either a flight director or autopilot mode engaged. In this case the “approach” flight guidance mode should be used.

Prior to LPV approach operation, the operator needs to be authorised by their competent authority for such operations.

10.1. Flight Operations Documentation

The relevant parts and sections of the Operations Manual (e.g. Aircraft Operations Manual, check lists, training of crew) should be revised to take account of the operating procedures detailed in APPENDIX 3. The operator should make timely amendments to the Operations Manual to reflect relevant procedure and data base checking strategies. Manuals and check lists need to be submitted for review by the competent authority as part of the authorisation process.

10.2. Flight Crew Training

The flight crew should receive appropriate training, briefings and guidance material in order to safely conduct an LPV approach. This material and training should cover both normal and abnormal procedures. Standard training and checking, such as recurrent aeroplane/STD training and proficiency checks, should include LPV approach procedures. Based on this, the operator should determine what constitutes a qualified crew.

The operator should ensure that during line operations flight crew can perform assigned duties reliably and expeditiously for each procedure to be flown in:

a) normal operations: and

b) abnormal operations.

A training program should be structured to provide sufficient theoretical and practical training. An example of training syllabus is described in APPENDIX 4.

10.3. Aerodrome competence and Operator verification

Before planning a flight to an aerodrome (destination or alternate) with the intent to use a LPV approach procedure contained in the Navigation Database, the operator should determine the operational characteristics of the procedure in accordance with EU-OPS 1.975 or the applicable operational regulations. Further details are provided in APPENDIX 2.

Based on this assessment, the appropriate information should be given to the crew. If the aerodrome access requires a specific competence, the designated crew shall have a validated competence.

10.4. Navigation Database Management

10.4.1. Operator involved in the operation of aeroplanes for commercial air transportation

The operator shall comply with the requirements of EU-OPS 1.873 for the management of navigation databases.

10.4.2. Operator not involved in the operation of aeroplanes for commercial air transportation

The operator shall not use a navigation database for LPV approach operations unless the navigation database supplier holds a Type 2 Letter of Acceptance (LoA) or equivalent.

An EASA Type 2 LoA is issued by EASA in accordance with EASA OPINION Nr. 01/2005 on "The Acceptance of Navigation Database Suppliers" dated 14 January 2005. The FAA issues a Type 2 LoA in accordance with AC 20-153, while Transport Canada (TCCA) is issues an Acknowledgement Letter of an Aeronautical Data Process using the same basis. Both the FAA LoA and the TCCA Acknowledgement Letter are seen to be equivalent to the EASA LoA.

EUROCAE/RTCA document ED-76/DO-200A Standards for Processing Aeronautical Data contains guidance relating to the processes that the supplier may follow. The LoA demonstrates compliance with this standard.

Note 1: The LPV approach is characterised in the navigation database by the FAS Data Block protected by a CRC . The FAS Data Block contains the lateral and vertical parameters, which define the approach to be flown. Those parameters have been calculated, validated and promulgated by the Air Navigation Service Provider. In addition, each FAS Data Block ends with a CRC, which wraps around the approach data. Consequently, the integrity is ensured when the airborne equipment making use of the data successfully passes the CRC on the data block.

Quality Monitoring

The operator should continue to monitor both the process and the products in accordance with the quality system required by the applicable operational regulations.

Data Distribution

The operator should implement procedures that ensure timely distribution and insertion of current and unaltered electronic navigation data to all aircraft that require it.

10.4.3. Reportable Events

A reportable event is one that adversely affects the safety of the operation and may be caused by actions/events external to the operation of the aircraft navigation system. The operator should have in place a system for investigating such an event to determine if it is due to an improperly coded procedure, or a navigation data base error. Responsibility for initiating corrective action rests with the operator.

For those operators for whom approval is granted under EU-OPS 1, Technical defects and the exceeding of technical limitations, including the following events, should be the subject of Occurrence Reports (see EU-OPS 1.420):

a) Significant navigation errors attributed to incorrect data or a database coding error.

b) Unexpected deviations in lateral/vertical flight path not caused by pilot input or erroneous operation of equipment.

c) Significant misleading information without a failure warning.

d) Total loss or multiple navigation equipment failure.

e) Loss of Integrity (LOI) function whereas SBAS for LPV approach operations had not been notified as unavailable or unreliable during pre-flight planning.

11. AVAILABILITY OF DOCUMENTS

JAA documents are available from the JAA publisher Information Handling Services (IHS). Information on prices, where and how to order is available on the JAA website: www.jaa.nl

EASA documents may be obtained from EASA (European Aviation Safety Agency), PO Box 101253, D-50452 Koln, Germany. Website: www.easa.europa.eu

EUROCAE documents may be purchased from EUROCAE, 102 rue Etienne Dolet, 92240 MALAKOFF, France, (Fax: 33 1 46 55 62 65). Website: www.eurocae.eu

FAA documents may be obtained from Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325, USA. Website: www.faa.gov/aviation.htm

RTCA documents may be obtained from RTCA Inc, 1828 L Street, NW, Suite 805, Washington, DC 20036, USA, (Tel: +1 202 833 9339; Fax: +1 202 833 9434). Website: www.rtca.org.

ICAO documents may be purchased from Document Sales Unit, International Civil Aviation Organisation, 999 University Street, Montreal, Quebec, Canada H3C 5H7, (Fax: +1 514 954 6769, e-mail: sales_unit@icao.org) or through national agencies.

APPENDIX 1: GLOSSARY

The following are definitions of key terms used throughout this AMC.

Aircraft-Based Augmentation System (ABAS). An augmentation system that augments and/or integrates the information obtained from the other GNSS elements with information available onboard the aircraft.

Area navigation (RNAV): A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Accuracy: The degree of conformance between the estimated, measured, or desired position and/or the velocity of a platform at a given time, and its true position or velocity. Navigation performance accuracy is usually presented as a statistical measure of system error and is specified as predictable, repeatable and relative.

APV (Approach Procedure with Vertical guidance). An instrument approach procedure which utilises lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.

Availability: An indication of the ability of the system to provide usable service within the specified coverage area and is defined as the portion of time during which the system is to be used for navigation during which reliable navigation information is presented to the crew, autopilot, or other system managing the flight of the aircraft.

Basic GNSS operation: Operation that are based on GNSS Aircraft Based Augmentation System (ABAS). An ABAS system is typically a GNSS receiver with fault detection compliant to E/TSO-C129a, E/TSO-C145( ) or E/TSO-C146( )

Continuity of Function: The capability of the total system (comprising all elements necessary to maintain aircraft position within the defined airspace) to perform its function without non-scheduled interruptions during the intended operation.

Cyclic Redundancy Check (CRC). A mathematical algorithm applied to the digital expression of data that provides a level of assurance against loss or alteration of data.

DA(H): Decision altitude (DA) or Decision height (DH). A specified altitude or height in the precision approach or approach with vertical guidance at which a missed approach must be initiated if the required visual reference to continue the approach has not been established

Fault Detection and Exclusion (FDE): FDE is a receiver processing scheme that autonomously provides integrity monitoring for the position solution, using redundant range measurements. The FDE consist of two distinct parts: fault detection and fault exclusion. The fault detection part detects the presence of an unacceptably large position error for a given mode of flight. Upon the detection, fault exclusion follows and excludes the source of the unacceptably large position error, thereby allowing navigation to return to normal performance without an interruption in service.

FAP: Final Approach Point.

FPAP: Flight Path Alignment Point. FPAP coordinates are stored in the FAS Data Block (see also RTCA DO-229( )).

FSD: Full Scale Deflection

FTP: Fictitious Threshold Point. The threshold location is referred to as the FTP when it is displaced from the runway. FTP coordinates are stored in the FAS Data Block (see also RTCA DO-229( )).

GNSS stand-alone receiver: A GNSS system incorporating the GNSS sensor, the navigation capability and the navigation data base.

GNSS sensor: A GNSS system incorporating only the GNSS receiving and positioning part. It doesn't incorporate the navigation capability and the navigation data base.

GPA: Glidepath Angle. It represents the angle of the approach path (glide path) with respect to the horizontal plane defined according to WGS-84 at the LTP/FTP. GPA is stored in the FAS data block (see also RTCA DO-229( )).

HAL: Horizontal Alert Limit.

ILS Look alike: "ILS Look alike" is defined as the ability of a non-ILS based navigation receiver function to provide operational characteristics and interface functionality to the rest of the aircraft equivalent to that provided by an ILS based receiver function. The output should be in DDM/micro amps, with a sensitivity equivalent to an ILS receiver.

Integrity: The ability of a system to provide timely warnings to users when the system should not be used for navigation.

LPV: Localiser Precision with Vertical guidance.

LPV approach operation: RNAV GNSS approach operation conducted down to LPV minima.

LPV approach procedure: RNAV GNSS approach procedure containing LPV minima.

LPV approach capability: Airborne capability to fly LPV approach procedure.

LPV OCA(H). Obstacle clearance altitude (OCA) or obstacle clearance height (OCH). The lowest altitude or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria.

LTP: Landing Threshold Point. The threshold location is referred to as the LTP when it is collocated with the runway. LTP coordinates are stored in the FAS Data Block.

Receiver Autonomous Integrity Monitoring (RAIM): A technique whereby a GNSS receiver/processor determines the integrity of the GNSS navigation signals using only GPS signals or GPS signals augmented with altitude. This determination is achieved by a consistency check among redundant pseudo range measurements. At least one satellite in addition to those required for navigation should be in view for the receiver to perform the RAIM function.

RNAV System: A navigation system which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these. A RNAV system may be included as part of a Flight Management System (FMS).

RNAV(GNSS) approach: A GNSS RNAV approach promulgated by a state and designed in accordance with PANS-OPS Criteria ICAO Doc 8168.

SBAS: Satellite Based Augmentation System. SBAS augments core satellite constellation by providing ranging, integrity and correction information via geostationary satellites.

This system comprises a network of ground reference stations that observe satellites signals, and master stations that process observed data and generate SBAS messages for uplink to the geostationary satellites, which broadcast the SBAS message to the users.

RNP APCH: RNP AProaCH. A RNP approach defined in the ICAO Performance Based Manual (PBN) manual. An approach equivalent to the RNAV (GNSS) one.

TSO-C129( )/ETSO-C129( ) GPS Class A equipment: Equipment incorporating both the GNSS sensor and navigation capability. This equipment incorporates RAIM as defined by TSO/ETSO-C129( ).

TSO-C129( )/ETSO-C129( ) GPS Class B and C equipment: GNSS sensor providing GNSS data (position, integrity,..) to an integrated navigation system (e.g. FMS).

TSO-C146( ) Class GAMMA: This functional class corresponds to equipment consisting of both the GNSS/SBAS position sensor and a navigation function, so that the equipment provides path deviations relative to a selected path. The equipment provides the navigation function required of a stand-alone navigation system. This equipment also provides integrity in the absence of SBAS signal through the use of FDE. In addition, this class of equipment requires a data base, display outputs and pilot controls.

TSO-C145( )/ETSO-C145( ) class BETA: Equipment consisting of a GNSS/SBAS sensor that determines position (with integrity) and provides position and integrity to an integrated navigation system (e.g. flight management system, multi sensor navigation system). This equipment also provides integrity in the absence of the SBAS signal through the use of fault detection and exclusion (FDE).

TSO-C146( )/ETSO-C146( ) or TSO-C145( )( )/ETSO-C145( ) Operational Class 1: This operational class supports oceanic and domestic enroute, terminal, LNAV and departure operation.

TSO-C146( )/ETSO-C146( ) or TSO-C145( )/ETSO-C145( ) Operational Class 2: This operational class supports oceanic and domestic enroute, terminal, LNAV, LNAV/VNAV and departure operation.

TSO-C146( )/ETSO-C146( ) or TSO-C145( )/ETSO-C145( ) Operational Class 3: This operational class supports oceanic and domestic enroute, terminal, LNAV, LNAV/VNAV, LPV and departure operation.

VAL: Vertical Alert Limit.

Vertical Navigation: A method of navigation which permits aircraft operation on a vertical flight profile using altimetry sources, external flight path references, or a combination of these.

VTF: Vector To Final.

APPENDIX 2: OPERATIONAL CHARACTERISTICS OF THE PROCEDURE AND ITS OPERATIONAL USE

The operator should show evidence that consideration has been given to the evaluation of any new or modified LPV approach procedures. Particular attention should be paid to procedures:

- in mountainous environment;
- within the proximity of well known obstacles; and
- that may require adequate knowledge for the aerodrome access or aerodrome competence qualification, as specified in EU-OPS 1.975 or the applicable operational requirements.

Competence may be required specifically for an LPV approach procedure or the procedure may be published for an aerodrome already listed as requiring an aerodrome competence. The required competence may be aircraft type related and subject to periodic revalidation. Particular attention should be paid to procedures that:

- are not in radar coverage;
- have a missed approach trajectories involving turns, especially at low altitudes;
- are subject to a declared exemption to the procedure design rules specified by the ICAO PANS OPS; and
- every other case considered necessary to be evaluated by the operator.

The operator may develop an internal process (e.g. filtering methods or tools covering the AIP review) to detect LPV approach procedure(s) showing one or more of the above-listed characteristics.

The operational evaluation of a LPV approach procedure showing evidence of the above mentioned operational characteristics may include, at operator discretion, an approach conducted with the aircraft in VMC or the use of a full flight simulator (FFS) in order to evaluate if the procedure is correctly executed by the navigation system and fly-able with the aircraft type.

APPENDIX 3: LPV APPROACH OPERATIONAL PROCEDURES

This appendix should be used by the operator to amend operational manual(s) to support LPV approach operation.

1. Normal Procedures

1.1 Pre-flight Planning

The onboard navigation data must be current and must include the appropriate procedures.

In addition to the normal pre-flight planning the following checks must be carried out:

a) The instrument approach chart should clearly identify the LPV approach operation as RNAV(GNSS) or equivalent (e.g. RNAV(GNSS) RWY 27,…). The operator should determine in accordance with the promulgated OCA(H) and the operational requirement (e.g. EU-OPS 1.430) the Decision Altitude/Height (DA(H)).

b) The flight crew must ensure that LPV approach procedures which may be used for the intended flight (including alternate aerodromes) are selectable from a valid navigation data base (current AIRAC cycle) and are not prohibited by a company instruction or NOTAM.

   The flight crew could check approach procedures (including alternate aerodromes) as extracted by the system (e.g. CDU flight plan page) or presented graphically on the NAV display, in order to confirm the correct loading and the reasonableness of the procedure content. The vertical path of the LPV approach procedure could be checked as extracted from the navigation database on the system Man Machine Interface (e.g. CDU).

   If above verification is not satisfactory, the flight crew should not use the procedure, and not consider this approach(es) during the selection of aerodromes for the intended flight.

   Note1: For LPV approach operations, the flight crew selects the desired approach procedure using its name or the SBAS channel number and the onboard system automatically extracts the high-integrity procedure and associated alert limits (VAL, HAL). This information is protected from data corruption by a cyclic redundancy check (CRC) determined during the procedure design.

c) The flight crew should ensure sufficient means are available to navigate and land at the destination or at an alternate aerodrome in the case of loss of LPV airborne capability. In particular, the flight crew should check that:

   - a non RNAV GNSS based procedure is available at the alternate (where a destination alternate is required) unless the airspace authority does not require such requirement (e.g. FAA within WAAS coverage);
   - at least one non RNAV GNSS based procedure is available at the destination aerodrome (where a destination alternate is not required) unless the airspace authority does not require such requirement (e.g. FAA within WAAS coverage).

d) Operators and flight-crews must take account of any NOTAMs (including SBAS NOTAMs) or operator briefing material that could adversely affect the aircraft system operation, or the availability or suitability of the procedures at the airport of landing, or any alternate airport.

e) If the missed approach procedure is based on conventional means (e.g. VOR, DME) the appropriate airborne equipment required to fly this procedure must be available

and serviceable onboard the aircraft. The associated ground-based navigation aids must also be operational.

If the missed approach procedure is based on RNAV (no conventional or dead reckoning missed approach available) the appropriate airborne equipment required to fly this procedure must be available and serviceable onboard the aircraft (e.g. RNP APCH capable system).

f) Any MEL restriction must be observed.

1.2 Prior to Commencing the Procedure

The Final approach segment (FAS) of an LPV approach procedure may be intercepted by an approach transition (e.g. P-RNAV or initial/intermediate segments of an RNP APCH approach) or through vectoring (interception of the extended Final approach segment following ATC instruction).

In addition to normal procedure prior to commencing the approach (before the IAF and in compatibility with crew workload), the flight crew must verify the correctness of the loaded procedure by comparison with the appropriate approach charts. This check must include:

- The waypoint sequence;
- Reasonableness of the tracks and distances of the approach legs, and the accuracy of the inbound course and mileage of the final approach segment.

Note: As a minimum, this check could be a simple inspection of a suitable map display.

- The vertical path angle.

ATC tactical interventions in the terminal area may include radar headings, 'direct to' clearances which by-pass the initial legs of an approach, interception of an initial or intermediate segment of an approach or the insertion of waypoints loaded from the database. In complying with ATC instructions, the flight crew should be aware of the implications for the navigation system in particular:

- The manual entry of coordinates into the navigation system by the flight crew for operation within the terminal area is not permitted;
- 'Direct to' clearances may be accepted to the Intermediate Fix (IF) provided that the resulting track change at the IF does not exceed 45°.

Note: Direct to clearance to FAP is not acceptable.

The approach system provides the capability for the flight crew to intercept the Final Approach track well before the FAP (Vector To Final (VTF) function or equivalent). This function should be used to respect a given ATC clearance.

1.3 During the Procedure

The system provides lateral and vertical guidance relative to the LPV Final Approach Segment or to the extended final approach segment (for the direct transition).

The crew must check that the GNSS approach mode indicates LPV (or an equivalent annunciation) 2 NM before the FAP.

The final approach segment should be intercepted no later than the FAP in order for the aircraft to be correctly established on the final approach course before starting the descent (to ensure terrain and obstacle clearance). The appropriate displays should be selected so that the following information can be monitored:

- Aircraft position relative to the lateral path;

- Aircraft position relative to the vertical path;
- Absence of LOI (Loss Of Integrity) alert.

The crew should respect all published altitude and speed constraints.

The flight crew shall maintain the aircraft within ⅓ the full scale deflection for the lateral deviation and within ½ the full scale deflection for the vertical deviation when manual flying the procedure

Prior to sequencing the FAP, the procedure must be discontinued if there is:

- Loss of integrity/Loss of Navigation is indicated by a warning annunciator (e.g. absence of power, equipment failure).

After sequencing the FAP, the procedure must be discontinued, unless the flight crew have in sight the visual references required to continue the approach, if there is:

- Loss of integrity/Loss of Navigation is indicated by a warning annunciator;
- Loss of vertical guidance is indicated (even if lateral guidance is displayed);
- lateral or vertical deviation are excessive and cannot be timely corrected.

The missed approach must be flown in accordance with the published procedure (e.g. conventional or RNAV).

2. Abnormal Procedures

Abnormal procedures to address Cautions and Warnings resulting from the following conditions should be developed:

- Failure of the navigation system components, including those affecting flight technical errors (e.g. failures of the flight director or autopilot).
- Fault Detection and Exclusion (FDE) alert or loss of integrity function.
- Warning flag or equivalent indicator on the lateral and/or vertical navigation display.
- Degradation of the GNSS approach mode during a LPV approach procedure (e.g. downgrade from LPV to LNAV).

In case of a complete RNAV guidance loss during the approach, the crew must follow the operator defined contingency procedure.

In the event of communications failure, the flight crew should continue with the procedure in accordance with published lost communication procedures.

The flight crew should notify ATC of any problem with the navigation system that results in the loss of the approach capability.

APPENDIX 4: FLIGHT CREW TRAINING SYLLABUS

The flight crew training program should be structured to provide sufficient theoretical and practical training, using a simulator, training device, or line training in an aircraft, in the concept of RNAV GNSS approach operations to LPV minima and the use of the aircraft's approach system in such operations to ensure that flight crew are not just task oriented. The following syllabus should be considered as a minimum amendment to the training programme to support these operations:

1. RNAV APPROACH CONCEPT CONTAINING LPV MINIMA:

a) Theory of approach operations

b) Approach charting

c) Use of the approach system including:

   i. Selection of the LPV approach procedure

   ii. ILS look alike principle

d) Use of lateral navigation mode(s) and associated lateral control techniques

e) Use of vertical navigation mode(s) and associated vertical control techniques

f) R/T phraseology for LPV approach operations

g) The implication for LPV approach operations of systems malfunctions which are not related to the approach system (e.g. hydraulic or engine failure)

2. RNAV APPROACH OPERATION CONTAINING LPV MINIMA:

a) Definition of LPV approach operations and its direct relationship with RNAV(GNSS) procedures.

b) Regulatory requirements for LPV approach operations

c) Required navigation equipment for LPV approach operations:

   i. GPS concepts and characteristics

   ii. SBAS augmentation and characteristics

   iii. MEL

d) Procedure characteristics

   i. Chart depiction

   ii. Aircraft display depiction

   iii. Minima

e) Retrieving a LPV approach procedure from the database (e.g. using its name or the SBAS channel number)

f) Procedure change at destination airport, change arrival airport and alternate airport

g) Flying the procedure:

   i. Use of autopilot, autothrottle and flight director

   ii. Flight Guidance(FG) mode behaviour

   iii. Lateral and vertical path management

   iv. Adherence to speed and/or altitude constraints

v. Fly interception of an initial or intermediate segment of an approach following ATC notification

vi. Fly interception of the extended final approach segment (e.g. using the VTF function).

vii. Consideration of the GNSS approach mode indication (LPV, LNAV/VNAV, LNAV,…)

viii. The use of other aircraft equipment to support track monitoring, weather and obstacle avoidance

h) ATC procedures

i) Abnormal procedures

j) Contingency procedures