

to limitations in the system inputs, incompatible technologies between the aeroplane and the system being added, or economic considerations.

- (a) We discourage incorporating a new additional master visual function into the flight crew alerting system. If it is not feasible to include additional systems and associated alerts in the existing master visual function, an additional master visual function may be installed, provided that it does not delay the flight crew's response time for recognising and responding to an alert.
 - (b) Where possible, new alerts should be integrated into the existing flight crew alerting system. If these alerts cannot be integrated, individual annunciators or an additional alerting display system may be added.
 - (c) Not all alerts associated with failure flags need to be integrated into the central alerting system. However, for those alerts requiring immediate flight crew awareness, the alert needs to meet the attention-getting requirements of [CS 25.1322\(c\)\(2\)](#) as well as the other requirements in [CS 25.1322](#). Thus, a Master visual alert or Master aural alert may not be initiated, but an attention-getting aural or tactile indication must still accompany an attention-getting visual failure flag to meet the attention-getting requirement of [CS 25.1322\(a\)\(1\)](#), which requires attention-getting cues through at least two different senses for Warning and Caution alerts.
- b. Visual Alerts. Following the guidance in paragraphs 5 and 6 of this AMC, determine whether or not the added system features will require activation of an aeroplane Master visual alert.
- c. Aural Alerts
- (1) Using the guidance in this AMC, determine if an added system will require activating an aural alert.
 - (2) The new aural alert should be integrated into the existing aural alerting system and functions. If this is not possible, a separate aural alerting system may be installed, provided that a prioritisation scheme between existing aural alerts and the new aural alerts is developed so that each alert is recognised and can be acted upon in the time frame appropriate for the alerting situation. This may require a demonstration of any likely combination of simultaneous alerts. After the new and existing alerts have been merged, follow the guidance in this AMC for determining how to prioritise the alerts.
- d. Tactile Alerts
- (1) Using the guidance in this AMC, determine if an added system will require activating a tactile alert.
 - (2) If possible, incorporate the new tactile alert into the existing alerting system. If this is not possible, a separate tactile alerting system may be installed, provided that the following elements are included:
 - (a) A prioritisation scheme between existing tactile alerts and the new tactile alerts should be developed so that each alert is recognised and can be acted upon in the time frame appropriate for the alerting situation. After the new and existing alerts have been merged, follow the guidance in this AMC for determining how to prioritise the alerts.

- (b) A means to ensure that an individual alert can be understood and acted upon. This may require a demonstration of any likely combination of simultaneous alerts.

15. Alerts for Head-Up Displays (HUDs)

- a. HUDs have visual characteristics that merit special considerations for alerting. First, most HUDs are single-colour (monochromatic) displays and are not capable of using different colours, such as red, amber and yellow to signify alert information. Second, HUDs are located in the pilot's forward field of view, separated from the instrument panel, and focused at optical infinity. As a result, many visual indications on the instrument panel are not visible to the pilot while viewing the HUD, and the timely detection of visual alerts displayed on the instrument panel may not be possible. Therefore, even though HUDs are not intended to be classified as integrated caution and warning systems, they do need to display certain alerts, such as Time-critical warnings, to perform their role as a primary flight display (PFD). Monochromatic HUDs are not required to use red and amber to signify Warning and Caution alerts, but do need to provide the equivalent alerting functionality (for example, attention-getting, clearly understandable, not confusing) as current head-down display (HDD) PFDs ([CS 25.1322\(e\)](#)).
- b. Alerting functions presented in the HUD should not adversely affect the flight crew's use of the HUD by obstructing the flight crew's outside view through the HUD.
- c. Time-critical warnings that are displayed on the HDD PFD also need to be presented on the HUD to ensure equivalent timely pilot awareness and response (for example, ACAS II, windshear, and ground-proximity warning annunciations) ([CS 25.1301\(a\)](#)). Otherwise, the physical separation of the HUD and head-down fields of view and the difference in accommodation (that is, focal distance) would hinder timely pilot awareness of visual alerts displayed head-down.
- d. While a pilot is using the HUD, if the master alerting indications are not visible or attention-getting, the HUD needs to display alerts that provide the pilot with timely notification of Caution conditions, Warning conditions, or both.
- e. [CS 25.1322\(e\)](#) requires visual alert indications on monochromatic displays to use coding techniques so the flight crew can clearly distinguish between Warning, Caution, and Advisory alerts. Since monochromatic HUDs are incapable of using colours to distinguish among Warning, Caution, and Advisory information, other visual display features (coding techniques) are necessary, such as shape, location, texture, along with the appropriate use of attention-getting properties such as flashing, outline boxes, brightness, and size. The use of these visual display features should be consistent within the set of flight deck displays, so that the intended meaning is clearly and unmistakably conveyed. For example, Time-critical warnings might be boldly displayed in a particular central location on the HUD, while less critical alerts, if needed, would be displayed in a different manner.
- f. For multi-colour HUDs, the display of Warning and Caution alerts should be consistent with HDD PFD presentations.
- g. Pilot flying and pilot monitoring roles should account for the use of HUDs to ensure timely awareness of certain alerts, especially because of field of view factors.
- (1) For single-HUD installations, when the pilot flying is using the HUD, the other pilot should be responsible for monitoring the head-down instruments and alerting systems for system failures, modes, and functions that are not displayed on the HUDs.

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- (2) For dual-HUD installations there needs to be greater reliance on master alerting indications that are capable of directing each pilot's attention to non-HUD alerts when both HUDs are in use. If master alerting indications do not provide sufficient attention to each pilot while using the HUD, then each HUD should provide annunciations that direct the pilot's attention to HDDs. The types of information that should trigger the HUD master alerting display are any Cautions or Warnings not already duplicated on the HUD from the HDD.

[Amdt 25/11]

Appendix 1 – Examples for Including Visual System Elements in an Alerting System

ED Decision 2015/019/R

This appendix includes detailed guidance and examples to help applicants with a means of compliance and design for visual system elements in an alerting system. They are based on the Agency's experience with existing and proposed alerting systems that comply with [CS 25.1322](#). The extent to which this guidance and these examples are applied to a specific type investigation programme will vary, depending on the types of alerts presented, and the level of integration associated with an alerting system. The visual elements of an alerting system typically include a Master visual alert, Visual alert information, and Time-critical warning visual information.

1. Master Visual

- a. Location. Master visual alerts for Warnings (master warning) and Cautions (master caution) should be located in each pilot's primary field of view. Appendix 5 of this AMC includes a definition of pilot primary field of view.
- b. Onset/Duration/Cancellation
 - (1) The onset of a Master visual alert should occur:
 - (a) in a timeframe appropriate for the alerting condition and the desired response,
 - (b) simultaneously with the onset of its related Master aural alert or Unique tone, and its related Visual alert information. Any delays between the onset of the Master visual alert and its related Master aural alert or Unique tone, and its Visual alert information should not cause flight crew distraction or confusion,
 - (c) simultaneously at each pilot's station (Warnings, Cautions).
 - (2) The Master visual alert should remain on until it is cancelled either manually by the flight crew, or automatically when the alerting condition no longer exists.
 - (3) After the Master visual alert is cancelled the alerting mechanisms should automatically reset to annunciate any subsequent fault condition.
- c. Attention-Getting Visual Characteristics. In addition to colour, steady state or flashing Master visual alerts may be used, as long as the method employed provides positive attention-getting characteristics. If flashing is used, all Master visual alerts should be synchronised to avoid any unnecessary distraction. [AMC 25-11](#), Electronic Flight Deck Displays, provides additional guidance for using flashing alerts.
- d. Brightness
 - (1) Master visual alerts should be bright enough to attract the attention of the flight crew in all ambient light conditions.
 - (2) Manual dimming should not be provided unless the minimum setting retains adequate attention-getting qualities when flying under all ambient light conditions.

- e. Display and Indicator Size and Character Dimensions
 - (1) Design all character types, sizes, fonts, and display backgrounds so that the alerts are legible and understandable at each pilot's station. These elements should provide suitable attention-getting characteristics.
 - (2) We recommend that the alerts subtend at least 1 degree of visual angle.
 - f. Colour
 - (1) Standard colour conventions must be followed for the Master visual alerts ([CS 25.1322\(d\)](#)):
 - Red for Warning
 - Amber or yellow for Caution
 - (2) Master visual alerts for conditions other than Warnings or Cautions (for example, Air Traffic Control (ATC) Datalink alerts) must meet the requirements in [CS 25.1322\(f\)](#) and follow the guidance in this AMC. We recommend using a colour other than red, amber, or yellow.
 - g. Test function. To comply with the safety requirements of [CS 25.1309](#), include provisions to test/verify the operability of the Master visual alerts.
2. Visual Information
- a. Quantity and Location of Displays
 - (1) To determine the quantity of displays that provide Warning, Caution, and Advisory alerts, take into account the combination of ergonomic, operational, and reliability criteria, as well as any physical space constraints in the flight deck.
 - (2) The visual alert information should be located so that both pilots are able to readily identify the alert condition.
 - (3) All Warning and Caution visual information linked to a Master visual alert should be grouped together on a single dedicated display area. There may be a separate area for each pilot. Advisory alerts should be presented on the same display area as Warning and Caution information. The intent is to provide an intuitive and consistent location for the display of information.
 - b. Format and Content
 - (1) Use a consistent philosophy for the format and content of the visual information to clearly indicate both the alert meaning and condition. The objectives of the corresponding text message format and content are to direct the flight crew to the correct checklist procedure, and to minimise the risk of flight crew error.
 - (2) The alerting philosophy should describe the format and content for visual information. Use a consistent format and content that includes the following three elements:
 - The general heading of the alert (for example, HYD, FUEL)
 - The specific subsystem or location (for example, L-R, 1-2)
 - The nature of the condition (for example, FAIL, HOT, LOW)

- (3) For any given message, the entire text should fit within the available space of a single page. This encourages short and concise messages. Additional lines may be used provided the Alert message is understandable.
- (4) If alerts are presented on a limited display area, use an overflow indication to inform the flight crew that additional alerts may be called up for review. Use indications to show the number and urgency levels of the alerts stored in memory.
- (5) A “Collector message” can be used to resolve problems of insufficient display space, prioritisation of multiple alert conditions, alert information overload, and display clutter. Use Collector messages when the procedure or action is different for the multiple fault condition than the procedure or action for the individual messages being collected. For example, non-normal procedures for loss of a single hydraulic system are different than non-normal procedures for loss of two hydraulic systems. The messages that are “collected” (for example, loss of each individual hydraulic system) should be inhibited so the flight crew will only respond to the correct non-normal procedure pertaining to the loss of more than one hydraulic system.
- (6) An alphanumeric font should be of a sufficient thickness and size to be readable when the flight crew are seated at the normal viewing distance from the screen.

Note 1: Minimum character height of 1/200 of viewing distance is acceptable (for example, a viewing distance of 36 inches requires a 0.18 inch character height on the screen) (See DOD-CM-400-18-05)

Note 2: Arial and sans serif fonts are acceptable for visual alert text. The size of numbers and letters required to achieve acceptable readability depends on the display technology used. Stroke width between 10% and 15% of character height appears to be best for word recognition on text displays. Extensions of descending letters and ascending letters should be about 40% of letter height.

Note 3: Different fonts can be used to differentiate between new and previously acknowledged Visual alert information.

- c. Colour. The presentation of Visual alert information must use the following standard colour conventions (§ 25.1322(e)):
 - Red for Warning alerts
 - Amber or yellow for Caution alerts
 - Any colour except red, amber, yellow, or green for Advisory alerts
 - (1) Red must be used for indicating non-normal operational or non-normal aircraft system conditions that require immediate flight crew awareness and an immediate action or decision.
 - (2) Amber or yellow must be used for indicating non-normal operational or non-normal aircraft system conditions that require immediate flight crew awareness and less urgent subsequent flight crew response (compared to a Warning alert).
 - (3) Advisories may use any colour except red or green for indicating non-normal operational or non-normal system conditions that require flight crew awareness and may require subsequent flight crew response.

Note: Use of red, amber, or yellow not related to Caution and Warning alerting functions must be limited to prevent diminishing the attention-getting characteristics of true Warnings and Cautions ([CS 25.1322\(f\)](#)).

- d. Luminance
 - (1) The Visual alert information should be bright enough so that both pilots are able to readily identify the alert condition in all ambient light conditions.
 - (2) The luminance of the Visual alert information display may be adjusted automatically as ambient lighting conditions change inside the flight deck. A manual override control may be provided to enable the pilots to adjust display luminance.

3. Time-Critical Warning Visual Information

- a. Location. Time-critical warning visual information should appear in each pilot's primary field of view. Appendix 5 of this AMC includes a definition for pilot primary field of view.

Note: The primary flight display (PFD) is used as a practical and preferred display for displaying the Time-critical warning alerts since the pilot constantly scans the PFD. Integrating time-critical information into the PFD depends on the exact nature of the Warning. For example, a dedicated location on the PFD may be used both as an attention-getting function and a visual information display by displaying alerts such as "WINDSHEAR," "SINK RATE," "PULL UP," "TERRAIN AHEAD," and "CLIMB, CLIMB." In addition, graphic displays of target pitch attitudes for Airborne Alert and Collision Avoidance System (ACAS) II Resolution Advisories and Terrain may also be included.

- b. Format
 - (1) The corresponding visual and aural alert information should be consistent.
 - (2) Time-critical warning visual information may be presented as a text message (for example, "WINDSHEAR"). Certain Time-critical warning information, including guidance, may be presented graphically (for example, graphics representing an ACAS II Resolution Advisory).
 - (3) Text messages and graphics for Time-critical warning information must be red ([CS25.1322\(e\)\(1\)\(i\)](#)). When displaying Time-critical warnings on monochromatic displays, other graphic coding means must be used ([CS25.1322\(e\)](#)).
 - (4) The information must be removed when corrective actions (e.g. sink rate has been arrested, aeroplane climbed above terrain, etc.) have been taken, and the alerting condition no longer exists ([CS 25.1322\(a\)\(3\)](#)).
- c. Size. To immediately attract the attention of the flight crew and to modify their habit pattern for responding to Warnings that are not time-critical. We recommend that a display for Time-critical warnings subtend at least 2 square degrees of visual angle.

4. Failure Flags. Failure flags indicate failures of displayed parameters or their data source. Failure flags are typically associated with only single instrument displays. The same colours used for displaying flight crew alerts are used for displaying failure flags. In the integrated environment of the flight deck it is appropriate to display instrument failure flags in a colour consistent with the alerting system, as part of the alerting function (see paragraph 5b in the body of this AMC).

[Amendment 25/11]

[Amendment 25/17]

Appendix 2 – Examples for Including Aural System Elements in an Alerting System

ED Decision 2011/004/R

1. General

- a. Detailed guidance and examples are included in this appendix to help applicants with a means of compliance, requirements, and detailed design of an alerting system. They are based on the Agency's experience with existing and proposed alerting systems that should comply with [CS 25.1322](#). The extent to which this guidance and these examples are applied to a specific type investigation programme will vary, depending on the types of alerts that are presented, and the level of integration associated with an alerting system. The aural elements of an alerting system include:
 - Unique tones, including Master aural alerts
 - Unique Voice information (callouts)
- b. Each sound should differ from other sounds in more than one dimension (frequency, modulation, sequence, intensity) so that each one is easily distinguishable from the others.

2. Master Aural Alert and Unique Tones

- a. Frequency
 - (1) Use frequencies between 200 and 4500 Hertz for aural signals.
 - (2) Aural signals composed of at least two different frequencies, or aural signals composed of only one frequency that contains different characteristics (spacing), are acceptable.
 - (3) To minimise masking, use frequencies different from those that dominate the ambient background noise.
- b. Intensity
 - (1) The aural alerting must be audible to the flight crew in the worst-case (ambient noise) flight conditions whether or not the flight crew are wearing headsets (taking into account their noise attenuation and noise cancelling characteristics) ([CS 25.1322\(a\)\(2\)](#)). The aural alerting should not be so loud and intrusive that it interferes with the flight crew taking the required action.
 - (2) The minimum volume achievable by any adjustment (manual or automatic) should be adequate to ensure it can be heard by the flight crew if the level of flight deck noise subsequently increases.
 - (3) We recommend automatic volume control to maintain an acceptable signal-to-noise ratio.
- c. Number of Sounds
 - (1) Limit the number of different Master aural alerts and unique tones, based on the ability of the flight crew to readily obtain information from each alert and tone. While different studies have resulted in different answers, in general these studies conclude that the number of unique tones should be less than 10.
 - (2) Provide one unique tone for master warning and one unique tone for master caution alerts.

- (3) We do not recommend a Master aural alert for advisories because immediate flight crew attention is not needed for an Advisory alert.
- d. Onset/Duration
- (1) The onset of the Master aural alert or unique tone should occur in a timeframe appropriate for the alerting condition and the desired response. Any delays between the onset of the Master aural alert or unique tone and its related visual alert should not cause flight crew distraction or confusion.
- (2) We recommend ramping the onset and offset of any aural alert or unique tone to avoid startling the flight crew.
- (a) A duration for onsets and offsets of 20-30 milliseconds is acceptable.
- (b) An onset level of 20-30 decibels above the ambient noise level is acceptable.
- (3) If more than one source of the Master aural alert or unique tone is provided, the Master aural alert or unique tone for the same condition should occur simultaneously at each pilot's station. Any timing differences should not be distracting nor should they interfere with identifying the aural alert or unique tone.
- (4) Signal duration of the Master aural alert and unique tones should vary, depending on the alert urgency level and the type of response desired.
- (5) Unique tones associated with Time-critical warnings and Cautions should be repeated and non-cancelable until the alerting condition no longer exists (for example, stall warning), unless it interferes with the flight crew's ability to respond to the alerting condition.
- (6) Unique tones associated with Warnings and Cautions should be repeated and non-cancelable if the flight crew needs continuous awareness that the condition still exists, to support them in taking corrective action. The aural warning requirements listed in [CS 25.1303\(c\)\(1\)](#) and [CS 25.729\(e\)](#) must be followed.
- (7) Unique tones associated with Warnings and Cautions should be repeated and cancelable by the flight crew if the flight crew does not need a continuous aural indication that the condition still exists (for example, Fire Bell or Abnormal Autopilot Disconnect) and if a positive acknowledgement of the alert condition is required.
- (8) Unique tones associated with Warnings and Cautions should not be repeated if the flight crew does not need continuous aural indication that the condition still exists.
- (9) Unique tones that are not associated with a Warning or a Caution (for example, certain advisories, altitude alert, or selective calling (SELCAL)) should be limited in duration.
- (10) Master aural alerts for Warnings and Cautions should be repeated and non-cancelable if the flight crew needs continuous awareness that the condition still exists, to support the flight crew in taking corrective action ([CS 25.729\(e\)\(2\)](#)). The requirements for aural Warnings in [CS 25.729\(e\)](#) must be followed.
- (11) Master aural alerts for Warnings and Cautions should be repeated until the flight crew acknowledges the warning condition or the warning condition no longer exists.

e. Cancellation

- (1) For Caution alerts, if the flight crew does not need continuous aural indication that the condition still exists, the Master aural alert and unique tone should continue through one presentation and then be automatically cancelled.
- (2) If there is any tone associated with an Advisory alert, it should be presented once and then be automatically cancelled.
- (3) Provide a means to reactivate cancelled aural alerts (for example, the aural alert associated with a gear override).
- (4) When silenced, the aural alerts should be automatically re-armed. However, if there is a clear and unmistakable annunciation in the pilot's forward field of view that the aural alerts have been silenced, manual re-arming is acceptable.

3. Voice Information. For a Time-critical warning, use Voice information to indicate conditions that demand immediate flight crew awareness of a specific condition without further reference to other indications in the flight deck. A second attention-getting sensory cue, such as a visual cue, is still required ([CS 25.1322\(c\)\(2\)](#)). Additional reasons for using Voice information include:

- a. Limiting the number of unique tones.
- b. Transferring workload from the visual to the auditory channel.
- c. Enhancing the identification of an abnormal condition and effectively augmenting the visual indication without replacing its usefulness.
- d. Providing information to the flight crew where a voice message is preferable to other methods.
- e. Assuring awareness of an alert no matter where the pilot's eyes are pointed.
- f. Voice Characteristics
 - (1) General.
 - (a) The voice should be distinctive and intelligible.
 - (b) The voice should include attention-getting qualities appropriate for the category of the alert, such as voice inflection, described below.
 - (2) Voice Inflection. Voice inflection may be used to indicate a sense of urgency. However, we do not recommend using an alarming tone indicating tension or panic. Such a tone may be inappropriately interpreted by flight crews of different cultures. Depending on the alerting condition, advising and commanding inflections may be used to facilitate corrective action, but the content of the message itself should be sufficient.
 - (3) Voice Intensity.
 - (a) Aural voice alerting must be audible to the flight crew in the worst-case (ambient noise) flight conditions whether or not the flight crew is wearing headsets (taking into account the headsets' noise attenuation characteristics) ([CS 25.1301\(a\)](#)). Aural voice alerting should not be so loud and intrusive that it interferes with the flight crew taking the required action. The minimum volume achievable by any adjustment (manual or automatic) (if provided) of aural voice alerts should be adequate to ensure it can be