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LPV status of Airbus Helicopters aircraft

AIRBUS HELICOPTERS FLEET

H130  H135  EC145/ H145

AS365N3+ and H155

Light (CS27) to heavy (CS29) helicopters

Civil and/or military

Covering a wide range of mission (oil&gas, HEMS, Search and rescue, police, law enforcement, personal and business aviation…)

H125

H120

NH90 (via NHIndustries)

Tiger

Super Puma (H225/H215..)

H175

H160
LPV status of Airbus Helicopters aircraft

Why LPV on helicopter

- It allows approach on small airport / heliport w/o need of ground infrastructure as ILS
- ILS decommissioning
- More and more LPV approaches are published, in area of SBAS coverage
- Steep approach capability for helicopters (close to 10°) allowing
  - noise abatement in high density populated area
  - approach in environment with obstacle
- PinS allowing approach on a point and then proceed VFR or visually to a landing pad

- Main mission segments asking for LPV
  - HEMS
  - oil & gas

- Emerging demand from military customers (Europe…)

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LPV integration and avionics impact

LPV implementation requires modification of avionics system

- DISPLAY
- H/C with LPV capability
- FMS/GNSS
- MEGHAS
- AHCAS
- HELIONIX
- AFCS (*)
- APM2000 family
- HELIONIX
- GNS/GTN series
  - CMA9000
  - CMA5024

(*) no change in case of ILS like LPV status of Airbus Helicopters aircraft
**LPV implementation types**

<table>
<thead>
<tr>
<th>LPV implementation type</th>
<th>Characteristics</th>
<th>Avionics impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILS like</td>
<td>During RNP APCH, manual transition required between ‘en route’ format and ILS format based on LPV equipment deviations, close to the approach</td>
<td>No change of AFCS Minor change of display using the ILS input</td>
</tr>
<tr>
<td>Full LPV</td>
<td>During RNP APCH automatic transition to LPV equipment deviations</td>
<td>Change of AFCS (*), with improved performance Change of display</td>
</tr>
</tbody>
</table>

When LPV capability is provided, LNAV/VNAV using GNSS as altitude source is also added

(*) geometric path is used instead of angular deviation as performed on ILS guidance
LPV implementation strategy

- LPV implementation will depend on H/C to be retrofitted or new H/C

- No LPV on H/C which are no more manufactured, due to avionics HW and SW high upgrade cost
  - AS 332L2 with IFDS avionics suite (end 80’s beginning 90’s)
  - AS 332 MK1 with MFD225 display (end 90’s), and AS355

- LPV as ILS like on avionics suite where capabilities of development are limited
  - BK117C-2, H135 with MEGHAS avionics (mid 90’s), H155

- Full LPV on avionics where development are going on or new avionics
  - H225e (possible retrofit of H225 in this standard) with AHCAS avionics
  - H145/BK117D2 with HELIONIX avionics
  - H135 with HELIONIX avionics
  - H175 with HELIONIX avionics
  - H160 with HELIONIX avionics
LPV status of Airbus Helicopters aircraft

No LPV

Cockpit of a AS 332L2 with IFDS

Cockpit of a AS365 with MFD255
LPV status of Airbus Helicopters aircraft

LPV implementation as ILS like

Cockpit of an H145 with MEGHAS

Display with ILS

Minor changes vs ILS display (add Level of Service..)

Display with LPV

No AFCS change
LPV status of Airbus Helicopters aircraft

LPV: full implementation

H225 cockpit with AHCAS (8” x 6”)

AFCS upper modes

Angular deviation

Level of service

NAV source

SBAS status

approach data
LPV status of Airbus Helicopters aircraft

LPV: full implementation

H145 cockpit with HELIONIX (display 6”x8”)

Level of service
NAV source
SBAS status
approach data

AFCS upper modes
Angular deviation
LPV status of Airbus Helicopters aircraft

**FM for LPV**

- LPV capability provided with dual GNSS and dual FM
- LPV guidance performed by the GNSS (due to DAL B)
- Development performed mainly with two FMS/GNSS

**GARMIN FMGPS (GNS/GTN series)**

- Example

**CMC Electronics**

- FMS CMA9000 + GPS CMA5024

![GNS430W](image)

![GTN750](image)
LPV status of Airbus Helicopters aircraft

LPV: family concept

- Implementation on different platforms
  - example

<table>
<thead>
<tr>
<th></th>
<th>H145/H135</th>
<th>H160/H175</th>
<th>H225</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISPLAY</td>
<td>HELIONIX</td>
<td>HELIONIX</td>
<td>AHCAS</td>
</tr>
<tr>
<td>AFCS</td>
<td>HELIONIX</td>
<td>HELIONIX</td>
<td>APM2010</td>
</tr>
<tr>
<td>FMS</td>
<td>GTN750</td>
<td>CMA9000</td>
<td>CMA9000</td>
</tr>
</tbody>
</table>

- Family concept is kept and maximum reuse is performed

- Interchangeability of FMS is made easier

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Typical architecture for full LPV

- Dual GNSS, dual FMS
- Any MFD connected to both FM and both GNSS
- Any AFCS connected to both FM and both GNSS
- Automatic reconfiguration in case of equipment FM/GNSS failure
- Only one FM/GNSS (monitored by x-FM/GNSS) is displayed
- GNSS performs the LPV approach, from FASDB provided by FM

Certification performed in front of EASA guidance materials AMC20-28, and CRI for steep approach
Challenge of LPV implementation

- **Procedures**
  - Procedure evolution including introduction of course change at FAF

- **Regulation**
  - AMC20-28 EASA available in 2012
  - CRI for steep approach

- **Economical**
  - Transition to dual system
  - Impact on legacy fleet for retrofit
  - Full LPV requiring display modification and AFCS change for several avionics suite (display/AFCS/FM)
  - Many customers not under SBAS coverage

- **Technical**
  - Antenna installation (for robustness to structure masking especially at high latitudes)
  - Multipath (small ground plane on helicopter)
  - Side impact on avionics (TAWS…)
  - Configuration of system for area out of SBAS coverage and without LPV
LPV verification / certification

- Verification tests performed on rig
  - Simulated flights with real avionics system (FMS, AFCS, display)
  - GNSS constellation simulator connected to the GNSS via the antenna input
- Nominal cases test
- Degraded cases test (equipment failure or discrepancies, GNSS constellation), and assessment of system reconfiguration

- Verification tests performed in flight
  - Several tenth of hours of flight required
  - Different slopes, different wind conditions and different course relative to final approach
- Existing procedures or Airbus Helicopters defined procedures compliant with ICAO but at a location in a dedicated test area close to Airbus Helicopters premises of Marignane
- Recently approaches LPV published on Marseille
LPV verification / certification

- In Donauworth, publication of several LPV procedures for testing for test and demonstration including steep approach of $10^\circ$, standard maximum slope of $6.3^\circ$, and with course change at FAF.

Donauworth view of landing area

LPV approach example
- Not in the runway axis
- Slope: $6.3^\circ$
- FAF at 3000ft

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LPV status of Airbus Helicopters aircraft

LPV implementation on helicopter fleet

- **WAAS certified**
- **EGNOS certified**

### 2010
- **H155 (ILS like) – mid 2013**
- **EC145/BK117 C2 (ILS like) – Mid 2015**

### 2015
- **H135 (EC135 P1/P2 T1/T2) certification (ILS like) – end 2014**
- **H145/BK117 D2 (full LPV) – end 2015**
- **H155 (ILS like) – mid 2013**
- **EC145/BK117 C2 (ILS like) – Mid 2015**
- **H175 certification (full LPV) – end 2015**
- **H225 certification (full LPV) – end 2015**

### Mid 2016
- **H135 (EC135 P3/T3) certification (full LPV) – in progress**
- **H145/BK117 D2 (full LPV) – end 2015**
- **H155 (ILS like) – mid 2013**
- **EC145/BK117 C2 (ILS like) – Mid 2015**
- **H175 certification (full LPV) – end 2015**
- **H225 certification (full LPV) – end 2015**

### 2020
- **H160 certification (full LPV)**
## LPV status of Airbus Helicopters aircraft

### Airbus Helicopters – Fleet status

<table>
<thead>
<tr>
<th>HC</th>
<th>FMS</th>
<th>Basic Avionics</th>
<th>LPV type</th>
<th>Slope</th>
<th>Course change at FAF</th>
<th>Date of approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC135</td>
<td>GNS430W</td>
<td>MEGHAS</td>
<td>ILS like</td>
<td>&lt;6°</td>
<td>no</td>
<td>Q4 2010 (STC)</td>
</tr>
<tr>
<td>H135</td>
<td>GTN750</td>
<td>MEGHAS</td>
<td>ILS like</td>
<td>&lt;6.3°</td>
<td>yes</td>
<td>Q4 2014</td>
</tr>
<tr>
<td>(P1/T1, P2/T2)</td>
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</tr>
<tr>
<td>H135</td>
<td>GTN750</td>
<td>HELIONIX</td>
<td>Full LPV</td>
<td>&lt;10°</td>
<td>yes</td>
<td>Planned Q4 2016</td>
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<tr>
<td>(P3/T3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BK117C2</td>
<td>GNS430W</td>
<td>MEGHAS</td>
<td>ILS like</td>
<td>&lt;6.3°</td>
<td>no</td>
<td>Q4 2010 (STC)</td>
</tr>
<tr>
<td>BK117C2</td>
<td>GNS430W</td>
<td>MEGHAS</td>
<td>ILS like</td>
<td>&lt;6.3°</td>
<td>yes</td>
<td>Q2 2015</td>
</tr>
<tr>
<td>BK117D2 / H145</td>
<td>GTN750</td>
<td>HELIONIX</td>
<td>Full LPV</td>
<td>&lt;10°</td>
<td>yes</td>
<td>Q4 2015</td>
</tr>
<tr>
<td>EC155</td>
<td>GNS400W</td>
<td>MEGHAS</td>
<td>ILS like</td>
<td>&lt;6°</td>
<td>no</td>
<td>Q2 2014 (STC)</td>
</tr>
</tbody>
</table>
# Airbus Helicopters – Fleet status

<table>
<thead>
<tr>
<th>HC</th>
<th>FMS</th>
<th>Basic Avionics</th>
<th>LPV type</th>
<th>Slope</th>
<th>Course change at FAF</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>H160</td>
<td>CMA9000</td>
<td>HELIONIX</td>
<td>Full LPV</td>
<td>&lt;10°</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>H175</td>
<td>CMA9000</td>
<td>HELIONIX</td>
<td>Full LPV</td>
<td>&lt;10°</td>
<td>Yes</td>
<td>Q4 2015</td>
</tr>
<tr>
<td>H225 (note 1)</td>
<td>CMA9000</td>
<td>HELIONIX</td>
<td>Full LPV</td>
<td>&lt;6,3°</td>
<td>Yes</td>
<td>Q4 2015</td>
</tr>
</tbody>
</table>

- NOTE 1: with H225e (upgrade of H225 including avionics)
- Studies initiated for military helicopters as NH90
- Some HC may remain without LPV (example AS 332 L2)
- Some HC manufactured as H215, LPV not yet initiated
Possible way ahead

- LPV procedures for increased operational benefit on airport
  PinS LPV procedures for HEMS, SNI approaches

- Study on benefit for helicopter missions:
  approaches on oil rig, or on wind farm

- Transition to multiconstellation/multifrequency receiver (GNSS L5, GALILEO, GLONASS (Russian mandate), BEIDOU..), impact on avionics, and associated operational benefit (better integrity, better availability, low RNP,…), A-PNT (Alternate Positioning)

- PBN implementation
  - Low IFR routes – RNP 0.3
  - RNP-AR
  - A-RNP

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LPV status of Airbus Helicopters aircraft

## ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFCS</td>
<td>Automatic Flight Control System</td>
</tr>
<tr>
<td>CRI</td>
<td>Certification Review Item</td>
</tr>
<tr>
<td>DAL</td>
<td>Design Assurance Level</td>
</tr>
<tr>
<td>EGNOS</td>
<td>European Geostationary Navigation Overlay Service</td>
</tr>
<tr>
<td>FASDB</td>
<td>Final Approach Segment Data Block</td>
</tr>
<tr>
<td>FMS</td>
<td>Flight Management System</td>
</tr>
<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
</tr>
<tr>
<td>HEMS</td>
<td>Helicopter Emergency Medical Service</td>
</tr>
<tr>
<td>PBN</td>
<td>Performance Based Navigation</td>
</tr>
<tr>
<td>PinS</td>
<td>Point in Space</td>
</tr>
<tr>
<td>RNP</td>
<td>Required Navigation Performance</td>
</tr>
<tr>
<td>RNP-AR</td>
<td>RNP Authorization Required</td>
</tr>
<tr>
<td>SNI</td>
<td>Simultaneous Non Interfering</td>
</tr>
<tr>
<td>TAWS</td>
<td>Terrain Awareness and Warning System</td>
</tr>
<tr>
<td>WAAS</td>
<td>Wide Area Augmentation System</td>
</tr>
</tbody>
</table>
LPV status of Airbus Helicopters aircraft

END OF PRESENTATION