Disposition for Interdirectorate Comments

Advisory Circular 25.11A, Change 1, Electronic Flight Deck Displays

	Comment	Requested Change	Disposition
1.	**Commenter:** Davenport, ASW-112 6.1 Ops Concept for HUD	Shouldn't the "operational concept" of using the HUD in a certification document be restrained to the intended use of the HUD(s)? In this paragraph, it is suggesting that the manufacturer/installer of the HUD define crew-coordination-type tasks and responsibilities that may be better left to the operators and AFS. Suggest changing the intent to focus on the applicant defining how they intend the HUD be used to assist the flight crew vs. how the flight crew will perform their duties whilst using the HUD.	No change is needed. The intent of this paragraph is to be able to evaluate the suitability of the dual-HUD installation in the context of the way the flight crew would/could perform its duties. We evaluate not only compliance of the "added" equipment, but the entire airplane, as modified by the installation of the equipment. Baring any limitations that might arise from the certification evaluation, this operational concept considered for the evaluation is not meant to limit or define the operator's crew coordination procedures. The design of the HUD, together with the rest of the cockpit/flightdeck configuration, can affect the ability of the crew to perform all tasks, not just those for which the HUD is installed. If the crew's use of the dual-HUD system diminishes their awareness of other essential information, timely intervention for conditions that not alerted because the original type design assumed a vigilant crew, then that needs to be known. HUD certification activities are conducted jointly by the FAA ACO and AEG specialists. What the AEG finds concerning operational suitability during the evaluation may be included in the FSB report for recommended training and flight crew procedures. We did not change the AC in regard to this issue.
2.	**Commenter:** Davenport, ASW-112 6.1 Ops Concept for HUD	Should there be, in paragraph 6.1 or another appropriate paragraph concerning dual-HUD, discussion about a method to help the flight crew assess HUD alignment?	No change seems to be needed. Paragraph 4.6 and sub-paragraphs apply equally to HUDs of single and dual installations. We are not sure what more needs to be said for the sake of a dual-HUD installation. We did not change the AC in regard to this issue.
3.	**Commenter:** Davenport, ASW-112	Roll paragraph 6.3.1 into 6.2. Both talk about scanning HD displays while using HUD,	No change is needed. The entire section 6.0 is closely related. Section 6.2 describes issues of crew awareness, 6.3.1 is one of the elements, in addition to 6.3.2 and

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	6.3.1.		6.3.3, to be considered when defining the operational concept. We did not change the AC in regard to this issue.
4.	**Commenter:** Davenport ASW-112 6.3.2	Move the last sentence: "For any case in which at least one pilot is not scanning the head-down instruments full-time, the design should have compensating design features that ensure an equivalent level of timeliness and awareness of the information provided by the head-down visual indications" to the beginning of the paragraph. Delete the remainder of the paragraph as it relates to operational issues. How will the applicant show that they assure scanning of the HD displays absent a cue or other technological device to remind the crew to look at their HD displays (intimated in the existing last sentence)? If that is the intent, then the paragraph could state something like, "The applicant should provide a method to periodically alert the crew to monitor their HD displays"…. (or something similar but more eloquent). Rationale for deletion: This is an operational, not certification, domain. AFS/AEG and the operator should develop these procedures.	It would be possible to move the last sentence, but no change is needed. The first sentence of the current draft states the primary intent - for the applicant to explain (or justify) how the head-down scan is ensured. The last sentence is a special, though likely, condition when certain compensating features would be needed. We disagree the implication that this section is outside the scope of certification. The HUD is central to operating the airplane when it is in use, and for a dual-HUD installation, all the more. The effect that the use of this modified configuration has on routine flight operation is a key aspect of its airworthiness. The applicant is expected to study this issue during its product development, conduct piloted studies to determine the adequacy of crew awareness and provide compensating features, as necessary. The applicant should describe this so that the FAA, too, will evaluate the acceptability of the installation design for the operational concept. While alerting the crew may be an effective means to compensate for non-full time head-down scanning, it may be too prescriptive. We leave it to the applicant to provide effective compensations that the FAA will evaluate. We did not change the AC in regard to this issue.

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5.	**Commenter:** Davenport, ASW-112 6.4 Reassessment.	"The applicant should globally reassess the alerting functions to ensure that the flightcrew is aware of alerts and responds to them in a timely manner. The reassessment should review the design and techniques, the alerting attention-getting properties (e.g., visual master warning, master caution, and aural alerts), and other alerts in the flight deck. The flightcrew's awareness of alerts might differ between single- and dual-HUD installations. ~~With a dual-HUD installation, there may be periods when neither pilot is scanning the instrument panel.~~ [It is redundant to the sentence below] With a single-HUD configuration, the PNF refers only to the head-down instrument panel and may have responsibility for monitoring indications on that panel. With dual-HUD configurations, both pilots' attention may be turned to their HUDs **and neither of them is scanning the instrument panel. In these cases**, they might miss an alert that would otherwise be plainly visible to a pilot not using a HUD.	No change needed. Perhaps the sentences are somewhat redundant. The sentence the commenter wishes to delete is an assertion that the sentences which follow are meant to elaborate and support (i.e., how we got to that assertion). We did not change the AC in regard to this issue.
6.	**Commenter:** Davenport, ASW-112 3.3 Hazard Detection	The weather display echoes from precipitation and ground returns should be clear, automatic, timely, concise, and distinct so the flightcrew can easily interpret, analyze, and avoid hazards. The radar range, elevation, and azimuth indications should provide sufficient time to safely avoid the hazard [THIS SENTENCE IS UNCLEAR, SUGGEST CLARIFICATION. NOT SURE HOW INDICATIONS OF RANGE, ELEVATION, AND AZIMUTH PROVIDE TIME]	We modified the sentence, "The radar range, elevation, and azimuth indications should provide sufficient information for flight crews to safely avoid the hazard."
7.	**Commenter:** Robin Sova, ACE-114	For completeness and to reflect the latest technologies, change the last sentence to:	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion.

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	Page 12, Table 1, fifth cell	"These controls include hard controls (physical buttons and knobs) and soft controls (virtual or programmable buttons and knobs, generally controlled through a cursor device or line select keys or voice or touchscreen control)."	We did not change this part of the AC at this time.
8.	**Commenter:** Robin Sova, ACE-114 Page 14, Paragraph 5.a, first sentence	For completeness by giving more complete examples, change the last sentence to: "For the purposes of this AC, a "display system" includes not only the display hardware and software components but the entire set of avionic devices implemented to display information to the flightcrew (e.g., radios, sensors, databases, databuses, electrical wiring, computers/processors, control input devices, etc)."	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
9.	**Commenter:** Robin Sova, ACE-114 Page 29, Paragraph 21.e(3), first sentence	For correctness, change the last sentence to: "When an integrated standby display is used to provide a backup means of primary flight information, the safety analysis should substantiate that common cause failures have been adequately addressed in the system design, including the design of functions accomplished via software and complex electronic hardware."	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
10.	**Commenter:** Robin Sova, ACE-114 Page 30, Paragraph 21.e(9), first sentence	For correctness, change the last sentence to: "This means of controlling the display of information, called window manager in this AC, should be developed to the software assurance level at least as high as the highest integrity function required of any window. For example, a window manager should be level "A" if the information displayed in any window must be ~~is~~ level "A" (see RTCA DO-178B)."	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
11.	**Commenter:** Robin Sova, ACE-114 Page 67, Paragraph 41.b(2)	The first sentence addresses "Soft" Controls. This paragraph does not mention voice or touch screen controls; these should be added to this section for completeness with latest technology.	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. See AC 20-175 controls for flight deck systems for guidance for touch and voice

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			We did not change this part of the AC at this time.
12.	**Commenter:** Robin Sova, ACE-114 Page 67, Paragraph 41.b(2)(b)1, the second sentence	For correctness, it should be changed to: "The hardware and software design assurance levels and tests for the GUI and control device should be commensurate with the level of criticality of the <u>failure condition of the</u> airplane system they will control."	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
13.	**Commenter:** Robin Sova, ACE-114 Page A1-5, Section 2.2, second paragraph, fourth bullet, first sentence	For correctness, it should be changed to: "Flight tests should also be conducted in maneuvering flight and expected levels of turbulence to evaluate proper functioning of any damping routines incorporated into the <u>design of the</u> low speed awareness <u>function's</u> software…"	We did not revise this appendix of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
14.	**Commenter:** Robin Sova, ACE-114 Page A3-2, Definition of Criticality	For correctness, this definition should be changed to: **"Criticality -** Indication of the hazard level associated with a function<u>'s failure, considering abnormal behavior due to any source (including human</u>, hardware, software, etc., ~~considering abnormal behavior (of this function, hardware, software~~), alone, in combination, or in combination with external events." The original definition is inaccurate by equating "function, hardware, software"; only the result of a function's failure should matter in defining criticality, with the hardware and/or software merely being the implementers of the critical functions.	We did not revise this appendix of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
9.	**Commenter:** J. Brady, ACE-111 Appendix 5 Page A5-10 and A5-11	Partial Index of TSOs This has listed: TSO-C9c Automatic Pilots TSO-C52b Flight Director Equipment These TSOs are no longer effective, need to replace with: TSO-C198 Automatic Flight Guidance and Control	We did not revise this appendix of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.

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		System (AFGCS) Equipment Also, Page A5-18 list of RTCA documents add RTCA DO-325 Automatic Flight Guidance and Control Systems and Equipment	
10.	**Commenter:** Bulger, AIR-130 Table 1 (page 9)	The FAA is getting away from using the Class I, II, and III descriptions for EFBs. The current designations are "installed" and "portable." For Table 1, change Class III to "Display aspects of installed electronic flight bag equipment."	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
11.	**Commenter:** Bulger, AIR-130 Table 2 (page 9)	The FAA is getting away from using the Class I, II, and III descriptions for EFBs. The current designations are "installed" and "portable." For Table 2, change Class I and II to "portable electronic flight bags"	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
12.	**Commenter:** Bulger, AIR-130 Chapter 3 Paragraph 16.	Change reference from SAE AS 8034A to 8034B. 8034B is the most current version of the SAE standard and has been invoked in TSO-C113a. Also, 8034A was deliberately not recognized by the FAA. Change reference from SAE AS 8034A to 8034B. Note: There are 5 references to 8034A throughout the document that need to be updated	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
13.	**Commenter:** AIR-130 Appendix 6, A6-3, para 1.3.	Check to ensure consistency between guidance on HUD in this appendix and in AC 25.1329-1B.	The same person who authored the HUD guidance material in AC 25.1329-1B also drafted the guidance in the HUD appendix. They are consistent. No change.
14.	**Commenter:** AIR-130 Appendix 7.	General Comment on Appendix 7. No flight test discussion to evaluate these characteristics, criteria, etc….	No change. Appendix 7 is designed to be specific to weather displays. The discussion on flight test for all display types is in the general section of AC 25-11A to include chapter 8 on showing compliance and compliance considerations.

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			We did not change the AC in regard to this issue.
15.	**Commenter:** AIR-130 Appendix 7, Paragraph 4.4	"DO-220 does not describe standard for windshear threat symbol. There is a statement on icon size criteria in paragraph 2.2.2.13 which is not sufficient to characterize the windshear threat symbol. Windshear threat symbol should be characterized based on windshear performance criteria" Suggest delete this sentence in reference to DO-220	DO-220 does provide the size criteria for the symbol and under what conditions and in what location it might be provided. We agree that a description of the Icon/symbol is not provided. We did not change the AC in regard to this issue.
16.	**Commenter:** AIR-130 Appendix 7, paragraph 4.6, second sentence	Change "may" to "must."	Typically, we do not use "must" unless there is rule language associated with its use. We did not change the AC in regard to this issue.
17.	**Commenter:** AIR-130 Appendix 7, paragraph 3.2.	TSO-C63d, Appendix 2, modifies the minimum performance standard of display of weather radar returns. Change paragraph to read "The display of on-board weather radar information should be in accordance with TSO-C63d, *Airborne weather radar equipment*, and the applicable portions of RTCA/DO-220, *Minimum….."*	We added the underlined language shown below. **3.2 Minimum Performance Standards** The display of on-board weather radar information should be in accordance with the applicable portions of RTCA/DO-220, Minimum Operational Performance Standards for Airborne Weather Radar with Forward-Looking Windshear Capability. TSO-C63d allows exceptions to the minimum performance standards of RTCA/DO-220 for Radar Equipment Class A and B.
18.	**Commenter:** AIR-130, Appendix 7, paragraph 2.2.4, second note.	Change note to read "Refer to paragraph 31.c(5) in Chapter 5 of this AC for information on guidelines on color progression."	Changed.
19.	**Commenter:** AIR-130 Delete Note "(**) Applicable to the display part of the system only." in Table 8 on page 36	We agree that "Display of misleading weather radar information" is major; however, the "remote" criterion is not constrained to the display part of the system only. It's been accepted practice in certification of (Part 25) weather detection and display systems that the probability of unannunciated malfunction or missed detection of weather detection is also remote (e.g. see TSO-C63d, paragraph 3.a(2)).	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
20.	**Commenter:** AIR-130 Appendix 6, 3.1.3.1	The text in this paragraph does not match the rest of the section.	We have revised this section as follows: 3.1.3 Display…

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		The first sentence should be moved up under paragraph 3.1.3. 3.1.3.1 title should be changed to reference autopilot monitoring. Change the second sentence in paragraph 3.1.3.1 to "When the HUD is used to monitor autopilot it should display the following information:"	"~~This a~~ Additional information ~~is mainly~~ may be related to the display of command guidance or ~~situational information~~ specific flight parameter information needed for operating the airplane by reference to the HUD." 3.1.3.1 Command Guidance. "~~For example, if~~ When the HUD is ~~to be~~ used tomonitor the autopilot, it should display the following information: 3.1.3.2 ~~Aircraft Maneuvers~~ Flight Parameter Information "The HUD should also display additional flight parameter information, if required, to enable the pilot to ~~perform aircraft maneuvers~~ operate the airplane during phases of flight for which the HUD is approved. This additional information may include:"
21.	**Commenter:** AIR-130 The second sentence of paragraph 3.1.3.2 is extraneous. Paragraphs 3.1.3.2.1-3.1.3.2.1.4 are extraneous.	Delete the second sentence of 3.1.3.2 and paragraphs 3.1.3.2.1 thru 3.1.3.2.1.4	We revised these sections. (See Comment 20.)
22.	**Commenter:** AIR-130 Page 13, Section B, First paragraph	I would think it will be useful to verify what are two existing part 25 regulations and the associated guidance material that are going to be revised, for information if you will.	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
23.	**Commenter:** AIR-130 Page 16, Section b	Add another bullet to this section for "Proper configuration of display by Flightcrew," since there could be circumstances where the electronic map is unavailable, or the display has not been properly configured by the flight crew.	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
24.	**Commenter:** AIR-130 Chapter 3. General	I think it would be worthwhile to define similarity in displays. Similarity in displays features make it too	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will

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		easy for a busy flightcrew member to make an error and not realize it until the airplane's behavior becomes sufficiently different from what the flightcrew expects. For example, it is believed by some that the similarity between the display representations of flight path angle and vertical speed played a major role in the Air Inter Airbus A320 accident at Strasbourg, France in 1992, and in several similar incidents.	review this suggestion. We did not change this part of the AC at this time.
25.	**Commenter:** AIR-130. Chapter 3, paragraph 16.b. (p. 22) and 16.c.(p. 23)	Instead of referencing a specific version of DO-160, suggest referencing AC 21-16G. It outlines the FAA's guidance on environmental qualification. FAA current environmental policy, described in AC 21-16G, is typically any revision of DO-160 after DO-160D Change 3 is satisfactory. Change RTCA DO-160E references throughout document to AC 21-16G.	We did not revise the main body of the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this part of the AC at this time.
26.	**Commenter:** AIR-130. (LRV) Page A5-16, para 6.d.	Update RTCA address. Change to 1150 18th Street NW, Suite 910, Washington, D.C. 20036.	We did not revise this appendix in the AC. We added Appendixes 6 and 7. When we revise the AC, we will review this suggestion. We did not change this appendix in the AC at this time.
27.	**Commenter:** AIR-130. (LRV) Page A6-3. Paragraph 1.1 states guidance applies to HUDs used as supplemental display, then states guidance applies to HUDs used effectively as primary flight displays. Paragraph 3.1.2.1 claims HUD is "de facto primary flight display." Will HUDs intended function as a supplemental display be allowed in reality, or must applicant always treat HUD as a	Current language conveys intended function can be as a *supplemental* display, but it appears all requirements of a primary flight display are imposed. If this is correct, then remove reference to "supplemental display."	No change. The problem is what is meant by the terms supplemental and primary. "Supplemental" is meant to convey that the HUD is in addition to the primary flight display and its loss or lack of availability is not as critical to safety of flight. However, when the HUD is being used to enable a particular operation, such as a low visibility approach and landing (e.g., Cat III), the pilot will not be scanning head down for the flight information - so for that period of time, the HUD is a "*de facto* primary flight reference." It is the primary means of displaying flight information during such an operation. Loss of the HUD may cause discontinuation, at least, of that operation.

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	primary flight display?		Furthermore, while the pilot is using the HUD as a primary flight reference, and therefore not including the head down PFD in the instrument scan, any visual flight information and alerts essential to the safety of flight must be displayed on the HUD.
28.	**Commenter:** AIR-130. (LRV) Page A6-5, paragraph 3.1.1. If no HUD guidance is included in Appendix 6 for EFVS and SVS, then where does applicant look?	Add sentence to read, "For EFVS and SVS guidance, refer to	We agree. We are monitoring the status of the proposed update to AC 20-167 to 20-167A and use the latter reference if it will be out soon. We have revised the last sentence of paragraph 3.1.1 to state: "While HUDs may be designed to display enhanced and synthetic visual imagery, particular means of compliance guidance for this purpose is not found in this appendix. Refer to AC 20-167, *Airworthiness Approval of Enhanced Vision System, Synthetic Vision System, Combined Vision System, and Enhanced Flight Vision System Equipment,*" for guidance."
29.	**Commenter:** AIR-130. (LRV) Page A6-7, paragraph 3.2.1. General Comment: Is there a concern for HUD image needing to be removed when the pilot's hands are busy with the flight controls and thrust levers? If so, add statement for control placement so pilot does not have to remove hands from flight controls or throttle.	Add last sentence, "Provide a control which permits the pilot flying to deactivate and reactivate the head-up display on demand without removing the pilot's hands from the primary flight controls (yoke or equivalent) or thrust control."	No change. This has not been a requirement for part 25 HUD installations. It has only been applied for EVS and SVS on the HUD, and we know of no incidents or problems that would prompt the FAA to change this.
30.	**Commenter:** AIR-130. (LRV) Page A6-9, paragraph 4.2.3. Previous paragraphs treat HUD	Delete "When the HUD is a primary flight display, when" and change sentence to read, "Dimensions larger than the minimums shown below may be necessary when airworthiness approval is predicated on	No change. The sentence is correct as stated.

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	as a primary flight display, so remove reference in paragraph 4.2.3 stating, "When the HUD is a primary flight display,"	the use of the HUD, or when the applicant's intended function states the pilot can be reasonably expected to operate the primarily by reference to the HUD."	
31.	**Commenter:** AIR-130. (LRV) Page A6-14, paragraph 4.7.1.1.	Change "10,000 fL" to "10,000 ft."	We spelled out the acronym to clarify that "fL" means foot-Lamberts and is a unit of measure for luminance.
32.	**Commenter:** AIR-130. (LRV) Page A6-15, paragraph 5.1.4.1. Text states, "The applicant should identify conditions for which the pilot transitions between the HUD and the head-down display and develop scenarios for evaluation…" In all likelihood, the FAA already knows these conditions, so why ask the applicant?	Change to read, "The applicant should develop scenarios for evaluation (e.g., simulation for flight test) for pilot transitions between the HUD and the head-down display."	No change is needed. FAA does likely have some experience with this, but it is the applicant who submits data and proposes type inspection and then the FAA reviews, approves and perhaps may provide additional cases. Installation designs (of the HUD and of the flight deck) are not identical and may not have identical intended functions. The applicant also will have to use the scenarios and conditions in company simulations/flight tests prior to FAA evaluations. Prior to FAA tests, the applicant will provide statements that the type design complies with the requirements, with data from such tests to support it.
33.	**Commenter:** AIR-130. (LRV) Page A6-15, paragraph 5.1.4.2. Current text states, "While the head-up and head-down displays may display information…any difference should not create confusion, misinterpretation, unacceptable delay, or otherwise hinder the pilot's transition between the two displays." Restate paragraph to be more direct and avoid confusion.	Suggest change to read, "There should be no confusion, misinterpretation, unacceptable delay, or hindrance to the pilot's transition between the two displays."	No change is needed. This paragraph provides a deeper level of advisory guidance than the commenter proposes. Certification experience in has shown that this is useful when disagreements arise.

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34.	**Commenter:** AIR-130. (LRV) Page A6-19, paragraph 5.4.6.3. General Comment : Text mentions "Extreme attitude symbology and automatically decluttering the HUD at extreme attitudes has been found acceptable…." Generally accepted philosophy, but what data shows improved recovery time from HUD decluttering compared to not decluttering the HUD?	If data supports this action, suggest changing to read, "Extreme attitude recovery symbology and automatically decluttering the HUD at extreme attitudes has been found acceptable…."	No change is needed. This section provides advisory guidance to the applicant and regulator that a display mode change is not ruled out and that special unusual attitude cues should not be visible during "normal" maneuvering. The applicant is not obliged to show "improved recovery time" with a decluttered display mode. Rather the applicant must demonstrate satisfactory recovery time. The data to support this is provided by each applicant's demonstration. Designs may differ, but a decluttered mode may enable the pilot to focus on the essential information and cues. Nevertheless, prior experience aside, the applicant must demonstrate the adequacy of the design for cases of unusual attitude.
35.	**Commenter:** AIR-130.(LRV) Page A6-20, paragraph 6.2. Text states, "With single HUD installations, the PF likely uses the HUD as a primary flight reference…." This is presumptive on how the pilot flies the airplane and should be left to ops guidance. Additionally, which systems, modes, and functions are not displayed on the HUD? Past practice indicates TCAS, GPWS, and windshear alerting displayed on head-down display must also have a corresponding display or annunciation on the HUD. For comparison, see AC 25.1329-1B, paragraph 46.d. Policy	Change to read, "With single HUD installations and if supported by the applicant's intended function, the HUD may be used as a primary flight reference presuming the PNF monitors the head-down instruments and alerting systems for failures of systems, modes, and functions that are not displayed on the primary flight displays or HUD. However, in the case where both flightcrew members have HUDs, the flightcrew should be able to maintain an equivalent level of awareness of key information such as powerplant indications, alerting messages, and aircraft configuration indications."	No change is needed. The point here is that the pilot flying (PF) while using the HUD during a particular phase of flight (e.g., instrument approach, takeoff, etc.) is neither expected nor likely to also scan the head-down PFD and hence be even less aware of information on other flight deck displays. This is not just about TCAS, TAWS, and windshear, but also other flight deck alerts and indications not found in the HUD, nor the head-down PFD. So what happens with a dual-HUD installation? What is the concept for use of the PM HUD? How likely is the PM to be scanning head-down? Is it as likely as for the single-HUD installation? Perhaps, perhaps not. The applicant, taking the HUD installation design and the type design of the flight deck, must examine this issue and establish the operational concept for its use. The FAA intent is to evaluate the adequacy of the entire

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	should be consistent. Additionally, second sentence in paragraph presumes both pilots are using HUD at same time, which may not be operational practice.		type design with this concept in mind. The applicant must tell the FAA whether they expect both pilots to be referring to their HUDs simultaneously and if so, how the design will compensate for less visual scanning of the head down instruments and indications.
36.	**Commenter:** AIR-130. (LRV) Page A6-20, paragraph 6.3.2. General Comment: Text states the applicant should explain how the scan of the head-down instruments is ensured during all phases of flight, and, if not, what compensating features help the flightcrew maintain awareness…" Realizing no standard acceptable means of compliance is likely, some accepted means of compliance can be suggested, or the guidance should state what additional information must be displayed to the pilot at all times (besides what is already required).	Suggest changing first sentence in paragraph 6.3.2 to read: "The applicant's HUD and head-down display design features should ensure the flight crew maintains awareness of key information such as powerplant indications, alerting messages, and aircraft configuration indication."	No change is needed. The point is "how" and proving it. It cannot be assumed. Actually, this guidance is consistent with current FAA dual-HUD certification practice via issue paper and seems to work well.
37.	**Commenter:** Joe Brownlee, ANM-160L Page A6-9, ¶4.1 Design Eye Position.	…the DEP with their <u>shoulder harness and</u> seat belts fastened, …. [HUD use during takeoff and landing is with the aircrew wearing both seat belts and shoulder harnesses, which may be more restrictive than just wearing a seat belt.]	Agree, same as intended, more technically correct. Changed.

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38.	**Commenter:** Joe Brownlee, ANM-160L Page A6-20, ¶6.2	Flightcrew Awareness of Other Instruments and Indications. [The paragraph properly concerns aircrew awareness of both instruments and information possibly not displayed on a HUD. The title should so introduce the paragraph.]	Changed.
39.	**Commenter:** Joe Brownlee, ANM-160L Page A6-14, ¶5.1.3.5 Flight Guidance Systems	Add: If a HUD landing flare guidance cue is available, the cue symbol should be annunciated clearly, appear as a pitch command, not be obscured by ground clutter and move in a smooth manner to invite following.	No change. Perhaps the suggested method is preferable, but we have accepted flight-path-referenced Flare guidance and have no evidence that it would be unacceptable. Furthermore, this paragraph does not address the appearance of guidance cues on the HUD, but the appearance of FGS mode annunciations.
40.	**Commenter:** Jay Yi, ANM-130S	Somewhere in Appendix 6 will need to indicate requirements for aligning the HUD system.	No change. Paragraphs 4.3, 4.4, and 4.6 of Appendix 6 address this issue.
41.	**Commenter:** Jay Yi, ANM-130S Paragraph 3.1.2.2	Indicate that the primary flight display is the Head-Down Display and not the HUD. When either one of the Head-Down Displays is blank, the flight crew should stow the HUD and use the available Head-Down Display and Standby Flight Display.	No change. Which display is primary may depend on the installation, the phase of flight, and how the pilot uses the HUD during the phase of flight. During approach and landing, the pilot flying may use the HUD without reference to the head-down PFD, making the HUD a de facto PFD. The intent of this paragraph is limited to *what* should be displayed on the HUD, not which of the displays is primary.
42.	**Commenter:** Jay Yi, ANM-130S	Somewhere in Appendix 6 needs to indicate which part of the HUD system can be TSO'd and which part cannot be TSO'd.	No change. There is no HUD TSO and AIR-100 has determined not to publish one. Perhaps there are functions of the HUD which might fit certain TSOs and that would have to be assessed on a case-by-case basis. As indicated at the Avionics Workshop, the TSO C113 does not apply to HUD, because AS8034a specifically does not include HUD.

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	Comment	Requested Change	Disposition
43.	**Commenter:** Thuan Nguyen, ANM-130S	Can a HUD be certified as a stand alone component? If so, should it be considered an incomplete TSO? Should HUD be a component of a TSO article?	No change. For most factors, the HUD must be assessed as an installation. Most significant criteria apply to the HUD as installed, not as it would be on the bench. As indicated at the Avionics Workshop, the TSO C113 does not apply to HUD, because AS8034a specifically does not include HUD. Perhaps there are certain TSOs that would apply to certain HUD functions, which must be assessed on a case-by-case basis.
44.	**Commenter:** Tin Truong	**2.2.4** The use of red and yellow must be in compliance with § 25.1322(e). There is no definition of "warning" in FAR Part 1 nor in the subject AC. Normally, a warning requires immediate attention. However in weather forecast displays, warning (red) is not an immediate threat. The use of the color red in weather display may appear to be in conflict with the conventional meaning of warning and should be stated as acceptable in its context.	If another function uses red, amber or yellow other than for alerting, § 25.1322(f) applies: "Use of the colors red, amber, and yellow on the flight deck for functions other than flightcrew alerting must be limited and must not adversely affect flightcrew alerting.**"** While there is no definition of warning in Part 1, AC 25.1322-1 in appendix 5, Definitions, defines warning as "the level or category of alert for conditions that require immediate flightcrew awareness and immediate flightcrew response." Alerting definitions were added to facilitate standardization of alerting terms. AC 25.1322-1 Chapter 11 addresses the use of color for alerts and non-alert functions. The use of red, amber, or yellow on weather displays is normally for awareness. However, like in the case of windshear, it can also be used for the alerting function which then requires two senses such as a visual and aural. The use of alerting colors on weather displays for a non-alerting function has to still meet the § 25.1322(f) requirement of not adversely affecting the alerting function. For visual alert indications, red must be used for warnings; and amber or yellow for caution category alerts (per § 25.1322(e)). We did not change the AC in regard to this issue.

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	Comment	Requested Change	Disposition
45.	**Commenter:** Tin Truong	**2.3.7** When the source of the weather information source is not the onboard sensors, some means to identify its relevance (e.g., a time stamp or the age of the product) should be provided. Presenting the product age is particularly important when combining information from multiple weather products. A time stamp indicates when a product was delivered (present or past). Does forecast weather need to be identified with future time?	We added, **"**In addition, the effective time of forecast weather should also be provided." to 2.3.7. We agree. When the source of the weather information source is not the onboard sensors, some means to identify its relevance (e.g., a time stamp or the age of the product) should be provided. Presenting the product age is particularly important when combining information from multiple weather products. In response to your question regarding forecast weather, we have said that if the source of the weather is not the onboard sensors, some means to identify its relevance should be provided.

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	Comment	Requested Change	Disposition
46.	**Commenter:** Michael Carlson Denver ACO 303-342-1092 Appendix 7, Page A7-4 and A7-5, 5.1 and 5.2.	Providing the specific Hazard Classification (i.e., Major) for loss of weather and misleading weather would be beneficial for applicants creating an FHA and the ACO when reviewing the FHA. The effect of a system based on the failure condition of displaying misleading weather should be the same for any Part 25 aircraft that is flying in IMC, so the Hazard Classification could be defined in this AC by TAD. The Function, Failure Condition and Hazard Classification could be broken down in these sections for aircraft that fly in VMC only or IMC and that should cover the majority for Part 25 aircraft. The same could be done for loss of weather information.	No change. For Part 25 airplanes, IFR is the norm. They are not restricted to VMC and the FHA should assume instrument flight. Misleading weather display could be considered major, per Table 8, page 36, of main body of the AC. The hazard classification for loss of weather display is very conditional, and, in general, it may be considered minor. Obviously, when navigating through a severe weather environment, the hazard could be greater.
47.	**Commenter:** AIR-500 Incorrect date.	Reminder: Place the correct date when the document is signed in the header section of all the pages affected by the change and on the cover page of the "Page Control Chart."	The date will change. The current date is simply a placeholder.
48.	**Commenter:** AIR-500 Global Change within Appendix 6. Missing space.	There should be two spaces between sentences. For examples refer to paragraphs 3.3.2.3, 4.7.1.2, 5.1.3.2.1, 5.1.3.2.2, 5.4.2.1, 4.6, etc.	No change. Only one space follows a period in accordance with Section 2.48 of the GPO Style Guide, and the Plain Language Program Manager, Bruce Corsino.
49.	**Commenter:** AIR-500 Global Change within Appendices 6 & 7 Inconsistent format.	The original document does not use multiple decimals for the labeling of the subparagraphs and subsections. The original document uses letters and numbers for the formatting of subparagraphs and subsections. Use the same format that is used in the original document by eliminating the usage of multiple decimals	Understand. The format used in these appendices is actually more useful for certification purposes when attempting to find and correlate criteria found in a long document. This may be debatable, but finding them in the main AC is difficult (nevertheless the main AC is in scope for revision).
50.	**Commenter:** AIR-500 Cover Page of the Page Control Chart Incorrect spacing.	There should be five spaces between the "Page Control Chart" and the signature block.	Changed.

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	Comment	Requested Change	Disposition
51.	**Commenter:** AIR-500 Table of Contents, Appendix 6, Page 9 Inconsistent formatting.	The formatting of the new appendices (e.g., 1.0, 1.1,…) is not consistent with the format of the previous appendices (appendix 1 & 5). Make the numbering and format of all appendices consistent	The numbering within the original appendixes is not consistent. Appendix 1 already uses a different numbering scheme than Appendix 5. The format used in the newly added appendices (6 and 7) is more useful for certification purposes when attempting to find and correlate criteria found in a long document. This may be debatable, but finding them in the main AC is difficult. However, the main body of the AC is not being revised.
52.	**Commenter:** AIR-500 Table of Contents, Appendix 7, Page 10 Incorrect alignment.	Adjust the alignment to the left of the title "Weather Displays" and labeling of page "A7-1" bold in the header.	Changed.
53.	**Commenter:** AIR-500 Paragraph 6a, last sentence, Page 14	There should be two spaces between sentences.	No change. Only one space follows a period in accordance with Section 2.48 of the GPO Style Guide, and the Plain Language Program Manager, Bruce Corsino.
54.	**Commenter:** AIR-500 Appendix 1,Paragraph 2.1, 1st paragraph last sentence, Page A1-2	There should be two spaces between sentences.	No change. Only one space follows a period in accordance with Section 2.48 of the GPO Style Guide, and the Plain Language Program Manager, Bruce Corsino.
55.	**Commenter:** AIR-500 Appendix 1, Paragraph 2.1,top of Page A1-3 Paragraphs combined and not consistent with the original AC.	Per the current, AC the sentence beginning with "Airspeed scale markings such as stall warning…" should be a new paragraph. If not, make sure there are two spaces between sentences.	Changed.

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	Comment	Requested Change	Disposition
56.	**Commenter:** AIR-500 Appendix 1, Between 2nd & 3rd Bullets, Page A1-5 Missing space.	There should be two spaces between each bullet.	No spaces exist between the bullet and text. The spacing is determined by tabs. No change.
57.	**Commenter:** AIR-500 Appendices 6 & 7, Pages A6-1 & A7-1 Improper usage of change mark bar line.	Since the whole appendix is new, then you do not need to place a bar line on this page. Bar lines are only used only to indicate where a change has taken place if the entire page hasn't changed.	Changed.
58.	**Commenter:** AIR-500 Appendix 6, Page A6-1	An appendix should not have a table of contents by itself. Move the table of contents, if needed to page 9. However, the level of detail on page 9 should be sufficient. Delete A6-1 and A6-2.	We understand that appendixes typically do not have tables of contents. However, the ToC at the beginning of the appendix makes it more useful to the user to (1) be able to find information, and (2) see the overarching structure of the document. The intent is to help people efficiently find information. No change.
59.	**Commenter:** AIR-500 Appendix 6, Pages A6-3 – A6-21	Other appendices within the document appear not to used periods after the paragraph titles. Remove the periods and keep a consistent format.	Changed.
60.	**Commenter:** AIR-500 Appendix 6, Paragraph 1.1, 1st sentence, Page A6-3	Rewrite to read: …and functions of head-up displays (HUD) for transport category airplanes.	No change. This sentence uses "displays"; therefore, we used "HUDs" to indicate the plural.
61.	**Commenter:** AIR-500 Appendix 6, Paragraph 1.3, 1st sentence, Page A6-3	The term "Advisory Circular" has already been defined. Use the acronym "AC."	This place is the first occurrence of "Advisory Circular (AC)" in the appendix, and therefore should be spelled out. No change.

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62.	**Commenter:** AIR-500 Appendices 6 & 7, Pages A6-4 - A7-5	For Appendices 6 and 7, consider using numbers and letters to denote hierarchy instead of multiple decimals.	In an effort to be consistent with the other appendixes, we used numbers. Appendixes 1, 2, and 5 use a numbering system, not letters. Furthermore, the use of alternating numbers and letters fails to convey the place and hierarchy of a paragraph in a long document. The reader must often go back a page or more to find what upper level paragraph it belongs to. No change.
63.	**Commenter:** AIR-500 Appendix 6, paragraph 2.1.1, 1st sentence, Page A6-4	The term "Title 14, Code of Federal Regulations" has already been defined in the original document in paragraph 1 on page 8. Use the acronym "14 CFR".	This place is the first occurrence of "Title 14" in the appendix, and therefore should be spelled out. No change.
64.	**Commenter:** AIR-500 Appendix 6, Paragraph 3.3.2.3, last sentence, Page A6-8	Delete the title to "ARP 5288" "Transport Category Airplane head Up Display (HUD) Systems". This information has already been defined in Chapter 3.	This place is the first occurrence of the document in the appendix, and therefore should be spelled out. No change.
65.	**Commenter:** AIR-500 Appendix 6, Paragraph 4.1, 1st sentence and paragraph 4.2.1, 3rd sentence, Pages A6-8 & A6-9	The term "design eye position" has already been defined. Use the acronym "DEP".	This place is the first occurrence of the term in the appendix, and therefore should be spelled out. No change.
66.	**Commenter:** AIR-500 Appendix 6, Paragraph 4.3.2.3, Page A6-11	Place the "allowable display accuracy errors" into a table to improve the readability.	Agreed. Changed.
67.	**Commenter:** AIR-500 Appendix 6, Paragraph 4.7, 1st sentence, Page A6-12	Delete the titles to "ARP 5288" "Transport Category Airplane head Up Display (HUD) Systems" and "AS 8055, Minimum Performance Standard for Airborne Head Up Display (HUD)". This information has already been defined in Chapter 3.	This place is the first occurrences of the documents in the appendix, and therefore should be spelled out. No change.
68.	**Commenter:** AIR-500 Appendix 6, Below Paragraph 5.1.2, Page A6-13	Incorrect space. Remove the extra found below paragraph 5.1.2 by paragraph 5.1.3 to the previous page.	The headings are formatted to "keep with next" as to avoid orphaned/widowed headings. No change.

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69.	**Commenter:** AIR-500 Appendix 6, Paragraph 5.2.3, Page A6-16	Delete the title to AC 25.1329-1B, "Approval of Flight Guidance Systems". This information has already been defined in Appendix 1.	This place is the first occurrence of the document in the appendix, and therefore should be spelled out. No change.
70.	**Commenter:** AIR-500 Appendix 7, both Note Sections, Page A7-2	Bold the term "Note". Keep format consistent with rest of document.	Changed.
71.	**Commenter:** AIR-500 Appendix 7, both Note Sections, Page A7-2	Label the "Note" Section as: Note 1 and Note 2 since there are two in the same section.	Changed.
72.	**Commenter:** AIR-500 Appendix 7, Paragraph 2.2.2, Page A7-1	The term "Title 14, Code of Federal Regulations (14 CFR) has already been defined. Use the acronym 14 CFR. Remove the italics from the reference to "14 CFR 25.1322(f).	Changed.
73.	**Commenter:** AIR-500 Appendix 7, Paragraph 2.2.3, Page A7-1	Remove the close parenthetical found after the term "Broadcast in the AC title.	The open and closed parentheses contain a parenthetical phrase, "(such as the conventions established in ARINC 708 and AC 20-149, Safety and Interoperability Requirements for Initial Domestic Flight Information Service-Broadcast)" that separates the subject, "conventions," from the verb, "should be followed." No change.
74.	**Commenter:** AIR-500 Appendix 2.2.4, Page A7-1	Delete "AC 25.1322-1". Replace with "AC 25.1322". This AC number was used previously in paragraph 5.2.3.	Changed.
75.	**Commenter:** AIR-500 Appendix 2.2.4, Page A7-1	Delete the title to AC 25.1322-1, "Flight Crew Alerting". This information has already been defined in Appendix 6.	This place is the first occurrence of the document in the appendix, and therefore should be spelled out. No change.

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76.	**Commenter:** AIR-500 Appendix 7, Paragraph 2.2.4, 1st Note Section, Page A7-2	Delete the title to AC 20-149, "Safety and Interoperability Requirements for Initial Domestic Flight Information Service Broadcast". This information has already been defined in paragraph 2.2.3.	This place is the first occurrence of the document in the appendix, and therefore should be spelled out. No change.
77.	**Commenter:** AIR-500 Appendix 7, Between 2nd Note Section and Paragraph 2.3, Page A7-2	Remove the extra space between the second "Note" section and paragraph 2.3.	Changed.
78.	**Commenter:** AIR-500 Appendix 7, Paragraph 2.3.10, 1st sentence, Page A7-3	Define the term for the acronym "METARs" first. Use the acronym "METARs" after the first usage.	Changed.
79.	**Commenter:** AIR-500 Appendix 7, Paragraph 2.3.12.2, Page A7-3	The term "Terrain Awareness and Warning System" has already been defined. Use the acronym "TAWS."	This place is the first occurrence of the term in the appendix, and therefore should be spelled out. No change.
80.	**Commenter:** AIR-500 Appendix 7, Paragraph 4.4, last sentence, Page A7-4	Delete the title to RTCA/DO-220, "Minimum Operational Performance Standards for Airborne Weather Radar with Forward Looking Windshear Capability." This information has already been defined in paragraph 3.2.	Changed.

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	Comment	Requested Change	Disposition
81.	**Commenter:** AFS-350cf I am caught in a loop between the following statements in Appendix 6 and it appears the only time a HUD could be supplemental is when it is not being used. Can this be clarified? This becomes a concern when determining the content of the ICA, paragraph 8.0	**1.1 Purpose** -- This guidance applies to HUDs that are intended to be used as a supplemental display ----It also applies to HUDs that are intended to be used effectively as primary flight displays. **1.2 Definition of Head-Up Display (HUD).** A HUD is a display system that projects primary flight information **3.1.2.1 HUD as De Facto Primary Flight Display.** If a HUD displays primary flight information, it is considered a *de facto* primary flight display while the pilot is using it,	No change. The term "primary flight display" can be conditional. In one sense, PFD refers to the primary display in the flight deck for that pilot, considering the potential loss of displays. Even if the pilot is, for moment, using the HUD as the primary reference, if it fails there may still be a PFD installed and available head down - which makes the airplane perfectly airworthy perfectly and sufficiently equipped to continue safe flight. In another sense, PFD or primary flight reference refers to the display that for the moment or for the phase of flight or particular operation is the primary reference for the pilot (in lieu of the head down PFD). For example, a pilot conducting a manual Category III approach and landing will necessarily be using the HUD as the primary flight reference or PFD - and is not expected, nor required to scan the head down PFD. In such cases, the HUD is a *de facto PFD.*