AC 20-158A, The Certification of Aircraft Electrical and Electronic Systems for Operation in the High-intensity Radiated Fields (HIRF) Environment (Public Coordination) Comment Matrix

Para	Commenter/ Organization	Comment Summary	Proposed Resolution	Disposition
1.b	Bell Helicopter Textron	The words, “you must follow it in all important respects” were changed to “you must follow it entirely to comply with this AC”. Other AC material that use similar wording also include a clarification of the words “should”, “must”, or “will.” Without this clarification, “should” statements within the document could be interpreted has firm requirements, and it appears some “should” statements are intended to be “must.” Given this new wording in the purpose section, specific definition and use of “should” “must” and “will” should be employed.	Add explanation of the use of “should” and “must” in the purpose section. Correct usage in the document as required.	**Accepted.** The following text was added: “The term “must” is used to indicate mandatory requirements when following the guidance in this AC. The term “should” is used when following the guidance is recommended, but not required to comply with this AC.”

g. Step 7 Aircraft Assessment Decision item (2)	Bell Helicopter Textron	The addition of the item (2) as stated below is inappropriate and should be removed: *"(2) Integrated display systems include the display equipment, control panels, and the sensors that provide information to the displays. In some systems, the sensors also provide information to level A systems that are not displays, such as flight or engine controls. In these systems, the sensors cannot use the generic transfer functions of the level A display system for compliance."* 1) The statement does not qualify whether the sensor which is providing information to a non-display level-A system is doing so in support of a level-A function. An air data computer, for example, may support Level-A flight display functions but might also support level-B or level-C functions within a Level-A flight control or engine control system. Those non-display Level-A systems would have been evaluated based on their specific requirements for the failure of Level-B or Level-C supporting systems. By the statement above, simply providing information to a non-display Level-A system would deny use of the generic transfer functions in its display role. This does not make sense and it is assumed this was not the intent of adding this item. 2) If a sensor is used by both a level-A control systems and a Level-A display system, and <u>does</u> support a Level-A function within the control system, then its use should be and will be assessed as part of the showing of compliance for the non-display Level-A system – whether it be a flight control system, engine control system, or whatever. As such there is no need to add the paragraph to make the statement made here.	This paragraph provides no additional clarification or benefit and needs to be removed entirely.	**1) Partially accepted.** The intent of paragraph 9.g (2) is appropriate. For example, a component in an integrated display system, such as a sensor, also provides information to Level A flight controls, the sensors cannot use the generic transfer function. The language in paragraph 9.g (2) is revised as follows to clarify generic transfer functions and attenuation are not appropriate for Level A Non Display functions: "(2) Integrated display systems include the display equipment, control panels, and the sensors that provide information to the displays. In some systems, the sensors also provide information to level A systems that are not displays. For example, if the sensors also provide information to Level A flight controls, you must use actual transfer functions and attenuation when demonstrating compliance for these sensors and the flight controls." **2) Not Accepted.** Paragraph 9.g. (2) provides a clarification on when generic transfer functions may be used for Level A display systems.

		3) This leaves upgraded systems as the apparent target for this requirement - Specifically in the case of a modified or upgraded Level-A display system using an existing aircraft sensor that also provides information to an un-modified Level-A control system. Assuming the un-affected control system was previously HIRF qualified under a lesser requirement, then this item would either (a) force a much higher qualification of the sensor than normally required for a Level-A display, or (b) it would force specific aircraft testing which was not supposed to be the case when upgrading display systems, or (c) it would force the installation of separate sensors for upgraded display systems adding significant cost and weight to the aircraft. This provision defies common practice. AHRS sensors (Attitude heading reference systems) are commonly the Level-A sensor common to flight displays and flight controls. It is common to use AHRS signals to support after-market installation and upgrades of radar systems, TAWS, TCAS, GPS/FMS systems ADSB etc, or installation of flight data recording devices (any device needing pitch, roll, or heading information.) These connections are typically done to separately buffered outputs of the AHRS and are generally accepted to not impact the HIRF qualification or certification of a level A control function that may be supported by the sensor. We do not believe the intent of this AC is to prevent such safety equipment from being readily installed or upgraded. Yet as stated, the item specifically targets the upgrade of Level-A display systems to "tax" them with re-qualifying the sensor for their role in unmodified functions when similar connections are allowed to support other systems without imposing these consequences. This seems a back-door method to force HIRF requalification of legacy control systems when the display system upgraded are performed.		**3) Not Accepted.** Paragraph 9.g.(2) (Step 7) does not require reevaluation of a previously approved sensor. Paragraph 9.g.(1) allows Level A display systems only to be evaluated using generic transfer functions and attenuation from appendix 1 without using actual transfer functions and attenuation. Paragraph 9.g.(2) clarifies that sensors which are part of a Level A display system, but also part of another Level A critical system such as a flight control, can't use the generic transfer functions. Actual transfer functions and attenuation must be used when demonstrating compliance for these sensors and the flight control system. Separated the following sentence in paragraph 9.g.(2):"You should choose whether you will use aircraft tests, previous coupling/attenuation data from similar aircraft types (similarity), or for level A display systems only, the generic transfer functions and attenuation in appendix 1 to this AC." into two sentences: "You should choose whether you will use aircraft tests, previous coupling/attenuation data from similar aircraft types (similarity). For level A display systems only, use the generic transfer functions and attenuation in appendix 1 to this AC."

g. Step 7 Aircraft Assessment Decision item (2)	Bell Helicopter Textron	4) Defining the integrated display system in this section is inappropriate. As stated it could be implied to specify the required inclusions for the HIRF integrated systems test. If this is the intent, the definition should be in section e. “Step 5” and not in this section. This definition of the display system is also insufficiently specific, and if taken literally, contrary to other provisions in the guidance and SAE documents. Guidance and SAE documents allow for sensors and control panels supporting non-level A functions, and whose failure cannot impact level A functions may be simulated rather than be included in integrated system testing. If this is not allowed, future upgrade of navigation systems (which is typical in the industry) would require HIRF requalification of the integrated display system.		**4) Not Accepted.** Paragraph 9.g.(2) appropriately clarifies that sensors which are part of a Level A display system, but also part of another Level A critical system such as flight or engine control, can’t use the generic transfer functions. Actual transfer functions and attenuation must be used when demonstrating compliance for these sensors and the flight control system. The failures and malfunctions of those Level A flight or engine control systems can more directly and abruptly contribute to a catastrophic failure event than display system failures and malfunctions; therefore, Level A flight or engine control systems should have a more rigorous HIRF compliance verification program. The intent of paragraph 9.e (Step 5) is to describe the integrated system test for a Level A system.

Appendix 1 Paragraph 2. b. (1)	Bell Helicopter Textron	There is no regulatory or scientific basis for specifying a different requirement for rotorcraft as opposed to airplanes where construction is equivalent. Equivalent constructions will attenuate HIRF equivalently. As such the addition of the statement, "*Display units installed in rotorcraft typically have no attenuation unless specific shielding is provided in the bulkhead, glare shield, panel, and doors*" seems to improperly target rotorcraft for exclusion from the other generic attenuation guidance. Furthermore it provides no clear indication of what is meant by "specific shielding" (as opposed to non-specific shielding provided as a consequence of construction?) This provision for rotorcraft, in the "No Attenuation" section, specifically conflicts with the general provisions in other sections. For example, the section on 6dB attenuation still states, "*This attenuation is appropriate when the level-A display equipment and associated wiring are located in aircraft areas with minimal HIRF shielding, such as a cockpit in a nonconductive composite fuselage with minimal additional shielding.*" Furthermore the remark references attenuation provided by a "typical" rotorcraft without specifying the construction of a typical rotorcraft. Rotorcraft varies widely in construction and features. It is inappropriate to make such a statement without specifying what is assumed for a typical rotorcraft – unless the attempt of this statement is to generally deny use of generic attenuation to rotorcraft simply because they are rotorcraft. This would not be in keeping with the allowances that were supposed to be provided for the affordable upgrade of display systems. Actual testing of rotorcraft we have conducted has produced attenuation results that generally follow the construction descriptions under item b. For example: Testing has proven 6dB attenuation in a rotorcraft cockpit with large transparencies, with some conductive structure, with other un-bonded conductive structure (i.e. carbon composite doors with no special bonding provisions). The 6dB attenuation was measured at the face of the display. Behind the displays for wiring, a basic metallic enclosure of the instrument panel with gaps still remaining but not facing direct into RF sources (bent waveguide effect) saw 12 to 20+ dB of attenuation which again matches the general guidance. This testing reveals it might be appropriate to note that for cockpits where the construction of the cockpit and cabin differ significantly from the cockpit systems enclosures, it is not uncommon to cite one level of attenuation for the face of cockpit display systems, and another level of attenuation for the rear of the units and the associated wiring, connectors, etc. This is more in keeping with what actual testing has revealed.	The statement "Display units installed in rotorcraft typically have no attenuation unless specific shielding is provided in the bulkhead, glare shield, panel, and doors" in item b(1) should be removed. Instead we feel item "b" should be amended to add the underlined text: "Guidance on the use of the generic attenuation is given below. For cockpit mounted display systems in particular, it may be appropriate to establish one level of attenuation for the face of the display and another for the back of the unit and its associated wiring when the guidance below indicates a significant difference in the attenuation provided in these areas.	**Partially accepted.** The intent of the generic attenuation is to provide attenuation for applicants without the requirement for a specific aircraft attenuation test. Queries to other rotorcraft manufacturers indicate that actual attenuation measured in a helicopter cockpit where display units are installed is typically less than 6 dB. As described in paragraph 3 in appendix 1, a rotorcraft manufacturer can develop its own generic transfer functions and attenuation from actual measurements and use in its HIRF compliance. Deleted the following from paragraph 2.b.(1) in appendix 1: "Display units installed in rotorcraft typically have no attenuation unless specific shielding is provided in the bulkhead, glareshield, panel, and doors." Added a new paragraph 2.b.(6) in appendix 1 as follows: "Generic Attenuation for Rotorcraft. Display units installed in rotorcraft typically have minimal attenuation unless specific shielding is provided in the bulkhead, glare shield, panel, and doors." Renumbered remaining paragraphs accordingly.

9.e.(3)	Rockwell Collins	The referenced paragraph states, in part, "*Place the system in various operating modes to ensure the integrated system is tested when operating at its maximum sensitivity in various operating modes.*" It would seem that focus should be placed on configuring the integrated system under test in a mode(s), as practical, that allows the system to operate at its maximum sensitivity. It is conceivable that some operating modes of a system would not exhibit a maximum sensitivity state by design. The context of the original same paragraph of AC 20-158 (no change) aligned itself to the guidance provided in Section 6.6.3.1 of SAE ARP5583 (no change) and Section 7.4.1 of SAE ARP5583A rather than the proposed revision.	Consider revising the proposed text of AC 20-158A to read, 'Place the system in various operating modes to ensure the integrated system is tested when operating at its maximum sensitivity.'	**Accepted.** Changed the sentence as: "Place the system in various operating modes to ensure the integrated system is tested when operating at its maximum sensitivity."
	Garmin	Concur without comments		

5. 6.	Mauricio Veloso / ANAC Brazil Cert. Authority	The §25.1317(a)(2) regulation has caused confusion in the applicants interpretation, especially in cases where the system architecture was conceived with the back-up system demonstrated to be immune to HIRF, instead of the primary system. In this case, the immunity of the back-up system may be considered adequate for compliance with (a)(1), yet the primary system normally still has to be tested to demonstrate compliance with (a)(2) and (a)(3). This is allegedly not clear to the applicant that questions the meaning of Normal Operation " and "Automatically recover… unless it conflicts… Regarding the definition of "Normal Operation", an applicant has misinterpreted the Boeing comment and FAA disposition in the rule preamble, considering that if the function is affected or recovered up to a point that minimally allows continued safe flight and landing, this is adequate for (a)(2) compliance. The ARP5583A provides some examples, but is also not very clear on this subject.	1) To include in the AC a clarification of what is expected for compliance with §25.1317(a)(2) and (a)(3). 2) In this context, to include the definitions and clarifications for "Normal Operation", "Automatically recover…unless it conflicts..." 3) To highlight the importance of correct observation of (a)(2) and (a)(3), if the primary system is not the immune part, used for compliance with (a)(1).	**Accepted.** 1) If a system performs functions with potentially catastrophic failure effects, then the system must comply with § 25.1317(a). § 25.1317(a)(2) states: "The system automatically recovers normal operation of that function, in a timely manner, after the airplane is exposed to HIRF environment I, …." The applicant must show the system automatically recovers normal operation of that function, in a timely manner, after the airplane is exposed to HIRF environment I. § 5.1.1 in SAE ARP5583A provides examples to clarify §§ 25.1317(a)(2) and (a)(3). 2) Added the following as the new second sentence to paragraph 6.e.(2): "The definitions of "normal operation" and "automatically recover" in paragraph 5 of this AC are provided in the context of §§ 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2)." Added the following to paragraph 5: **5.c. Automatically Recover.** Return to normal operations without pilot action. **5.u. Normal operation.** A status where the system is performing its intended function. Specifically in the context of §§ 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2) normal operation is defined as the ability to perform functions to the extent necessary to continue safe flight and landing, but not necessarily full functional performance." 3) According to § 25.1317(a), if the failure of the function, regardless of whether it's performed by the primary or backup systems, is catastrophic, then §§ 25.1317(a)(1), (2), and (3) apply to the electrical and electronic elements of the systems.

6.	Mauricio Veloso / ANAC Brazil Cert. Authority	It is not clear what are the actual differences between the §2x.1309 Safety Assessment and the "Safety assessment related to HIRF", mentioned in this paragraph, and how one relates to the other. The definition of "system" in §25.1317(a) is also open to interpretations, which cause confusion. One interpretation is to consider all parts necessary to comply with §2x.1309 (to achieve <10^-9) as the "system". Other interpretations allow §25.1317(a) "system" to be defined as smaller parts or divisions of the §2x.1309 "system". Example of how this confusion may significantly affect the application of the rule: Consider a system that has an electronic part (primary) and a purely mechanical part (immune to HIRF) as back-up. The loss of the electronic part is classified as major and the loss of the mechanical back-up is classified as minor. The failure of both is catastrophic. The question is: for this system, which paragraph applies? 1317(a) or 1317(c)?	1) To clarify the definition of "system" for §25.1317(a). 2) To provide a better clarification of "Safety assessment related to HIRF". 3) To include typical and clarifying examples, similar to the one provided in the "Comment Summary".	**Accepted.** 1) § 5.2.1 in ARP5583A states: "In the HIRF regulations, the term 'system' refers to the electrical and electronic equipment, associated software, and interconnecting wires installed on aircraft to perform a specific function." 2) § 6.b(1) in the draft AC 20-158A states: "The process used for identifying these systems should be similar to the process for showing compliance with 14 CFR 23.1309, 25.1309, 27.1309, and 29.1309, as applicable. These sections address any system failure that may cause or contribute to an effect on the safety of flight of an aircraft. The effects of a HIRF encounter should be assessed to determine the degree to which the aircraft and its systems safety may be affected. The operation of the aircraft systems should be assessed separately and in combination with, or in relation to, other systems." 3) In the commenter's example and following the discussion in 2) above, § 25.1317(a) applies. Added a new second sentence in paragraph 6.b.(1) to read: "You should define the elements of the system performing a function, considering redundant or backup equipment that makes up the system."

6.	Mauricio Veloso / ANAC Brazil Cert. Authority	The level of HIRF protection required for a back-up system is not clear. For example, the failure of the back-up of a Level A primary system may be considered Minor, according to the Safety Assessment, but certainly this back-up system must have some level of HIRF protection demonstrated. It is not clear if compliance with (a)(2) and (a)(3) is required or if a level of protection equivalent to (b) or (c) would be adequate for the back-up.	1) To provide clarification of what is the level of HIRF protection required for back-up systems, especially for Level A systems.	**Accepted.** If a system performs functions with potentially catastrophic failures, then the system must be shown to comply with § 25.1317(a). All potential failures associated with the system must be considered to ensure that there are no failures that would prevent the system from performing its function. Consider the aircraft electrical and electronic brake system and the backup system is the mechanical emergency brake, mechanically actuated by the crew, directly commanding actuation of hydraulic valves. In this example of the brake system, one catastrophic failure is the activation of the brakes during take-off acceleration. If this is unannunciated to the pilot, this could result in failing to achieve takeoff speeds before reaching the end of the runway. So for this failure, having a mechanical emergency brake does not mitigate this failure. This would lead back to requiring the brake system (with electrical and electronic elements) to comply with § 25.1317(a). This points out the importance of having a very thorough safety assessment. The safety assessment should consider the common cause effects of HIRF, particularly for highly integrated systems and systems with redundant elements. Added the following before the last sentence in paragraph 6.b.(2) to read: "The safety assessment should consider the common cause effects of HIRF, particularly for highly integrated systems and systems with redundant elements."

6-b	P Teichert Airbus S.A.S.	Identify the Systems to be Assessed: The process of systems categorization is not addressed in detail.	Airbus proposes to highlight the specificity of HIRF that has to be considered as a common cause of failure to several systems. Indeed, such a condition is not necessarily considered when safety analyses are performed and can result in the upgrade of the categorization of some systems.	**Accepted.** Added the following before the last sentence in paragraph 6.b.(2) to read: "The safety assessment should consider the common cause effects of HIRF, particularly for highly integrated systems and systems with redundant elements."
6-b (1)(b),(3)	P Teichert Airbus S.A.S.	Identify the Systems to be Assessed: It is not clear if the notion "failure condition" refers to "failure conditions", potentially induced by the HIRF environment" or if it is "failure conditions", already present in the system before the HIRF exposure.	Airbus considers that the notion "failure condition" refers to "failure conditions" potentially induced by the HIRF environment.	**Not accepted.** Table 1 in § 6.b(2) in the AC provides the corresponding failure condition classification and system HIRF certification level for the appropriate HIRF regulations §§ 23.1308, 25.1317, 27.1317, and 29.1317. The HIRF regulations define the failure conditions, such as § 25.1317(a) which states "… that performs a function whose failure would prevent the continued safe flight and landing …". These failure conditions do not necessarily result strictly from HIRF. In fact, prior to the system HIRF tests, the applicant doesn't know if HIRF will cause the failure that prevents continued safe flight and landing. These failure conditions are defined based on the consequence of failure, not the cause of the failure.

8-d Figure 2	P Teichert Airbus S.A.S.	Methods of Compliance Verification The Low-Level Direct Drive (LLDD) test is limited to the 1st Airframe resonant frequency. Airbus demonstrated that it is possible to extend the use of the LLDD beyond this frequency. The frequency limit is more related to the capability of the test set-up to represent the current density topology on the airframe compared to an in-flight illumination. The effort done of the set-up can make possible to extend this technique up to 5 or 10 times the lowest airframe resonant frequency.	Airbus proposes to state that the domain of validity of the method should be justified by the applicant by a specific analysis given in the test plan.	**Not accepted.** In general, the AC only provides guidance on using the LLDD test up to the 1st airframe resonant frequency. Applicants choosing to use the LLDD test beyond the first airframe resonant frequency should follow the guidance in paragraph 8.d(2) to use other HIRF compliance techniques.
8-d Step 13 Page 28	P Teichert Airbus S.A.S.	Assess Immunity: The environments applicable to Level A systems are not necessarily realistic when Level A RF receivers like the ILS Loc and G/S are used in the mode that makes them Level A.	A specific and more realistic environment should be defined for operability of these systems within a certain level of HIRF exposure corresponding to the operational flight path.	**Not accepted.** The commenter references paragraph 9.m. Step 13 (Assess Immunity). Paragraph 9 is referenced in paragraph 8.d (Methods of Compliance Verification). AC 20-158A does not address system specific requirements, such as those for the ILS Localizer or Glide Slope. Paragraph 9.m.(9) provides guidance on RF receivers with aircraft mounted antennas: “Because the definition of adverse effects and the RF response at particular portions of the spectrum depends on the RF receiver system function, refer to the individual RF receiver minimum performance standards for additional guidance. However, because many RF receiver minimum performance standards were prepared before implementation of HIRF requirements, the RF receiver pass/fail criteria should be coordinated with the FAA.”

6 g	Doug Pope/ Honeywell	Wrong tense used in the following sentence "Since December 1, 2012, section (d) of the HIRF regulations and paragraph 6.g of this AC were no longer applicable"	Since December 1, 2012, section (d) of the HIRF regulations and paragraph 6.g of this AC are no longer applicable.	**Accepted.** Changed made.
Figure A1-1	Doug Pope/ Honeywell	The descriptive note for figure A1-1 is not on the same page with the figure.	Format the document such that the descriptive note, for Figure A1-1, is kept with Figure A1-1.	**Accepted.** Changed made.
A1-2 (b)(1)	Doug Pope/ Honeywell	The following was introduced in this update of the Advisory Circular, "Display units installed in rotorcraft typically have no attenuation unless specific shielding is provided in the bulkhead, glareshield, panel, and doors". Paragraph A1-1(a) indicates the transfer functions are derived from test results obtained from a significant number of aircraft. This update does not clearly indicate if this change reflects results obtained from a significant number of aircraft. This paragraph A1-2 (b)(1) already indicates no attenuation credit can be used for unprotected nonconductive composite structures and areas where there is no guarantee of structural bonding. The text introduced in this section "Display units installed in rotorcraft typically have no attenuation unless specific shielding is provided in the bulkhead, glareshield, panel, and doors" appears redundant to the guidance already provided in this section.	Delete the added text "Display units installed in rotorcraft typically have no attenuation unless specific shielding is provided in the bulkhead, glareshield, panel, and doors".	**Partially accepted.** See disposition to the fourth comment from Bell Helicopter Textron. This information was moved to a separate section and the language changed from "no" attenuation to "minimal" attenuation. FAA experience shows many instances where rotorcraft attenuation was minimal. This guidance does not prevent applicant use of actual test data or prevent rotorcraft applicants from using generic attenuation credit when appropriate.

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