Designing advanced Navigation & Approach functions with safety in mind

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Overview

- **NAVIGATION**
  - **RNP 0.3** "All Phases of Flight"
    - Moving **from RNP 0.3 to RNP 0.1 Helicopter Operations**
- **APPROACH**
  - **D-GLS Approach** – Differential - GPS Landing System Approach
    - **OWS (Obstacle Warning System): LOAM** and **OPLS** systems
    - **SVS / EVS / CVS** systems on classic PFD or on new **HMD** displays
- **Concluding Remarks**

H/C Low Level IFR Routes using RNP 0.3 "All phases of flight" 1/3

In the framework of Flight Trials SESAR VP-818 (spring 2016), Navigation Specification RNP 0.3 "All Phases of Flight" positively flown in Linate TMA area **MD/MC** (Medium Density/Medium Complexity) as application of Navigation specification RNP 0.3 of

PBN manual 9613 4th edition.

Table II-A-1-1. Application of navigation specification by flight phase

Part Chapter	Navigation specification	Flight phase							
		En-route oceanic/remote	En-route continental	Arrival	Approach				DEP
					Initial	Intermediate	Final	Missed[1]	
C, Ch.7	RNP 0.3[8]		0.3	0.3	0.3	0.3		0.3	0.3

8. The RNP 0.3 specification is primarily intended for helicopter operations.

H/C Low Level IFR Routes using RNP 0.3 “All phases of flight” 2/3

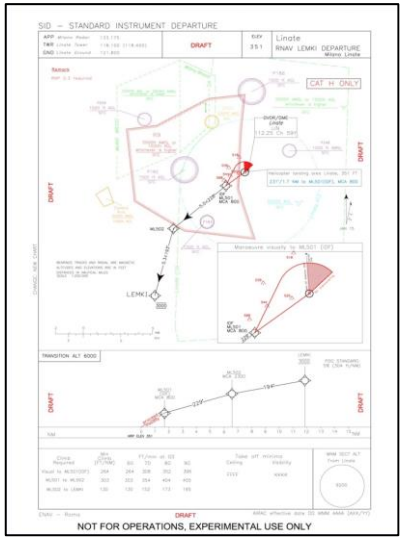
Scenario, according to **SNI** concept of operations, flown with AW139 and AW189 helicopters during the RNP 0.3 exercise:

- Departure from Linate (LIML) FATO helipad using PinS departure joined with,
- Low Level IFR route KY159 and,
- PinS Approach with LNAV minima with Missed Approach procedure on Malpensa (LIMC)

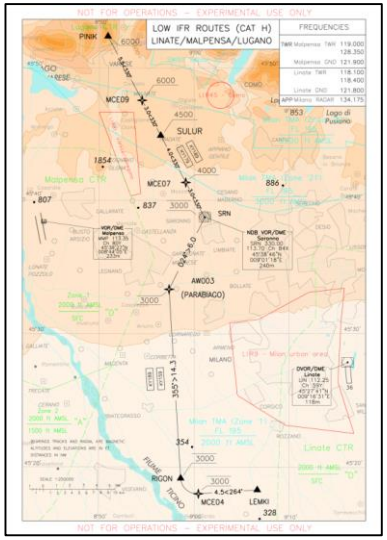
- *Low Level network in airspace of Milan TMA (class "A") to connect two of the main airports in the Milan area*
- ***RNP 0.3** from LIML FATO take-off to MAHWP of LIMC PinS approach.*

Flight trail’s Charts

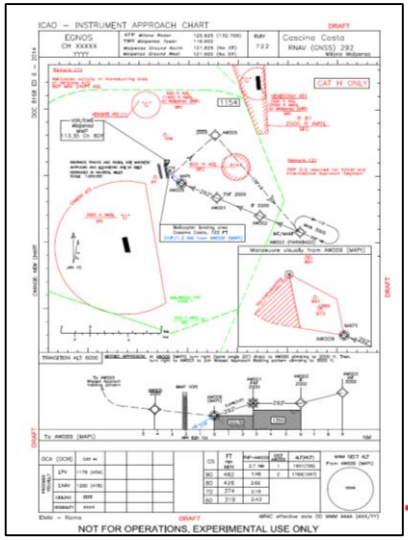
PinS Departure ...



Route ...



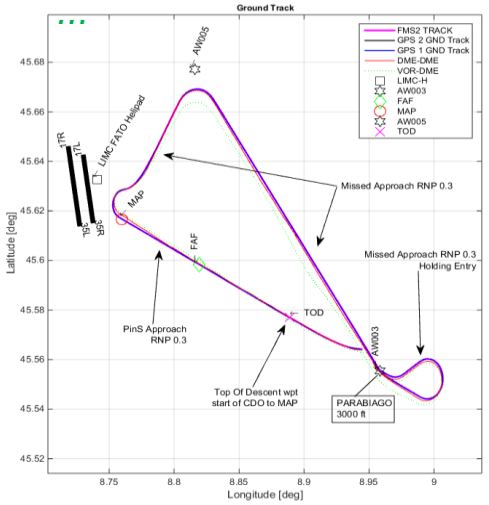
PinS Approach ...



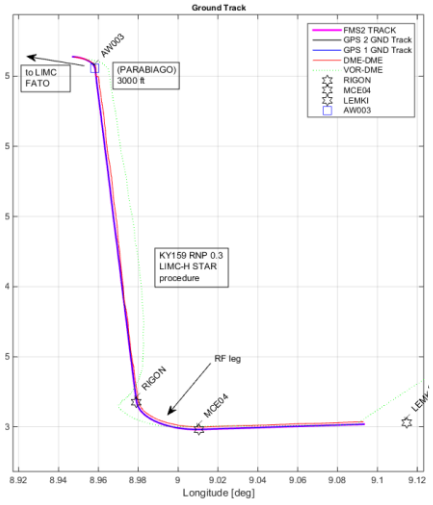
H/C Low Level IFR Routes using RNP 0.3 “All phases of flight” 3/3

AW189 P5 track from takeoff on LIML helipad for RNP 0.3 PinS departure, RNP 0.3 Low Level IFR route and RNP 0.3 PinS approach with LNAV minima and Missed Approach procedure on LIMC.

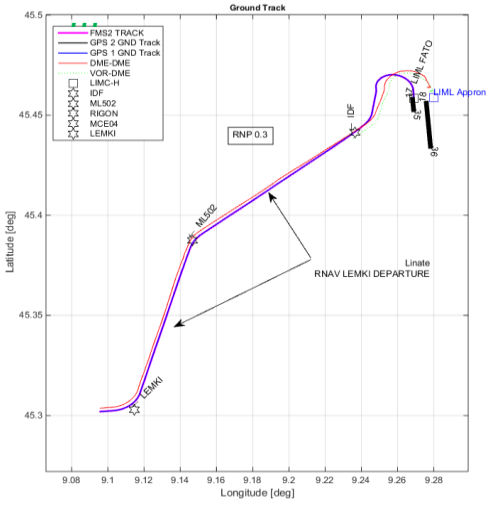
LIMC PinS Approach …

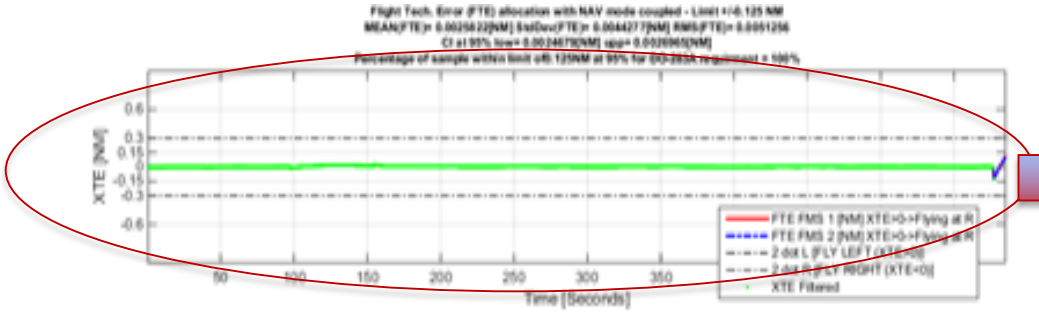


KY159 Route …



LIML PinS Departure …





Lateral Performance Vs RNP 0.3 …

The lateral XTK remains **<< 0.1 NM** (Mean[XTK] = 0.002582 [NM] (< 6 m)) during PinS departure, IFR route and PinS approach and Missed Approach.

Performance results → RNP Operations Next Step:
DEP + En-Route + Arrival Approach (Initial, Intermediate) + Missed Approach phases moved to RNP 0.1 for Rotorcraft Operation

Moving from RNP 0.3 to RNP 0.1 for helicopter operation

NEXT STEP proposal for Rotorcraft operations

Navigation specification	Flight phase							
	En-route oceanic/remote	En-route continental	Arrival	Approach				DEP
				Initial	Intermediate	Final	Missed[1]	
RNP 0.3[8]		0.3	0.3	0.3	0.3		0.3	0.3
RNP 0.1		**0.1**	**0.1**	**0.1**	**0.1**		**0.1**	**0.1**

RNP 0.1 H/C Operations … increased Safety!

- **Current**: modern helicopter are fully capable for ***RNP 0.3 "All phases of Flight" operations***
- **Future**: *Based on flight test results, modern helicopters, already equipped with Advanced **RNP Monitoring & Alerting function and Flight Sensors with coasting capability**, are also ready to comply to new Navigation Specification equal to **RNP 0.1** to guarantee a safety enhancement in RNP (**excluding Final segment of approach**)*

Benefits for moving in RNP 0.1 for Rotorcraft Operations

- *safety enhancement in RNP rotorcraft operation in case of **HD/HC** (High Density/High Complexity) **TMA** scenario (e.g. Heathrow or Schiphol airport area) or **dense populated area***
- *Marked reduction in fuel consumption, flight time and distance flown in comparison to the reference scenario*
- *RNP 0.1 grants more efficient routing in an obstacle reach or noise density **demanding environment** (mountain area)*

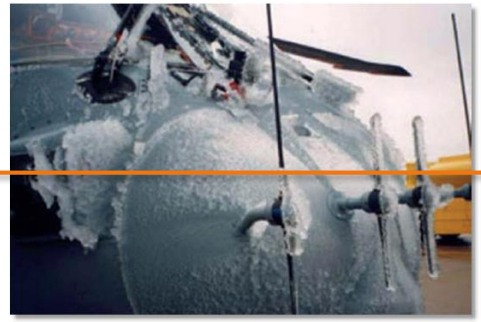
User Approaches: H24 SAR Service 'Problem'

The missions aborted or canceled due to weather **below HEMS/MEDEVAC VFR minimum** is a real limitation for customer.

E.g. here below the last REGA data (*) ...

Our «Problem» 24h-Rescue Service

rega



Requirement
for all weather air rescue from a patient perspective

Year	
2010	458
2011	483
2012	560
2013	572
2014	583
2015	590

Over the past years several HEMS and SAR missions had to be canceled due to weather conditions which where below VFR limits

Trend – increasing!

rega

Helicopter HEMS with ***"All Weather Condition"*** capability is the solution.

(*) REGA courtesy

User Approaches: beyond VFR Approach

LHD FMS on AW139 and AW189&AW169 provides, for Tactical approach operations, the **VFR Approach** function that allows the automatic descent, down to any pilot's defined waypoint in VMC condition.

In marginal or below VFR condition VFR Approach doesn't solve the 'problem' ...

VFR Approach

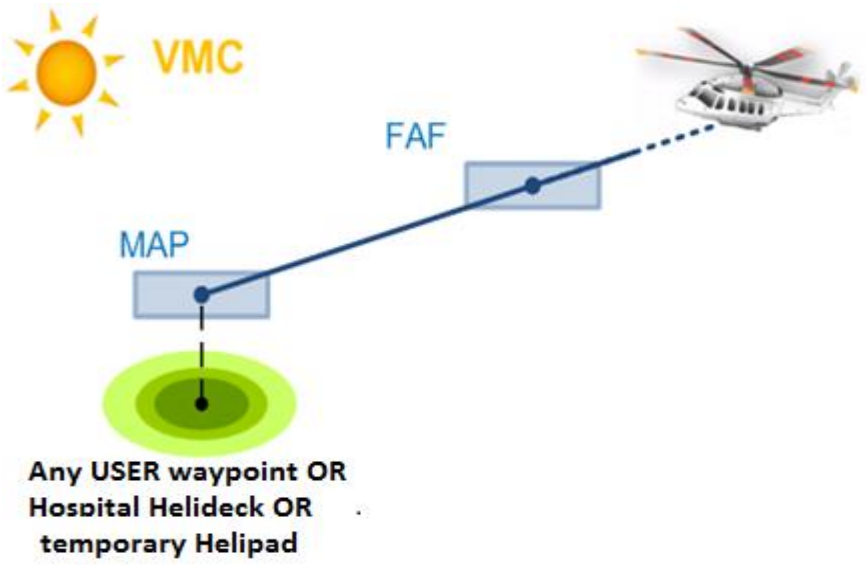
pro & cons

- **To any pilot's defined waypoint**
- **Only in VMC!**

VFR Approach function:

- It's flexible but ...
- It does NOT solve ***"All Weather Condition"*** requirement.

Otherwise an IFR approach on airport/heliport is required.



Precision Approaches Limitations for Tactical Operations

LPV and GLS CAT-I Precision Approaches require …

- **Costs to implement/develop/update a LPV/GLS procedure for SAR operator (e.g. at hospital helideck, SAR base helipad, etc.)**
- An airport/heliport's **fixed-earth** survey points (near the runway/helipad) for truth reference for **integrity** and to precisely define the Final Approach Segment to the landing point
- **Government data (FAS)** and **NAV DB** database update every 28 days
- **SBAS** (EGNOS, WAAS, MSAS, etc.) coverage for LPV; moreover LPV/LP approach can not be implemented beyond latitude72N and 72S.
- **permanently installed ground infrastructures** as "truth-reference" for GBAS differential corrections (i.e. GNSS receivers and VHF transmit antenna)

These requirements could be significant limitations for Helicopter in "Tactical" Approach Operations (e.g. emergency helipad, hospital helideck, Oil Rig Approach, Navy ship approach)

with reference to HSAR/EMS or Military helicopter operations, these limitations can be overcome with a new type approach:
Differential - GPS Landing System (D-GLS) Approach
for helicopter operations towards *"All Weather Condition" capability*

D-GLS Approach key aspects for Tactical Operations

Tactical

- D-GLS Ground Station located on any **moving platform** (ship or oil rig helideck) or **fixed-earth** landing site.
- **NO fixed-earth point** survey required
- **NO government NAV database** required and updated
- **NO SBAS (EGNOS, WAAS, ...)** coverage required

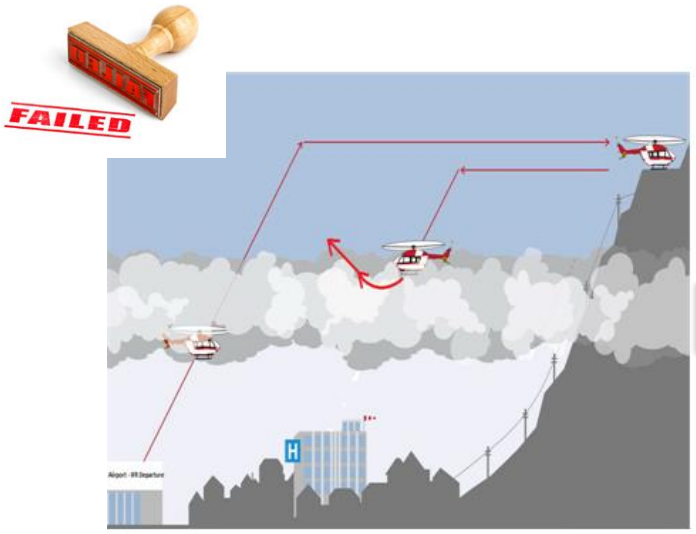
Instant-on

- approach defined with respect to where the **D-GLS ground station** is located
- based on a transportable **compact ground station** (in response to the immediate-need emergency - provisional helipad or at Hospital helideck)
- **Quick set-up** for the approach definition

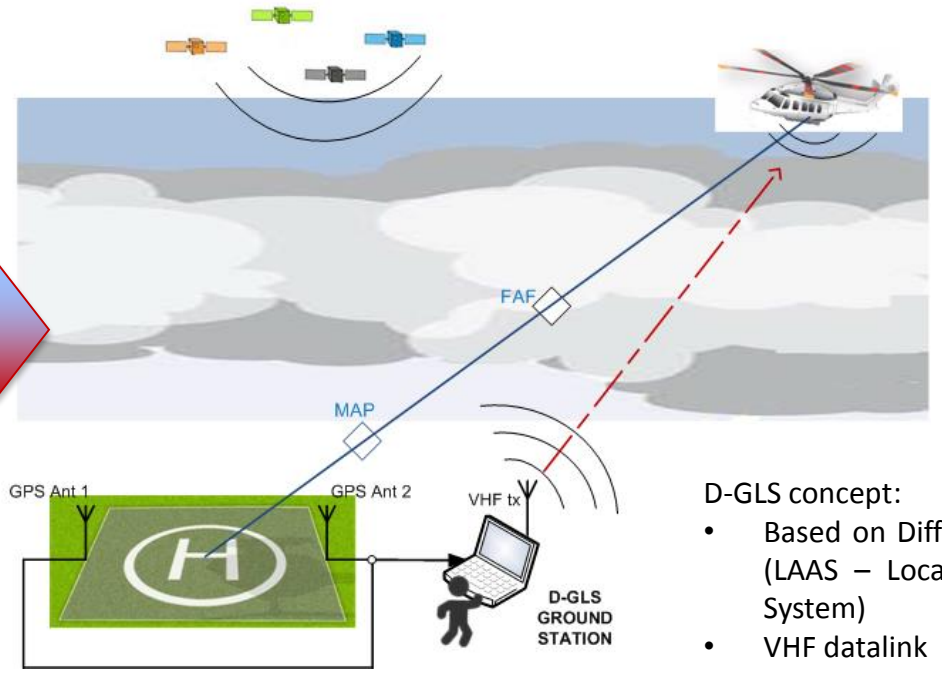
Precision

- Same performance and integrity as either LPV 200 or GLS GAST-C (CAT-I) PA **anywhere** in the world for **immediate HEMS/SAR operations with marginal visibility**
- **CAT-I accuracy** guaranteed by relative positioning
- **CAT-I Integrity** guaranteed by ground station

D-GLS approach: How it works ... e.g. in HEMS scenario



Hospital Landing Aborted!
Go – Around to Airport …



MAP below ceiling

D-GLS concept:

- Based on Differential GPS (LAAS – Local Area Aug. System)
- VHF datalink
- Base station transmits GPS measurement data to avionic H/C

Why D-GLS ?

- It's a key enabler of Helicopter Precision "Tactical" Approach Operations
- It enhances lateral/vertical precision and integrity improving safety, accessibility and efficiency for operators, pilots and helipads/helidecks.
- It allows access to helipad/helideck in adverse weather conditions and at night
- It is crucial for **saving lives** in case of SAR/HEMS operations to Hospital helideck or not prepared helipad close to disaster area
- **Increase crew safety below VFR** limits providing more precise lat/vert guidance
- Cost effectiveness: it provides a high precision solution for helipad/helideck as airport's runway.

D-GLS approach: possible applications

SAR/HEMS

- Temporary helipad in remote area for MEDEVAC **anywhere and anytime**
- Hospital helideck to extend the operation in low visibility condition

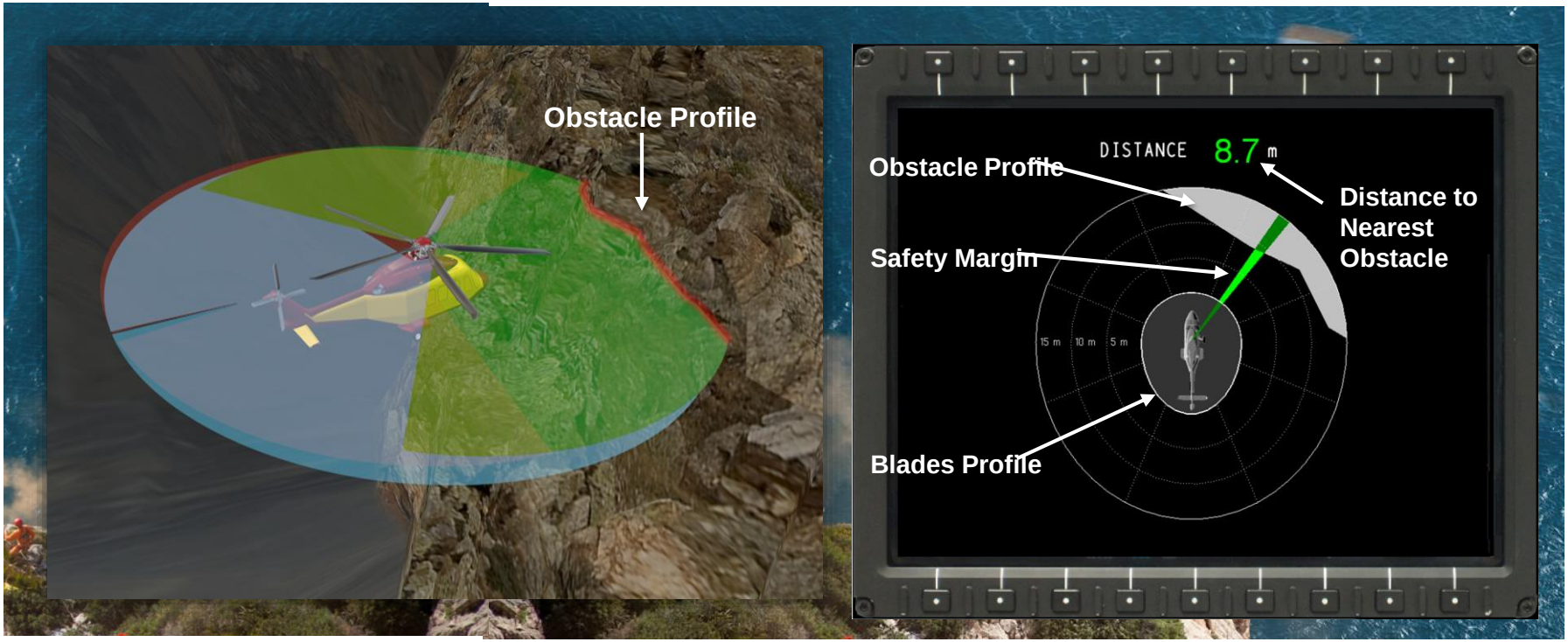
Civil

- Oil Rig Approach
- Small airport/heliport with no SBAS/GBAS

Military

- Military basecamp (e.g. approach during a sand storm in the desert)
- Ship deck (e.g. coast guard or Navy ship operations)

OWS: Obstacle Proximity LiDAR System for safe Approach operation 1/2



During approach on temporary area OPLS system informs the pilots and the crew members about the presence of short range obstacles like rocks, trees and buildings.

CERTIFIED on AW139 and AW189. AW169 in progress

OWS: LOAM System for safe Approach operation 2/2

To increase the safety during the approach in final segment for SAR/HEMS Approach the LOAM system:

- Increase safety of flight and approach
- Detect obstacle on vertical flight path
- Enhance Pilot situational awareness when focused on mission target and increase its reaction time.

Design & development in progress …

EVS system for safe Navigation and Approach

Proposal for increased Safety :

During **Navigation and Approach** the **EVS** Camera (*Enhanced Vision System*) provides the thermal representation of the area in front of the aircraft enhancing the vision capability in low visibility conditions (night, haze, smoke, smog, light fog, etc.).

Approach (AW139 cockpit) ...

Cruise ...

Departure ...

CVS System (Future Function) for safe Navigation and Approach

Proposal for increased Safety :

The **CVS** (Combined Vision System) is a thermal imaging camera combined with synthetic imagery (SVS), whereby the real-time EVS depiction is presented as a translucent overlay on the database-derived synthetic visuals on the PFD.

The CVS system should be integrated with basic PFD or HMD display and use for **Navigation and Approach**.

* Reference photos of Honeywell experimental CVS on AW139

HMD - Next generation Enhanced Flight Vision System for safe Navigation and Approach operation

Proposal for increased Safety :

During Approach operations the **HMD** (Helmet Mounted Display) should be used to fuse conformal flight guidance cues with synthetic vision presentation, high-resolution EVS video (CVS) and potentially LOAM. The HMD will guarantee a unique situation awareness during a approach (e.g. on temporary NOT prepared helipad or hospital helideck, …).

Design & development in progress …

* Reference photos of Elbit experimental HMD system

CVS System – EUROCAE Working Group 79

In order to design and to be able to reach the civil certification of the Combined Vision Systems (EVS/SVS/CVS), LHD is active member of EUROCAE WG79 that has the purpose to define and create, in close support to EASA, the Minimum Aviation System Performance Standards (MASPS) for Combined Vision for Rotorcraft operations.

The MASPS will describe Combined Vision Systems for Rotorcraft to be used first for Situational Awareness, then for Credit and tied to specific operational scenarios.

WG79 has identified a strong operational interest of the rotorcraft community to benefit from the combined vision system technology.

Concluding Remarks

- RNP 0.1 can guarantee significative safety enhancement for rotorcraft IFR procedures operating in city area and/or SNI procedure with fixed wing. Helicopter avionics is capable – customers require it – ICAO Nav. Spec. should be updated

- New D-GLS approach will open new operational scenarios to provide the capability to perform an approach in any not prepared/temporany helipad-helideck

- 2 Obstacle Warning Systems available (OPLS and LOAM) as part of integrated avionic to improve sitautional awareness during approach as most demanding phase of flight.

- The EVS/CVS system as part of integrated avionic on PFD or on HMD display will increase the safety of Navigation and Approach to move to '**All Weather Conditions**' operations.

THANK **YOU** FOR YOUR ATTENTION

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