AMC 034 – HUD and EVS

ACCEPTABLE MEANS OF COMPLIANCE (AMC)

GUIDE FOR

HEAD-UP DISPLAYS (HUD)

AND

ENHANCED VISION SYSTEMS (EVS)

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HEAD-UP DISPLAYS (HUD) AND ENHANCED VISION SYSTEMS (EVS)

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1 INTRODUCTION

1.1 Definitions

Head-up display (HUD). A display system which presents flight information into the pilot's forward external field of view and which does not significantly restrict the external view.

Enhanced vision system (EVS). An electronic means of displaying a real-time image of the external scene through the use of imaging sensors.

1.2 General

The material in this AMC provides guidance for HUD and EVS intended for installation and operational use in aircraft engaged in international air navigation. HUD and EVS may be installed and operated to enhance situational awareness or to obtain an operational credit such as lower minima for approach and landing operations. HUD and EVS may be installed separately or together as part of a hybrid system.

Any use of these systems, and any operational credit gained from their use, requires approval from the DCA.

Note: Operational credit can only be granted within the limits of the design approval.

The primary reference for operators is JAR-OPS 1, Subpart E for AOC holders and AUA-OPS 2 for general aviation operators.

2. HUD

2.1 General

A HUD presents flight information into the pilot's forward external field of view without significantly restricting that external view.

A variety of flight information may be presented on a HUD depending on the intended flight operation, flight conditions, systems capabilities and operational approval. A HUD may include, but is not limited to, the following:

(a) airspeed;

(b) altitude;

(c) heading;

(d) vertical speed;

(e) angle of attack;

(f) flight path or velocity vector;

(g) attitude with bank and/or pitch references;

(h) course and glidepath with deviation indications;

(i) status indications (navigation sensor, autopilot, flight director, etc.); and

(j) alerts and warning displays (ACAS, wind shear, ground proximity warning, etc.).

2.2 HUD Operational Applications

Flight operations with HUD can improve situational awareness by combining flight information located on head-down displays with the external view to provide pilots with more immediate awareness of relevant flight parameters and situation information while they continuously view the external scene.

This improved situational awareness can also reduce errors in flight operations and improve the pilot's ability to transition between visual and instrument references as meteorological conditions change. Flight operations applications may include the following:

(a) enhanced situational awareness during all flight operations, but especially during taxi, take-off, approach and landing;

(b) reduced flight technical error during take-off, approach and landing especially in all-weather operations; and

(c) improvements in performance due to precise prediction of touchdown area, tail strike awareness/warning and rapid recognition and recovery from unusual attitudes.

HUD may be used for the following purposes:

(a) to supplement conventional flight deck instrumentation in the performance of a particular task or operation. The primary cockpit instruments remain the primary means for manually controlling or manoeuvring the aircraft; and

(b) as a primary flight display;

(1) information presented by the HUD may be used by the pilot in lieu of scanning head-down displays. Operational approval of a HUD for such use allows the pilot to control the aircraft by reference to the HUD for approved ground or flight operations; and

(2) information presented by the HUD may be used as a means to achieve additional navigation or control performance. The required information is displayed on the HUD. Operational credit, in the form of lower minima, for HUD used for this purpose may be approved for a particular aircraft or automatic flight control system.

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Additional credit may also be allowed to conduct operations with HUD in situations where automated systems are otherwise used.

2.3 HUD Training

Training requirements are established, monitored and approved by the DCA in accordance with Appendix 1 to Appendix 1 to JAR-OPS 1.450 Low Visibility Operations – Training & Qualifications. These training requirements address all flight operations for which the HUD is designed and operationally approved. Some training elements may require adjustments based on whether the aeroplane has a single or dual HUD installation.

Training must include contingency procedures required in the event of head-up display degradation or failure. HUD training should include the following elements as applicable to the intended use:

(a) an understanding of the HUD, its flight path and energy management concepts, and symbology. This should include operations during critical flight events (ACAS TA/RA, upset and wind shear recovery, engine or system failure, etc.);

(b) HUD limitations and normal procedures, including maintenance and operational checks performed to ensure normal system function prior to use. These checks include pilot seat adjustment to attain and maintain appropriate viewing angles and verification of HUD operating modes;

(c) HUD use during low visibility operations, including taxi, take-off, instrument approach and landing in both day and night conditions. This training should include the transition from head-down to head-up and head-up to head-down operations;

(d) failure modes of the HUD and the impact of the failure modes or limitations upon crew performance;

(e) crew coordination, monitoring and verbal call out procedures for single HUD installations with head-down monitoring for pilot-not-equipped with HUD and head-up monitoring for pilot-equipped with HUD;

(f) crew coordination, monitoring and verbal call-out procedures for dual HUD installations with use of HUD by the pilot flying the aircraft and either head-up or head-down monitoring by the other pilot;

(g) consideration of the potential for loss of situational awareness due to "tunnel vision" (also known as cognitive tunnelling or attention tunnelling);

(h) any effects that weather, such as low ceilings and visibilities, may have on the performance of a HUD; and

(i) HUD airworthiness requirements.

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3. EVS

3.1 General

EVS present a real-time electronic image of the external scene through the use of image sensors. This information should be displayed on a head-up or head-down display. When enhanced vision imagery is displayed on a HUD, it should be presented to the pilots' forward external field of view without significantly restricting that external view.

A variety of image sensors may be used individually or in combination to present a real-time electronic image of the external scene. Image sensors may include sensors using low-level light intensification, thermal emissions, radar or other electronic emissions.

3.2 Operational Applications

Flight operations with enhanced vision image sensors allow the pilot to view an image of the external scene obscured by darkness or other visibility restrictions. When the external scene is partially obscured, enhanced vision imaging may allow the pilot to acquire an image of the external scene earlier than with natural or unaided vision. The improved acquisition of an image of the external scene may improve situational awareness.

This enhanced imagery may also allow pilots to detect terrain or obstructions on the runway or taxiways. An enhanced image can also provide visual cues to enable earlier runway alignment and a more stabilized approach.

The enhanced vision images may also be used to obtain approval to use reduced visibility minima when the images are presented into the pilot's external field of view on a HUD without significantly restricting that view. The approval also requires specific aircraft performance parameters and navigation guidance to be presented on the HUD. The combined display of aircraft performance, guidance and imagery may allow the pilot to maintain a more stabilized approach and smoothly transition from enhanced visual references to standard visual references. This increased capability has enabled some States to approve approach and landing operations for operators using approved HUD with enhanced vision imagery when reported visibilities are less than normal published requirements.

3.3 EVS Credit

Approval requirements differ based on whether the intended function of the system is to increase situational awareness or to obtain operational credit.

When enhanced vision imagery is used to improve situational awareness, operational approval requirements may be limited. An example of this type of operation may include an EVS on a head-down display that is only used for situational awareness of the surrounding area of the aircraft during ground operations where the display is not in the pilot's primary field of view. For enhanced situational awareness, the installation and operational procedures need to ensure that EVS operations do not interfere with normal procedures or

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the operation or use of other aircraft systems. In some cases, modifications to these normal procedures, other systems or equipment may be necessary to ensure compatibility.

When enhanced vision imagery is used for operational credit, operational approvals may require that the imagery be combined with flight guidance and presented on a HUD. Operational approvals may also require that this information be presented on a head-down display. A pilot could use this system to continue an instrument approach below published minimum altitudes using the enhanced visual imagery combined with flight guidance on the HUD.
When EVS is used for operational credit, operational approval standards should ensure the credit for the individual image sensor or combination of sensors is appropriate. Operational credit may be applied for any flight operation, but credit for instrument approach and landing operations is most common.

3.4 EVS Training

Training requirements are established, monitored and approved by the DCA in accordance with Appendix 1 to Appendix 1 to JAR-OPS 1.450 Low Visibility Operations – Training & Qualifications. These training requirements may include recency of experience requirements if the DCA determines those requirements are significantly different than current requirements for the use of HUD without enhanced vision imagery or conventional head-down instrumentation.

EVS training must address all flight operations for which the enhanced vision display is approved. This training must include contingency procedures required in the event of system degradation or failure. Training for EVS used for situational awareness should not interfere with other required operations. Training for EVS used for operational credit also requires training for the applicable HUD used to present the enhanced visual imagery. EVS training should include the following elements as applicable:

(a) an understanding of the system characteristics and operational constraints. Normal procedures, controls, modes, and system adjustments;

(b) EVS limitations;

(c) EVS airworthiness requirements;

(d) enhanced vision display during low visibility operations, including taxi, take-off, instrument approach and landing.

(e) System use for instrument approach procedures in both day and night conditions;

(f) failure modes of the EVS and the impact of the failure modes or limitations upon crew performance, in particular, for two-pilot operations;

(g) crew coordination and monitoring procedures and pilot call-out responsibilities;

(h) transition from enhanced imagery to visual conditions during the runway visual acquisition;

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(i) rejected landing: loss of visual cues of the landing area, touchdown zone, or rollout area; and

(j) any effects that weather, such as low ceilings and visibilities, may have on the performance of an EVS.

Note: LED runway lighting may not be visible to crews using HUD/EVS due to the fact that LEDs are non-incandescent lights.

4. APPLICATION & APPROVAL PROCESS

4.1 Application

An application for the approval for the use of HUD/EVS must be made in writing by the operator using the application form in Attachment. The AMC must be read with the checklist.

4.2 Supporting Documents

The documents listed below in respect of each aircraft, should normally accompany the application for grant of approval for HUD/EVS.

(a) The copies of Supplemental Type Certificates (STC) for each type of equipment fitted on each aircraft respectively, that cover the following aspects:

(1) minimum level of integrity and availability; and

(2) functional criteria.

(b) Maintenance programme/approved maintenance schedule for each aircraft. (i.e. transit, periodical inspection and test).

(c) Equipment lists (MMEL and MEL) that identify the minimum equipment necessary for HUD/EVS operations in respect of each aircraft.

(d) Part of the Aircraft Flight Manuals (AFMs) for each aircraft, that specifies the following:

(1) the basis for certification together with any HUD/EVS system limitations; and

(2) the appropriate HUD/EVS system operating and emergency procedures applicable to the equipment installed:

(i) Normal procedure for operating the equipment;

(ii) Equipment operating limitations; and

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(iii) Emergency operating procedures.

(e) Training programmes in respect of the HUD/EVS equipment installed in each aircraft for:

(1) Maintenance personnel; and

(2) Flight crew. All operators must submit training syllabi and other appropriate material to show that the operational practices and procedures and training items related to HUD/EVS operations are incorporated in training programmes where applicable (e.g. initial, upgrade, recurrent).

(i) The ground school training syllabus should indicate the following:

- EVS Theory
- Interpretation of images.
- Display characteristics.
- Calibration checks.
- Visual anomalies.
- Eye and seat position.
- Weather/fog characteristics.
- Low visibility operations.
- Crew briefings/callouts.
- Duties of PF/PNF and CRM.
- Actions at DA and 100 ft agl.
- Transition from EVS imagery to non-EVS visual.
- Use of clear switch.
- Recognition of malfunctions.
- AFM performance and obstacle clearance on go-around.
- Use of auto-flight systems and minimum engage height.
- AFM limitations and system failures.

(ii) The simulator training should be to Appendix 1 to JAR OPS 1.450 standard.

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(iii) Line training under supervision & recurrent training must be addressed.

(f) Operators must revise their operations manual and checklists to include information/guidance on standard operating procedures. Manuals and checklists must be submitted for review as part of the application process. Practices and procedures in the following areas must be standardised and include ground and flight procedures and flight crew qualification requirements.

- Definitions.
- Check that crew are qualified for EVS/HUD operations.
- MEL handling.
- Equipment required for EVS operations.
- Types of approach where EVS can be used.
- Statement that autopilot/flight director should be used whenever possible.
- Minimum visual references for landing.
- Approach Ban and RVR.
- Stabilised Approach Criteria.
- Correct seating and eye position.
- Crew co-ordination, e.g. duties of PF and PNF such as:
  - designation of handling and non-handling pilots;
  - use of automatic flight control system;
  - checklist handling;
  - approach briefing;
  - radio communications handling;
  - monitoring and cross-checking of instruments and radio aids; and
  - use of the repeater display by PNF.
- Contingency procedures including:
  - failures above and below decision height;
  - ILS deviation warnings;

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- autopilot disconnect;
- auto-throttle disconnect;
- electrical failures;
- engine failure;
- failures and loss of visual references at or below decision height; and
- EVS/HUDLS failure below normal decision height.

• Failure reporting procedures and records

(g) Evidence that approach plates are in accordance with Appendix 1 to JAR-OPS 1.430.

4.3 Approval

Approval to utilize HUD/EVS will be granted by adding the Airspace Approval Certificate.

4.4 Cancellation of HUD/EVS Approval

Operators are reminded that after an approval to utilize HUD/EVS and associated operational credit is issued, the DCA conducts regular surveillance on all operations using this equipment. When appropriate, the DCA may consider any error or operational deficiency reports in determining remedial action. Repeated occurrences, attributed to HUD/EVS, may result in cancellation of the approval and/or operational credit.

Information that indicates the potential for repeated errors may require a modification of an operator's training programme. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training.

When de-register the aircraft the all Approvals will be cancelled automatically.

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APPENDIX 1

Application for Special Operational Approvals INS-16.020

MINISTRY OF TOURISM
TRANSPORTATION AND LABOUR

Department of Civil Aviation
ARUBA

1. Applicant Details			2. Aircraft Details
Operator:			Aircraft Registration: **P4 -... ... ...**
AOC No. (if applicable):			
Coordinator/Administrator:	#1	#2	
Name:			Aircraft Mfr.: .....
Tel:			Model: .....
Email:			Aircraft S/N: .....

3. Applying for:	Page Reference	AMC Reference	Additional remarks from the Applicant:
a. □ RVSM,	2	AMC-036	
b. □ MNPS/RVSM	2	AMC-036	
c. □ RNP≤0.3 Authorization	2	AMC-036	
d. □ RNP≤0.3 Approach	2	AMC-036	
e. □ RNAV-1/PR-NAV	2	AMC-036	
f. □ RNAV-2	2	AMC-036	
g. □ RNAV-5/BR-NAV	2	AMC-036	
h. □ RNP-4	2	AMC-036	
i. □ RNP-10	2	AMC-036	
j. □ CAT I *(Below standard)*	3	AMC-035	
k. □ CAT II	3	AMC-035	
l. □ CAT III □ a,	3	AMC-035	
□ b	3	AMC-035	
m. □ EFB	4	AMC-033	
n. □ HUD/EVS	5	AMC-034	
o. □ CPDLC	6	AMC-037	
p. □ GPS *(Approach)*	2	AMC-036	
Additional Information	7	----------	

4. Applicant's Declaration:

The undersigned certifies that the above information and the corresponding pages are correct and true and the aeroplane equipment, continuing airworthiness, minimum equipment for dispatch, operating procedures and flight crew training comply with the requirements of DCA-Aruba.

Name:	Position:	Signature:	Date: (in dd-mmm-yyyy)

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APPENDIX 1 cont'd.

Application for Special Operational Approvals INS-16.020

3(n.)	HEADS UP-DISPLAY (HUD) AND EVS, refer to AMC-034	
1. Approval Requested		
HUD only □	EVS only □	HUD and EVS □
Make & Type:		
Operational credit requested If yes, provide details below	Yes □	No □
2. Airworthiness Supporting Documentation		*(tick if attached)*
AFM showing aircraft certification standard		
STC *(if applicable)*		
Maintenance Programme *(amendments)*		
MMEL/MEL		
3. Operations Supporting Documentation		*(tick if attached)*
AFM, AFM Supplement, STD *(if applicable)*		
Operations Manual (SOPs)		
Operations Manual training		
4. Details *(additional information continuing on page 7)*		

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APPENDIX 1 cont'd.

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