HEAD-UP DISPLAY AND ENHANCED VISION SYSTEM 
(HUD AND EVS)

1 GENERAL. Advisory Circulars (ACs) are issued by the Civil Aviation Authority of Singapore (CAAS) and contain information about standards, practices and procedures acceptable to the Authority. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.

2 PURPOSE. This Advisory Circular (AC) provides guidance to the operator applying for operational approval for the operations of HUD and/or EVS.

3 APPLICABILITY. This AC applies to all Singapore AOC holders.

4 CANCELLATION. This is the first AC issued on this subject.

5 EFFECTIVE DATE. This AC is effective from 23 July 2010.

6 REFERENCES. The following materials were referred to for the development of this AC:
   a) ICAO Annex 6 Part I Attachment J; and
   b) RTCA DO-315 / EUROCAE ED-179

7 DEFINITIONS.

7.1 Enhanced vision system (EVS) is a system to display electronic real-time images of the external scene achieved through the use of image sensors.

7.2 Head-up display (HUD) is a display system that presents flight information into the pilot’s forward external field of view.

8 INTRODUCTION.

8.1 HUD and EVS are installed and operated for the enhancement of situational awareness for the pilot and as such may be used to request for operational credits such as lower minima for approach and landing operations.
8.2 The installation and operational use of these systems as well as any operational credit that can be derived from their use require Authority approval.

8.3 Subject to, but not limited to, the operator’s experience of the airport and limits of the design approval of the equipment, the Authority may, at its discretion, consider the grant of operational credit for the use of HUD/EVS when operating in instrument conditions.

9 HEAD UP DISPLAY (HUD)

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

9.2 A variety of flight information may be presented on a HUD depending on the intended flight operation, flight conditions, systems capabilities and operational approval.

9.3 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 (i.e. navigation sensor, autopilot, flight director, etc.); and
(j) alerts and warning displays (i.e. ACAS, wind shear, ground proximity warning, etc.).

9.4 HUD applications in operations

9.4.1 The HUD improves situational awareness by combining flight information located on head-down displays with the external view. This enables the pilot with more immediate awareness of relevant flight parameters and situation information while he continuously views the external scene.

9.4.2 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.

9.4.3 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
9.4.4 Information presented by the HUD may be used by the pilot

(a) 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

(b) as a means to achieve additional navigation or control performance. The required information is displayed on the HUD. The Authority, at its discretion, may grant operational credit in the form of lower minima for the use of HUD in conjunction with the use of automatic flight control system.

9.5 HUD training

9.5.1 The operator shall develop, establish, and monitor training requirements for approval by the Authority. These training requirements should include requirements for recency of experience if those requirements are significantly different than current requirements for the use of conventional head-down instrumentation.

9.5.2 HUD training should address all aspects of flight operations for which the HUD is designed and operationally approved.

9.5.3 The training should include contingency procedures for head-up display degradation or failure. The following elements should also be included:

(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.
10 ENHANCED VISION SYSTEM (EVS)

10.1 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.

10.2 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.

10.3 Operational applications

10.3.1 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.

10.3.2 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 stabilised approach.

10.3.3 The enhanced vision images may also be used to request operation credit for reduced visibility minima when the images are presented into the pilot’s external field of view on a HUD without significantly restricting that view.

10.3.4 For consideration toward grant of operation credit the Authority may require

(a) specific aircraft performance parameters and navigation guidance to be presented on the HUD.
(b) the operator to demonstrate that the combined display of aircraft performance, guidance and imagery enable the pilot to maintain a more stabilised approach and smooth transition from enhanced visual references to standard visual references.

10.4 EVS Operational Approval

10.4.1 The Authority grants EVS operational approval for the purpose of enhancing the situational awareness of the flight crew. The grant of EVS operational credit, e.g. lower than normal minima, must be discussed and approved by the Authority.

10.4.2 For enhanced situation awareness approval, the operator must ensure that the installation and operational procedures for EVS operations do not interfere with normal procedures or the operation or use of other aircraft systems.

10.4.3 For enhanced vision imagery operational credit consideration by the Authority, the operator may be required by the Authority that

(a) the imagery be combined with flight guidance and presented on a HUD;
(b) this information be presented on a head-down display; and
(c) the 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.

10.5 EVS training
10.5.1 The operator shall develop, establish, and monitor training requirements approval by the Authority. These training requirements should include recency of experience if those requirements are significantly different than current requirements for the use of conventional head-down instrumentation.

10.5.2 EVS training should address all aspects of flight operations for which the EVS is designed and operationally approved.

10.5.3 This training should include contingency procedures required in the event of system degradation or failure.

10.5.4 The training for EVS used for situational awareness should not interfere with other required operations.

10.5.5 The training for EVS used for operational credit should require training for the applicable HUD used to present the enhanced visual imagery.

10.5.6 EVS training should include the following elements:

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

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

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

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

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

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

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

11 WITHDRAWAL OF HUD AND/OR EVS OPERATIONAL APPROVAL.

11.1 The operational approval is conditional upon the operator’s continued compliance with the conditions specified above as well as those specified in the Authority’s Letter of Approval.

11.2 Adverse reports of system fidelity or reliability shall be investigated and rectified promptly. Any non-compliance of approval conditions may result in the Authority withdrawing the approval.