(4) Indications.The following paragraphs provide guidanceon numeric readouts, gauges, scales, tapes and graphical depictions such as schematics. Graphics related to interactivity are discussed in paragraph 31e of this chapter and Chapter 7 of this AMC. Graphics and display indications should:

— Be readily understood and compatible with other graphics and indications in the flight deck.

— Be identifiable and readily distinguishable.

— Follow the guidance for viewability presented in paragraphs 31a, 31b, 31c(1), and 31c(2) of this chapter.

(a) Numeric Readouts. Numeric readouts include displays that emulate rotating drum readouts where the numbers scroll, as well as displays where the digit locations stay fixed.

1 Data accuracy of the numeric readout should be sufficient for the intended function and to avoid inappropriate flight crew response. The number of significant digits should be appropriate to the data accuracy. Leading zeroes should not be displayed unless convention dictates otherwise (for example, heading and track). As the digits change or scroll, there should not be any confusing motion effects such that the apparent motion does not match the actual trend.

2 When a numeric readout is not associated with any scale, tape, or pointer, it may be difficult for pilots to determine the margin relative to targets or limits, or compare between numeric parameters. A scale, dial, or tape may be needed to accomplish the intended flight crew task.

3 For North, numeric readouts of heading should indicate 360, as opposed to 000.

(b) Scales, Dials, and Tapes. Scales, dials, and tapes with fixed and/or moving pointers have been shown to effectively improve flight crew interpretation of numeric data.

1 The displayed range should be sufficient to perform the intended function. If the entire operational range is not shown at any given time, the transition to the other portions of the range should not be distracting or confusing.

2 Scale resolution should be sufficient to perform the intended task. Scales may be used without an associated numeric readout if alone they provide sufficient accuracy for the intended function. When numeric readouts are used in conjunction with scales, they should be located close enough to the scale to ensure proper association, yet not detract from the interpretation of the graphic or the readout.

3 Delimiters, such as tick marks, should allow rapid interpretation without adding unnecessary clutter. Markings and labels should be positioned such that their meaning is clear yet they do not hinder interpretation. Pointers and indexes should not obscure the scales or delimiters such that they can no longer be interpreted. Pointers and indexes should be positioned with sufficient accuracy for their

intended function. Accuracy includes effects due to data resolution, latency, graphical positioning, etc.

(c) Other Graphical Depictions. Depictions include schematics, synoptics, and other graphics such as attitude indications, moving maps, and vertical situation displays.

1 To avoid visual clutter, graphic elements should be included only if they add useful information content, reduce flight crew access or interpretation time, or decrease the probability of interpretation error.

2 To the extent it is practical and necessary, the graphic orientation and the flight crew's frame of reference should be correlated. For example, left indications should be on the left side of the graphic and higher altitudes should be shown above lower altitudes.

3 If there are multiple depictions, such as "thumbnail" or overlaid depictions, the orientation (for example, heading up, track up, North up, etc.) should be the same for each depiction. This does not apply to other systems where the captain and first officer may select different presentations of the same information and are used exclusively by that flight crew member.

4 Graphics that include 3-Dimensional effects, such as raised buttons or the aeroplane flight path in a perspective view, should ensure that the symbol elements used to achieve these effects will not be incorrectly interpreted.

(5) Colour Coding

(a) If colour is used for coding at least one other distinctive coding parameter should be used (for example, size, shape, location, etc.). Normal aging of the eye can reduce the ability to sharply focus on red objects, or discriminate blue from green. For pilots with such a deficiency, display interpretation workload may be unacceptably increased unless symbology is coded in more dimensions than colour alone. However, the use of colour alone for coding information has been shown to be acceptable in some cases, such as weather radar and terrain depiction on the lateral view of the navigation display.

(b) To ensure correct information transfer, the consistent use and standardisation of colour is highly desirable. In order to avoid confusion or interpretation error, there should not be a change in how the colour is perceived over all foreseeable conditions. Colours used for one purpose in one information set should not be used for an incompatible purpose that could create a misunderstanding within another information set. In particular, consistent use and standardisation for red and amber or yellow, per CS 25.1322, is required to retain the effectiveness of flight crew alerts. A common application is the progression from green to amber to red, representing increasing degrees of threat, potential hazard, safety criticality, or need for flight crew awareness or response. Inconsistencies in the use of colour should be evaluated to ensure that they are not susceptible to confusion or errors, and do not adversely impact the intended function of the system(s) involved.

(c) If colour is used for coding it is considered good practice to use six colours or less for coding parameters. Each coded colour should have sufficient chrominance separation so it is identifiable and distinguishable in all foreseeable lighting and operating conditions and when used with other colours. Colours should be identifiable and distinguishable across the range of information element size, shape, and movement. The colours available for coding from an electronic display system should be carefully selected to maximise their chrominance separation. Colour combinations that are similar in luminance should be avoided (for example, Navy blue on black or yellow on white).

(d) Other graphic depictions such as terrain maps and synthetic vision presentations may use more than six colours and use colour blending techniques to represent colours in the outside world or to emphasize terrain features. These displays are often presented as background imagery and the colours used in the displays should not interfere with the flight crew interpretation of overlaid information parameters as addressed in paragraph 31c(5)(e)1 of this chapter.

(e) The following table depicts previously accepted colour coding and the functional meaning associated with each colour. The use of these colours is recommended for electronic display systems with colour displays. (Note: Some of these colours may be mandatory under CS-25).

Table 11 Recommended Colours for Certain Features

Feature	Colour
Warnings	Red
Flight envelope and system limits, exceedances	Red or Yellow/Amber as appropriate (see above)
Cautions, non-normal sources	Yellow/Amber
Scales, dials, tapes, and associated information elements	White
Earth	Tan/Brown
Sky	Blue/Cyan
Engaged Modes/Normal Conditions	Green
Instrument landing system deviation pointer	Magenta
Divisor lines, units and labels for inactive soft buttons	Light Gray

Note

(1) Use of the colour green for tape elements (for example airspeed and altitude) has also been found acceptable if the colour green does not adversely affect flight crew alerting.

(f) The following table depicts display features that should be allocated a colour from either Colour Set 1 or Colour Set 2.

Table 12 Recommended Colour Sets for Certain Display Features

Display Feature	Colour Set 1	Colour Set 2
Fixed reference symbols	White	Yellow
Current data, values	White	Green
Armed modes	White	Cyan
Selected data, values	Green	Cyan
Selected heading	Magenta	Cyan

Active route/flight plan	Magenta	White

Notes

(1) Use of the colour yellow for functions other than flight crew alerting should be limited and should not adversely affect flight crew alerting.

(2) In Colour Set 1, magenta is intended to be associated with those analogue parameters that constitute “fly to” or “keep centred” type information.

(g) Colour Pairs.For further information on this subject, see the FAA report No DOT/FAA/CT-03/05 HF-STD-001, Human Factors Design Standard (HFDS): For Acquisition of Commercial Off-the-Shelf Subsystems, Non-Developmental Items, and Developmental Systems.

(h) When background colour is used (for example, grey), it should not impair the use of the overlaid information elements. Labels, display-based controls, menus, symbols, and graphics should all remain identifiable and distinguishable. The use of background colour should conform to the overall flight deck philosophies for colour usage and information management. If texturing is used to create a background, it should not result in loss of readability of the symbols overlaid on it, nor should it increase visual clutter or pilot information access time. Transparency is a means of seeing a background information element through a foreground one – the use of transparency should be minimised because it may increase pilot interpretation time or errors.

(i) Requiring the flight crew to discriminate between shades of the same colour for distinct meaning is not recommended. The use of pure blue should not be used for important information because it has low luminance on many display technologies (for example, CRT and LCD).

(j) Any foreseeable change in symbol size should ensure correct colour interpretation; for example, the symbol needs to be sufficiently large so the pilot can interpret the correct colour.

d. Dynamic (Graphic) Information Elements on a Display

(1) General. The following paragraphs cover the motion of graphic information elements on a display, such as the indices on a tape display.Graphic objects that translate or rotate should do so smoothly without distracting or objectionable jitter, jerkiness, or ratcheting effects. Data update rates for information elements used in direct aeroplane or powerplant manual control tasks (such as attitude, engine parameters, etc.) equal to or greater than 15 Hertz have been found to be acceptable. Any lag introduced by the display system should be consistent with the aeroplane control task associated with that parameter. In particular, display system lag (including the sensor) for attitude which does not exceed a first order equivalent time constant of 100 milliseconds for aeroplanes with conventional control system response is generally acceptable.

(2) Movement of display information elements should not blur, shimmer, or produce unintended dynamic effects such that the image becomes distracting or difficult to interpret. Filtering or coasting of data intended to smooth the motion of display elements should not introduce significant positioning errors or create system lag that makes it difficult to perform the intended task.

(3) When a symbol reaches the limit of its allowed range of motion, the symbol should either slide from view, change visual characteristics, or be self-evident that further deflection is impossible.

(4) Dynamic information should not appreciably change shape or colour as it moves. Objects that change sizes (for example, as the map range changes) should not cause confusion as to their meaning and should remain consistent throughout their size range. At all sizes the objects should meet the guidance of this chapter as applicable (that is, the objects should be discernable, legible, identifiable, placed accurately, not distracting, etc.).

e. Sharing Information on a Display. There are three primary methods of sharing information on a given display. First, the information may be overlaid or combined, such as when traffic alert and collision avoidance system (TCAS) information is overlaid on a map display. Second, the information can be time shared so that the pilot toggles between functions, one at a time. Third, the information may be displayed in separate physical areas or windows that are concurrently displayed. Regardless of the method of information sharing, care should be taken to ensure that information that is out prioritised, but is needed, can be recovered, and that it will not be needed more quickly than it can be recovered.

(1) Overlays and Combined Information Elements. The following guidelines apply:

— When information is graphically overlaid over other information (for example, an aeroplane symbol over a waypoint symbol) in the same location on a display, the loss of information availability, information access times, and potential for confusion should be minimised.

— When information obscures other information it should be shown that the obscured information is either not needed when it is obscured or can be rapidly recovered. Needed information should not be obscured. This may be accomplished by protecting certain areas of the display.

— If information is integrated with other information on a display, the projection, the placement accuracy, the directional orientation and the display data ranges should all be consistent (for example, when traffic or weather is integrated with navigation information). When information elements temporarily obscure other information (for example, pop-up menus or windows), the resultant loss of information should not cause a hazard in accordance with the obscured information’s intended function.

(2) Time Sharing.The following guidelines apply:

— Guidance on Full-time vs. Part-time Displays (see paragraph 36c(3) of this AMC).

— Any information that should or must be continuously monitored by the flight crew should be displayed at all times (for example, attitude).

— Whether or not information may be time shared depends on how easily it can be retrieved in normal, non-normal, and emergency operations. Information for a given performance monitoring task may be time shared if the method of switching back and forth does not jeopardise the performance monitoring task.

— Generally, system information, planning, and other information not necessary for the pilot tasks can be time shared.

(3) Separating Information Visually.When different information elements are adjacent to each other on a display, the elements should be separated visually so the pilots can easily distinguish between them. Visual separation can be achieved with, for example, spacing, delimiters, or shading in accordance with the overall flight deck information management philosophy. Required information presented in reversionary or compacted display modes following a display failure should still be uncluttered and still allow acceptable information access time.

(4) Clutter and De-Clutter

(a) A cluttered display presents an excessive number or variety of symbols, colours, and/or other unnecessary information and, depending on the situation, may interfere with the flight task or operation. A cluttered display causes increased flight crew processing time for display interpretation, and may detract from the interpretation of information necessary to navigate and fly the aeroplane. Information should be displayed so that clutter is minimised.

(b) To enhance pilot performance a means should be considered to de-clutter the display. For example, an attitude indicator may automatically de-clutter when the aeroplane is at an unusual attitude to aid the pilot in recovery from the unusual attitude by removing unnecessary information and retaining information required for the flight crew to recover the aeroplane. Failure messages, flags, or comparative monitoring alerts related to the information required to be indicated by CS 25.1303 should not be removed from the main primary flight display by decluttering the display, as long as the associated indication is maintained on the primary flight display.

f. Annunciations and Indications

(1) General. Annunciations and indications include annunciator switches, messages, prompts, flags, and status or mode indications which are either on the flight deck display itself or control a flight deck display. Reference: CS 25.1322 and the associated AMC for information regarding specific annunciations and indications such as warning, caution, and advisory level alerts.

(a) Annunciations and indications should be operationally relevant and limited to minimise the adverse effects on flight crew workload.

(b) Annunciations and indications should be clear, unambiguous, timely, and consistent with the flight deck design philosophy. When an annunciation is provided for the status or mode of a system, it is recommended that the annunciation indicate the actual state of the system and not just the position or selection of a switch. Annunciations should only be indicated while the condition exists.

(2) Location.Annunciations and indications should be consistently located in a specific area of the electronic display. Annunciations that may require immediate flight crew awareness should be located in the flight crew's forward/primary field of view.

(3) Managing Messages and Prompts

(a) The following general guidance applies to all messages and prompts:

— When messages are currently being displayed and there are additional messages in the queue that are not currently displayed, there should be an indication that the additional messages exist.

— Within levels of urgency, messages should be displayed in logical order. In many cases the order of occurrence of events has been found to be the most logical way to place the messages in order.

— See CS 25.1322 and AMC 25.1322 for information on warning, caution, and advisory alerts.

(4) Blinking. Blinking information elements such as readouts or pointers are effective methods of annunciation. However, the use of blinking should be limited because it can be distracting and excessive use reduces the attention getting effectiveness. Blinking rates between 0.8 and 4.0 Hertz should be used, depending on the display technology and the compromise between urgency and distraction. If blinking of an information element can occur for more than approximately 10 seconds, a means to cancel the blinking should be provided.

g. Use of Imaging. This paragraph provides guidance on the use of images which depict a specific portion of the aeroplane environment. These images may be static or continuously updated. Imaging includes weather radar returns, terrain depictions, forecast weather maps, video, enhanced vision displays, and synthetic vision displays. Images may be generated from databases or by sensors.

(1) Images should be of sufficient size and include sufficient detail to meet the intended function. The pilots should be able to readily distinguish the features depicted. Images should be oriented in such a way that their presentation is easily interpreted. All images, but especially dynamic images, should be located or controllable so they do not distract the pilots from required tasks. The source and intended function of the image and the level of operational approval for using the image should be provided to the pilots. This can be accomplished using the aeroplane flight manual, image location, adequate labelling, distinct texturing, or other means.

(2) Image distortion should not compromise image interpretation. Images meant to provide information about depth (for example, 3-Dimensional type perspective displays) should provide adequate depth information to meet the intended function.

(3) Dynamic images should meet the guidance in paragraph 31d of this chapter, above. The overall system lag time of a dynamic image relative to real time should not cause flight crew misinterpretation or lead to a potentially hazardous condition. Image failure, freezing, coasting or colour changes should not be misleading and should be considered during the safety analysis.

(4) When overlaying coded information elements over images, the information elements should be readily identifiable and distinguishable for all foreseeable conditions of the underlying image and range of motion. The information elements should not obscure necessary information contained in the image. The information should be depicted with the appropriate size, shape, and placement accuracy to

avoid being misleading. They should retain and maintain their shape, size, and colour for all foreseeable conditions of the underlying image and range of motion.

(5) When fusing or overlaying multiple images, the resultant combined image should meet its intended function despite any differences in image quality, projection, data update rates, sensitivity to sunlight, data latency, or sensor alignment algorithms. When conforming an image to the outside world, such as on a HUD, the image should not obscure or significantly hinder the flight crew's ability to detect real world objects. An independent brightness control of the image may help satisfy this guideline. Image elements that correlate or highlight real world objects should be sufficiently coincident to avoid interpretation error or significantly increase interpretation time.

32. – 35. [RESERVED]

CHAPTER 6 ORGANISING ELECTRONIC DISPLAY INFORMATION ELEMENTS

36. Organising Information Elements

a. General. This chapter provides guidance for integrating information into the flight deck related to managing the location of information, arranging the display, windowing, configuring and reconfiguring the display, and selecting the sensors across the flight deck displays. The following paragraphs include guidance for various flight deck configurations from dedicated electronic displays for the attitude director indicator and the horizontal situation indicator to larger display sizes which use windowing techniques to display various functionalities on one display area. In some flight decks the primary flight information and the navigation display are examples of information that is displayed using windowing techniques. Chapter 5 of this AMC provides guidance for information elements including: text, labels, symbols, graphics, and other depictions (such as video) in isolation and combination.

b. Types and Arrangement of Display Information. This paragraph provides guidance for the arrangement and location of categories of information. The categories of information include:

— Primary flight information including attitude, airspeed, altitude, and heading.

— Powerplant information which covers functions relating to propulsion.

— Other information.

(1) Placement - General Information. The position of a message or symbol within a display conveys meaning to the pilot. Without the consistent or repeatable location of a symbol in a specific area of the electronic display interpretation error and response times may increase. The following information should be placed in a consistent location under normal conditions:

— Primary flight information (see paragraph 36b(3) in this chapter and Appendix 1 of this AMC).

— Powerplant information (see paragraph 36b(4) in this chapter and Appendix 2 of this AMC).

— Flight crew alerts – each flight crew alert should be displayed in a specific location or a central flight crew alert area.

— Autopilot and flight director modes of operation.

— Lateral and vertical path deviation indicators.

— Radio altitude indications.

— Failure flags should be presented in the location of the information they reference or replace.

— Data labels for navigation, traffic, aeroplane system, and other information should be placed in a consistent position relative to the information they are labelling.

— Supporting data for other information, such as bugs and limit markings, should be consistently positioned relative to the information they support.

— Features on electronic moving map displays (for example, VORs, waypoints, etc.) relative to the current aeroplane position. In addition, the features should be placed on a constant scale for each range selected.

— Segment of flight information relative to similar information or other segments.

(2) Placement - Controls and Indications. When a control or indication occurs in multiple places (for example a “Return” control on multiple pages of a flight management function), the control or indication should be located consistently for all occurrences.

(3) Arrangement - Basic T Information

(a) CS 25.1321(b) includes specifications for the “Basic T” arrangement of certain information required by CS 25.1303(b).

(b) The following paragraphs provide guidance for the Basic T arrangement. This guidance applies to single and multiple display surfaces.

1 The Basic T information should be displayed continuously, directly in front of each flight crew member under normal (that is, no display system failure) conditions. CS 25.1321(b) requires that flight instruments required by CS 25.1303 must be grouped on the instrument panel and centred as nearly as practicable about the vertical plane of the pilot's forward vision.

2 The Basic T arrangement applies to the primary display of attitude, airspeed, altitude, and direction of flight. Depending on the flight deck design, there may be more than one indication of the Basic T information elements in front of a pilot. For example, heading information may appear on back-up displays, HUDs, and moving map displays. The primary airspeed, altitude, and direction indications are the respective display indications closest to the primary attitude indication.

3 The primary attitude indication should be centred about the plane of the flight crew’s forward vision. This should be measured from the DEP at the flight crew station. If located on the main instrument panel, the primary attitude indication must be in the top centre position (CS 25.1321(b)). The attitude indication should be placed so that the display is unobstructed under all flight conditions. Refer to SAE ARP 4102/7 for additional information.

4 The primary airspeed, altitude, and direction of flight indications should be located adjacent to the primary attitude indication. Information elements placed within, overlaid, or between these indications, such as lateral and vertical deviation, are acceptable when they are relevant to respective airspeed, altitude, or directional indications used for accomplishing the basic flying task, and are shown to not disrupt the normal crosscheck or decrease manual flying performance.

5 The instrument that most effectively indicates airspeed must be adjacent to and directly to the left of the primary attitude indication (CS 25.1321(b)). The centre of the airspeed indication should be aligned with the centre of the attitude indication. For airspeed indications, vertical deviations have been found acceptable up to 15 degrees below to 10 degrees above when measured from the direct horizontal position of the aeroplane waterline reference symbol. For tape type airspeed indications, the centre of the indication is defined as the centre of the current airspeed status reference.

6 Parameters related to the primary airspeed indication, such as reference speeds or a mach indication, should be displayed to the left of the primary attitude indication.

7 The instrument that most effectively indicates altitude must be located adjacent to and directly to the right of the primary attitude indication (CS 25.1321(b)). The centre of the altitude indication should be aligned with the centre of the attitude indication. For altitude indications, vertical deviations have been found acceptable up to 15 degrees below to 10 degrees above when measured from the direct horizontal position of the aeroplane waterline reference symbol. For tape type altitude indications, the centre of the indication is defined as the centre of the current altitude status reference.

8 Parameters related to the primary altitude indication, such as the barometric setting or the primary vertical speed indication, should be displayed to the right of the primary altitude indication.

9 The instrument that most effectively indicates direction of flight must be located adjacent to and directly below the primary attitude indication (CS 25.1321(b)). The centre of the direction of flight indication should be aligned with the centre of the attitude indication. The centre of the direction of flight indication is defined as the centre of the current direction of flight status reference.

10 Parameters related to the primary direction of flight indication, such as the reference (that is, magnetic or true) or the localiser deviation should be displayed below the primary attitude indication.

11 If applicants seek approval of alternative instrument arrangements by equivalent safety under Part 21A.21(c)2, the Agency will normally require well-founded research, or relevant service experience from military, foreign, or other sources to substantiate the applicants' proposed compensating factors.