COMMENT RESPONSE DOCUMENT (CRD) TO NOTICE OF PROPOSED AMENDMENT (NPA) 2009-12

for amending the Executive Director Decision No. 2003/02/RM of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes (« CS-25 »)

"Avionics"

Explanatory Note

I. General

1. The purpose of the Notice of Proposed Amendment (NPA) 2009-12, dated 30 November 2009 was to propose an amendment to Decision 2003/02/RM of the Executive Director of the European Aviation Safety Agency of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes (« CS-25 »).

II. Consultation

2. The draft Executive Director Decision amending Decision N° 2003/02/RM was published on the web site (http://www.easa.europa.eu) on 3 December 2009. By the closing date of 3 March 2010, the European Aviation Safety Agency ('the Agency') had received 136 comments from 14 National Aviation Authorities, professional organisations and private companies.

III. Publication of the CRD

3. All comments received have been acknowledged and incorporated into this Comment Response Document (CRD) with the responses of the Agency.

4. In responding to comments, a standard terminology has been applied to attest the Agency's acceptance of the comment. This terminology is as follows:

   - **Accepted** – The comment is agreed by the Agency and any proposed amendment is wholly transferred to the revised text.
   - **Partially Accepted** – Either the comment is only agreed in part by the Agency, or the comment is agreed by the Agency but any proposed amendment is partially transferred to the revised text.
   - **Noted** – The comment is acknowledged by the Agency but no change to the existing text is considered necessary.
   - **Not Accepted** - The comment or proposed amendment is not shared by the Agency

   The resulting text highlights the changes as compared to the current rule.

5. The Executive Director Decision will be issued at least two months after the publication of this CRD to allow for any possible reactions of stakeholders regarding possible misunderstandings of the comments received and answers provided.

6. Such reactions should be received by the Agency not later than 8 April 2011 and should be submitted using the Comment-Response Tool at http://hub.easa.europa.eu/crt.

IV. Summary of comments received and responding Agency actions

7. The NPA was generally well received and considered a real benefit to the aviation community.

8. Some concerns were expressed that the use of colour was too restrictive and yellow and amber should be treated separately. The NPA had already made provision to allow the use of alerting colours for non-alerting functions (CS 25.1322(f)), provided these colours were limited in use and did not adversely effect flight crew alerting by desensitising the flight crew to the meaning and importance of alert colours. The Agency retains the position that due to their colour similarity, there should be no differentiation between yellow and amber.

9. In response to comments, a limited number of changes to CS 25.1322 were introduced, largely to clarify the intended rule. Changes introduced are highlighted in the resulting text within the table below.

10. As advised in the NPA, on-going dialogue with the FAA was maintained post-NPA to enhance harmonisation of proposals. Proposed CS 25.1322, including the changes introduced in this CRD, are fully harmonised with changes proposed in 14 CFR §25.1322. Furthermore, AMC 25.1322 and FAA AC 25.1322 have jointly undergone extensive reorganisation to enhance its clarity and readability. The revised, harmonised AMC 25.1322 is attached in Annex 1.

11. Comments received on AMC 25-11 mainly related to editorial inaccuracies that have occurred in transposing the original working group report. These inaccuracies have been corrected.

12. One comment questioned the list of colour pairs to avoid on displays. The Agency agrees that the list may be too prescriptive as some of the colour pairs have been accepted in the past. The table is removed but reference to the FAA report is retained for guidance.

V. CRD table of comments, responses and resulting text

(General Comments)	-

comment	*1* comment by: *Swedish Transport Agency, Civil Aviation Department (Transportstyrelsen, Luftfartsavdelningen)* There is a trend of increasing problems with laser pointers directed at aircraft, and consequently increased risk for the pilots to be distracted or temporary flash blinded. In the future, it is likely that the pilots can be equipped with protecting devices (such as glasses), protecting from one or more specific wavelengths. Besides from protecting the pilot's eyes, the corresponding colours of the head down displays and HUD will be filtered. To prevent those colors to be less readable, guidelines for colours not to be used should be added.
response	*Noted* This was out of scope of the present task and may be considered for future rulemaking.

comment	*26* comment by: *Luftfahrt-Bundesamt* The LBA has no comments on NPA 2009-12.
response	*Noted*

comment	*27* comment by: *Swiss International Airlines / Bruno Pfister* SWISS International has NO FURTHER COMMENTS to the NPA 2009-12 Avionics
response	*Noted*

comment	*29* comment by: *AIRBUS* <u>General Comment:</u> The proposed standards bring a real benefit to the commercial aviation community since they consider now the latest technology and functionality for flight crew alerting embodied in the current flight decks. However, in our opinion, the proposed amendment to the airworthiness standards raises a significant concern on use of colour which is restricted, such as (but not limited to): • yellow not to be used for functions other than flight crew alerting, • green not to be used for advisory alert indications. One of the major safety benefits of the Airbus aircraft is the common cockpit philosophy. In order to maintain this benefit in future aircraft, it is important that the basic elements of the cockpit and display philosophy do not change significantly. There is no evidence that the Airbus colour philosophy has

caused any of the types of confusion cited in the NPA, and in fact, as far as the use of red for warnings and amber for cautions is concerned, Airbus is entirely compliant.

As far as the colour convention is concerned, the Airbus cockpit philosophy has always considered the requirements of the FAR 25.1322, which is effective since 1977 and still applicable, then the similar requirements of the JAR/CS 25.1322. The current rules do not prevent the use of yellow for functions other than flight crew alerting since this colour is not mentioned at all, and the use of green for advisory alert indications.

So significant changes of the rule, and more particularly proposed restrictions on use of yellow and green, if applied to future aircraft, will make the commonality between our cockpits lost, and the result will be confusion for pilots familiar with the existing colour coding, adverse impact on cross-crew qualification and a resulting reduction in safety.

This proposed new rule might be justified and useful if applied right from the start to an aircraft design, but applying it to new members of an existing family of aircraft (for which there are already over 5000 in service), will bring no improvement but a possible reduction in safety and efficiency.

In addition, Airbus is concerned about a potential disagreement, even possible conflicts, between US and European regulations (refer to Docket No. FAA-2008-1292, NPRM 09-05 Flight crew Alerting), with potential very significant impacts on design, certification activities, training, qualification…

response

Not accepted

The use of yellow was added as it is commonly used on the flight deck for cautionary alerts. Furthermore, its visual similarity to amber can make it difficult to distinguish any difference. The limited use of amber/yellow for non-alerting functions is still permitted, but it will be important that the flight crew do not become desensitised to the meaning and importance of colour coding for alerts, which could increase the flightcrew's processing time, add to their workload, and increase the potential for flight crew confusion or errors.

Regarding the use of the colour green, Airbus use of the term "alert" does not coincide with its use in AMC 25.1322. An advisory indication according to Airbus may differ from the definition of advisory ***alert*** used in the AMC. Green indicates normal while an alert generally represents something non-normal. Green should never represent something non-normal.

As stated in the NPA, the Agency has maintained a dialogue with the FAA to further enhance harmonisation between EASA and FAA rules and guidance material post-NPA. This has resulted in all technical differences being removed.

comment

128 comment by: *David McKenney*

I endorse the concept of

- Using the colour "Red" for Warning alert indications and "amber/yellow" for Caution Alert indications.
- Removing the existing ability to deviate from the colour standard for flight crew visual alerts and creating a single and consistent colour

standard for alert categories across all future large aeroplane flight decks.

- The colour “yellow” is added to proposed CS 25.1322(e)(1)(ii) so that either amber or yellow can be used for caution alert indications.
- Red and Green are mentioned in proposed CS 25.1322(e)(1)(iii) to specify that they cannot be used for an advisory alert. I believe that yellow and amber be added to this list to specify they cannot be used for an advisory alert as well as Red and green.
- Allow the use of the colours red, amber, and yellow for non-alerting functions only if the applicant shows that such use is limited and would not adversely affect flight crew alerting by impairing their ability to interpret and respond to an alert. By standardising the colours used for alerts and by limiting the use of the above colours for other functions on the flight deck, the flight crew will be more likely to both rapidly detect an alert and understand the urgency of the alert.
- In the case of Warning and Caution alerts, it is often necessary to further prioritise alerts within each category to ensure time critical alerts are given priority and to avoid the presentation of multiple alerts simultaneously.
- Furthermore, to ensure immediate flight crew awareness of Warning and Caution alerts irrespective of flight crew attentiveness or workload levels, such alerts must use two different senses when presenting the alert to the crew.

response

Not accepted

While we would recommend not to use yellow and amber for advisory alerts, and have added guidance to the AMC to this effect (Paragraph 11(b)), we have consciously decided not to expressly exclude yellow and amber as colours for advisory alerts. This is based on the Agency’s previous acceptance of designs that feature these colours for advisory alerts and their acceptable safety record. Where colour is not used as the primary means to distinguish between caution and advisory alerts, other coding techniques must be used to meet the intent of CS 25.1322(a)(2).

TITLE PAGE p. 1

comment

85 comment by: *FAA*

The FAA appreciates the opportunity to respond. The FAA also encourages continued harmonization efforts between airworthiness authorities in the development of this document.

response

Noted

A. Explanatory Note - VI. Harmonisation p. 6-7

comment

95 comment by: *Boeing*

Page: 6

Section: *VI. Harmonisation*

Boeing appreciates EASA's efforts in attempting to harmonize the proposed requirements of this CS and AMC with the recommendations of the Avionic Systems Harmonization Working Group (ASHWG) and with the FAA's parallel activities for regulation and guidance material. We rely on the long-standing cooperative relationship between European and US aviation authorities to ensure a high level of civil aviation safety worldwide. The aviation industry looks forward to one set of harmonized standards on this critical subject that is safety-based, data-driven, and reasonable to implement. Harmonized standards will not only maintain the necessary high level of safety internationally, but also will result in lower costs, less inefficiency, and less confusion for operators, manufacturers, and suppliers when complying with the requirements.

response

Noted

As stated in the NPA, the Agency has maintained a dialogue with the FAA to further enhance harmonisation between EASA and FAA rules and guidance material post-NPA. This has resulted in all technical differences being removed.

comment

96 comment by: *Boeing*

Page: 7
Paragraph: *24*

RE: Comments are specifically invited on the differences in presentation and format between FAA draft AC 25.1322-1X and AMC 25.1322.

Boeing offers the following comments regarding the differences between the draft AC25.1322-1X and AMC 25.1322. The presentation and formatting of the two documents are both satisfactory. Content differences between the two documents are similar, although the content of the AMC is preferred for the following reasons.

First, the AMC includes less design guidance information, which we consider is better located in industry standards than in an AC/AMC.

Second, the AMC keeps a better focus on acceptable means of compliance for alerting systems and their functions, and does not depart on addressing design guidance for features that are not directly associated with alerting systems [see for example, AC 25.1322-1X, paragraphs 10.c. and 10.d. regarding checklists, and some of paragraph 16 having to do with head-up displays (HUDs)].

Third, the content of the AMC has had the benefit of being better coordinated with what we understand will be the eventual content of the final CS and 14 CFR §25.1322 (for example, alert level definitions and use of color in alerting are better coordinated and correctly described in the AMC). **Overall, we prefer the content of the AMC**.

response	*Noted* Comment has been taken into account in reaching a harmonised AC/AMC.

comment	*98* comment by: *Boeing* Page: 7 Paragraph: *25* Boeing has previously provided comments to the FAA's AC 25-11A, Chapter 4, Safety Aspects of Electronic Display Systems, and many of those same comments are included in our comments to this NPA. It is important that the Example Safety Objectives expressed in this AMC not be overly conservative, as the weight and importance of the material in this AMC set an expectation that may not be justifiable. We consider that our comments and suggestions provided are more consistent with actual system safety assessments provided on recent certification programs, and would provide better Example Safety Objectives.
response	*Noted* (See response to individual comments.)

A. Explanatory Note - VII. Regulatory Impact Assessment: p. 7-10

comment	*2* comment by: *CAA-NL* The CAA-NL wonders if it is necessary to align the related ETSO's with this proposal, for instance ETSO C113 Multifunctional Displays in relation with the amended AMC 25-11.
response	*Not accepted* The two documents are not addressing the same aspects.

B. Draft Decision - I. CS 25.1322: Flight Crew Alerting p. 11-12

comment	*23* comment by: *Bombardier Aerospace* (c)(2): The proposed rule states that attention-getting cues must be provided through at least two different senses. However, there are cases, as acknowleged in the proposed AMC 25.1322 para 7A, where a single alert element can have sufficient attention getting characteristics by itself. The CS and AMC material should be harmonized by rewording the rule to permit exceptions if justified.
response	*Partially accepted* Following further consideration, permitting a single alert element in the example quoted (failure flag on a primary flight display) does not meet the

intent of CS 25.1322 in providing immediate flight crew awareness of a Warning or Caution alert. The concern is that the flight crew may not immediately recognise such a failure at a critical flight phase (e.g. landing) if already subject to a high workload in performing operational procedures and check lists. The AMC is therefore reworded to better reflect the rule in mandating 2 different senses.

comment

30 comment by: *AIRBUS*

B. – I. - CS 25.1322 – (a) 3) in page 11

Proposed text:
Complement § 3) as shown:
"3) be removed when the alerting condition no longer exists, except if justified."

Justification:
The requirement should be flexible enough to allow some tolerances or exceptions, notably when :

- data or parameters, required to determine the condition, are not available
- the procedure must be carried out up to its end, even if the alerting situation no longer exists, in accordance with AMC 25.1322-1 - Appendix A.3 (2) in page 30 :

"The Visual Alert Information for Time-Critical Warnings should be erased when corrective actions have been taken, or when the alerting situation no longer exists"

response

Not accepted

The function of an Alert is to identify an abnormal condition to the flight crew. Once achieved, the alert is no longer necessary unless the condition persists. Retaining the alert when the failure or abnormal condition no longer exists is misleading to the crew and may create unintended consequences.

comment

31 comment by: *AIRBUS*

B. – I. - CS 25.1322 – (d) 2) in page 12

Proposed text:
Modify § 2) as shown:
"2) provide a means to suppress an attention getting component of an alert caused by a failure of the alerting function that interferes with the flight crew's ability to safely operate the aeroplane. This means must not be readily available to the flight crew such that it could be inadvertently operated, or by habitual reflexive action. In this case, there must be a clear and unmistakable annunciation to the flight crew that an alerting function has been manually inhibited, preventing an alert to be generated."

Justification:
The existing last sentence of the here above mentioned paragraph is very ambiguous since it is difficult to interpret to what the alert and suppression are referring to:

- timely or false alert ?
- suppression of the attention getting component only or suppression of the alert ? Temporarily or definitively ?
- alert caused by a failure of the alerting system or by the failure of the source system which is monitored by the alerting system ?
- …

From paragraph A. V. 16. in page 5, Airbus interprets the last sentence of CS 25.1322 – (d) 2) as follows: if the visual and/or aural alert capability of the alerting system has been inhibited to minimize nuisance due to a failure of the alerting system (e.g. permanent tone), then the flight crew must be aware that timely alerts due to failures of source systems might not be generated anymore.

response

Not accepted

CS 25.1322(d)(2) addresses suppression of an attention-getting component of an alert caused by a failure of the alerting function (i.e. the alerting system itself or any related inputs), that interferes with the flight crew's ability to safely operate the aeroplane.

It is presumed that nuisance alerting will have been prevented (25.1322(d)(1)). However a means to suppress the attention-getting component of an alert caused by failure of the alerting function must be provided. For example the ability to suppress an aural alert that prevents or interferes with the crew's ability to safely operate the aeroplane. If this attention-getting component is suppressed there must be a clear and unmistakable annunciation to the flight crew that the function has been suppressed. Depending on the design, this may mean suppression of all aurals or suppression of the alert creating the aural, for example.

comment

32 comment by: *AIRBUS*

B. – I. - CS 25.1322 – (e) 1) ii) in page 12

Proposed text:
Modify § ii) as shown:
"(e) 1) ii) Amber for Caution alert indications."

Justification:
The requirement to consider the colour yellow for Caution alert indications and to restrict its use on the flight deck for flight crew alerting only, is considered as too much restrictive (see Airbus comment about CS 25.1322 (f)).
Airbus cockpit philosophy is amber for abnormal situations and yellow is a colour extensively used in all the airbus cockpits to distinguish some specific data from other non-abnormal data, but not for alerting purposes.
For instance, aircraft mock up, roll pointer, boxes on PFD are in yellow.
Yellow is used to display background elements on the airport moving map.
In the same way, many FMS information are in yellow to indicate temporary states, ie before their validation (e.g., temporary flight path…) but they are not alerts.
Experience has shown that amber and yellow colours and their meaning are

clearly distinguished by crews operating Airbus aircraft.
The use of yellow has never been restricted up to now by any regulations, and more particularly, by the current Title 14 Code of Federal Regulations (14CFR) § 25.1322, which is effective since 1977, or by the JAR-25 and CS-25 European regulations.
Therefore, Airbus proposes that only the amber colour be used for caution alerts.

response

Not accepted

The visual similarity between amber and yellow can make it difficult to distinguish any difference. The rule is therefore formulated to standardise on amber or yellow for caution alerts.

CS 25.1322(f) makes provisions to allow the limited use of amber/yellow for non-alerting functions providing it is limited so that flight crews do not become desensitised to the meaning and importance of colour coding.

comment

33 comment by: *AIRBUS*

B. – I. - CS 25.1322 – (e) 1) iii) in page 12

Proposed text:
Modify § iii) as shown:
"(e) 1) iii) Any colour except red for Advisory alert indications."

Justification:
The requirement not to use green for advisory alert indications is considered as too much restrictive.
Indeed, the green colour is already used on airbus aircraft for advisory alerts but, generally, associated with another means to distinguish it from normal conditions. For instance, flashing green is used for some parameters approaching, but not going beyond, limit values. Green can be used as an advisory indication to address a condition which could become abnormal later during the flight (e.g. an engine approaching oil low level may be considered as acceptable for a short remaining flight time but not for a long-range flight).
Airbus considers that the distinction of the warning/caution alerts from advisory alert indications as the main NPA objective, can be fulfilled by a combination of solutions and not only by a colour convention. Master caution and master warning (lights) associated to aural alerts (sounds) and automatic display of procedures on ECAM, are an alternate unambiguous means to fulfil this objective, as required by CS 25.1322 paragraph (c) 2). In addition, the prioritization as required by paragraph (b) of the CS 25.1322 allows discriminating the more urgent alerts (red warnings and amber cautions) from the less urgent ones (e.g. green advisory alerts).

response

Not accepted

Colour is a powerful means to indicate the level of urgency and the standardisation of colour throughout the industry will have positive safety benefits. Green historically is a colour that indicates normal behaviour and under this standardisation scheme should never represent something non-normal.

comment 34 comment by: AIRBUS

B. – I. - CS 25.1322 – (f) in page 12

Proposed text:
Modify § f) as shown:
"(f) Use of the colours red and amber on the flight deck for functions other than flight crew alerting must be limited and must not adversely affect flight crew alerting. However:

- The use of red is acceptable for failure flags on Primary Flight Display and Navigation Display that may require immediate crew awareness and response,
- The use of red and amber is acceptable for Weather display, Terrain hazard and TCAS sector, provided widely spread standards are respected."

Justification:
The requirement about the colour red normally reserved for warning alert indication, is considered as too much restrictive, ie. if warning alerts are restricted to conditions that require immediate flight crew response.
Red should be allowed to alert the flight crew about failure of radio-navigation sensors (VOR, DME, ILS…) providing raw data to be displayed, even if an immediate flight crew response is not systematically required. Indeed, the radio-navigation sensors and associated display cannot determine which type of operations is flown or will be flown and so, the colour coding must always consider the worst case, notably interruption of an operation or possible significant adverse impact on a forthcoming operation or the mission. For instance, a VOR failure may lead to stop a VOR approach (thus requiring an immediate flight crew response) whereas the same VOR system failure in cruise does not require an immediate flight crew response but will prevent a VOR approach which was planned at destination.

Airbus suggests that the colour yellow be not reserved for alerting functions and be used without any restrictions.
Airbus cockpit philosophy is amber for abnormal situations and yellow is a colour extensively used in all the airbus cockpits to distinguish some specific data from other non-abnormal data, but not for alerting purposes.
For instance, aircraft mock up, roll pointer, boxes on PFD are in yellow.
Yellow is used to display background elements on the airport moving map.
In the same way, many FMS information are in yellow to indicate temporary states, ie before their validation (e.g., temporary flight path…) but they are not alerts.
Experience has shown that amber and yellow colours and their meaning are clearly distinguished by crews operating Airbus aircraft.
The use of yellow has never been restricted up to now by any regulations, and more particularly, by the current 14CFR § 25.1322, which is effective since 1977, or by the JAR-25 and CS-25 European regulations.

The red, amber and yellow are used for graphical depictions of weather phenomenon and of terrain elevation even if this colour convention does not fulfil the CS 25.1322 (e)(1) i) and ii) requirements. Airbus considers as

justified the use of red, amber and yellow for graphical depictions of weather phenomenon and of terrain elevation, in order to alert the flight crew of conditions that are precursors to potential time-critical-warning conditions or of conditions which may have significant adverse impact on a forthcoming operation or the mission.
Moreover, colour convention used by weather and TAWS systems is given by AEEC Arinc standards (708 for RADAR/PWS, 735A for TCAS, 762 for TAWS).
The limitation given in the paragraph (f) may be interpreted (or misinterpreted) as not allowing the use of the colours red, amber or yellow for the weather and TAWS systems. In this case, this interpretation would be conflicting with the industry standards mentioned here above, and which are used by all equipment suppliers and airframers, and already recognized by the authorities through already obtained equipment qualification approvals (TSO) or systems certifications.
Airbus reminds as well that all the current weather radar and TAWS systems use the magenta for flight crew alerting purposes.
Magenta is used by the weather radar system to alert of a turbulence ahead, as the red could do so.
Magenta is used by the TAWS system for advisory alert indications.
Therefore, Airbus proposes that the use of red, amber and yellow and green is considered systematically as acceptable with no restrictions or limitations to display weather and terrain hazard levels, and to display TCAS sector. In this case, green is for guidance purposes in the frame of a TCAS resolution advisory.

response

Not accepted

Failure flags are considered as visual alert information and must conform to the flight crew alerting philosophy and colour convention (see in particular Appendix 1 paragraph 4 of the AMC). Inclusion of individual means of compliance or particular systems is not appropriate within the rule. Furthermore, CS 25.1322(f) will still permit the limited use of red, amber and yellow for non-alerting functions.

At a later date, a separate Appendix to AMC 25-11 on weather displays will be included. However, when these colours are associated with an alerting function, the use of red and amber is justified.

comment

87 comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

Book 1 - CS 25.1322(c)(1)

Prioritization of alerts within each category has been a goal for all manufactures, nevertheless there is no common standard nowadays on how this can be achieved, neither through the manufacturers nor through the certification authorities. Some times there is not even common standard for an alert level – if it should be a caution or a warning, for example. Requiring the manufacturers to prioritize the alerts within each category will be an enormous burden without having clear and unambiguous requirements. Prioritizing alerts will require them to be defined by flight phase, condition and time. A pressurization failure which might require immediate alertness when flying at high altitude does not require the same level of alertness when in an approach procedure. If there is this same failure together with an engine failure then it

will depend on the flight phase which one should be dealt with first. And as we have seen in past programs, prioritization required by one certification authority is not always acceptable to others authorities.

In spite of all this, in a multiple failure scenario the final decision is still in the pilots' hand. There is no way the manufacturers can evaluate and design a system to cover all possible scenarios. The best way to deal with it is still through training. The information presented on Section 8, item 8.a does sufficiently clarify the subject.

Book 1 - CS 25.1322(c)(2)

There are several types of alerts, either caution or warning, that do not normally provide cues through two different senses and for which adding another sense will not increase the pilot alertness, as matter of fact will just clutter the pilots' sensorial system. The stick-shaker actuation is one of them. Adding an aural or visual alert to it will not do any better than the way the systems are designed today. The same approach also applies to aural alerts such as autobrake and some autopilot and autothrottle disengagement. Warning and caution alerts displayed through crew alerting system message should provide two different indications. Better clarification for these cases should be provide through item 7.b(1) and (2).

response *Not accepted*

For (c)(1) - The CAST accident analysis and recommendations indicate that this is an important safety enhancement. Smart alerting systems can distinguish between actual operating conditions and prioritise alerts accordingly.

Paragraph 8 of the AMC is fully compatible with the rule.

For (c)(2) – The stick shaker does in fact provide 2 senses: tactile and aural, usually accompanied by a stall warning indication and a visual indication on the speed tape. The rule and associated revised AMC are believed to be clear in this regard.

comment *88* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

Book 1 - 23.1322 (d)(2)

Embraer believes it is not sufficiently clear that the last sentence of this part of the requirement is referring to a global suppression mechanism (*e.g.* if it will suppress the entire aural warning functionality) or if it is referring to a punctual suppression mechanism (*e.g.* if it is required to suppress each aural message that sounds continuously, one by one).

In addition, if the annunciation has been suppressed due to the failure of the alerting system, it would be interesting to understand which other means EASA is proposing to alert the flight crew that the alert was suppressed.

response *Not accepted*

This paragraph is intentionally non-prescriptive. It may depend on the design whether or not all alerts are being suppressed.

comment 90 comment by: *David McKenney*

CS 25.1322(a)(1)(ii) currently states “determine the correct action, if any.” Request this paragraph add the word “help” so that it reads “help determine the correct action, if any.”

Alerts themselves should in no way predetermine the action required for the crew; only “help” the pilot determine the appropriate action. Endorsement of this NPRM is contingent on EASA utilizing the final rule to not certify any equipment that would diminish the Captain’s authority to determine the appropriate actions to take based on any alert or combination of alerts.

CS 25.1322(e)(1)(iii) currently states “Any colour except red or green for Advisory alert indications.” We request this paragraph add the word “amber, yellow” so that it reads “Any colour except red, amber, yellow, or green for Advisory alert indications.”

I believe that the use of amber or yellow should also be prohibited for advisory alerts since the colors amber and yellow are already reserved for caution alerts (proposed CS 25.1322(e)(1)(ii)) and color coding is used as the primary means for distinguishing between alert categories. Under the current rule, amber or yellow can be used for both caution and advisory alerts on the same display. This makes it more difficult for the flightcrew to rapidly distinguish between alerting categories when two alert categories (caution and advisory) are the same color. This difficulty is significantly enhanced when there are many mixed category of alert messages with the same colour. Using different colors to distinguish between the caution and advisory alerts will help satisfy other proposed rule changes that require alerts to ‘‘be readily and easily detectable and intelligible by the flightcrew under all foreseeable operating conditions including those where multiple alerts are provided’’ (proposed CS 25.1322(a)(2)) and allow the flightcrew to correctly recognize the ‘‘urgency of flightcrew response’’ (CS 25.1322(b)).

Your justification statement A(V)(15) states “CS 25.1322(e): This paragraph removes the existing ability to deviate from the colour standard for flight crew visual alerts and creates a single and consistent colour standard for alert categories across all future large aeroplane flight decks. As colour coding is used as the primary means for distinguishing between alert categories, this will avoid potential human factors issues associated with pilots flying multiple types.” If “colour coding is used as the primary means for distinguishing between alert categories” to “avoid potential human factors issues,” allowing the same colour to be used in two different alert categories would immediately negate what you are trying to achieve and introduce increased risk and error.

While discussing colour standardization, your proposed AMC 25.1322 (8)(e) on page 23 states “The objective is to limit the use of red and amber/yellow within the flight deck so that these colours always provide an indication of immediacy of response commensurate with the associated hazard.” I agree with this statement. Additionally, the AMC contradicts CS 25.1322(e)(1)(iii). By allowing the use of amber/yellow in advisory messages which only “require flight crew awareness and may require subsequent flight crew response,” CS

25.1322(e)(1)(iii) does not meet your stated requirements for only using amber/yellow on the “flight deck so that these colours always provide an indication of **immediacy of response** commensurate with the associated hazard.” By your own justification statements and expanded statements in the AMC to increase safety, the colours amber and yellow must both be excluded as colours for Advisory alert indications.

response

Not accepted

Regarding a(1)(ii), we believe this may be solved by indenting the paragraphs (i) and (ii) to discriminate from the lead-in sentence (1). In the case of time-critical warnings, the alert can indeed command rather than help the pilot in determining the appropriate action (e.g "Pull-up" in the case of a terrain warning).

Regarding (e)(1)(iii), while we would recommend not to use yellow and amber for advisory alerts, and have added guidance to the AMC to this effect (Paragraph 11(b)), we have consciously decided not to expressly exclude yellow and amber as colours for advisory alerts. This is based on the Agency’s previous acceptance of designs that feature these colours for advisory alerts and their acceptable safety record. Where colour is not used as the primary means to distinguish between caution and advisory alerts, other coding techniques must be used to meet the intent of CS 25.1322(a)(2).

comment

99 comment by: *Boeing*

Page: 11
Proposed CS 25.1322
Paragraph*: (c) 1)*

Boeing suggests proposed CS 25.1322(c)(1) be revised as follows:

"(c) Warning and Caution alerts must:

1) be prioritised within each category~~, when multiple alerts would cause flight crew confusion, or the sequencing of flight crew response is necessary~~ ***to ensure the highest priority alerts can be presented if multiple alerts are active at the same time."***

Our suggested revision is for simplification and clarity only.

JUSTIFICATION: Boeing agrees with the need to prioritize warning and caution level alerting indications, especially where the absence of prioritization would cause the alerting function to be ineffective or cause flight crew confusion. There are clearly alerting features that need to be prioritized. For example, within voice aural alerting, the voices must be prioritized such that simultaneous voice alerts aren’t presented at the same time, resulting in un-intelligible voice alerting, and then prioritized such that the higher priority voice alerts are presented before, and not inhibited by, lower priority voice alerts. This same prioritization issue applies to tone aural alerts and visual alerts that share a limited display space.

	Two issues: #1 The way paragraph (c) 1) is written, it can be interpreted that it is acceptable to have flight crew confusion due to multiple alerts, as long as the alerts are prioritized. Boeing contends that it should not be acceptable to have confusing alerting presentations, even if multiple alerts are presented. Further, paragraph (a) 2) already requires alerts to be easily detectable and intelligible, “including conditions where multiple alerts are provided”. #2 Paragraph (c) 1) tries to use the sequencing of flight crew responses as justification for prioritizing crew alerts. Prioritizing crew alerts can affect how quickly the flight crew is made aware of a condition, but not how quickly they will respond, at least not directly. Flight crews determine how quickly they will respond. The justification for prioritizing alerts within a category is to ensure the highest priority alert can be presented when the information resources available to alert the flight crew are limited.
response	*Partially accepted* The intent of the comment is supported. However, the text is aligned with the FAA rule text by adding "when necessary". The "when necessary" is then further elaborated in AMC (See paragraph 8).

comment	*129* comment by: *Dassault Aviation* § a)3 - This sentence prevents from using inhibition phases such as T/O or LDG. Typically on some existing designs, if an alert occurs prior to the take-off run, and is inhibited during T/O, it will not be removed during T/O if the failure condition disappear during the T/O phase.
response	*Partially accepted* If the condition no longer exists, the alert should be removed. However, if the condition is specially related to the t/o or landing phase of flight, and the failure condition remains and may reoccur during the flight, then the flight crew should be alerted accordingly.

comment	*130* comment by: *Dassault Aviation* § c)1 - Inside one category, can the prioritization be time-based ?
response	*Noted* Prioritisation should be based on urgency of pilot awareness and urgency of flight crew response. If flight crew response needs to be sequenced, then clearly the presentation of alerts should reflect this sequence.

comment	*131* comment by: *Dassault Aviation* § d)2 - Replace "failure" by "malfunction". The key point to be addressed here is the display of misleading alert information, not the loss of alert information.
response	*Not accepted*

The text refers to a failure mode of the alerting function and not to the specific system. The origin of the alert, whether true or false, is not the concern here, only the ability to suppress the attention-getting component of an alert once it is triggered, if this would subsequently impact on the flight crew's ability to safely operate the aeroplane.

resulting text

CS 25.1322 Flight Crew Alerting

...

(a) Flight crew alerts must:

1) ...

i) ...

ii) determine the appropriate actions, if any.

...

(b) Alerts must conform to the following prioritisation hierarchy based on the urgency of flight crew awareness and ~~urgency of flight crew~~ response.

...

(c) Warning and Caution alerts must:

1) be prioritised within each category, when necessary, ~~when multiple alerts would cause flight crew confusion, or the sequencing of flight crew response is necessary~~

...

3) permit each occurrence of the attention-getting cues required by subparagraph (c)(2) to be acknowledged and suppressed, unless they are required to be continuous.

...

(d)

1) prevent the presentation of an alert ~~that~~when it is inappropriate or unnecessary ~~for the particular condition~~

2) provide a means to suppress an attention-getting component of an alert caused by a failure of the alerting function that interferes with the flight crew's ability to safely operate the aeroplane. This means must not be readily available to the flight crew ~~such~~so that it could be operated inadvertently ~~operated~~ or by habitual reflexive action. ~~In this case~~When an alert is suppressed, there must be a clear and unmistakable annunciation to the flight crew that the alert has been suppressed.

(e) Visual alert indications must:

1) ...

2) use ~~distinguishable~~visual coding techniques, together with other alerting function elements on the flight deck, to distinguish between ~~for~~ Warning, Caution and Advisory alert indications, if they are ~~shown~~presented on monochromatic displays that are incapable of conforming to the colour convention in paragraph (e)(1).

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting p. 12-13

comment *14* comment by: *Eurocopter*

Appendices A and B provide examples of visual and aural alerting elements. An

	appendix C providing examples of tactile/haptic alerting elements would be useful.
response	*Noted* It may be considered as a future task.

comment	*71* comment by: *AIRBUS* AMC 25.1322 - General comment: The comments made to the sections B. – I. - CS 25.1322 – (e) 1) ii) in page 12, B. – I. - CS 25.1322 – (f) in page 12 and B. – I. - CS 25.1322 – (e) 1) iii) in page 12 regarding the use of yellow and green colours are also valid for the proposed AMC 25.1322.
response	*Not accepted* (See response to comment #33.)

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 2. SCOPE p. 13

comment	*100* comment by: *Boeing* Page: 13 AMC 25.1322: Flight Crew Alerting Paragraph: *2. SCOPE* Revised the first sentence of the second paragraph in Paragraph 2 as follows: *"This AMC provides guidance ~~to what is considered an alert~~* ***on how to implement flight crew alerting***. …" The concern has to do with the statement that this AMC provides guidance as to what is considered an alert, where this AMC and parent CS are primarily about how to implement flight crew alerting. **JUSTIFICATION:** It is not the intent of the proposed CS or AMC to define what should be an alert. The requirement for what should be an alert is defined by specific regulation [e.g., landing configuration warning per CS 25.729(e)], by analysis [(e.g., per §25.1309(c)] or the alerting philosophy of a flight deck.
response	*Partially accepted* Intent accepted. Text is revised and aligned with FAA AC.

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 3. RELATED CERTIFICATION SPECIFICATIONS p. 13-14

comment	*6* comment by: *Thales Avionics SA* NPA sentence : "CS 25.1322 Warning, caution, and advisory lights" Typography mistake : In the given list the title associated to CS 25.1322 is no longer "*Warning, caution, and advisory lights*" but "Flight Crew alerting"
response	*Accepted*

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 6. DEFINITIONS p. 15-18

comment	*7* comment by: *Thales Avionics SA* NPA paragraph §6 : "Communication Message" This part of paragraph §6 is read as a definition about communication messages and their corresponding duty crew action in a routinely manner. However the three subsequent classifications and associated crew response give a definition, which is quite similar with warning, caution and advisory Alert and can be heard as equivalent. Finally this part of paragraph §6, and the text proposed in this NPA, does not clarify the integration of normal communication messages into a crew alerting function without impairing it. **Proposed change :** (1) To delete the "Communication Message" definition since it is not used elsewhere in the text ; or (2) to specify further in the text a principle to drive the integration of "Communication Message" into the flight crew alerting function.
response	*Not accepted* Communication messages have been added in the definitions for completeness. However, as communication messages are seen as part of normal operation, they are not considered as Alerts and are not discussed further in the AMC.

comment	*8* comment by: *Thales Avionics SA* NPA paragraph §6 : "Time-Critical Warning" "Time-Critical Warning" definition is still ambiguous as all warnings already

require immediate crew response. The associated principle “to maintain the safe operation” needs a clarification within its possible hierarchical classification since “safe operation” could be heard in priority's order as for instance :
- first to flight management ; or
- first to systems management (ie. electrical) ; or
- first to engine/energy management.

In addition the E/TSO C151 table 4-2 about alert prioritization scheme gives an other classification than "time-Critical Warnings" examples. Particularly there is an inconsistency for TCAS RA which is classified with a lower priority than TAWS cautions, but is classified with the highest level in this NPA.

Finally this text needs a more comprehensive definition about "immediate flight crew response" notion and the associated maximum allowable delay for : time critical warnings – warnings – caution alerts.

Proposed change :
In general manner to re-arrange the text in order :
(1) To keep consistency with E/TSO C151.
(2) To specify which is the driver of priority.
(3) To state on acceptable or unacceptable delay about each incoming alert type.

response

Partially accepted

(1) The term TCAS RA is misleading in that a "resolution ADVISORY" is associated with a WARNING alert and is therefore seen as compatible with these proposals. The prioritisation scheme included in ETSO C151a largely addresses alerts associated with terrain avoidance and is aimed at T/O and approach phases of flight. The inclusion of ACAS audio alerts has been added to enable integration of systems. As the flight condition associated with these alerts is not the same, they will in practice have a high priority.

(2) The definition for time-critical warnings has been amended to remove any ambiguity. The prioritisation of alerts will depend on the urgency of flight crew awareness and urgency of flight crew response. The applicant will need to establish for each alert condition the consequences on the aircraft of a failure of the flight crew to respond in a timely manner and ensure alert priorities are set accordingly to prevent such a situation arising. The prioritisation may be dependent on the phase of flight.

(3) The rule and AMC deliberately do not quantify "immediate flight crew response" and the maximum allowable alert delay, as these parameters will generally be type specific. What is important to establish during design is the ability of the flight crew to recognise and respond immediately and appropriately, without exceptional skill, to ensure that foreseeable unsafe conditions can be adequately controlled.

comment

72 comment by: *FAA*

Recommend adding the last sentence (shown below) to the definition of an

alert for clarity and harmonization with the FAA. The scope of the proposed rule and AC has been expanded to include all forms and indications of alerts.

A generic term used to describe a flight deck indication meant to attract the attention of and identify to the flightcrew a non-normal operational or airplane system condition. Alerts are classified at levels or categories corresponding to Warning, Caution, and Advisory.
Alert indications also include non-normal range markings (for example, exceedances on instruments and gauges.)

response *Accepted*

(See also Comment #103.)

comment *73* comment by: *FAA*

Caution.
Recommend updating definition with proposed rule language shown below:
Caution: For conditions that require immediate flight crew awareness and subsequent flight crew response.

response *Accepted*

comment *74* comment by: *FAA*

Failure Flag
Recommend adding the word “visual”. ”One local visual means…..”

response *Accepted*

comment *89* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

Book 2 – Item 6. Definitions

Communication Message

Since the AMC provides MOC and guidance for flight crew alerting functions and system and considering that this type of message is not a flight crew alert per the definitions in Section 6, it is our understanding that the AMC should not applies to this type of Message. If this is not correct then a revision to the text is required.

response *Not accepted*

Communication messages have been added in the definitions for completeness. However, as communication messages are seen as part of normal operation, they are not considered as Alerts and are not discussed further in the AMC.

comment *101* comment by: *Boeing*

Page: 16
AMC 25.1322: Flight Crew Alerting

Paragraph: *6. DEFINITIONS*

The definition for “Caution” in this section of the AMC uses different text than the CS 25.1322 to describe the urgency of flight crew response. We recommend that the AMC definition for “Caution” be revised as follows:

“The level of alert for conditions that require immediate flight crew awareness and ~~not immediate but~~ subsequent flight crew response.”

JUSTIFICATION: The AMC definition of “Caution” should be made to be the same as the definition in the CS 25.1322. The CS definition is the preferred definition and was recommended by the ARAC ASHWG.

response *Accepted*

comment *102* comment by: *Boeing*

Page: 16
AMC 25.1322: Flight Crew Alerting
Paragraph: *6. DEFINITIONS*

We recommended that a definition for “Flight Crew Response” be included in the definitions section of this AMC. The definition that was used in the draft AC 25.1322-1X and came from the ARAC committee is appropriate, and reads as follows:

“Flight Crew Response: The activity accomplished due to the presentation of an alert such as an action, decision, prioritization, or search for additional information.”

JUSTIFICATION: The definitions for warning, caution, and advisory level alerts use as one of their key discriminators the urgency of flight crew response. The term was intended to be interpreted very broadly, so as to encompass the wide range of actions and activities that a flight crew may accomplish in response to a crew alert. A common understanding of what constitutes a flight crew response between applicants and certification agencies will facilitate a more consistent interpretation of CS 25.1322 and also foster better standardization in industry.

response *Accepted*

comment *103* comment by: *Boeing*

Page: 16
AMC 25.1322: Flight Crew Alerting
Paragraph: *6. DEFINITIONS*

Boeing supports the AMC definition of “Flight Crew Alert,” as opposed to the FAA’s draft AC 25.1322-1X version. The AMC definition does not include non-normal range markings as flight crew alerts.

JUSTIFICATION: Non-normal range markings are not alerts if not defined as

an alert per an applicant's alerting function design and philosophy. Current regulatory requirements (25.1549) drive requirements for "non-normal range markings" that are inconsistent with 25.1322. Non-normal range markings alone would likely not meet the implementation requirements of a flight crew alert per the new CS 25.1322, should exceeding the range markings demand immediate flight crew awareness.

response

Noted

After further coordination between EASA and FAA, the definition of "alert" was harmonised with the non-normal range markings included.

Non-normal range markings should be thought of as Visual alert information and present data to the flight crew on the exact nature of the alerting situation. Operation within the non-normal range should be associated with a Caution or Warning alert and an additional alerting element will therefore need to be provided through a separate sense to comply with CS 25.1322(c)(2) to ensure immediate flight crew awareness is provided. The Agency has not identified any inconsistence between the new 25.1322 and 25.1549.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 7. GENERAL p. 19

comment

91 comment by: *David McKenney*

AMC 25.1322 (7) on page 19 currently states "The purpose of alerting functions on aeroplanes is to get the attention of the flight crew, and inform the flight crew of specific aeroplane system conditions and certain operational events that require their awareness." I request this paragraph add the words "and, in modern alerting systems, to advise them of possible actions to address the conditions (e.g. such as an aural command to "pull up") so it reads "The purpose of alerting functions on aeroplanes is to get the attention of the flight crew, and inform the flight crew of specific aeroplane system conditions and certain operational events that require their awareness and, in modern alerting systems, to advise them of possible actions to address the conditions (e.g. such as an aural command to "pull up."

When discussing the purpose of alerting functions on aeroplanes, AMC 25.1322 (7) on page 19 currently does not mention an important attribute of modern alerting functions that advises pilots of the required actions for time critical response such as in the case of TAWS. I believe this important attribute should be mentioned when discussing the purpose of alerting functions in AMC 25.1322.

I request the following paragraph be added between current AMC 25.1322 (7) paragraphs 2 and 3 on page 19 (i.e., Following the sentence in paragraph 2 "Conditions and events that do not require flight crew awareness should not cause an alert." and before the sentence in paragraph 3 that starts "For all alerts which are presented to the flight crew,")

For all alerts presented to the flightcrew, the action or accommodation (for example, light, aural annunciation, engine-indication-and-crew-alerting system

	(EICAS) message, master caution) for an alert must provide the flightcrew with the information needed to identify the alert and determine the corrective action, if any (CS 25.1322 (a)(1)). When discussing the purpose of alerting functions on aeroplanes, AMC 25.1322 (7) on page 19 currently does not mention any reference to CS 25.1322 (a)(1(ii) which requires the Flight Crew Alert to provide the flight crew the information needed to determine the appropriate action. This crucial statement needs to be included in this general discussion of the purpose of alerting functions.
response	*Partially accepted* Intent is accepted. Text is further developed.

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 7. GENERAL - 7.a Alert Presentation Elements p. 19

comment	*35* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 7. a – 2nd paragraph in page 19 Proposed text: Add the wording "as far as practicable" in the 2nd sentence of the 2nd paragraph as follows: "For example, the onset of the Master Visual Alert should occur simultaneously, as far as practicable, with the onset of the Master Aural Alert." Justification: In some cases of multiple alerts, if a high priority master aural alert is already being emitted, the Master Aural Alert of a lower priority alert may be delayed whereas its associated Master Visual Alert will be displayed immediately.
response	*Partially accepted* Proposed text is substituted by "normally" to cater for this case. (See AMC 25.1322 paragraph 5c(5).)

comment	*36* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 7. a – 3rd paragraph in page 19 Proposed text: Remove the term "/yellow" in the following sentence from AMC 25.1322: "To maintain the effectiveness of visual alerting, consistent use of the colours red and amber~~/yellow~~ should be implemented throughout the flight deck."

Justification:
Refer to Airbus comments on B. – I. - CS 25.1322 – (e) 1) ii) in page 12 and B. – I. - CS 25.1322 – (f) in page 12 about the colour yellow as a Caution alert indication and the limitation of its use.

response *Not accepted*

Due to the similarity between yellow and amber, no distinction is made in these proposals.

comment *75* comment by: *FAA*

Regarding the following words in the NPA: A single alert element (e.g. failure flag on a primary flight displays), may be accepted as complying with CS 25.1322 (c)(2) provided that it has sufficient attention getting characteristics by itself.

The suggested use of a single alert element in the AMC is not permitted by the proposed 25.1322 rule/specification. The rule/specification requires two different senses for warning and caution category alerts. Also there is no assurance that a "visual" on an instrument would attract the pilot's immediate attention if the pilots are looking elsewhere.

Recommend removing this sentence to harmonize language with the proposed AC 25.1322 language regarding flags.

response *Accepted*

comment *92* comment by: *David McKenney*

AMC 25.1322 (7)(a) on page 19 currently states "A single alert element (e.g. failure flag on a primary flight displays), may be accepted as complying with CS 25.1322 (c)(2) provided that it has sufficient attention getting characteristics by itself." I request this paragraph add the words "the visual requirement of" so that it reads "A single alert element (e.g. failure flag on a primary flight displays), may be accepted as complying with the visual requirement of CS 25.1322 (c)(2) provided that it has sufficient attention getting characteristics by itself." Furthermore, I request the following paragraph be added immediately preceding this sentence.

"Not all alerts associated with failure flags need to be integrated in the central alerting system. However, for those alerts requiring immediate flightcrew awareness, the alert needs to meet the attention getting requirements of CS 25.1322(c)(2). Thus, a master visual or master aural alert may not be initiated, but an aural or tactile attention indication must still accompany the visual failure flag to meet the attention getting requirement of CS 25.1322(c)(2), which requires attention-getting cues through at least two different senses for warning and caution alerts."

As currently written, I do not agree with the statement that a single alert element (e.g. failure flag on a primary flight displays) by itself may be

	accepted as complying with CS 25.1322 (c)(2) in the case of a Warning and Caution alert. This statement is also in conflict with paragraph 15 of your justification which states: “Furthermore, to ensure immediate flight crew awareness of Warning and Caution alerts irrespective of flight crew attentiveness or workload levels, such alerts must use two different senses when presenting the alert to the crew.” Modern flight decks are becoming more complex and we are finding evidence that flight crews may not be monitoring the Primary Flight display as closely as in the past during certain phases of flight as a result of the increased use of automation on the flight deck and increased workload. Allowing a single failure flag on the Primary flight display to meet the requirements of using two senses for a Warning or Caution Alert would decrease safety and does not meet the intent of CS 25.1322(c)(2).
response	*Partially accepted* Text is removed. (Also see Comment #75.)

comment	*132* comment by: *Dassault Aviation* Propose to add "unless the corresponding aural alert is already being delayed by an other aural alert"
response	*Partially accepted* (See Comment #35.)

comment	*133* comment by: *Dassault Aviation* Not consistent with CS 25.1322 (c) (2) where at least two alert elements are required
response	*Accepted* (See Comment #75.)

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 7. GENERAL - 7.b Functional Components for each type of alert p. 20-21

comment	*37* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 7. b (1) in page 20 Proposed text: Modify the existing 1st note as follows: “Note: Voice Information may be preceded <u>or followed</u> by a Master Aural Alert"

Justification:
In some existing designs and for some alerts, the Voice Information may be followed by a Master Aural Alert (e.g. stall warning).

response *Not accepted*

The aim of the Master Aural Alert is to provide an attention-getting cue to the flight crew. Having a Master Aural Alert after the voice alert will not achieve this objective.

comment *38* comment by: *AIRBUS*

B. – II. - AMC 25.1322 – 7. b (1) in page 20

Proposed text:
Add a note below the existing 2nd note:
"Note 2 : A unique tactile alert sensed by each pilot can also meet the paragraph CS 25.1322 (c) 2) requirement for one of the two senses."

Justification:
AMC 25.1322 § 7. b (1) does not consider tactile indications whereas CS 25.1322 (c) 2) does so.

response *Accepted*

(See paragraph 6a Note 2 and 6b.)

comment *76* comment by: *FAA*

Regarding the wording:
"It is recognised that in a limited number of cases a Master Visual Alert and Master Aural Alert may not be required."

Recommend replacing the word "required" with the word "warranted" to remove the possible implication that a master visual alert and master aural alert is required. While a master visual and master aural caution and warning would be typical, there is no rule requirement for a master alert. The rule/specification requirement is for at timely attention-getting cues through at least two different senses for alerts requiring immediate awareness and is silent on the design mechanism

response *Accepted*

comment *77* comment by: *FAA*

Reference: Note: For Time-critical Warnings, the use of a Master Visual Alert is not required.

Again there is no requirement for a master alert in the rule language.

response *Accepted*

comment	*78* comment by: *FAA* Reference: For example, a TCAS II Traffic condition, which can be a precursor to a TCAS II Resolution Advisory condition, may not have an associated Master Visual Alert ("master caution") and is acceptable because the TCAS Traffic Voice Information alone provides the characteristic of a Caution. Comment: Since the use of the word "advisory" is associated with the word "caution" in the title of TCAS, additional clarification is recommended such as a note attached to words "resolution advisory condition" explaining that an RA may generate a caution level alert. This situation like the time critical warning condition meets the requirements of the proposed rule since it provides timely attention-getting cues through at least two different senses by a combination of aural and visual indications. That is the visual RA and the aural.
response	*Partially accepted* The example of TCAS/ACAS is removed to avoid confusion.

comment	*93* comment by: *David McKenney* AMC 25.1322 (7)(b) on page 20 currently does not mention any reference to CS 25.1322 (c)(2). I request that the following paragraph be placed immediately after the line (7)(b) and before line (7)(b)(1): *The functional elements used in the alerting and information functions for warning and caution alerts must provide timely attention-getting cues, resulting in immediate flightcrew awareness, through at least two different senses (CS 25.1322(c)(2).* This is an important over-riding concept that is important to consider when discussing functional components for each type of alert. The reader needs to be provided this information before reading paragraphs (7)(b) (1-3). Without this statement, several of the statements in paragraphs (7)(b) (1-2) are misleading and those paragraphs will have to be modified separately. It makes more sense to add this paragraph at the beginning of the section as an overriding principle. AMC 25.1322 (7)(b)(1) on page 20 currently states "It is recognised that in a limited number of cases a Master Visual Alert and Master Aural Alert may not be required." I request that this paragraph add the words "if another visual means provides more timely attention-getting characteristics" so it reads "It is recognised that in a limited number of cases a Master Visual Alert and Master Aural Alert may not be required if another visual means provides more timely attention-getting characteristics."

I believe that the current sentence is incomplete and can be misleading. It does not provide enough information or guidance on when a Master Visual Alert and Master Aural Alert may not be required. Adding our proposed wording to the end of the sentence provides clarification and removes any incongruity.

AMC 25.1322 (7)(b)(1) on page 20 currently states “For example, Visual Information presented in the pilot’s primary forward field of view may be acceptable in place of a Master Visual Alert if it provides sufficient attention-getting characteristics.” I request that a sentence be added after this sentence that reads: “However, an aural alert, such as an aural command to ‘pull up,’ or another sensory cue, would still be required to meet the requirements of CS 25.1322(c)(2).”

CS 25.1322 (c)(2) states that Warning and Cautions alerts must provide timely attention-getting cues through at least two different senses by a combination of aural, visual, or tactile indications. The example given may provide an alternate means for presenting a visual cue in lieu of a Master Visual Alert, but the example does not and should not remove the requirement of using a second sense (aural or tactile) to provide timely attention-getting cues. The suggested wording was included in the FAA proposed AC 25.1322 which was acceptable.

response

Partially accepted

Introductory paragraph added (see Paragraph 6).

Intent of change to (7)(b)(1) are accepted (see AMC paragraph 6c).

resulting text

For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 7. GENERAL - 7.c Alerting System Reliability and Integrity p. 21

comment

79 comment by: *FAA*

Reference: The alerting functions or system should be designed to avoid False Alerts and Nuisance Alerts, while providing reliable alerts to the flight crew when needed.

The proposed 25.1322(d) provides the following language: The alert function must be designed to minimise the effects of false and nuisance alerts.
Recommend changing the word “should” to “must” be designed to “minimise”….

response

Not accepted

The rule refers to designing the alerting function to "minimise the EFFECTS of false and nuisance alerts". One way of achieving this is to design the alerting

system to PREVENT false and nuisance alerts from being generated. The two are not identical, so "should" is believed to be the appropriate word. It is recognised that this may not be practical, so the words "as much as possible" have been added.

comment 134 comment by: *Dassault Aviation*

Malfunction of either Monitor Warning Function or Crew Alerting system should be indicated to the pilot

response *Noted*

System failure conditions are addressed under CS 25.1309.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 8. MANAGEMENT OF ALERTS - 8.a Prioritisation p. 21-22

comment 39 comment by: *AIRBUS*

B. – II. - AMC 25.1322 – 8. a (1) – 2nd paragraph in page 21

Proposed text:
Replace the existing sentence:
“A prioritisation scheme should be established for all alerts presented throughout the flight deck.”
By:
“A prioritisation scheme into warning, caution, and advisory categories, should be established for all alerts presented throughout the flight deck.”

Justification:
Existing proposed guideline can be misinterpreted as requesting that all systems generating local and centralized alerts be synchronized, in order that only one alert be presented at one time.

response *Partially accepted*

Text is amended and harmonised with FAA AC text.

comment 40 comment by: *AIRBUS*

B. – II. - AMC 25.1322 – 8. a (1) – 2nd paragraph in page 21

Proposed text:
After the existing text: “The prioritisation scheme, as well as the rationale for prioritisation should be documented and evaluated.”
Add the following text:
“The prioritization scheme can be a result of few basic principles and/or a consolidated experience from similar alerting functions or systems already certified, completed with positive in-service experience.”

Justification:

Evaluations, analysis and in service experience are considered as appropriate means to justify the prioritization scheme.

response *Not accepted*

The ASHWG final report, which is the basis for development of this rule and AMC, is silent on the use of service experience to justify any prioritisation scheme. It is difficult to validate service experience and the justification would have to be built on a case-by-case basis if an alternative means of compliance is suggested. It should also be recognised that the rule and AMC 25.1322 are in fact also built not only on principle but also service experience.

comment *41* comment by: *AIRBUS*

B. – II. - AMC 25.1322 – 8. a (1) – 3rd paragraph in page 21

Proposed text:
Complement § (1) as shown:
"Documentation should include the results of analysis or could consider the experience from already certified alerting functions or systems, showing that any alerts delayed or inhibited as the result of the prioritisation scheme do not adversely impact safety."

Justification:
Airbus suggests that the experience from already certified centralized alerting systems or alerting functions may be used when relevant for the evaluation of the delayed or inhibited alerts if any. Experience consists of already validated substantiations from previous certification activities about similar design, complemented or not with positive in-service experience.

response *Not accepted*

The ASHWG final report, which is the basis for development of this rule and AMC, is silent on the use of service experience to justify any prioritisation scheme. It is difficult to validate service experience and the justification would have to be built on a case-by-case basis if an alternative means of compliance is suggested. It should also be recognised that the rule and AMC 25.1322 are in fact also built not only on principle but also service experience.

comment *42* comment by: *AIRBUS*

B. – II. - AMC 25.1322 – 8. a (3) – 2nd paragraph in page 22

Proposed text:
Remove the terms "most recent or" from the 2nd sentence as follows:
"For example, the ~~most recent or~~ highest priority alert may be listed at the top of its own category."

Justification:
Existing text is conflicting with CS 25.1322 (b). Indeed, the alert prioritisation must be based on the urgency of flight crew awareness and urgency of flight crew response only, and not on their time of occurrence.

response	*Not accepted* The sentence refers to multiple visual alerts of the same urgency level and is not directly related to CS 25.1322(b) but to (c)(1). If alerts have been prioritised within a given level, it may be appropriate to show the highest priority at the top of the list. However, for those of equal priority, or if priority has not been established, displaying the most recent message at the top of a list may be appropriate.

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 8. MANAGEMENT OF ALERTS - 8.b Alert Inhibits p. 22

comment	*135* comment by: *Dassault Aviation* Does the AC adress filtering aspects ?
response	*Noted* Inhibition of consequential alerts are addressed under the concept of umbrella messages (See paragraph 8.b.)

comment	*136* comment by: *Dassault Aviation* Text should stipulate that inhibition relates to CAS and associated aurals only.
response	*Not accepted* The text refers to any flight crew alert.

comment	*137* comment by: *Dassault Aviation* Determination of correct action should be based on the approved device for such a task, e.g electronic check-list, AFM procedure, …It is proposed to delete "determine any correct action" since flightcrew are not supposed to build their own procedures in flight
response	*Not accepted* It is assumed that this comment refers to paragraph 8(d). According to CS 25.1322(a)(1)(ii), flight crew alerts "*provide the flight crew with information needed to determine the appropriate action, if any*". While some alerts may have an associated checklist, others may not as it is assumed that flight crew action is covered by training or basic airmanship.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 8. MANAGEMENT OF ALERTS - 8.c Clear/Recall of Alert Messages p. 22-23

comment	*43* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 8. c in page 23 Proposed text: Remove the existing 3rd sentence: “There should be a means to identify if alerts are stored (or otherwise not in view), either through a positive indication on the display or through normal flight crew procedures.” Justification: As a reminder, Airbus standard operating procedures already ask for a "recall" of all alerts that have been "cleared" or "cancelled" in the "preliminary cockpit preparation". Besides, at any time, the crew is able to check manually on the status page if alerts have been "cancelled". Regarding the "cleared" alerts, their potential "status" impact (approach procedure, consequent "inoperative system" display...) lead to a message in the status page for which a "status reminder" will be permanently displayed on the ECAM. There is a difference between an alert display and its potential associated messages display, so we do not concur with the required "means to identify if alerts are stored", which can be indirect in Airbus philosophy. Moreover, not all alerts need to lead to a "status" display and hence do not lead to a "positive indication on the display" once they are "cleared", so the need to identify that alerts are stored is not systematic. Besides, for "cancelled" alerts, there is a positive indication in the "status", which can be manually called, but no "status reminder" on the ECAM page (as a reminder there is a check at the beginning of the flight) Airbus in-service experience has shown that there is no operational benefit in permanently displaying to the crew the indication that they have intentionally cleared alerts, so we propose to remove this sentence.
response	*Not accepted* The Airbus comment relates to two different issues; an indication of alerts that have been cleared and an indication that alerts are stored. Regarding cleared alerts, there is no necessity to permanently indicate to the flight crew that alerts have been cleared, only to provide a means for the flight crew to recall cleared alerts if the failure condition still exists. Stored alerts are seen as a potential source of information to enable the flight crew to diagnose a failure condition and to correctly determine the appropriate action. An indication that alerts are stored or not displayed is therefore seen as an essential element to comply with CS 25.1322(a)(1).

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 8. MANAGEMENT OF ALERTS - 8.d Considerations for interface or integration with other systems p. 23

comment	*136* ❖ comment by: *Dassault Aviation* Text should stipulate that inhibition relates to CAS and associated aurals only.
response	*Not accepted* The text refers to any flight crew alert.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 8. MANAGEMENT OF ALERTS - 8.e Colour standardisation p. 23-24

comment	*44* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 8. e in page 23 and 24 Proposed text: Remove the term “yellow” in the first sentence and replace all “amber/yellow” by “amber” throughout all the paragraph 8.e. Justification: Refer to Airbus comments on B. – I. - CS 25.1322 – (e) 1) ii) in page 12 and B. – I. - CS 25.1322 – (f) in page 12 about the colour yellow as a Caution alert indication and the limitation of its use.
response	*Not accepted* Due to the similarity between yellow and amber, no distinction is made in these proposals.

comment	*45* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 8. e in page 23 and 24 Proposed text: In the list of examples of acceptable uses of red and amber, add : “TCAS sector”. Justification: The colour convention used by the TCAS system is given by the AEEC ARINC 735A standards.
response	*Not accepted* The list of examples is not intended to be exhaustive.

comment	*46* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 8. e – last paragraph in page 24 Proposed text: Add the following sentence after the last sentence of the last paragraph: “The use of red for failure flags on Primary Flight Display and Navigation Display that require immediate flight crew awareness and that may require or not immediate flight crew response according to the type of operations, is acceptable (eg., VOR failure flag).” Justification: The requirement (§ 8.e A.) to limit the colour red to conditions that require immediate flight crew response is considered as too much restrictive. Red should be allowed to alert the flight crew about failure of radionavigation sensors (VOR, DME, ILS, etc.) providing raw data to be displayed, even if an immediate flight crew response is not systematically required. Indeed, the radionavigation sensors and associated display cannot determine which type of operations is flown or will be flown and so, the colour coding must always consider the worst case, notably interruption of an operation or possible significant adverse impact on a forthcoming operation or the mission. For instance, a VOR failure may lead to stop a VOR approach (thus requiring an immediate flight crew response), whereas the same VOR system failure in cruise does not require an immediate flight crew response (but it will prevent a VOR approach which was planned at destination).
response	*Not accepted* Failure flags are treated as visual alert indications and are dealt with elsewhere in the AMC.

comment	*81* comment by: *FAA* Reference: A. Red may be used (on both alerting and non-alerting functions) for conditions that require immediate flight crew awareness and immediate flight crew response. B. Amber/yellow may be used (on both alerting and non-alerting functions) for conditions that require immediate flight crew awareness and subsequent flight crew response. Comment: Recommend clarification in the use of the word "may". Red “must” be used for warning level alerting functions. 25.1322(e)(1)(i) Amber/yellow must be used for caution level alerting. Red and amber/yellow 25.1322(e)(1)(ii) may be used for non-alerting functions if it meets 25.1322 (f)
response	*Partially accepted* Intent accepted. Wording is further developed.

comment	*104* comment by: *Boeing* Page: 23 AMC 25.1322: Flight Crew Alerting Paragraph: *8.e. Colour standardisation* We recommend that subparagraph B. be revised as follows: *"B. Amber/yellow may be used (on both alerting and non-alerting functions) for conditions that require immediate flight crew awareness and subsequent flight crew response**, or conditions that require flight crew awareness and may require a subsequent flight crew response**."* Our concern is that this does not identify that amber/yellow color is also appropriately used for both alerting and non-alerting functions for conditions that correspond to advisory level of alert. **JUSTIFICATION:** Our recommended changes would allow and promote color standardization on aircraft where advisory level alerts are implemented using amber or yellow. For indications that correspond to an associated advisory alert, such as a failed pump on a synoptic where the pump failure has an advisory alert, it should be acceptable to display in amber or yellow if the advisory alert color is amber or yellow. This may also help avoid any inconsistencies in guidance between what is described in paragraph 8.d and 8.e. of the proposed AMC.
response	*Partially accepted* The intent is accepted. The text has been amended as it is recommended that a separate and distinct colour is used to distinguish between Caution and Advisory alerts.

comment	*105* comment by: *Boeing* Page: 23 AMC 25.1322: Flight Crew Alerting Paragraph: *8.e. Colour standardisation* The third paragraph and its subparagraphs provide guidelines for agency approval for the use of the colors red and amber/yellow. We recommend that a guideline be added, where the use of red or amber/yellow is called out in the regulation. We recommend the following text should be added as a new subparagraph between subparagraphs B and C: ***"If the colours red and amber/yellow are required by other Part 25 design requirement."*** **JUSTIFICATION:** The AMC needs to allow use of red and amber/yellow for non-alerting functions when required by other Part 25 requirements, so that Part 25 requirements and this guidance are not in conflict with each other. (See for example CS 25.1549.)

response

Partially accepted

Colour consistency among propulsion (e.g. CS 25.1547), flight, navigation and any other display is addressed under new paragraph 11.d.

comment

106 comment by: *Boeing*

Page: 24
AMC 25.1322: Flight Crew Alerting
Paragraph: *8.e. Colour standardisation*

The example provided regarding red EGT limit/exceedance as requiring "immediate flight crew awareness and immediate flight crew action" is incorrect. We suggest deleting the following sentence:

"… For example, it is appropriate to have the EGT engine limit as red because in the event of an exceedance, this condition requires immediate flight crew awareness and immediate flight crew response. …"

We recommend replacing that sentence with the following

"… For example, it is appropriate to have the EGT engine limit as red because, ~~in the event of an exceedance, this condition requires immediate flight crew awareness and immediate flight crew response~~ ***per CS 25.1549(a), each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line. It is also appropriate to have the EGT engine limit red because it is appropriate to the task and context of use in that it is consistent with flight crew expectations to show an operating limit in the colour red per AMC 25-11. …"***

JUSTIFICATION: Per Appendix J of the draft final report of the AIA Powerplant Indication Task Team (PITT), which includes representatives from EASA, FAA, engine manufacturers, and airframe manufacturers, an exceedance of EGT limit does not require immediate crew action. The current draft Appendix J states:

"With respect to engine parameter limit exceedances, no immediate flight crew action (monitor, reduce power, and/or commanded shutdown) is generally required in response to an engine exceedance. This conclusion is supported in the following two ways:
--Firstly, service history for aircraft accident/incident data shows that in general no engine exceedance requires an immediate flight crew action to maintain continued operation.
-- Secondly, industry experts have supported this conclusion and incorporated the conclusion into FAA supported engine malfunction training material."

Along these lines, when crew alerts are provided for engine limit exceedances, the corresponding color of the appropriate level of alert for the condition may be different from the color of the limit marking required by CS 25.1549. For example, some applications provide an amber caution alert for exceedance of the red EGT limit, and some applications provide an amber advisory alert for

	exceedance of the red engine oil temperature limit.
response	*Partially accepted* Reference to engine limits is removed.

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 8. MANAGEMENT OF ALERTS - 8.f Suppression of False Alerts p. 24

comment	*138* comment by: *Dassault Aviation* Change "suppress an alert to suppress a false alert".
response	*Accepted*

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 9. CERTIFICATION TEST AND EVALUATION CONSIDERATIONS p. 24-25

comment	*47* comment by: *AIRBUS* B. – II. - AMC 25.1322 – 9. – 4th paragraph in page 25 Proposed text: Modify the 5th sentence of the 4th paragraph as follows: “The assessment of the alerts may be conducted in a laboratory, simulator or in the actual aircraft or may be based on experience from similar alerting functions or systems already certified”. Justification: Airbus suggests that the experience from already certified alerting functions or systems may be used when relevant for the evaluation of the alerts. Experience consists of already validated substantiations from previous certification activities about similar design, complemented or not with positive in-service experience.
response	*Not accepted* The ASHWG final report, which is the basis for development of this rule and AMC, is silent on the use of service experience to justify any prioritisation scheme. It is difficult to validate service experience and the justification would have to be built on a case-by-case basis if an alternative means of compliance is suggested. It should also be recognised that the rule and AMC 25.1322 are

in fact also built not only on principle but also service experience.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 10 APPLICABILITY TO CHANGED PRODUCTS - 10.b Visual Alerts p. 25-26

comment *82* comment by: *FAA*

This is under changes to existing airplanes.

(iii) It is permissible for some failure flags not to be integrated with the existing alerting functions.

Comment:
While it might be permissible for some failure flags not to be integrated on existing airplanes, the guidance should state that the failure flags should be integrated with the existing alerting functions following the airplanes design philosophy when practicable. If the failure warrants immediate flightcrew awareness a second attention getting sense is required in addition to the visual flag (25.1322 (c)(2))

response *Accepted*

comment *94* comment by: *David McKenney*

AMC 25.1322 (10)(b)(2)(iv) on page 25 currently states “A failure flag may be accepted as complying with CS 25.1322 (c)(2) provided that it has sufficient attention getting characteristics by itself.” I request this sentence be changed to match the wording in AMC 25.1322 (7)(a) on page 19 so that it reads “A single alert element (e.g. failure flag on a primary flight displays), may be accepted as complying with the visual requirement of CS 25.1322 (c)(2) provided that it has sufficient attention getting characteristics by itself.” Immediately following this sentence, I request the following sentence be added to AMC 25.1322 (10)(b)(2)(iv):

“Thus, a master visual or master aural alert may not be initiated, but an aural or tactile attention indication must still accompany the visual failure flag to meet the attention getting requirement of CS 25.1322(c)(2), which requires attention-getting cues through at least two different senses for warning and caution alerts.”

As currently written, I do not agree with the statement that a single alert element (e.g. failure flag on a primary flight displays) by itself may be accepted as complying with CS 25.1322 (c)(2) in the case of a Warning and Caution alert. This statement is also in conflict with paragraph 15 of your justification which states: “Furthermore, to ensure immediate flight crew awareness of Warning and Caution alerts irrespective of flight crew attentiveness or workload levels, such alerts must use two different senses when presenting the alert to the crew.”

Modern flight decks are becoming more complex and we are finding evidence

	that flight crews may not be monitoring the Primary Flight display as closely as in the past during certain phases of flight as a result of the increased use of automation on the flight deck and increased workload. Allowing a single failure flag on the Primary flight display to meet the requirements of using two senses for a Warning or Caution Alert would decrease safety and does not meet the intent of CS 25.1322(c)(2).
response	*Partially accepted* Text is removed. (Also see Comment #75.)

resulting text	For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - 10 APPLICABILITY TO CHANGED PRODUCTS - 10.d Special Considerations for Head-Up Displays (HUDs) p. 26

comment	*9* comment by: *Thales Avionics SA* NPA Sentence : "*Alerts that require continued flight crew awareness on the PFD should be presented on the HUD (e.g., TCAS, Windshear, and Ground Proximity Warning alerts*)". The harmonization group ASHWG is currently working on an appendix H to AC/AMC 25-11 about similar topic. Thales is implied in this group and supports these topics with their wording, the following is our proposal. **Proposed changes :** To replace sentence "*Alerts that require continued flight crew awareness on the PFD should be presented on the HUD (e.g. TCAS …*)" by (extract from harmonized AC/AMJ 25-11 appendix H §2.4): "*Single HUD installations where the pilot is likely to use the HUD as a primary flight reference rely on the fact that the PNF will monitor, full-time, the head-down instruments and alerting systems, for failures of systems, modes, and functions not associated with primary flight displays or HUD.*" ; and the adapted text : "*For those installation Alerts that require immediate flight crew awareness on the PFD should be presented on the HUD (e.g. TCAS ….) or compensating design features_(e.g., a combinations of means such as control system protections and an unambiguous reversion message in the HUD) and procedures that ensure the pilot has equivalently effective visual–information for timely awareness and satisfactory response to these alerts should be provided.*"
response	*Partially accepted* The proposed HUD appendix to AMC 25-11 has been technically agreed on by the working group and does not conflict with CS 25.1322 and the associated

AMC.

Changes to AMC 25.1322 have been made to harmonise with FAA and to align with the HUD appendix of AMC 25-11.

comment 10 comment by: *Thales Avionics SA*

NPA Sentence : "*For dual HUD installations, each HUD should provide attention getting cues equivalent to those provided on the on-side HDDs*".

For dual HUD operational concept and installation it should be taken into account the harmonized point of view through appendix H §.2.4. of ASHWG AC/AMC 25-11 where the difference between HUD information data and HDD is managed.

Maybe it would make sense waiting for the ASHWG AC/AMJ 25-11 appendix H to be frozen (end of march) before issuing any specific EASA dual HUD guidance about alerting.

response *Partially accepted*

The proposed HUD appendix to AMC 25-11 has been technically agreed on by the working group and does not conflict with CS 25.1322 and the associated AMC.

Changes to AMC 25.1322 have been made to harmonise with FAA and to align with the HUD appendix of AMC 25-11.

resulting text For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - APPENDIX A: EXAMPLES OF VISUAL ALERTING ELEMENTS p. 27-30

comment 48 comment by: *AIRBUS*

B. – II. - AMC 25.1322 – A.1 (2) – 4th paragraph in page 27

Proposed text:
Add the wording “except if justified” at the end of the 4th paragraph as follows:
"The Master Visual Alert should remain on until it is cancelled either manually by the flight crew, or automatically when the alerting situation no longer exists, except if justified."

Justification:
The requirement should be flexible enough to allow some tolerances or exceptions, notably when:

- data or parameters, required to determine the condition, are not available,

- the procedure must be carried out up to its end, even if the alerting situation no longer exists, in accordance with AMC 25.1322-1 - Appendix A.3 (2) in page 30: “The Visual Alert Information for Time-Critical Warnings should be erased when corrective actions have been taken, or when the alerting situation no longer exists”

response

Not accepted

The function of an Alert is to identify an abnormal condition to the flight crew. Once achieved, the alert is no longer necessary unless the condition persists. Retaining the alert when the failure or abnormal condition no longer exists is misleading to the crew and may create unintended consequences.

comment

49 comment by: *AIRBUS*

B. – II. - AMC 25.1322 – A.2 (4) – 5th paragraph in page 29

Proposed text:
Modify the 2nd sentence of the 5th paragraph as follows (the term “should” is replaced by “may”):
"A memory indication may be used to indicate the number and urgency level of the alerts that have been stored."

Justification:
Current text in the 5th paragraph requires that: "If alerts are presented on a limited display area, an overflow indication should be used to inform the flight crew that additional alerts may be called up for review. A memory indication should be used to indicate the number and urgency level of the alerts that have been stored."

Airbus considers that this requirement is too much solution-prescriptive. It would be up to the applicant to define the best solution considering other alerting system features and characteristics, Human Factors considerations, operational needs and lessons-learned from previous alerting systems developments. Significant Airbus experience on this topic has shown that there is no need at all to display the number and urgency levels of the alerts stored in memory. That can be source of nuisance. The Airbus alerting philosophy is based on the prioritization, just with an overflow indication, in order that all the flight crew attention remain focused on only one alert which has the highest priority. The prioritization reflects the Standard Operating Procedures (SOP), so the flight crew would deviate from SOP, with a possible adverse effect on safety, if they would review less urgent alerts whereas higher urgent alerts must be processed first. So, the solution proposed by the AMC should be considered as one possible solution but not as the only one.

response

Not accepted

The AMC is derived from extensive experience in showing compliance with the relevant regulations. However, in using "should" the applicant is provided with the option to offer an alternative means of compliance.

comment

139 comment by: *Dassault Aviation*

§ A 2 - Acknowledged messages should be displayed a different way

response

Accepted

Added as Note 3 in Appendix 1 paragraph 2(b)(6).

resulting text

For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - II. AMC 25.1322: Flight Crew Alerting - APPENDIX B: EXAMPLES OF AURAL ALERTING ELEMENTS p. 31-34

comment

19 comment by: *Eurocopter*

B.1(2) on page 31 and B.2(3) on page 33 require that:
"The aural 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 their noise attenuation characteristics)."
Headsets non wearing may be not relevant for some applications (helicopter applications especially). The sentence could be reworded as follows:
"The aural alerting must be audible to the flight crew in the worst-case (ambient noise) flight conditions whether _ the flight crew is wearing headsets (taking into account their noise attenuation characteristics) or not (if relevant)."

response

Not accepted

The assumption that a pilot will always be wearing a headset is not supported. The Agency is aware of at least one accident in Europe (fixed-wing in this case), where the crew was not wearing headsets (despite the obligation to do so under EU-OPS), and the lack of pilot audio alerting was a factor in the accident. In other parts of the world, such operational rules may be less demanding.

comment

24 comment by: *Bombardier Aerospace*

B.1 Master Aural Alert and Unique Tones:

Section (4) 'Onset/Duration' - 2nd to last paragraph reads

- *For Master Aural Alerts associated with Cautions and Unique Tones associated with a Caution, the sound should be limited in duration or can be continuous until the flight crew manually cancels it, or when the Caution condition no longer exists.*

Section (5) 'Cancellation' - 1st paragraph reads

- *For Caution level alerts, the Master Aural Alert and Unique Tone should continue through one presentation and cancel automatically.*

The first requirement allows continuous alert operation with manual cancellation while the second specifies limited sound duration with automatic

	cancellation. The inconsistency between these requirements should be removed.
response	*Accepted* The paragraph under "cancellation" (now Appendix 2 2e(1)) is amended to refer to Caution level aural alerts that are limited in duration.

comment	*50* comment by: *AIRBUS* B. – II. - AMC 25.1322 – B.2 (4) – 4th paragraph in page 34 Proposed text: Modify the 2nd sentence of the 4th paragraph as follows: "However, Voice Information associated with Time-Critical Warnings should not be repeated or should be cancellable if they interfere with the flight crew's ability to respond to the alerting condition (e.g. windshear warning, TCAS resolution advisory, terrain warning)." Justification: Time critical aural alerts from TAWS function (Terrain warning) are repeated until the alerting conditions no longer exist, but they are cancellable by the flight crew through the "emer cancel" switch (guarded switch) to allow clear aural communication between crewmembers when required.
response	*Not accepted* The proposed change goes against the objective of time-critical warnings in not distracting the flight crew from the time-critical task. Use of the "emer cancel" switch is intended for alerting system failure conditions where an inadvertent alert may interfere with the flight crew's ability to safely fly the aeroplane.

comment	*51* comment by: *AIRBUS* B. – II. - AMC 25.1322 – B.2 (5) – 6th paragraph in page 34 Proposed text: Remove the following existing text between brackets : "(e.g. the word "don't" at the beginning of a voice message should be avoided)." Justification: The word "don't" is used in "Don't sink" alert generated by the TAWS system to alert the crew that airplane is losing altitude after takeoff. The indication is correct and not misleading. Moreover, it is widely known and understood in pilot community.
response	*Not accepted* While we recognise that this conflicts with ETSO C151a and previously certificated designs, HF experience has identified the use of such words as a potential source of misleading information if only part of the message is

received.

comment 83 comment by: FAA

Reference:
B.2 Voice Information
NOTE: The purpose for using Voice Information is to indicate conditions that demand immediate flight crew awareness of a specific condition without further reference to other indications in the flight deck.
Voice Information may be applied:
- To limit the number of Unique Tones
- To transfer workload from the visual to the auditory channel
- To enhance the identification of an abnormal condition, and effectively augment the visual indication.
- To provide information to the flight crew where a voice message is preferable to other methods
- Where awareness of the alert must be assured no matter where the pilot's eyes are pointed

Comment:
This statement "without further reference to other indications in the flight deck" needs further clarification. For example it does not mean that one should not use a alert visual indication. This statement is normally associated with whether there is a need for additional master alerts as in the case of time critical alerts. Recommend harmonization with the FAA regarding the statement "without further reference to other indications in the flight deck".
The following sentence "- To enhance the identification of an abnormal condition, and effectively augment the visual indication" also indicates that the voice is used to "enhance" the visual indication (in other words other references).

response *Accepted*

resulting text For AMC 25.1322 resulting text, see Annex 1.

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays p. 35

comment 70 comment by: AIRBUS

AMC 25-11 - General comment:

The comments made to the sections B. – I. - CS 25.1322 – (e) 1) ii) in page 12, B. – I. - CS 25.1322 – (f) in page 12 and B. – I. - CS 25.1322 – (e) 1) iii) in page 12 regarding the use of yellow and green colours are also valid for the proposed AMC 25-11.

response *Noted*

(See response to individual comments.)

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 1 - BACKGROUND p. 40-42

comment	*52* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 1 – paragraph 4 – Table 1 in page 41 Proposed text: 4th row of the table 1: add the wording "or of installed resources of Class II Electronic Flight Bag" as follows: "Display aspects of Class III Electronic Flight Bag or of installed resources of Class II Electronic Flight Bag (installed equipment)." Justification: In accordance with AMC 20-25, Class 2 EFB data can be displayed on installed screens which are part of the aircraft configuration, and so certified.
response	*Not accepted* AMC 20-25 is still at the draft NPA stage. Whether or not installed displays can be used for Class II EFB information is still subject to discussion.

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 2 - ELECTRONIC DISPLAY SYSTEM OVERVIEW p. 43-44

comment	*97* comment by: *David McKenney* AMC 25-11 (Chapter 2)(11)(b) on page 43 currently states *"The applicant should establish and document the following human performance elements when developing a display system:* · *Flight crew workload,* I request the words "during normal and non-normal operations, including emergencies" be added to the first bullet so that it reads "Flight crew workload during normal and non-normal operations, including emergencies," I believe that any workload analysis should be conducted for normal and non-normal operations. This change should be made throughout the document anytime workload is mentioned.
response	*Accepted*

resulting text

CHAPTER 2.
ELECTRONIC DISPLAY SYSTEM OVERVIEW

11. General

...

b. Human Performance Considerations.

The applicant should establish and document the following human performance elements when developing a display system:

- Flight crew workload during normal and non-normal operations, including emergencies,

...

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 3. ELECTRONIC DISPLAY HARDWARE p. 44-49

comment	*3* comment by: *CAA-NL* In Note 3 on Page 45: The applicant is directed to the FAA certification Engineer. We assume that in the European context the EASA Certification Specialist is meant.
response	*Accepted* (See proposed change.)

comment	*12* comment by: *UK CAA* **Page 45 Note 4** **Comment:** References are made to the FAA version AC25-11A. They should reference the EASA document. **Justification:** Could cause confusion to the reader. **Proposed Text (if applicable):** Replace 'AC25-11A' with 'AMC25-11'.
response	*Accepted*

comment	*13* comment by: *UK CAA* **Page 47 and subsequent pages** **Paragraph No:** b. Installation (2) **Comment:** References are made throughout to 'RTCA DO 16OE' and 'EUROCAE ED 14E'. RTCA DO 160 is now at Revision F. Suggest the document uses 'RTCA DO 160( )' to denote latest issue at time of display system development. Note the DO160 is expected to be up-issued to Revision G in the near future. **Justification:** The AMC does not reflect the latest version of the RTCA / EUROCAE documents**.** **Proposed Text (if applicable):** Replace 'RTCA DO 160E' with **'**RTCA DO-160( )' and 'EUROCAE ED 14E' with 'EUROCAE ED 14( )'

response	*Partially accepted* References are changed to the EUROCAE document at the latest issue.

comment	*53* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 3 – paragraph 16. c. in page 48 Proposed text: Remove the issue of the RTCA and Eurocae documents in the following sentence: "RTCA DO-160E and EUROCAE document ED-14E provide information that may be used for an acceptable means of qualifying display equipment such that the equipment performs its intended function when subjected to anomalous input power." Justification: Those documents may be revised and either the last issue or the issue considered in the applicable aircraft certification basis should be considered.
response	*Partially accepted* References are changed to the EUROCAE document at the latest issue.

comment	*69* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 3 – paragraph 16 page 44, 45, Notes 2, 3 and 4 Comment: The references to the FAA and to the AC 25-11 in the notes 2, 3 and 4 should be replaced respectively by EASA and AMC 25.11.
response	*Accepted*

comment	*127* comment by: *Boeing* Page: 48 Chapter 3 Paragraph: 16.c.(4) *The display response to a short term power interrupt (<200 milliseconds) should be such that the intended function of the display is not adversely affected.* The term *"adversely affected"* can be interpreted many ways. To clarify this statement, we recommend revising the text as follows: *"The display response to a short term power interrupt (<200 milliseconds) should be such that the intended function of the display ~~is not adversely affected~~* ***need not continue for the duration of the interrupt, but should quickly return at the end of the interrupt."*** **JUSTIFICATION:** For electronic displays, this duration of power interrupt

would be non-normal on most airplanes. It is longer than normal power transients and shorter than non-normal long term power interrupts (>200 milliseconds). For this short term interrupt, the guidance of this AMC should allow displays to not function during the short interrupt. Further, the guidance should address the expected display behavior at the end of the interrupt, as does paragraph 16.c.(5) regarding long term power interrupts. Chapter 4 of this AMC already describes safety aspects of electronic display systems, which address the primary adverse display affects. What constitutes “adversely affected” should not have to be interpreted for this guidance on how to deal with short term power interrupts.

response

Not accepted

The wording has been carefully chosen to reflect the state-of-the-art in display technology. An electrical power transient of <200 milliseconds may occur during routine operation and is therefore likely to be a frequent event requiring minimal disruption.

comment

140 comment by: *Dassault Aviation*

§ b - A means should be available whereby the crew can turn off any flightdeck display

response

Not accepted

The need to switch off a display should be assessed as part of the system safety assessment of CS 25.1309. Guidance for the mitigation of failure conditions is provided in Chapter 4, paragraph c(1) of this AMC.

resulting text

CHAPTER 3.

ELECTRONIC DISPLAY HARDWARE

16. Display Hardware Characteristics.

...

NOTE 2: With regard to ..., the Agency~~FAA~~ has determined that ...

NOTE 3: The applicant should notify the Agency~~FAA certification engineer~~ if ...

NOTE 4: The most ... SAE document and AMC 25-11~~A~~, follow the guidance in AMC 25-11~~A~~.

...

b. Installation

...

(2) ~~RTCADO-160E,*Environmental Conditions and Test Procedures for AirborneEquipment*, and~~European Organisation for Civil Aviation Electronics (EUROCAE) ED-14~~E~~ *Environmental Conditions and Test Procedures for Airborne Equipment*, at the latest revision, provides information that may be used for an acceptable means of qualifying display equipment for use in the aeroplane environment.

...

c. Power Bus Transient. ~~RTCA DO-160E and~~ EUROCAE document ED-14~~E~~, at the latest revision, provides information ...

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 4 SAFETY ASPECTS OF ELECTRONIC DISPLAY SYSTEMS p. 49-60

comment

25 comment by: *Bombardier Aerospace*

Tables 3-10:

Example safety objectives are listed in the Tables 3 through 10 of this chapter. The safety objectives are specified only in terms of qualitative probability. It is recommended that the examples should include the failure condition severity classification since this classification is the starting point for determining both the system development assurance levels per ARP 4754 and the qualitative probability levels.

response

Not accepted

Failure condition severity was deliberately removed from the tables as this will be design specific and must be established by the applicant as part of the system safety assessment (see paragraph 25 of the NPA explanatory note).

comment

54 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Chapter 4 – paragraph 21. e. (10) 4 – Table 6 in page 56/57

Comment:
No information in the table 6 are addressed by the second note (**). This second note should be applicable for the safety objectives which are classified as “Remote” in Table 6.

Justification:
Refer to the ASHWG report

response

Accepted

comment

55 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Chapter 4 – paragraph 21. e. (10) 6 – Table 8 in page 58

Comment:
No information in the table 8 is addressed by the third note (***). This note should be applicable to the safety objective classified as “Remote” for both failure conditions “Display of misleading flight crew alerting information” and “Display of misleading flight crew procedures” of Table 8.

	The fourth note (****) should be applicable to the safety objective classified as “Remote” for the failure condition “Loss of the standby displays” and not to the failure condition “Display of misleading flight crew procedures”. Justification: Refer to the ASHWG report
response	*Partially accepted* First part accepted. Second part not accepted. The note refers to the failure condition of “display of misleading flight crew procedures”.

comment	*56* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 4 – paragraph 21. e. (10) 7 – Table 9 in page 59 Comment: Safety objectives for the following failure conditions should be modified as follows: “Remote” for the failure condition “Loss of one or more required engine indications for more than one engine” “Extremely Remote” for the failure condition “Misleading display of any required engine indications for more than one engine” Justification: This proposed classification is in accordance with the recommendations of the ASHWG report. In addition, the two notes under Table 9 do not explain how classification can be alleviated within the proposed range.
response	*Not accepted* The range of failure classification were added after the ASHWG report was issued and in response to the AIA Powerplant Indication Task Team’s concerns that the initial classifications may be inadequate in some circumstances.

comment	*57* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 5 – paragraph 31. c. (1) (a) in page 62 Proposed text: Remove the following existing text : “Avoid contractions, such as “can’t” instead of “cannot.”" Justification: Refer to comment about B. – II. - AMC 25.1322 – B.2 (5) – 6th paragraph in page 34. Some manufacturers generally use the contraction “don’t” for the standardized alert “don’t sink” of the TAWS.
response	*Accepted*

comment	*107* comment by: ***Boeing***
	Page: 54 Paragraph: *Table 3, line 2, Loss of all Primary attitude displays* The safety objective on this line in the table defines a range from *"Remote – Extremely Remote."* We request that the safety objective be revised to indicate just ***"Remote."*** **JUSTIFICATION:** This failure has been made more severe than what is currently defined in AMC 25-11 and currently-accepted systems, without any supporting accident/incident data, new specific risks, or unmitigated operational factors to warrant the change. Although the AMC explicitly states that the tables of failure conditions and associated safety objectives are only "examples," normal practice has often shown that the material in AMCs sets an expectation of compliance to which the authorities will hold – and have held -- the applicants. If more stringent objectives are now the expectation, we suggest that this be done more appropriately via general rulemaking rather than by guidance material.
response	*Not accepted* In most cases, the failure objective would be remote, as previously accepted. However, the applicant is required to perform a SSA in accordance with CS 25.1309 to establish the required system integrity.

comment	*108* comment by: ***Boeing***
	Page: 54 Paragraph: *Table 3, line 4, Display of misleading attitude information on one primary display* The safety objective on this line in the table is *"Extremely Remote."* We request that the safety objective be revised to indicate just ***"Remote."*** **JUSTIFICATION:** This failure has been made more severe than currently accepted systems, without any supporting accident/incident data, new specific risks, or unmitigated operational factors to warrant the change. The current AMC 25-11 states, *"Display of dangerously incorrect roll or pitch attitude on any single primary attitude display, without a warning must be Extremely Remote."* If indicated, this failure condition should not be hazardous.
response	*Not accepted* If this failure condition is detected, the information will either be removed or flagged to indicate a false indication. It would, therefore, no longer be misleading or dangerously incorrect.

comment	*109* comment by: ***Boeing***

Page: 54
Paragraph: *Table 3, line 6, Display of misleading attitude information on one primary display combined with a standby failure (loss of attitude or incorrect attitude)*

Boeing recommends deleting this example, as there are already sufficient examples for this parameter to lay the groundwork for a proper System Safety Analysis.

We suggest changing the hazard classification to ***"TBD."***

JUSTIFICATION: Nearly all airplanes before 14 CFR §121.305 (j) (ref. installation of a third gyroscopic bank-and-pitch indicator) were in this state after first failure condition; this condition is not necessarily catastrophic.

response *Not accepted*

This particular combination of failures needs to be addressed in the SSA and is considered a catastrophic failure condition. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system architecture.

comment *110* comment by: *Boeing*

Page: 55
Paragraph: *Table 4, line 2, Loss of all primary airspeed displays*

The safety objective on this line in the table defines a range from *"Remote – Extremely Remote."* We request that the safety objective be revised to indicate just ***"Remote."***

JUSTIFICATION: This failure has been made more severe than what is currently defined in AMC 25-11 and currently accepted systems, without any supporting accident/incident data, new specific risks, or unmitigated operational factors to warrant the change.

Although the AMC explicitly states that the tables of failure conditions and associated safety objectives are only "examples," normal practice has often shown that the material in AMCs sets an expectation of compliance to which the authorities will hold – and have held -- the applicants. If more stringent objectives are now the expectation, we suggest that this be done more appropriately via general rulemaking rather than by guidance material.

response *Not accepted*

In most cases, the failure objective would be remote, as previously accepted. However, the applicant is required to perform a SSA in accordance with CS 25.1309 to establish the required system integrity.

comment *111* comment by: *Boeing*

Page: 55

Paragraph: *Table 4, line 5*, *Display of misleading airspeed information on one primary display combined with a standby failure (loss of airspeed or incorrect airspeed)*

We recommend deleting this example.

JUSTIFICATION: There are already sufficient examples for this parameter to lay the groundwork for a proper System Safety Analysis

response

Not accepted

This particular combination of failures needs to be addressed in the SSA and is considered a catastrophic failure condition. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system architecture.

comment *112* comment by: *Boeing*

Page: 55
Paragraph: *Table 4, line 1*, *Loss of all airspeed displays, including standby display*

The safety objective on this line in the table is *"Extremely Improbable."* We request that the safety objective be revised to indicate ***"Extremely Remote."***

JUSTIFICATION: Nearly all modern airplanes have independent inertial reference unit (IRU) or multi-mode receiver/ground positioning system (MMR/GPS)- based groundspeed. Loss of airspeed display per se is not a "catastrophic" event a priori.

response

Not accepted

This table is intended to provide guidance by giving common examples. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system architecture.

comment *113* comment by: *Boeing*

Page: 55
Paragraph: *Table 5, line 1, Loss of all barometric altitude display, including standby display*

The safety objective on this line in the table is *"Extremely Improbable."* We request that the safety objective be revised to indicate ***"Extremely Remote."***

JUSTIFICATION: This failure has been made more severe than what is currently defined in AMC 25-11. With functioning attitude, airspeed and engines, plus non-barometric altimeters, navigation, communications, ground mapping weather, terrain depictions, etc., this failure is not a catastrophic event a priori.

Although the AMC explicitly states that the tables of failure conditions and

associated safety objectives are only “examples,” normal practice has often shown that the material in AMCs sets an expectation of compliance to which the authorities will hold – and have held -- the applicants. If more stringent objectives are now the expectation, we suggest that this be done more appropriately via general rulemaking rather than by guidance material.

response

Not accepted

This table is intended to provide guidance by giving common examples. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system architecture.

comment

114 comment by: *Boeing*

Page: 55
Paragraph: *Table 5, line 2, Loss of all barometric altitude primary display*

The safety objective on this line in the table defines a range from *“Remote – Extremely Remote.”* We request that the safety objective be revised to indicate just ***“Remote.”***

JUSTIFICATION: This failure has been made more severe than what is currently defined in AMC 25-11 and currently accepted systems, without any supporting accident/incident data, new specific risks, or unmitigated operational factors to warrant the change.

Although the AMC explicitly states that the tables of failure conditions and associated safety objectives are only “examples,” normal practice has often shown that the material in AMCs sets an expectation of compliance to which the authorities will hold – and have held -- the applicants. If more stringent objectives are now the expectation, we suggest that this be done more appropriately via general rulemaking rather than by guidance material.

response

Not accepted

In most cases, the failure objective would be remote, as previously accepted. However, the applicant is required to perform a SSA in accordance with CS 25.1309 to establish the required system integrity.

comment

115 comment by: *Boeing*

Page: 55
Paragraph: *Table 5, line 3*, *Display of misleading barometric altitude information on both primary displays*

The safety objective on this line in the table is *“Extremely Improbable.”* We request that the safety objective be revised to indicate ***“Remote.”***

JUSTIFICATION: Boeing's pilots have recently determined that dual misleading baro altitude is no worse than Remote (Major). We stated this in the recently FAA-approved Safety Analysis for Displays for the Boeing Model 747-8 and the plan is to include the information in the 777 AIMS Safety

	Analysis when that analysis is next updated.
response	*Not accepted* The applicant may demonstrate that a lower classification is justified due to the particular system architecture. EASA will be interested in reviewing the substantiation relating to the 747-8 and 777.

comment	*116* comment by: *Boeing* Page: 56 Paragraph: *Table 5, line 5, Display of misleading barometric altitude information on one primary display combined with a standby failure (loss of altitude or incorrect altitude* We recommend deleting the example. **JUSTIFICATION:** There are already sufficient examples for this parameter to lay the groundwork for a proper System Safety Analysis.
response	*Not accepted* This particular combination of failures needs to be addressed in the SSA and is considered a catastrophic failure condition. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system architecture.

comment	*117* comment by: *Boeing* Page: 56 Paragraph: *Table 6, line 2, Loss of all heading display in the flight deck* The safety objective on this line in the table is *"Extremely Improbable."* We request that the safety objective be revised to indicate ***"Extremely Remote."*** **JUSTIFICATION:** With operational mitigations such as track displays and global communications, loss of all heading display is not a catastrophic event a priori.
response	*Not accepted* The applicant may propose operational mitigations to substantiate a lower classification.

comment	*118* comment by: *Boeing* Page: 56 Paragraph: *Table 6, line 3, Display of misleading heading information on both pilots' primary displays* The safety objective on this line in the table defines a range from *"Remote – Extremely Remote."* We request that the safety objective be revised to

indicate just "***Remote***."

JUSTIFICATION: This failure has been made more severe than what is currently defined in AMC 25-11 and currently accepted systems, without any supporting accident/incident data, new specific risks, or unmitigated operational factors to warrant the change.

Although the AMC explicitly states that the tables of failure conditions and associated safety objectives are only "examples," normal practice has often shown that the material in AMCs sets an expectation of compliance to which the authorities will hold – and have held -- the applicants. If more stringent objectives are now the expectation, we suggest that this be done more appropriately via general rulemaking rather than by guidance material.

response *Not accepted*

In most cases, the failure objective would be remote, as previously accepted. However, the applicant is required to perform a SSA in accordance with CS 25.1309 to establish the required system integrity.

comment *119* comment by: *Boeing*

Page: 56
Paragraph: *Table 6, line 4*, Display of misleading heading information on one primary display combined with a standby failure (loss of heading or incorrect heading)

We recommend deleting this example.

JUSTIFICATION: There are already sufficient examples for this parameter to lay the groundwork for a proper System Safety Analysis.

response *Not accepted*

This particular combination of failures needs to be addressed in the SSA and is considered a catastrophic failure condition. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system architecture.

comment *120* comment by: *Boeing*

Page: 57
Paragraph: *5 Navigation and Communication (Excluding Heading, Airspeed, and Clock Data)*

We recommend deleting this paragraph.

JUSTIFICATION: Navigation (NAV) and communication (COM) requirements are imposed in operating rules, and they are not inherently hazardous at any level. Only when taken in an operational context related to how they are used, do either NAV or COM failures inherently have meaning. The AMC should be limited to airworthiness installation requirements; it should not include

operating rule requirements.

response

Not accepted

The notion that NAV and COM equipment is non-hazardous is not supported. When communication and navigation equipment is required by operational requirements, this equipment is subject to an airworthiness approval, which includes CS 25.1309.

comment

121 comment by: *Boeing*

Page: 58
Paragraph: *Table 8, line 9*, *Display of misleading flightcrew procedures*

The safety objective on this line in the table defines a range from *"Remote – Extremely Remote."* We request that the safety objective be deleted.

JUSTIFICATION: Flightcrew procedures are covered in the operating regulations. This is out of scope of CS-25. Further, the proposed guidance is so broad, it is of little use.

response

Not accepted

If procedures are electronically provided to the flight crew, then failure conditions which would affect the correct presentation of these procedures (e.g. electronic checklist) are subject to an airworthiness approval, including CS 25.1309.

comment

122 comment by: *Boeing*

Page: 58
Paragraph: *Table 8, line 10, Loss of the standby displays*

We recommend deleting the example.

JUSTIFICATION: There are already sufficient examples for this parameter to lay the groundwork for a proper System Safety Analysis.

response

Not accepted

Irrespective of the integrity of primary displays, standby instruments must have a minimum level of integrity.

comment

123 comment by: *Boeing*

Page: 58
Paragraph: *Table 8*

We request that Table 8 be expanded to include examples for features such as a clock, other functions required by CS 25.1303, or other examples of electronic display features implemented on modern flight deck displays.

JUSTIFICATION: Guidance is missing for parameters that are typically covered in certification of displays. The failure conditions in Chapter 4 cover only primary flight information, engine indications, total crew alerting, and some out-of-scope Part 121 information.

response

Noted

More parameters may be added in a future amendment.

comment

124 comment by: *Boeing*

Page: 59
Paragraph: *Table 9, line 4, Misleading display of any required engine indications on more than one engine*

The safety objective on this line in the table defines a range from *"Extremely Remote – Extremely Improbable."* We request that the safety objective be revised to indicate jus ***"Extremely Remote."***

JUSTIFICATION: This condition is generally not catastrophic. For example, a slight N1 bias on both engines, due to a potential aspirated total air temperature (TAT) probe failure, is not a catastrophic event.

response

Not accepted

This failure condition needs to be addressed in the SSA and is considered to be a potentially catastrophic failure condition. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system architecture.

comment

125 comment by: *Boeing*

Page: 59
Paragraph: *Table 9, line 3, Loss of one or more required engine indications on more than one engine*

The safety objective on this line in the table defines a range *from "Remote – Extremely Remote."* We request that the safety objective be revised to indicate just ***"Remote."***

Alternatively, we suggest a specific example of required engine indications be chosen that, if lost, has been deemed hazardous for several different display systems.

JUSTIFICATION: On many electronic display systems, the loss of a secondary engine indication on more than one engine may not even be noticed. Many combinations of failures are not hazardous.

response

Not accepted

This failure condition needs to be addressed in the SSA and is considered to be a potentially catastrophic failure condition. In all cases, the applicant may demonstrate that a lower classification is justified due to the particular system

architecture.

comment

126 comment by: *Boeing*

Page: 59
Paragraph: *Table 9, line 3*, *Loss of one or more required engine indications on more than one engine*

The failure condition on this line in the table is, *"Loss of one or more required engine indications for more than one engine."* The failure condition could be better restated as, ***"Loss of more than one required engine indication on more than one engine"*** with a safety objective of ***"Extremely Remote."***

JUSTIFICATION: Loss of a single indication is not hazardous because the pilot normally monitors the other engine parameters.

response

Not accepted

The applicant may demonstrate that a lower classification is justified due to the particular system architecture.

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 5. ELECTRONIC DISPLAY INFORMATION ELEMENTS AND FEATURES p. 60-71

comment

11 comment by: *Thales Avionics SA*

NPA Chapter 5, paragraph § c.(5).(g) : "The following colours pairs should be avoided" , Line "• *Red on black*"

Colour "red on black" is already used from many years and has been proven to be acceptable.

Proposed change :
To remove the line "~~Red on Black~~"

response

Accepted

The Agency accepts that the list of colour pairs to avoid may be too prescriptive, as some of the colour pairs have been accepted in the past. The table is removed and the reference to the FAA report is retained.

comment

15 comment by: *Thales Avionics SA*

NPA Chapter 5, paragraph §f (3) : Managing Messages and Prompts.

The first 2 bullets, within the above mentioned paragraph, deal with technical realization whereas the last one deals with additional recommendation, which may vary. Furthermore, the ARAC reference is not done neither in CS-25-1322 nor in AMC 25-1322.

Proposed change :
Last bullet should be removed "~~Reference the ARAC~~ …".

response

Accepted

Reference to CS 25.1322 and its associated AMC is contained in (f)(1) General.

comment

58 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Chapter 5 – paragraph 31.c.(3) (c) in page 63

Proposed text:
Add after the 1st sentence the following text:
"Non-standardised symbols which have been already assessed positively during previous certifications and completed with positive in-service experience, are acceptable as well. New non-standardised symbols can be considered as acceptable if assessed positively during the certification exercise."

Justification:
Airbus design is not limited to the use of standard symbologies. As an example, Avoid Terrain pattern, Obstacle icons and in general Terrain depiction and WXR depiction (Off path Weather) are non standard symbols. But it is also the case for many other symbologies already assessed positively on other Airbus A/C thanks to in-service experience and/or HF activities.

response

Not accepted

This is a recommendation. However, the applicant is free to propose other non-standard symbology based on validated service experience and assessed on a case-by-case basis.

comment

59 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Chapter 5 – paragraph 31.c.(5) (f) – Table 12 in page 67

Proposed text:
Like in Table 11, replace the term "specified" by "recommended" in the title of Table 12 as follows:
"Recommended Colours for Certain Display Features"
Add a triple asterisk after "Magenta" corresponding to the feature "Active route / flight plan"
Add a new note corresponding to this triple asterisk: "Active flight plan in green has been already found as acceptable".

Justification:
AMC 25-11 should propose acceptable means of compliance but it should not specify only one means. An AMC should remain objectives-oriented and not solutions-prescriptive. It should be the remit of the applicant to define a solution in accordance with the AMC objective.
On airbus aircraft, the active route/FPLN is displayed in green on the

Navigation Display and not in Magenta nor in White.

response

Partially accepted

Text associated with Table 11 is amended to advise that some colours may be mandatory under CS-25.
Title to Table 12 is amended.
Proposal to add an additional asterisk and note is not accepted. These are recommendations only and other colours proposed by the applicant may be accepted.

comment

60 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Chapter 5 – paragraph 31.c.(5) (g) in page 67

Proposed text:
Replace the existing sentence “The following colour pairs should be avoided:” by:
“The following colour pairs are not recommended but remain acceptable if they have been already assessed positively during previous certifications and completed with positive in-service experience, or if assessed positively during the actual certification exercise.”

Justification:
Some of the pairs of color listed in the AMC have been assessed positively on previous AIRBUS A/C for some display features. Examples of use of pairs colors listed in the AMC:

- Red on Cyan : Excess Attitude symbology on PFD
- Yellow on Green: A/C mock Up on FPLN, Weather bitmaps…
- Red on Green : Terrain and Weather bitmaps
- Magenta on green: Waypoints on FPLN, Weather display (Turbulence), abnormal situation on Terrain display (invalid terrain)…
- Magenta on Black: deviations linked to Instrument landing systems, MORA, Turbulences…
- Blue on Black: units on FMS pages
- Red on Black: warnings (W/S, Loss of primary flight data, TCAS RA …). Most of aircraft implementing Electronic Flight Deck Displays, use the “dark cockpit” principle and therefore, background of the Flight Deck displays is black. In order to comply with CS 25.1322 (e) 1) i), warning must be displayed in red, which is only possible on a black background.

response

Partially accepted

The Agency accepts that the list of colour pairs to avoid may be too prescriptive, as some of the colour pairs have been accepted in the past. The table is removed and the reference to the FAA report is retained.

comment

61 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Chapter 5 – paragraph 31.f.(3)(a) in page 70

Proposed text:

	Remove the third bullet referring to ARAC recommendations Justification: AMC for information on warning, caution, and advisory alerts is now in the proposed AMC 25.1322 (part of NPA 2009-12) that will supersede ARAC recommendations.
response	*Accepted*

resulting text

CHAPTER 5.
ELECTRONIC DISPLAY INFORMATION ELEMENTS AND FEATURES

31. Display Information Elements and Features.

...

c. Display Information Elements

(1) ...

...

(a) ...

- The use of only upper case letters for text labels is acceptable.
- ~~Avoid contradictions, such as "can't" instead of "cannot"~~
- Break lines of text only at spaces or other natural delimiters.

...

(5) ...

(e) The following table ... colour displays. (Note: Some of these colours may be mandatory under CS-25)

Table 11: Recommended Colours for Certain ~~Functions~~Features

Table 12: ~~Specified~~Recommended Colour Sets for Certain Display Features

...

(g) ~~The following colour pairs should be avoided:~~

~~• Saturated red and blue,~~
~~• Saturated red and green,~~
~~• Saturated blue and green,~~
~~• Saturated yellow and green,~~
~~• Yellow on purple,~~
~~• Yellow on green,~~
~~• Yellow on white,~~
~~• Magenta on green,~~
~~• Magenta on black (although this may be acceptable for lower criticality items),~~
~~• Green on white,~~
~~• Blue on black, and~~
~~• Red on black.~~

Colour Pairs. For further information on this subject see the FAA report *Human Factors Design Guide Update (Report Number DOT/FAA/CT-96/01): A Revision to Chapter 8 - Human Interface Guidelines.*

f. Annunciations and Indications.

...

(3) Managing Messages and Prompts.
(a) …

~~• Reference the ARAC recommendations for revising CS 25.1322 and the associated guidance material for information on warning, caution, and advisory alerts.~~

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 6. ORGANISING ELECTRONIC DISPLAY INFORMATION ELEMENTS p. 71-79

comment	*62* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 6 – paragraph 36.b.(1) in page 72 Proposed text: Replace the existing text of the 3rd bullet: "Flight crew alerts – each flight crew alert should be displayed in a specific location or a central flight crew alert area." By: "Flight crew alerts – refer to AMC 25.1322" Justification: The existing text may be in conflict with some parts of AMC 25.1322, notably with the text about time-critical warnings in the NPA section B. – II. - AMC 25.1322 – 7. b (1) in page 20. Indeed, a red-streaked speed scale is considered as a "Unique Visual Alert Information" to alert the crew of a STALL condition (time-critical warning). This flight crew alert is not displayed in a specific location or in a central flight crew alert area.
response	*Not accepted* The intent is to ensure that flight crew alerts are always displayed in a consistent and known position.

comment	*63* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 6 – paragraph 36.d.(2)(f) 1 in page 78 Proposed text: Add the following sentence to the existing paragraph 1: "Manual reconfiguration may be acceptable if assessed positively during the actual certification or from previous certification activities about similar design, complemented or not with positive in-service experience." Justification: In order not to be design-prescriptive, if manual reconfiguration has been assessed as being suitable (by simulator tests or flight tests, etc …), then the automatic solution might not be necessary.
response	*Not accepted*

The current text allows manual reconfiguration when assessed to be acceptable.

comment

64 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Chapter 6 – paragraph 36.e.(2)(a) in page 79

Proposed text:
Replace the existing 2nd sentence : “Manual switching may be acceptable in less complex systems or if immediate flight crew action is not required.” by:
“Manual switching may be acceptable if assessed positively during the actual certification or from previous certification activities about similar design, complemented or not with positive in-service experience.”

Justification:
On AIRBUS aircraft, sensor sources are not automatically switched. They are easily and manually selectable by the flight crew. Independent attitude, direction and air data sources are used for CAPT and F/O displays of primary flight information. In case of failure of the data source, a FWS alert is displayed on the WD (warning display) and a crew action is performed as per procedure to select the adequate source.

response

Partially accepted

Text is amended to remove automatic switching as a recommendation.

resulting text

CHAPTER 6.
ORGANISING ELECTRONIC DISPLAY INFORMATION ELEMENTS

36. Organising Information Elements.
...
e. Methods of Reconfiguration.
...
(2) Sensor Selection and Annunciation.
(a) Automatic switching of sensor data to the display system should be considered ~~is recommended~~, especially with highly integrated display systems to address those cases where multiple failure conditions may occur at the same time and require immediate flight crew action. Manual switching may be acceptable ~~in less complex systems or if immediate flight crew action is not required~~.

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 7. ELECTRONIC DISPLAY SYSTEM CONTROL DEVICES p. 80-83

comment

20 comment by: *Thales Avionics SA*

NPA paragraph §b(2)(b)6 ; sentence "*…If the initial response to a control input is not the same as the final expected response, a means of indicating the status of the pilot input should be made available to the flight crew*."

The text mentioned above is not clear enough to be used as a guidance particularly “initial response to a control input” compare to “final expected response” is not understood. What is the initiated state which is not in the effective response ? Suspected root cause is a kind of failure or normal response ?

Proposed change :
To give an other wording less ambiguous with one or two typical examples of situation to be avoided.

response

Not accepted

This refers to normal operation. The objective is to provide feedback to the flight crew that the system is operating after a selection.

comment

21 comment by: *Thales Avionics SA*

NPA paragraph §c. Cursor Control Devices ; line (2) "… *The safety assessment of the CCD should address reversion to alternate means of control following loss of the CCD. This includes an assessment on the impact of the failure on flight crew workload*"

This type of safety assessment about a provided reversion device can be only made at system level not at CCD level.

Proposed change :
To move this guidance from level §.c “Cursor Control Devices” to a higher level in Chapter 7 dedicated to a system display considerations, gathered with others equivalent cases .

response

Partially accepted

The lead-in sentence is revised for clarification.

comment

22 comment by: *Thales Avionics SA*

NPA paragraph §c. Cursor Control Devices ; line "…*Additional guidance on cursor control is contained in AC 20-145, Guidance for Integrated Modular Avionics (IMA) that Implement TSO-C153 Authorized Hardware Elements*"

The call for FAA AC20-145 as guidance is only relevant about § 16. “HUMAN FACTORS AND FLIGHT CREW INTERFACE GUIDANCE.”. Reference to TSO C153 is not adapted in this text, furthermore EASA is not supporting this TSO C153 neither to develop a corresponding ETSO.

Proposed change :
(1) To catch relevant guidance from AC20-145 §16 in order to fill in the present Chapter 7.
(2) To remove completely the above referenced sentence from NPA.

response

Accepted

	Reference is removed.

comment	*65* comment by: *AIRBUS* B. – III. - AMC 25.11 – Chapter 7 – paragraph 41.b.(2)(b) 6 in page 81 Proposed text: After the 2nd sentence: "The initial indication of a response to a soft control input should take no longer than 250 milliseconds." Add the following text: "If exceeded, the applicant should justify its acceptability." Justification: As far as practicable, graphical local feed back allow to insure a response time below 250ms. When no graphical local feed back can be implemented because the feed back needs the contribution of several systems, the response time can be in some cases greater than 250ms. Consequences should be assessed for acceptability.
response	*Not accepted* This is AMC only and any deviation will need to be justified by the applicant.

resulting text

CHAPTER 7.
ELECTRONIC DISPLAY SYSTEM CONTROL DEVICES

41. General.

c. Cursor Control Devices.

When the input device ... unique to CCDs. ~~Additional guidance on cursor control is contained in AC 20-145, *Guidance for Integrated Modular Avionics (IMA) that Implement TSO-C153 Authorized Hardware Elements.*~~

(1) ...
(2) The safety assessment ~~of the CCD~~ should ...

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Content - CHAPTER 8 SHOWING COMPLIANCE FOR APPROVAL OF ELECTRONIC DISPLAY SYSTEMS p. 83-85

comment	*4* comment by: *CAA-NL* Under (e) Test on page 85: Reverence is made to an approved test plan, with either the FAA or its designated representative present. We assume that in the European context the EASA or its Certification Specialist is meant.
response	*Accepted*

Text is amended.

resulting text

CHAPTER 8

SHOWING COMPLIANCE FOR APPROVAL OF ELECTRONIC DISPLAY SYSTEMS

46. Compliance Considerations (Test and Compliance).

b. Means of compliance

...

4(e) Test.

This means of compliance is conducted in a manner very similar to evaluations (see above), but is performed on conformed systems (or conformed items relevant to the test), in accordance with an approved test plan, and may be witnessed by the Agency~~with either the FAA or its designated representative present~~. A test can be conducted on a test bench, in a simulator, and/or on the actual aeroplane, and is often more formal, structured, and rigorous than an evaluation.

B. Draft Decision - III. AMC 25-11: Electronic Flight Deck Displays - Appendix 1 p. 87-92

comment

16 comment by: *Thales Avionics SA*

NPA paragraph § 2.1 : Airspeed and Altitude; sentence : "*Airspeed scale graduations in 5-knot increments with graduations labelled at 20-knot intervals are acceptable."*

For the airspeed scale graduations, the requirement to have graduations labelled at 20 kts intervals is more stringent than ETSO C2 and SAE AS 8019A.

Proposed change :
To keep the text from SAE AS 8019A : “The display shall include sufficient numerals positioned to permit quick and positive identification of each graduation.“

response

Not accepted

The aim of AMC is to provide a means of compliance that can be practically applied. The applicant may offer alternative solutions that meet the safety intent.

comment

17 comment by: *Thales Avionics SA*

NPA paragraph § 2.1 : Airspeed and Altitude; sentence : "*Minimum altimeter graduations should be in 100-foot increments with a present value readout, or 50-foot increments with a present value index only*".

The altimeter graduations requirements are not ETSO C10 compliant : SAE AS 392C requires that "*Markings shall be provided at intervals not exceeding 20 feet of altitude with major increment markings at 100 foot intervals*".

Proposed change :
To keep the text from SAE AS 392C

response

Partially accepted

The intent of the comment is accepted as ETSOs for instruments are applicable to electronic displays. However, the Agency has issued approved deviations from this standard, so the existing text is deleted and replaced by a reference to EASA's website that contains the list of ETSOs including the approved deviations.

comment

18 comment by: *Thales Avionics SA*

NPA paragraph § 2.1 : Airspeed and Altitude; sentence : " *Due to operational requirements, it is expected that aeroplanes without either 20-foot scale graduations or a readout of present value, will not be eligible for Category II low visibility operation with barometrically determined decision heights* ".

Is the CAT II low visibility operation with barometrically determined decision heights defined in CS-AWO ? Other EASA CS ? This sentence is probably not correct.

Proposed change :
To remove it.

response

Accepted

comment

66 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Appendix 1 – paragraph 4 in page 91

Proposed text:
In the 2nd paragraph, after the 2nd sentence "The FPV display on the HUD should be conformal with the outside view when the FPV is within the HUD field of view."
Add the following:
"The pilot should be informed when and where the FPV may be non-conformal (eg., by FPV symbol change)."

Justification:
On AIRBUS aircraft, the FPV conformal zone is limited by peripheral scales (speed scale, roll scale, altitude scale) in order to reduce the clutter. In de-cluttered levels, where some scales may be removed, the conformal zone is enlarged. Where the FPV is non-conformal, the symbol shape is modified (ghosted).

response

Noted

Already addressed in Appendix 1: Paragraph 4
"The normal FPV, the field-of-view limited FPV, and the caged FPV should each have a distinct appearance, so that the pilot is aware of the restricted motion or non-conformality."

comment 67 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Appendix 1 – paragraph 4 in page 91

Proposed text:
At the end of the 3rd paragraph, add the following:
"Exceptions for not displaying attitude, pitch and rolls symbols in some specific operations or unusual conditions, are acceptable if the applicant justifies an equivalent level of safety by compensating design features and/or by evaluation."

Justification:

- On AIRBUS A/C during APP (e.g. below DH) and VMC conditions, in order to provide maximum external visibility, only FPV and related symbols can be displayed on the HUD upon pilot request (attitude pitch and roll symbols are removed). For all other cases, attitude pitch and roll symbols are permanently and prominently displayed on the HUD.
- On Airbus A/C, in dynamic conditions such as unusual attitude recovery, Airbus recommends to revert to HDD. It has been already assessed positively by both EASA and FAA that this reversion is acceptable to recover a safe attitude in this situation (prominent message "EXCESSIVE ATT REVERT TO PFD" displayed on the HUD).

response *Not accepted*

The applicant may offer alternative solutions that meet the safety intent.

comment 68 comment by: *AIRBUS*

B. – III. - AMC 25.11 – Appendix 1 – paragraph 4 in page 91

Proposed text:
At the end of the 4th paragraph, add the following:
"in accordance with CS 25.1309."

Justification:
The level of safety for FPV/FPA design will be based on hazard classifications and safety objectives as per CS 25.1309 process, which are dependant of the aircraft features and architecture.

response *Not accepted*

CS 25.1309 is applicable throughout.

resulting **Appendix 1**

text

Primary Flight Information

...

...

2.1 Airspeed and Altitude

...

~~Airspeed scale graduations in 5-knot increments with graduations labelled at 20-knot intervals are acceptable. In addition, a means to rapidly identify a change in airspeed (for example, speed trend vector or acceleration cue) should be provided on moving scale tapes; if trend or acceleration cues are used, or a numeric present value readout is incorporated in the airspeed display, scale markings at 10-knot intervals are acceptable.~~

~~Minimum altimeter graduations should be in 100-foot increments with a present value readout, or 50-foot increments with a present value index only. Due to operational requirements, it is expected that aeroplanes without either 20-foot scale graduations or a readout of present value, will not be eligible for Category II low visibility operation with barometrically determined decision heights.~~

For acceptable means of compliance and guidance material on instrument graduations and markings, refer to the latest ETSOs and list of approved deviations on EASA's website (www.easa.europa.eu).

Annex 1: Revised AMC 25.1322

Table of Contents

1. Purpose. This AMC provides an acceptable means of compliance and guidance material for showing compliance with certain requirements of CS-25, for the design approval of flight crew alerting functions. This AMC addresses the type of alert function elements that should be considered (including visual, aural, and tactile or haptic elements), alert management, interface or integration of alerts with other systems, and colour standardisation. The appendices to this AMC also provide examples for including visual and aural system elements in an alerting system.

2. Scope

a. This AMC is applicable to aeroplane manufacturers, modifiers, avionics manufacturers, EASA type-certification engineers, human factor specialists and test pilots.

b. This AMC is applicable to new aeroplanes. It may also be applicable to modified aeroplanes and to integrating flight crew alerting system elements into existing aeroplanes. It applies to individual aircraft systems that provide flight crew alerting functions that may or may not be integrated with a central alerting system, as well as to systems whose primary function is alerting, such as a central alerting system.

3. Related Examples, Certification Specifications, Documents, and Definitions. Appendix 1 of this AMC provides examples for including visual system elements in an alerting system. Appendix 2 of this AMC provides examples for including aural system elements in an alerting system. Appendix 3 of this AMC lists the airworthiness and operational certification specifications related to this AMC. Appendix 4 of this AMC lists related AMCs and other documents that are provided for information purposes and are not necessarily directly referenced in this AMC. Appendix 5 provides definitions written to support the content of this AMC and its associated certification specification.

4. Background.

a. While the flight crew is ultimately responsible for the operation of the aeroplane, the provision of an alerting system that aids the flight crew in identifying non-normal operational or aeroplane system conditions and in responding in an appropriate and timely manner is an essential feature of every flight deck design. In the past, aeroplanes were designed with discrete lights for the alerting function. Now the alerting function can be integrated with other systems, including electronic display systems, tactile warning systems, and aural warning or tone generating systems.

b. CS-25 often provides references to an alert, such as a warning, to provide awareness of a non-normal condition. Many of these certification specifications were written without recognition of a consistent flight deck alerting philosophy, and may use the term “warning” and “alert” in a generic sense. This AMC does not intend to conflict with or replace the intent of those certification specifications. The intent here is to standardise flight crew alerting terminology used and to provide a means for applicants to show compliance with those certification specifications.

5. Designing a Flight crew Alerting System.

a. General. The purpose of flight crew alerts on aeroplanes is to attract the attention of the flight crew, to inform them of specific non-normal aeroplane system conditions or certain non-normal operational events that require their awareness, and, in modern alerting systems, to advise them of possible actions to address these conditions. The ability of an alert to accomplish its intent depends on the design of the complete alert function. This includes the sensor and the sensed condition required to trigger an alert, how that information is subsequently processed, including the level of urgency and priority assigned, and the choice of alert presentation elements to express the assigned level of urgency. Conditions that do not require flight crew awareness should not generate an alert.

b. Flight crew Alerting Philosophy. When developing a flight crew alerting system, use a consistent philosophy for alerting conditions, urgency and prioritisation, and presentation.

(1) Alerting conditions. Establish how aeroplane system conditions or operational events that require an alert (for example, engine overheating, windshear, etc.), will be determined.

(2) Urgency and Prioritisation. Establish how the level of urgency (Warning, Caution and Advisory) associated with each alerting condition will be prioritised and classified to meet the requirements listed in CS 25.1322(b) and CS 25.1322(c)(1). If an alert's urgency and prioritisation is context sensitive, state what information should be considered (for example, the priority associated with different alerting conditions may vary depending on the state of the aeroplane, phase of flight, system configuration, etc.).

(3) Presentation. Establish a consistent alert presentation scheme (for example, location of the alert on the flight deck, alert combinations [aural, visual, tactile], information presented in the Alert message, and colour and graphical coding standardisation). Also, determine the format in which that alert will be presented (for example, structure and timing of Alert messages) to support the alerting function's purpose.

c. Design Considerations. Consider the following concepts and elements when designing an alerting system:

(1) Only non-normal aeroplane-system conditions and operational events that require flight crew awareness to support flight crew decision making and facilitate the appropriate flight crew response should cause an alert. However, conditions that require an alert depend on the specific system and aeroplane design, and overall flight-deck philosophy. For example, the failure of a single sensor in a multi-sensor system may not necessarily result in an alert condition that requires pilot awareness. However, for a single sensor system, such a failure should result in an alert condition that provides the flight crew with the information needed to assure continued safe flight and landing.

(2) All alerts presented to the flight crew, (for example, light, aural annunciation, engine-indication-and-crew-alerting system (EICAS) message, master caution) must provide the

flight crew with the information needed to identify the non-normal operational or aeroplane system condition and determine the corrective action, if any (CS 25.1322 (a)(1)). Appropriate flight crew corrective actions are normally defined by aeroplane procedures (for example, in checklists) and are part of a flight crew training curriculum or considered basic airmanship.

(3) Implement a consistent flight crew alerting philosophy as described in paragraph 5.b of this AMC.

(4) Include the appropriate combination of alerting system presentation elements, which typically include:

(a) Master visual alerts

(b) Visual alert information (includes Failure flag indications)

(c) Master aural alerts

(d) Voice information

(e) Unique tones (unique sounds)

(f) Tactile or haptic information

(5) Use logic-based integrated alerting systems to ensure that alerting system elements are synchronised and provide the proper alert presentation format for each urgency level. For example, the onset of the Master visual alert should normally occur simultaneously with the onset of the Master aural alert.

(6) Present the alerts according to the urgency and prioritisation philosophy outlined in paragraph 5.b and described in detail in paragraph 8.a of this AMC.

(7) Visual alerts must conform to the colour convention of CS 25.1322(e). Paragraph 11 of this AMC provides guidance on the colour convention.

(8) If using aural alerts with multiple meanings, a corresponding visual, tactile, or haptic alert should be provided to resolve any potential uncertainty relating to the aural alert and clearly identify the specific alert condition.

6. Alert Functional Elements. The functional elements used in the alerting and information functions for Warning and Caution alerts must provide timely attention-getting cues, resulting in immediate flight crew awareness, through at least two different senses (CS 25.1322(c)(2)). Functional elements used for Advisory alerts do not require immediate flight crew awareness and are normally provided through a single sense.

a. Warning Alerts. Several alert functional element combinations are used to comply with CS 25.1322(c)(2) (two-senses requirement). The typical alert-element combinations for Warning alerts (not including Time-critical warning alerts) are shown below.

(1) Master visual alert, Visual alert information, and Master aural alert.

(2) Master visual alert, Visual alert information, and Voice information or Unique tone.

Note 1: Voice information may be preceded by a Master aural alert.

Note 2: A tactile alert may be combined with a visual or aural alert to meet the CS 25.1322 requirement for a combination of two senses.

b. Time-Critical Warning Alerts. Some Warnings may be so time-critical for the safe operation of the aeroplane that general alerts such as a Master visual alert and a Master aural alert may not provide the flight crew with immediate awareness of the specific alerting condition that is commensurate with the level of urgency of flight crew response necessary. In such cases, Warning elements dedicated to specific alerting conditions should be provided that give the flight crew immediate awareness without further reference to other flight deck indications. Examples of such Time-critical warnings include reactive windshear and ground proximity. The alerting elements for Time-critical warnings should include:

- Unique Voice information or Unique tone, or both, for each alerting condition, and
- Unique Visual alert information in each pilot's primary field of view for each alerting condition.

Note: A unique tactile alert sensed by each pilot can also meet the CS 25.1322(c)(2) requirement for one of the two senses.

c. Master Visual and Aural Alerts. A Master visual alert and a Master aural alert may not be warranted if other visual and aural means provide more timely attention-getting characteristics. If a Master visual alert and/or a Master aural alert are used, they should aid in the overall attention-getting characteristics and the desired flight crew response and not distract the flight crew from the time-critical condition. For example, unique Visual alert information presented in each pilot's primary field of view is acceptable in place of a Master visual alert if it provides immediate awareness and sufficient attention-getting characteristics. However, an aural alert, such as an aural command to "pull up," or another sensory cue, would still be required to meet CS 25.1322(c)(2).

d. Caution Alerts.

(1) The alert elements used for Caution are typically identical to those used for Warnings, as both require immediate flight crew awareness.

(2) Some Caution alerts are related to conditions that are precursors to potential Time-critical warning conditions. In these cases, the alerting system elements associated with the Caution should be consistent with the elements for related Time-critical warnings (described in paragraph 6.b of this AMC). For example, reactive windshear warnings, ground-proximity warnings, and Caution alerts can develop into Time-critical warning alerts.

e. Advisory Alerts.

(1) The alerting and informing functional elements for advisories must meet the applicable requirements of CS 25.1322 and should include Visual alert information. Advisory information should be located in an area where the flight crew is expected to periodically scan for information.

(2) Advisory information does not require immediate flight crew awareness. Therefore, it does not require alerting that uses a combination of two senses. In addition, a Master visual alert or Master aural alert is not typically used since immediate flight crew awareness is not needed.

(3) Aural or visual information such as maintenance messages, information messages, and other status messages associated with conditions that do not require an alert may be presented to the flight crew, but the presentation of this information should not interfere with the alerting function or its use.

7. Alerting System Reliability and Integrity.

a. The alerting system, considered alone and in relation to other systems, should meet the safety objectives of the relevant system safety standards (for example, CS 25.901(b)(2), CS 25.901(c), and CS 25.1309(b)). The reliability and integrity of the alerting system should be commensurate with the safety objectives associated with the system function, or aeroplane function, for which the alert is provided.

b. When applying the CS 25.1309(b) system safety analysis process to a particular system or function that has an associated flight crew alert, assess both the failure of the system or function and a failure of its associated alert (CS 25.1309(d)(4)). This should include assessing the effect of a single (common or cascading mode) failure that could cause the failure of a system function and the failure of any associated alerting function. A failure is defined as: “An occurrence that 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.” Therefore, in conducting the safety analysis, both loss of functions and malfunctions should be considered.

c. Since the flight crew alerting function is often integrated with, or is common to, other systems, the impact of a failure or error in the alerting system must be assessed separately and in relation to other systems as required by CS 25.1309(b). The cascading effects of a failure or error in the alerting function, and in the interfacing system, should be analysed. Give special consideration to avoid alerting that, through misinterpretation, could increase the hazard to the aeroplane (CS 25.1309(c)). For example, there should not be a foreseeable way that a fire warning for one engine could be misinterpreted as a fire on a different engine.

d. Assess the reliability of the alerting system by evaluating the reduction in the safety margin if the alerting system fails. The evaluation should address:

(1) Loss of the complete alerting function.

(2) A malfunction.

(3) Loss or malfunction of one alert in combination with the system condition for which the alert is necessary.

e. The integrity of the alerting system should be examined because it affects the flight crew's trust and response when assessing an alert. Since the individual assessment of a False or Nuisance alert for a given system may lead to a specific consequence, the impact of frequent False or Nuisance alerts increases the flight crew's workload, reduces the flight crew's confidence in the alerting system, and affects their reaction in case of a real alert. For example, if False or Nuisance alerts are presented, the flight crew may ignore a real alert when it is presented.

8. Managing Alerts. Prioritise alerts so that the most urgent alert is presented first to the flight crew.

a. Rules and General Guidelines.

(1) All flight deck alerts must be prioritised into Warning, Caution, and Advisory categories (CS 25.1322(b)).

(2) To meet their intended function(s), alerts must be prioritised based upon urgency of flight crew awareness and urgency of flight crew response (§ 25.1301(a)). Normally, this means Time-critical warnings are first, other Warnings are second, Cautions are third, and Advisories are last (CS 25.1322(b)).

(3) Depending on the phase of flight, there may be a need to re-categorise certain alerts from a lower urgency level to a higher urgency level. Furthermore, prioritisation within alert categories may be necessary if the presentation of multiple alerts simultaneously would cause flight crew confusion, or the sequencing of flight crew response is important. For example, when near threatening terrain, Time-critical warnings must be prioritised before other Warnings within the Warning alert category (CS 25.1322(c)(1)). JAA TGL-12 (TAWS), also identifies situations where prioritisation within alert categories is necessary.

(4) The prioritisation scheme within each alert category, as well as the rationale, should be documented and evaluated, by following the guidance in paragraph 13, *The Showing of Compliance*, of this AMC.

(5) Documentation should include the results of analyses and tests that show that any delayed or inhibited alerts do not adversely impact safety.

b. Multiple Aural Alerts.

(1) Aural alerts should be prioritised so that only one aural alert is presented at a time. If more than one aural alert needs to be presented at a time, each alert must be clearly distinguishable and intelligible by the flight crew (CS 25.1322(a)(2)).

(2) When aural alerts are provided, an active aural alert should finish before another aural alert begins. However, active aural alerts must be interrupted by alerts from higher urgency levels if the delay to annunciate the higher-priority alert impacts the timely response of the flight crew (CS 25.1301(a)). If the condition that triggered the interrupted alert is still active, that alert may be repeated once the higher-urgency alert is completed. If more than one aural alert requires immediate awareness and the interrupted alert(s) affects the safe operation of the aeroplane, an effective alternative means of presenting the alert to the flight crew must be provided to meet the requirements of CS 25.1322(a)(1) and (a)(2).

c. Multiple Visual Alerts.

(1) Since two or more visual alerts can occur at the same time, applicants must show that each alert and its relative priority are readily and easily detectable and intelligible by the flight crew (CS 25.1322(a)(2)).

(2) When multiple alerts exist in a specific category (for example, multiple Warning alerts or multiple Caution alerts), a means for the flight crew to determine the most recent or most urgent alert must be provided (CS 25.1322(c)(1)). For example, the most recent or highest priority alert may be listed at the top of its own category. If the alert is time-critical and shares a dedicated display region, it must have the highest alerting priority to satisfy its intended function (CS 25.1301(a)).

(3) Displays must either conform to the alert colour convention or, in the case of certain monochromatic displays not capable of conforming to the colour conventions, use other visual coding techniques per CS 25.1322(e). This is necessary so the flight crew can easily distinguish the alert urgency under all foreseeable operating conditions, including conditions where multiple alerts are provided (CS 25.1322(a)(2)).

d. Alert Inhibits.

(1) Alert inhibit functions must be designed to prevent the presentation of an alert that is inappropriate or unnecessary for a particular phase of operation (CS 25.1322(d)(1)). Alert inhibits can also be used to manage the prioritisation of multiple alert conditions. Inhibiting an alert is not the same as clearing or suppressing an alert that is already displayed.

(2) Alert inhibits should be used in the following conditions:

(a) When an alert could cause a hazard if the flight crew was distracted by or responded to the alert.

(b) When the alert provides unnecessary information or awareness of aeroplane conditions.

(c) When a number of consequential alerts may be combined into a single higher-level alert.

(3) Alerts can be inhibited automatically by the alerting system or manually by the flight crew.

(4) For operational conditions not recognised by the alerting system, provide a means for the flight crew to inhibit a potential alert that would be expected to occur as the result of the specific operation (for example, preventing a landing configuration alert for a different landing flap setting). For as long as the inhibit exists, there should be a clear and unmistakable indication that the flight crew manually inhibited that alert.

9. Clearing and Recalling Alert Messages. Clearing Alert messages from the current Warning, Caution, and Advisory display allows the flight crew to remove a potential source of distraction and makes it easier for the flight crew to detect subsequent alerts.

a. The following guidance should be applied for clearing and recalling or storing Alert messages:

(1) If a message can be cleared and the condition still exists, the system should provide the ability to recall any cleared Alert message that has been acknowledged.

(2) Either through a positive indication on the display or through normal flight crew procedures, a means should be provided to identify if Alert messages are stored (or otherwise not in view).

b. The Alert message must be removed from the display when the condition no longer exists (CS 25.1322(a)(3)).

10. Interface or Integration with Other Systems (Checklist, Synoptics, Switches, Discrete lamps).

a. The colour of all visual alerting annunciations and indications must conform to the colour convention in CS 25.1322(e). Use consistent wording, position, colour and other shared attributes (for example, graphic coding) for all alerting annunciations and indications.

b. Information displayed in the flight deck associated with the alert condition must facilitate the flight crew's ability to identify the alert (CS 25.1322(a)(1)(i)) and determine the appropriate actions, if any (CS 25.1322(1)(ii)).

c. Information conveyed by the alerting system should lead the flight crew to the correct checklist procedure to facilitate the appropriate flight crew action. Some flight deck alerting systems automatically display the correct checklist procedure or synoptic display when an alert is presented. Some alerts do not display an associated checklist procedure because the correct flight crew action is covered by training or basic airmanship (for example, autopilot disconnect and Time-critical warnings). In all cases, the aeroplane or system certification test programme should verify that the alerts provide or direct the flight crew to the correct procedures.

d. If multiple checklists can be displayed (for example, multiple checklists associated with multiple alerts), the flight crew should be able to readily and easily choose the appropriate checklist and action for each alert. For example, the flight crew must be able to easily distinguish

which checklist has priority regarding what the flight crew needs to do first to determine the appropriate actions, if any (CS 25.1322(a)(1)(ii)).

11. Colour Standardisation. The objective of colour standardisation is to maintain the effectiveness of visual alerts by enabling the flight crew to readily distinguish between alert categories.

a. Visual alert indications must conform to the following colour convention (CS 25.1322(e)):

(1) Red for Warning alert indications.

(2) Amber or yellow for Caution alert indications.

(3) Any colour except red or green for Advisory alert indications.

Note: Green is usually used to indicate "normal" conditions; therefore, it is not an appropriate colour for an Advisory alert. An Advisory alert is used to indicate a "non-normal" condition.

b. A separate and distinct colour should be used to distinguish between Caution and Advisory alerts. If a distinctive colour is not used to distinguish between Caution and Advisory alerts, other distinctive coding techniques must be used to meet the general requirements of CS 25.1322(a)(2) so that the flight crew can readily and easily detect the difference between Caution and Advisory alerts.

c. The colour displayed for the Warning Master visual alert must be the same colour used for the associated Warning alerts and the colour displayed for the Caution Master visual alert must be the same colour used for the associated Caution alerts (CS 25.1322(e)(1)).

d. The colours red, amber, and yellow must be used consistently (CS 25.1322 (e)(1)). This includes alert colour consistency among propulsion, flight, navigation, and other displays and indications used on the flight deck.

e. For monochromatic displays that are not capable of conforming to the colour convention required by CS 25.1322(e)(2), use display coding techniques (for example, shape, size, and position) so the flight crew can clearly distinguish between Warning, Caution, and Advisory alerts. This requirement is similar to using selected colour coding on multicolour displays that allows the flight crew to easily distinguish between Warning, Caution, and Advisory alerts (CS 25.1322(e)). These coding techniques must also meet the general alerting requirement in CS 25.1322(a)(2) so the alerts are readily and easily detectable and intelligible by the flight crew under all foreseeable operating conditions, including conditions where multiple alerts are provided. The wide use of monochromatic displays on the flight deck with flight crew alerting is normally discouraged, except when an increased safety benefit is demonstrated, for example, a HUD used as a primary flight display.

f. CS 25.1322(f) requires that the use of the colours red, amber and yellow on the flight deck for functions other than flight crew alerting must be limited and must not adversely affect flight crew alerting. Consistent use and standardisation for red, amber, and yellow is required to retain the effectiveness of flight crew alerts. It is important that the flight crew does not become desensitised to the meaning and importance of colour coding for alerts, which could increase the flight crew's processing time, add to their workload, and increase the potential for flight crew confusion or errors.

g. Where red, amber and yellow are proposed for non-flight crew alerting functions, substantiate that there is an operational need to use these colours to provide safety related awareness information. Examples of acceptable uses of red, amber, or yellow for non-alerting functions include:

- Weather radar display (for areas of severe/hazardous weather conditions that should be avoided);
- TAWS terrain display (for local terrain relative to the current altitude).

12. Minimising the Effects of False and Nuisance Alerts. As much as possible, the alerting functions or system should be designed to avoid False alerts and Nuisance alerts, while providing reliable alerts to the flight crew when needed. The effects of Nuisance and False alerts distract the flight crew, increase their potential for errors, and increase their workload. CS 25.1322(d) requires that an alert function be designed to minimise the effects of False and Nuisance alerts. Specifically, a flight crew alerting system must be designed to:

a. Prevent the presentation of an alert when it is inappropriate or unnecessary.

b. Provide a means to suppress an attention-getting component of an alert caused by a failure of the alerting system that interferes with the flight crew's ability to safely operate the aeroplane. This means must not be readily available to the flight crew so that it can be operated inadvertently or by habitual, reflexive action.

c. Permit each occurrence of attention-getting cues for Warning and Caution alerts to be acknowledged and then suppressed, unless the alert is required to be continuous (CS 25.1322(c)). Reaching forward and pressing a switch light is a common, acceptable means of suppressing the attention-getting components of an aural alert, a flashing master warning, or a caution light.

d. Remove the presentation of the alert when the condition no longer exists (CS 25.1322(a)(3)).

e. Pulling circuit breakers is not an acceptable primary means for the flight crew to suppress a False alert.

13. The Showing Of Compliance

a. Certification evaluations may be different from project to project because of the complexity, degree of integration, and specifics of the proposed alerting function or system. We

recommend developing a plan to establish how compliance with the rules will be shown and to document how issues will be identified, tracked, and resolved throughout the life cycle of the type investigation programme. We also recommend including the Agency early in the developmental process to discuss the acceptability of any proposed flight deck design and alerting philosophy and the conditions that should be alerted to the flight crew. Typically, the certification programme is used for this purpose. For addressing human factors and pilot interface issues, in addition to the guidance in this AMC, compliance with CS 25.1302 and associated AMC must be shown.

b. When following the guidance in this AMC, document any divergence from this AMC, and provide the rationale for decisions regarding novel or unusual features used in the design of the alerting system. This will facilitate the certification evaluation because it will enable the Agency to focus on areas where the proposed system diverges from the AMC and has new or novel features.

c. In accordance with the certification programme, provide an evaluation of the alerting system. In this case an evaluation is an assessment of the alerting system conducted by an applicant, who then provides a report of the results to the Agency. Evaluations are different from tests because the representation of the alerting system does not necessarily conform to the final documentation and the Agency may or may not be present. Evaluations by the applicant may contribute to a finding of compliance, but they do not constitute a complete showing of compliance by themselves.

(1) The evaluation should include assessments of acceptable performance of the intended functions, including the human-machine interface, and acceptability of alerting system failure scenarios. The scenarios should reflect the expected operational use of the system. Specific aspects that should be included during the evaluation(s) are:

(a) Visual, aural, and tactile/haptic aspects of the alert(s).

(b) Effectiveness of meeting intended function from the human/machine integration, including workload, the potential for flight crew errors, and confusion.

(c) Normal and emergency inhibition and suppression logic and accessibility of related controls.

(d) Proper integration with other systems, including labelling. This may require testing each particular alert and verifying that the appropriate procedures are provided.

(e) Acceptability of operation during failure modes per CS 25.1309.

(f) Compatibility with other displays and controls, including multiple Warnings.

(g) Ensuring that the alerting system by itself does not issue Nuisance alerts or interfere with other systems.

(h) Inhibiting alerts for specific phases of flight (for example, take-off and landing) and for specific aeroplane configurations (for example, abnormal flaps and gear).

(2) The validation of the performance and integrity aspects will typically be accomplished by a combination of the following methods:

- Analysis
- Laboratory test
- Simulation
- Flight test

(3) Evaluate the alerts in isolation and combination throughout the appropriate phases of flight and manoeuvres, as well as representative environmental and operational conditions. The alerting function as a whole needs to be evaluated in a representative flight deck environment. Representative simulators can be used to accomplish the evaluation of some human factors and workload studies. The level and fidelity of the simulator should be commensurate with the certification credit being sought. The simulator should represent the flight deck configuration and be validated by the Agency. The assessment of the alerts may be conducted in a laboratory, simulator, or the actual aeroplane. Certain elements of the alerting system may have to be validated in the actual aeroplane. The evaluation should be conducted by a representative population of pilots with various backgrounds and expertise.

(4) Evaluations should also verify the chromaticity (red looks red and amber looks amber) and discriminability (colours can be distinguished from each other) of the colours being used, under the expected lighting levels. Evaluations may also be useful to verify the discriminability of graphic coding used on monochromatic displays. These evaluations can be affected by the specific display technology being used, so a final evaluation with production representative hardware is sometimes needed.

14. Integrating Flight crew Alerting System Elements into the Existing Fleet.

a. General.

(1) This material provides recommendations to applicants on how to retrofit existing aeroplanes so they comply with CS 25.1322 without major modifications to the current flight crew alerting system.

(2) System upgrades to existing aeroplanes should be compatible with the original aeroplane’s flight crew alerting philosophy. The existing alerting system might not be able to facilitate the integration of additional systems and associated alerts due 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.

(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.

Appendix 1

Examples for Including Visual System Elements in an Alerting System

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 AC 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 (CS 25.1322(e)(1)(i)). When displaying Time-critical warnings on monochromatic displays, other graphic coding means must be used (CS 25.1322(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).

Appendix 2

Examples for Including Aural System Elements in an Alerting System

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 heard by the flight crew if the level of flight deck noise subsequently increases.

(b) We recommend automatic volume control to maintain an acceptable signal-to-noise ratio.

g. Onset and Duration.

(1) The onset of Voice information should occur:

(a) In a timeframe appropriate for the alerting condition and the desired response.

(b) Simultaneously with the onset of its related Visual alert information. Any delays between the onset of the Voice information and its related visual alert should not cause flight crew distraction or confusion.

(c) Simultaneously at each pilot's station, if more than one source of the Voice information is provided for the same condition, so that intelligibility is not affected.

(2) The duration of Voice information associated with Time-critical warnings should continue until the alerting condition no longer exists (for example, terrain warning). The Voice information should be repeated and non-cancelable during this time.

(3) Voice information associated with Time-critical warnings and Cautions should *not* be repeated if it interferes with the flight crew's ability to respond to the alerting condition (for example, windshear warning, or ACAS II resolution advisory).

(4) To support the flight crew in taking corrective action Voice information associated with Warnings should be repeated and non-cancelable if the flight crew needs continuous awareness that the condition still exists.

(5) Voice information associated with Warnings should be repeated and cancelable if the flight crew does not need continuous aural indication that the condition still exists (for example, Cabin Altitude Warning or Autopilot Disconnect).

(6) Reset the alerting mechanisms after cancelling them so they will annunciate any subsequent fault condition.

(7) For voice alerts associated with a Caution alert, the corresponding Voice information should either:

(a) Be limited in duration (for example, ACAS II Traffic Advisory or Windshear Caution), or

(b) Be continuous until the flight crew manually cancels it or the Caution condition no longer exists.

h. Voice Information Content.

(1) The content should take into account the flight crew's ability to understand the English language.

(2) When practical, Voice information should be identical to the alphanumeric text message presented on the visual information display. If that is not possible, the Voice information and alphanumeric messages should at least convey the same information, so it is readily understandable and initiates the proper pilot response.

(3) For Time-critical warnings, the content and vocabulary of Voice information must elicit immediate (instinctive) directive corrective action (CS 25.1322(a)(2)). In order to do this, it should identify the condition triggering the alert. In some cases, it may also be necessary to provide guidance or instruction information.

(4) For Warning and Caution alerts, the content of Voice information must provide an indication of the nature of the condition triggering the alert (CS 25.1322(a)(2)). The Voice information should be descriptive and concise.

(5) The content should be consistent with any related visual information display (for example, Aural: “Pull up”; Visual: “Pull up” on the PFD.)

(6) Structure Voice information that uses more than one word so if one or more words are missed the information will not be misinterpreted (for example, avoid the word “don’t” at the beginning of a voice message).

(7) Design Voice information so the flight crew can easily distinguish one spoken word message from another to minimise confusion.

Appendix 3

Regulations

The following related documents are provided for information purposes and are not necessarily directly referenced in this AMC. The full text of CS-25 can be downloaded from the Internet at http://easa.europa.eu/agency-measures/certification-specifications.php.

CS-25 Paragraph	Subject
CS 25.207	Stall warning
CS 25.253(a)(2)	High-speed characteristics
CS 25.672(a)	Stability-augmentation and automatic and power-operated systems
CS 25.679(a)	Control system gust locks
CS 25.699	Lift and drag device indicator
CS 25.703	Take-off warning system
CS 25.729(e)	Retracting mechanism
CS 25.783(e)	Fuselage Doors
CS 25.812(f)(2)	Emergency lighting
CS 25.819(c)	Lower deck service compartments
CS 25.841(b)(6)	Pressurised cabins
CS 25.854(a)	Lavatory fire protection
CS 25.857(b)(3), (c)(1), (e)(2)	Cargo compartment classification
CS 25.859(e)(3)	Combustion heater fire protection
CS 25.863(c)	Flammable fluid fire protection
CS 25.1019(a)(5)	Oil strainer or filter
CS 25.1165(g)	Engine ignition systems
CS 25.1203(b)(2), (b)(3), (f)(1)	Fire-detector system
CS 25.1302	Installed systems and equipment for use by the flight crew
CS 25.1303(c)(1)	Flight and navigation instruments
CS 25.1305(a)(1), (a)(5), (c)(7)	Powerplant instruments

CS-25 Paragraph	**Subject**
CS 25.1309(a), (b), (c), (d)(4)	Equipment, systems, and installations
CS 25.1322	Flight crew Alerting
CS 25.1326	Pitot heat indication systems
CS 25.1329	Flight guidance system
CS 25.1331(a)(3)	Instruments using a power supply
CS 25.1353(c)(6)(ii)	Electrical equipment and installations
CS 25.1419(c)	Ice protection
CS 25.1517(3)	Rough air speed, V_{RA}
CS 25.1549	Powerplant and auxiliary power unit instruments
CS 25J1305	APU Instruments
CS-25 Appendix I, I 25.6	Automatic Take-off Thrust Control System (ATTCS) Powerplant controls
CS-AWO 153	Audible warning of automatic pilot disengagement
CS-AWO 253	Audible warning of automatic pilot disengagement
CS-AWO 352	Indications and warnings

Appendix 4

Related Documents

1. FAA Reports. A paper copy of the following reports may be ordered from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

a. Report DOT/FAA/RD-81/38, II, "Aircraft Alerting Systems Standardisation Study, Volume II, Aircraft Alerting Systems Design Guidelines."

b. Report DOT/FAA/CT-96/1, GAMA Report No. 10, "Recommended Guidelines for Part 23 Cockpit/Flight Deck Design" (September 2000), Section 4, Definitions, Primary Field of View.

2. ACs. An electronic copy of the following ACs can be downloaded from the Internet at http://rgl.faa.gov. A paper copy may be ordered from the U.S. Department of Transportation, Subsequent Distribution Office, M-30, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20795.

Number	Title
AC 20-69	Conspicuity of Aircraft Malfunction Indicators
AC 20-88A	Guidelines on the Marking of Aircraft Powerplant Instruments (Displays)
AC 25-7A, Change 1	Flight Test Guide for Certification of Transport Category Airplanes
AC 25-11A	Electronic Flight Deck Displays
AC 25-23	Airworthiness Criteria for the Installation Approval of a Terrain Awareness and Warning System (TAWS) for Part 25 Airplanes
AC 25.703-1	Takeoff Configuration Warning Systems
AC 25.783-1A	Fuselage Doors and Hatches
AC 25.1309-1A	System Design and Analysis
AC 25.1329-1B	Approval of Flight Guidance Systems
AC 25.1523-1	Minimum Flightcrew

3. Technical Standard Order (TSO). TSO C-151b, "Terrain Awareness and Warning Systems," can be downloaded from the Internet at http://rgl.faa.gov.

4. European Aviation Safety Agency (EASA) Documents. Copies of the following documents can be found on the EASA website at http://www.EASA.europa.eu.

Number	Title
AMC 25-11	Electronic Display Systems
AMC 25.1302	Installed Systems and Equipment for Use by the Flightcrew
AMC 25.1309	System Design and Analysis
AMC 25.1322	Alerting Systems

5. U.K. Civil Aviation Authority Document. Patterson, R.D. "Guidelines for Auditory Warning Systems on Civil Aircraft." Civil Aviation Authority paper 82017. London: Civil Aviation Authority, 1982.

6. Other Related Documents.

a. Abbott, K.; Slotte, S.M.; and Stimson, D.K. Federal Aviation Administration Human Factors Team Report: *The Interfaces Between Flightcrews and Modern Flight Deck Systems*. June 18, 1996. Federal Aviation Administration, Aircraft Certification Service, Transport Airplane Directorate, 1601 Lind Avenue, SW, Renton, WA 98057-3356. http://www.faa.gov/aircraft/air_cert/design_approvals/csta/publications/media/fltcrews_fltdeck.pdf.

b. DOD-CM-400-18-05, *Department of Defense User Interface Specifications for the Defense Information Infrastructure*, Defense Information Systems Agency, February 1998. E-mail: cio-pubs@disa.mil. The Defense Information Systems Agency website is restricted to visitors from .gov and .mil domains.

c. Edworthy, J. and Adams. A. *Warning Design: A Research Perspective*. London: Taylor and Francis, 1996. Mortimer House, 37-41 Mortimer Street, London, W1T 3JH. http://www.taylorandfrancis.com.

d. Kuchar, J.K. "Methodology for alerting-system performance evaluation." *Journal of Guidance, Control, and Dynamic*s, 19, pp. 438-444 (1996). AIAA, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191. http://www.aiaa.org/content.

e. Parasuraman, R. and Riley, V. "Human and Automation: use, misuse, disuse, abuse." *Human Factors: The Journal of the Human Factors and Ergonomics Society*, Volume 39, Number 2, June 1997, pp. 230-253. Human Factors and Ergonomics Society, PO Box 1369, Santa Monica, CA 90406-1369. http://hfes.publisher.ingentaconnect.com/.

f. SAE ARP 4033. *Pilot-System Integration*, August 1, 1995. SAE International, 400 Commonwealth Drive, Warrendale, PA 15096. http://www.sae.org.

g. Satchell, P. *Cockpit Monitoring and Alerting System*. Aldershot, England: Ashgate, 1993. Summit House, 170 Finchley Road, London NW3 6BP, England. http://www.ashgate.com.

Appendix 5

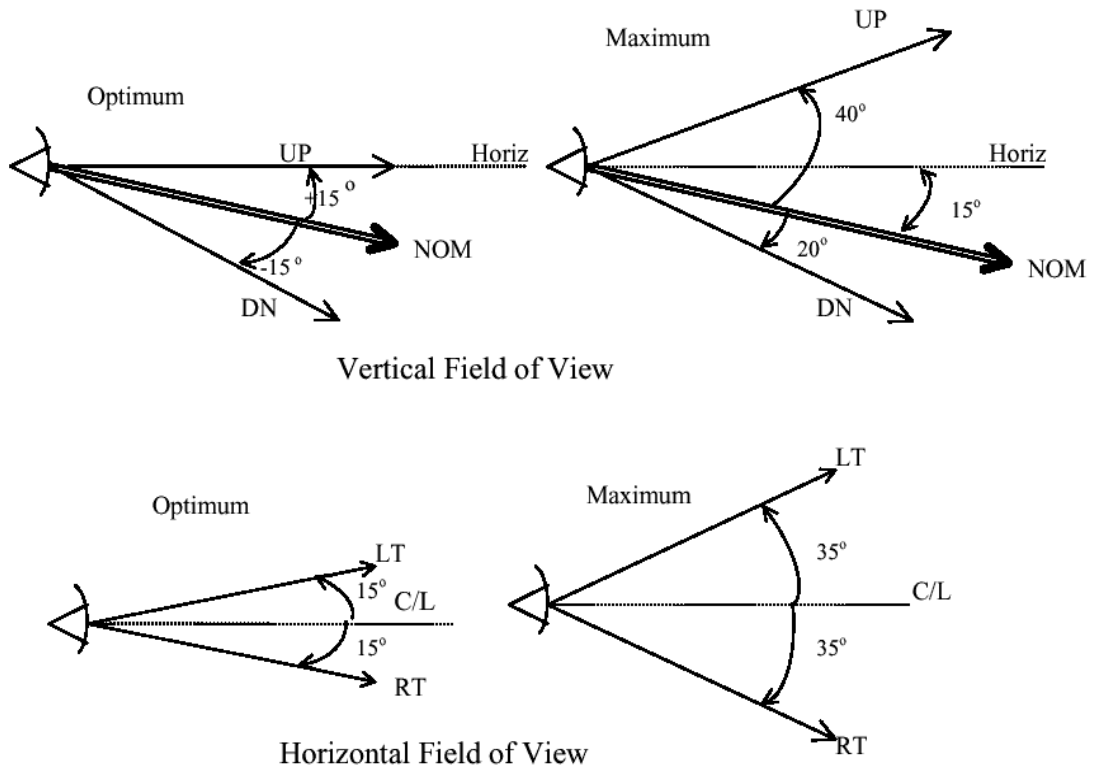
Definitions

Definitions are written to support the content of this AMC and its associated certification specification. Elsewhere, terms such as "warning" may be used in a manner that is not consistent with the definitions below. However, the intent of this section is to facilitate standardisation of these terms.

Term	**Definition**
Advisory	The level or category of alert for conditions that require flight crew awareness and may require subsequent flight crew response.
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. Alerts are classified at levels or categories corresponding to Warning, Caution, and Advisory. Alert indications also include non-normal range markings (for example, exceedences on instruments and gauges.)
Alert inhibit	Application of specific logic to prevent the presentation of an alert. Alerts can be inhibited automatically by the alerting system or manually by the flight crew.
Alert message	A visual alert comprised of text, usually presented on a flight deck display. *Note: Aural Alert messages are referred to as "Voice Information."*
Alerting function	The aeroplane function that provides alerts to the flight crew for non-normal operational or aeroplane system conditions. This includes Warning, Caution, and Advisory information.
Alerting philosophy	The principles, guidance, and rules for implementing alerting functions within a flight deck. These typically consider: 1. The reason for implementing an alert. 2. The level of alert required for a given condition. 3. The characteristics of each specific alert. 4. Integration of multiple alerts.

Term	Definition
Attention-getting cues	Perceptual signals (visual, auditory, or tactile/haptic) designed to attract the flight crew's attention in order to obtain the immediate awareness that an alert condition exists.
Caution	The level or category of alert for conditions that require immediate flight crew awareness and a less urgent subsequent flight crew response than a warning alert.
Collector message	An Alert message that replaces two or more related Alert messages that do not share a common cause or effect. Example: A "DOORS" alert Collector message is displayed when more than one entry, cargo, or service access door is open at the same time.
Communication message	A type of message whose initiating conditions are caused by incoming communications, primarily data link conditions. Traditionally, this type of message is not a flight crew alert and does not indicate a non-normal system or operational condition.
(1) Comm High	A communication message which requires immediate flight crew awareness and immediate flight crew response. *Note: At this time there are no communication messages defined that require immediate flight crew response.*
(2) Comm Medium	An incoming communication message that requires immediate flight crew awareness and subsequent flight crew response.
(3) Comm Low	An incoming communication message which requires flight crew awareness and future flight crew response.
False alert	An incorrect or spurious alert caused by a failure of the alerting system including the sensor.
Failure	An occurrence that 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.

Term	Definition
Failure flag	One local visual means of indicating the failure of a displayed parameter.
Flashing	Short term flashing symbols (approximately 10 seconds) or flash until acknowledged.
Flight crew response	The activity accomplished due to the presentation of an alert such as an action, decision, prioritisation, or search for additional information.
Master aural alert	An overall aural indication used to attract the flight crew's attention that is specific to an alert urgency level (for example, Warning or Caution).
Master visual alert	An overall visual indication used to attract the flight crew's attention that is specific to an alert urgency level (for example, Warning or Caution).
Normal condition	Any fault-free condition typically experienced in normal flight operations. Operations are typically well within the aeroplane flight envelope and with routine atmospheric and environmental conditions.
Nuisance alert	An alert generated by a system that is functioning as designed but which is inappropriate or unnecessary for the particular condition.
Primary field of view	Primary Field of View is based upon the optimum vertical and horizontal visual fields from the design eye reference point that can be accommodated with eye rotation only. The description below and Figure A5-1 provide 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. For the horizontal visual field (relative to normal line-of-sight forward of the aircraft), the values are +/-15 degrees optimum, and +/-35 degrees maximum.

Term	Definition
 **Figure A5-1. Primary Field of View**	
Status	A specific aircraft system condition that is recognised using a visual indication, but does not require an alert and does not require flight crew response. These types of messages are sometimes used to determine aeroplane dispatch capability for subsequent flights.
Tactile/haptic information	An indication means where the stimulus is via physical touch, force feedback, or vibration (for example, a stick shaker).

Term	Definition
Time-critical warning	A subset of warning. The most urgent warning level to maintain the immediate safe operation of the aeroplane. Examples of Time-critical warnings are: • Predictive and Reactive Windshear Warnings, • Terrain Awareness Warnings (TAWS), • Airborne Collision Avoidance System (ACAS) II Resolution Advisories, • Overspeed Warnings, and • Low Energy Warnings.
Umbrella message	An Alert message that is presented in lieu of two or more Alert messages that share a common cause. Example: A single Engine Shutdown message in lieu of the multiple messages for electrical generator, generator drive, hydraulic pump and bleed air messages, which would otherwise have been displayed. This is different than a Collector message. A Collector message replaces two or more related Alert messages that do "not share" a common cause or effect.
Unique tone (unique sound)	An aural indication that is dedicated to specific alerts (for example, fire bell and overspeed).
Visual alert information	A visual indication that presents the flight crew with data on the exact nature of the alerting situation. For Advisory level alerts it also provides awareness.
Voice information	A means for informing the flight crew of the nature of a specific condition by using spoken words.
Warning	The level or category of alert for conditions that require immediate flight crew awareness and immediate flight crew response.