

## Appendix 3 – Definitions

*ED Decision 2011/004/R*

**Air Mass System** - An air mass-based system that provides a heading/airspeed/vertical velocity derived flight path presentation. It depicts the flight path through an air mass, will not account for air mass disturbances such as wind drift and windshear and, therefore, cannot be relied on to show the flight path relative to the earth's surface.

**Alert** – A generic term used to describe a flight deck indication meant to attract the attention of and identify to the flight crew a non-normal operational or aeroplane system condition. Warnings, Cautions, and Advisories are considered to be alerts.

**Annunciation** - A visual, auditory, or tactile stimulus used to attract a flight crew member's attention.

**Architecture** - The manner in which the components of a display or display system are organised and integrated.

**Basic T**- The arrangement of primary flight information as required by [CS 25.1321\(b\)](#); including attitude, airspeed, altitude, and direction information.

**Brightness** - The perceived or subjective luminance. This should not be confused with luminance.

**Bugs** - A symbol used to mark or reference other information such as heading, altitude, etc.

**Catastrophic** -Failure conditions that result in multiple fatalities, usually with the loss of the aeroplane.  
*(Note: In previous versions of [CS 25.1309](#) and the associated advisory material a “catastrophic failure condition” was defined as a failure condition that would prevent continued safe flight and landing.)*

**Chrominance**- The quality of a display image that includes both luminance and chromaticity and is a perceptual construct subjectively assessed by the human observer.

**Chromaticity** - Colourcharacteristic of a symbol or an image defined by its u', v' coordinates (See Commissions Internationale de L'Eclairage publication number 15.3, Colorimetry, 2004).

**Clutter** - Excessive number and/or variety of symbols, colours, or other information on a display that may reduce flight crew access or interpretation time, or decrease the probability of interpretation error.

**Coasting Data** - Data that is not updated for a defined period of time.

**Coding**- The use of assigning special meanings to some design element or characteristic (such as numbers, letters, symbols, auditory signals, colours, brightness, or variations in size) to represent information in a shorter or more convenient form.

**Coding Characteristics** - Readily identifiable attributes commonly associated with a design element that provide special meaning and differentiate the design elements from each other; for example size, shape, colour, motion, location, etc.

**Colour Coding**- The structured use of colour to convey specific information, call attention to information, or impose an organisational scheme on displayed information.

**Command Information** - Displayed information directing a control action.

**Compact Mode**- In display use, this most frequently refers to a single, condensed display presented in numeric format that is used during reversionary or failure conditions.

**Conformal** - Refers to displayed graphic information that is aligned and scaled with the outside view.

**Contrast Ratio -**

For HUD - Ratio of the luminance over the background scene (see SAE AS 8055).

For HDD - Ratio of the total foreground luminance to the total background luminance.

**Criticality** - Indication of the hazard level associated with a function, hardware, software, etc., considering abnormal behaviour (of this function, hardware, software) alone, in combination, or in combination with external events.

**Design Eye Position** - The position at each pilot's station from which a seated pilot achieves the required combination of outside visibility and instrument scan. The design eye position (DEP) is a single point selected by the applicant that meets the specifications of [CS 25.773\(d\)](#), [CS 25.777\(c\)](#), and [CS 25.1321](#) for each pilot station. It is normally a point fixed in relation to the aircraft structure (neutral seat reference point) at which the midpoint of the pilot's eyes should be located when seated at the normal position. The DEP is the principal dimensional reference point for the location of flight deck panels, controls, displays, and external vision.

**Display Element** – A basic component of a display, such as a circle, line, or dot.

**Display Refresh Rate** - The rate at which a display completely refreshes its image.

**Display Resolution** - Size of the minimum element that can be displayed, expressed by the total number of pixels or dots per inch (or millimetre) of the display surface.

**Display Response Time** - The time needed to change the information from one level of luminance to a different level of luminance. Display response time related to the **intrinsic response** me linked to the electro-optic effect used for the display and the way to address it).

**Display Surface/Screen** - The area of the display unit that provides an image.

**Display System** - The entire set of avionic devices implemented to display information to the flight crew. This is also known as an electronic display system.

**Display Unit** - Equipment that is located in the flight deck, in view of the flight crew, that is used to provide visual information. Examples include a colour head down display and a head up display projector and combiner.

**Earth Referenced System** -An inertial-based system which provides a display of flight path through space. In a descent, an earth-referenced system indicates the relationship between the flight path and the terrain and/or the artificial horizon.

**Enhanced Flight Vision System (EFVS)**- An electronic means to provide a display of the forward external scene topography (the natural or manmade features of a place or region, especially in a way to show their relative positions and elevation) through the use of imaging sensors such as millimetre wave radiometry, millimetre wave radar, and low light level image intensifying.

**Enhanced Vision System (EVS)** - An electronic means to provide a display of the forward external scene topography through the use of imaging sensors, such as forward looking infrared, millimetre wave radiometry, millimetre wave radar, and low light level image intensifying.

*NOTE: An EFVS is an EVS that is intended to be used for instrument approaches under the provisions of 14 CFR 91.175 (l) and 91.175 (m), and must display the imagery with instrument flight information on a HUD.*

**Extremely Improbable** -An extremely improbablefailure condition is so unlikely that it is not anticipated to occur during the entire operational life of all aeroplanes of one type.

**Extremely Remote** - An extremely remote failure condition is not anticipated to occur to each aeroplane during its total life, but may occur a few times when considering the total operational life of all aeroplanes of that type.

**Eye Reference Position (ERP)** - A single spatial position located at or near the centre of the HUD Eye Box. The HUD ERP is the primary geometrical reference point for the HUD.

**Failure** - An occurrence which affects the operation of a component, part, or element, such that it can no longer function as intended (this includes both loss of function and malfunction). *NOTE: Errors may cause failures but are not considered to be failures.*

**Failure Condition** - A condition having an effect on the aeroplane and/or its occupants, either direct or consequential, which is caused or contributed to by one or more failures or errors, considering flight phase and relevant adverse operational or environmental conditions, or external events.

**Field of View** - The angular extent of the display that can be seen by either pilot with the pilot seated at either pilots station.

**Flicker**- An undesired, rapid temporal variation in the display luminance of a symbol, group of symbols, or a luminous field. It can cause discomfort for the viewer (such as headaches and irritation).

**Flight Deck Design Philosophy**- A high level description of the design principles that guide the designer and ensure a consistent and coherent interface is presented to the flight crew.

**Flight Path Angle (FPA)** so known as a Flight Path Symbol, Climb, Dive Angle, or “caged” (on the attitude indicator centreline) Flight Path Vector) - A dynamic symbol displayed on an attitude display that depicts the vertical angle relative to the artificial horizon, in the pitch axis, that the aeroplane is moving. A flight path angle is the vector resultant of the forward velocity and the vertical velocity. For most designs, the FPA is earth referenced, though some use air mass vectors. Motion of the FPA on the attitude display is in the vertical (pitch) axis only with no lateral motion.

**Flight Path Vector (FPV)** so known as Velocity Vector or Flight Path Marker) - A dynamic symbol displayed on an attitude display that depicts the vector resultant of real-time flight path angle (vertical axis) and lateral angle relative to aeroplane heading created by wind drift and slip/skid. For most designs, the FPV is earth referenced, though some use air mass vectors which cannot account for wind effects

**Foreseeable Conditions** - The full environment that the display or the display system is assumed to operate within, given its intended function. This includes operating in normal, non-normal, and emergency conditions.

**Format (See Figure A3-2)** - An image rendered on the whole display unit surface. A format is constructed from one or more windows (see ARINC Specification 661).

**FPV/FPA-referenced Flight Director (FD)** - A HUD or HDD flight director cue in which the pilot “flies” the FPV/FPA cue to the FD command in order to comply with flight guidance commands. This is different from attitude FD guidance where the pilot “flies” the aeroplane (that is, pitch, boresight) symbol to follow pitch and roll commands.

**Full-time Display** - A dedicated continuous information display.

**Functional Hazard Assessment** - A systematic, comprehensive examination of aeroplane and system function to identify potential Minor, Major, Hazardous, and Catastrophic failure conditions that may arise as a result of malfunctions or failures to function.

**Grey Scale**- The number of incremental luminance levels between full dark and full bright.

**Hazard** - Any condition that compromises the overall safety of the aeroplane or that significantly reduces the ability of the flight crew to cope with adverse operating conditions.

**Hazardous** – A hazardous failure condition reduces the operation of the aeroplane or the ability of the flight crew to operate in adverse conditions to the extent that there would be:

- A large reduction in safety margins or functional capabilities;
- Physical distress or excessive workload such that the flight crew cannot be relied upon to perform their tasks accurately or completely; or
- Serious or fatal injury to a relatively small number of the occupants other than the flight crew.

**Head Down Display (HDD)** - A primary flight display located on the aeroplane's main instrument panel directly in front of the pilot in the pilot's primary field of view. The HDD is located below the windscreen and requires the flight crew to look below the glareshield in order to use the HDD to fly the aeroplane.

**Head Mounted Display (HMD)** – A special case of HUD mounted on the pilot's head. Currently, there are not any HMDs used in CS-25 installations, but guidance will be provided in the future, as needed.

**Head Up Display (HUD)** - A display system that projects primary flight information (for example, attitude, air data, guidance, etc.) on a transparent screen (combiner) in the pilot's forward field of view, between the pilot and the windshield. This allows the pilot to simultaneously use the flight information while looking along the forward path out the windshield, without scanning the head down displays. The flight information symbols should be presented as a virtual image focused at optical infinity. Attitude and flight path symbology needs to be conformal (that is, aligned and scaled) with the outside view.

**HUD Design Eye Box** - The three-dimensional area surrounding the design eye position, which defines the area, from which the HUD symbology and/or imagery are viewable.

**Icon**- A single, graphical symbol that represents a function or event.

**Image Size** - The viewing area (field) of the display surface.

- Direct View Display: The useful (or active) area of the display (for example, units cm x cm).
- Head Up Display: The total field of view (units usually in degrees x degrees).  
(Total field of view defines the maximum angular extent of the display that can be seen by either eye allowing head motion within the eyebox (see 8055)).

**Indication** - Any visual information representing the status of graphical gauges, other graphical representations, numeric data messages, lights, symbols, synoptics, etc. to the flight crew.

**Information Update Rate** - The rate at which new data is displayed or updated.

**Interaction**- The ability to directly affect a display by utilizing a graphical user interface (GUI) that consists of a control device (for example, a trackball), cursor, and “soft” display control that is the cursor target.

**Latency** - The time taken by the display system to react to a triggered event coming from an input/output device, the symbol generator, the graphic processor, or the information source.

**Layer** - A layer is the highest level entity of the Display System that is known by a User Application.

**Luminance** - Visible light that is emitted from the display. Commonly-used units: foot-lamberts, cd/m<sup>2</sup>.

**Major** - A major failure condition reduces the operation of the aeroplane or the ability of the flight crew to operate in adverse conditions to the extent that there would be, for example:

- A significant reduction in safety margins or functional capabilities;
- Physical discomfort or a significant increase in flight crew workload
- Physical distress to passengers or cabin crew, possibly including injuries.

**Menu** - A list of display options available for selection.

**Message** - A communication that conveys an intended meaning such as an alerting or data link message.

**Minor** - A minor failure condition would not significantly reduce aeroplane safety and would involve crew actions well within their capabilities. Minor failure conditions may include:

- A slight reduction in safety margins or functional capabilities;
- A slight increase in crew workload (such as routine flight plan changes); or
- Some physical discomfort to passengers or cabin crew.

**Misleading Information** - Incorrect information that is not detected by the flight crew because it appears as correct and credible information under the given circumstances.

When incorrect information is automatically detected by a monitor resulting in an indication to the flight crew, or when the information is obviously incorrect, it is no longer considered misleading. The consequence of misleading information will depend on the nature of the information, and the given circumstances.

**Mode** - The functional state of a display and/or control system(s). A mode can be manually or automatically selected.

**MSG-3**- Maintenance Steering Group 3. A steering group sponsored by the Airline Transportation Association whose membership includes representatives from the aviation industry and aviation regulatory authorities.

**Occlusion** - Visual blocking of one symbol by another, sometimes called occulting.

**Partitioning**- A technique for providing isolation between functionally independent software components to contain and/or isolate faults and potentially reduce the effort of the software verification process.

**Pixel**- A display picture element which usually consists of three (red, green, blue) sub-pixels (also called dots on a cathode ray tube).

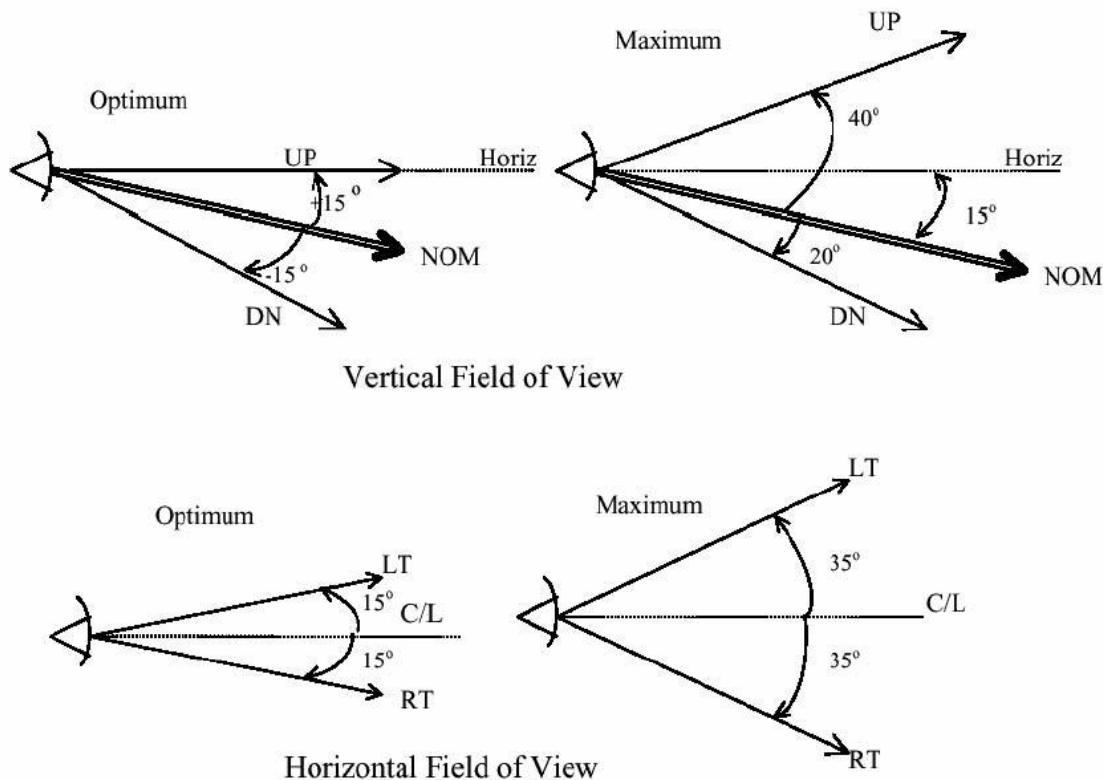
**Pixel Defect** - A pixel that appears to be in a permanently on or off-state.

**Primary Flight Displays**- The displays used to present primary flight information.

**Primary Field of View (FOV) (See Figure A3-1)** - Primary Field-of-View is based on the optimum vertical and horizontal visual fields from the design eye reference point that can be viewed with eye rotation only using foveal or central vision. The description below provides an example of how this may apply to head-down displays.

With the normal line-of-sight established at 15 degrees below the horizontal plane, the values for the vertical (relative to normal line-of-sight forward of the aircraft) are

+/-15 degrees optimum, with +40 degrees up and -20 degrees down maximum.



**Figure A3-1 Primary Field of View**

**Primary Flight Information-** The information whose presentation is required by [CS 25.1303\(b\)](#) and [CS 25.1333\(b\)](#), and arranged by [CS 25.1321\(b\)](#).

**Primary Flight Instrument** - Any display or instrument that serves as the flight crew's primary reference of a specific parameter of primary flight information. For example, a centrally located attitude director indicator is a primary flight instrument because it is the flight crew's primary reference for pitch, bank, and command steering information.

**Prompt**- A method of cueing the flight crew that some input or action is required.

**Required Engine Indications**- The information whose presentation is required by [CS 25.1305](#).

**Reversionary** - The automatic or flight crew initiated (manual) relocation of display formats or windows following a display failure.

**Shading** - Shading is used as:

- A coding method for separating information, change in state, give emphasis, and depth information.
- A blending method between graphic elements (map displays, synthetic vision system).

**Soft Control**- Display element used to manipulate, select, or de-select information (for example, menus and soft keys).

**Standby Display**- A backup display that is used if a primary display malfunctions.

**Status information** - Information about the current condition of an aeroplane system and its surroundings.

**Symbol** - A symbol is a geometric form or alpha-numeric information used to represent the state of a parameter on a display. The symbol may be further defined by its location and motion on a display.

**Synthetic Vision** – A computer generated image of the external topography from the perspective of the flight deck. The image is derived from aircraft attitude, high-precision navigation solution, and terrain database terrain, obstacles, and relevant cultural features.

**Synthetic Vision System** – An electronic means to display a synthetic vision image of the external scene topography to the flight crew.

**Texturing** - A graphic, pictorial effect used to give a displayed object or graphic a specific “look” (metallic, grassy, cloudy, etc.). Texture is used:

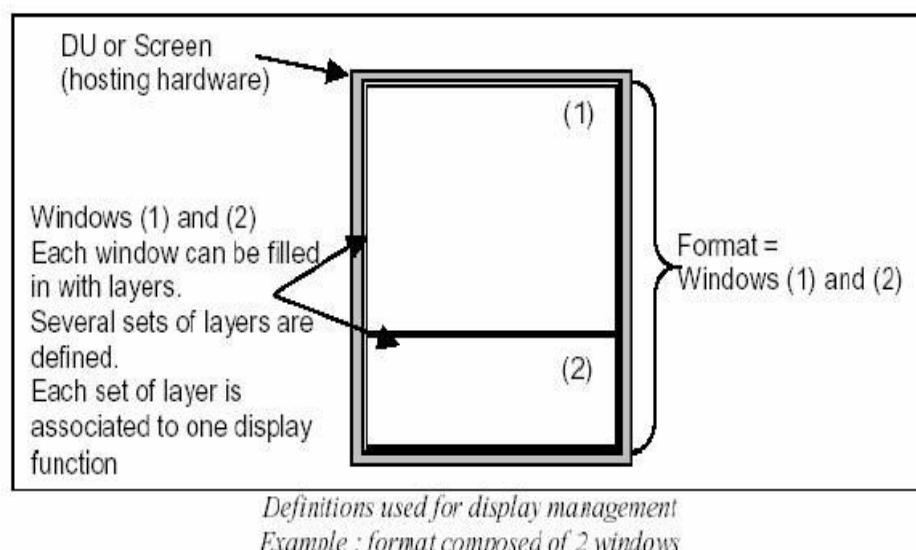
- As a coding method for separating information, change in state, give emphasis, and depth information.
- As a blending method between graphic elements (map displays, synthetic vision system).
- To enhance similarity between a synthetic image and the real world image.

**Time Sharing** – Showing different information in the same display area at different times.

**Transparency**- A means of seeing a background information element through a foreground information element. Transparency can alter the colour perception of both the “front” element and the “back” element.

**Viewing Angle** – The angle between the normal line of sight (looking straight ahead) and the line from the eye to the object being viewed. The angle can be horizontal, vertical, or a composite of those two angles.

**Window (See Figure A3-2)** - A rectangular physical area of the display surface. A window consists of one or more layers (see ARINC Specification 661).



**Figure A3-2 – Display Format**

**Windowing** - The technique to create windows. Segmenting a single display area into two or more independent display areas or inserting a new display area onto an existing display.

[Amdt 25/11]

## Appendix 4 – Acronyms Used in this AMC

*ED Decision 2015/019/R*

AC	(FAA) Advisory Circular
AMC	Acceptable Means of Compliance
ARAC	Aviation Rulemaking Advisory Committee
ARP	Aerospace Recommended Practices
AS	Aerospace Standard
CCD	Cursor Control Device
CFR	Code of Federal Regulations
CRT	Cathode Ray Tube
CS-AWO	EASA Certification Specifications for All Weather Operations
DEP	Design Eye Position
EASA	European Aviation Safety Agency
EFVS	Enhanced Flight Vision System
ERP	Eye Reference Position
ETSO	European Technical Standard Order
EUROCAE	European Organisation for Civil Aviation Equipment
EVS	Enhanced Vision System
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Controls
FD	Flight Director
FHA	Functional Hazard Assessment
FMS	Flight Management System
FOV	Field-of-View
FPA	Flight Path Angle
FPV	Flight Path Vector
GNSS	Global Navigation Satellite System
GUI	Graphical User Interface
HDD	Head-Down Display
HMD	Head-Mounted Display
HUD	Head-Up Display
ILS	Instrument Landing System
ICAO	International Civil Aviation Organization
JAA	Joint Aviation Authorities
LCD	Liquid Crystal Display
MSG-3	Maintenance Steering Group 3
PF	Pilot Flying
PNF	Pilot Not Flying
RA	Resolution Advisory
RNAV	Area Navigation
SAE	SAE International (formerly Society of Automotive Engineers)
SVS	Synthetic Vision System
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Alert and Collision Avoidance System
VFR	Visual Flight Rules

VNAV	Vertical Navigation
VOR	Very High Frequency Omnidirectional Stations

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## Appendix 6 – Head-Up Display

*ED Decision 2015/019/R*

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No table of contents entries found.

#### 1.0 Introduction

##### 1.1 Purpose

This Appendix provides additional guidance related to the unique aspects, characteristics, and functions of Head-Up Displays (HUDs) for transport category aeroplanes. This Appendix also addresses issues related to the design, analysis, and testing of HUDs. It addresses HUDs that are designed for a variety of different operational concepts and functions. This guidance applies to HUDs that are intended to be used as a supplemental display in which the HUD contains the minimum information immediately required for the operational task associated with the intended function. It also applies to HUDs that are intended to be used effectively as primary flight displays. This Appendix addresses both the installation of a single HUD, typically used by the left-side pilot, as well as special considerations related to dual HUDs, one for each pilot. This Appendix does not provide the guidance for display of vision system (e.g. Enhanced Flight Vision Systems (EFVS) and Synthetic Vision Systems (SVS)) video on the HUD. The airworthiness requirements and means-of-compliance criteria for display of video on the HUD may be found in the Certification Review Items (CRIs) issued by the Agency until new CSs and AMCs are issued.

##### 1.2 Definition of Head-Up Display (HUD)

An HUD is a display system that projects primary flight information (for example, attitude, air data, and guidance) on a transparent screen (combiner) in the pilot's forward Field-of-View (FOV), between the pilot and the windshield. This allows the pilot to simultaneously use the flight information while looking along the forward path out of the windshield, without scanning the Head-Down Displays (HDDs). The flight information symbols should be presented as a virtual image focussed at optical infinity. Attitude and flight path symbology needs to be conformal (that is, aligned and scaled) with the outside view.

##### 1.3 Other resources

For guidance associated with specific operations using HUDs, such as low-visibility approach and landing operations, see the relevant requirements and guidance material (e.g. EASA Certifications Specifications for All Weather Operations (CS-AWO), and FAA Advisory Circular (AC) 120-28D, Criteria for Approval of Category III Weather Minima for Takeoff, Landing, and Rollout). In addition, Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5288, Transport Category Aeroplane Head Up Display (HUD) Systems; SAE Aerospace Standard (AS) 8055, Minimum Performance Standard for Airborne Head Up Display (HUD); and SAE ARP5287, Optical Measurement Procedures for Airborne Head Up Display; provide guidance for designing and evaluating HUDs.