European Union Aviation Safety Agency

Comment-Response Document (CRD) 2020-09

RELATED NPA: 2020-09 — ED DECISION 2022/001/R — RMT.0643

26.1.2022

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1. Summary of the outcome of the consultation

During the public consultation of NPA 2020-09, 229 comments were submitted by 20 stakeholders from national competent authorities, organisations, industry companies and associations, and certification service providers.

The commentators were in general supportive of the proposed new AMC 20-193 and the proposed amendments to AMC 20-136 and AMC 158, and of the EASA–FAA harmonisation effort.

None of the commentators expressed any disagreement with the proposal nor created any controversy.

Further to the comments received, the text proposed in the NPA has been modified in some parts, mostly for improvement or clarification purposes.

The individual comments and EASA's responses to them are provided in Chapter 2 of this CRD.

2. Individual comments and responses

In responding to the comments, the following terminology is applied to attest EASA's position:

(a) **Accepted** — EASA agrees with the comment and any proposed change is incorporated into the text.

(b) **Partially accepted** — EASA either partially agrees with the comment or agrees with it but the proposed change is partially incorporated into the text.

(c) **Noted** — EASA acknowledges the comment, but no change to the text is considered necessary.

(d) **Not accepted** — EASA does not agree with the comment or proposed change.

(General Comments)	-

comment	*1* comment by: *Swedish Transport Agency, Civil Aviation Department (Transportstyrelsen, Luftfartsavdelningen)* Thank you for the opportunity to comment on NPA 2020-09, Regular update of AMC-20. Please be advised that there are no comments from the Swedish Transport Agency.
response	Noted Thank you

comment	*34* comment by: *CAA Finland* Traficom CAA FI has no comment on this NPA.
response	Noted Thank you

comment	*63* comment by: *General Aviation Manufacturers Association* Attachments #1 #2 Reference: GAMA20-64 Text In Question From NPA - ".. Overall, the proposed documents would provide economic benefit by streamlining the certification process, would have no safety, …" The change to the AMC does allow the use of simpler lightning and HIRF certification methods for CS-23, which does provide an economic benefit with better balance of safety and cost. However, it is hoped that in the future that something similar can be done for CS-27 since the proposed lightning and HIRF changes are considered to increase requirements that would increase cost of certification. How the increased cost is offset by a safety benefit is not discussed within the NPA not only for CS-27 but also for CS-25 and CS-29.

The increase in cost is primarily from:
1) Disallowing Active-back up channels (eg STBY) to be used in meeting sub part a of the lightning and HIRF rules. This puts all of the burden for meeting these rules on the Active channels (eg Primary system).
2) Any mechanical/hydraulic system used to mitigate a Level A function now requires a minimum level of reliability.
3) No methods have been defined for what might be required for existing aircraft certified to previous methods.

Proposed Solution:
Go back and properly address the increased cost that will be incurred for certifying Parts 25, 27, and 29 to the new methods proposed within AMC 20-136A and AMC 20-158A. If the cost/benefit is not positive, revise AMC 20-136A and AMC 20-158A and allow a 2nd public comment period.

response | Not accepted

The update of AMC 20-126 and 20-158 clarify the requirement and the way to show compliance with it, without additional cost.

comment | *128* comment by: *Embraer S.A.*

Embraer analysis and suggestions are applicable to both AMC 20-136A and 20-158A. We kept the wording for HIRF and Lightning inside parenthesis to make clear the broad applicability.

response | Noted

comment | *129* comment by: *Embraer S.A.*

Embraer understands that to apply the AMC 20-136A to CS-23 aircraft, as proposed in NPA 2020-09, is inadequate, since the AMC, in several points, is more restrictive than the requirement itself, as explained below:

Requirements 23.2515 and 23.2520 clearly state the need for *"return to normal operation in a timely manner"* and not *"automatic return to normal operation"*. Therefore, applicability of AMC 20-136A could implicate in more tests of electrical and electronic systems, in order to verify the active channel for normal operation and automatic return, in case of an upset. These tests may require increase of the protection levels required by the affected systems, or, at least, it would require review of the approach used for CS-23 certification on new projects. The changes in regulatory framework introduced by Amendment 5 of CS-23, lead to a more flexible regulation, aiming for a simpler certification process, the reduction of regulatory time and the cost burdens for the aviation industry and authorities. Therefore, implement the proposed AMC 20-136A would not be aligned with the current regulatory structure and practices. [Ref. EASA, 2017, ED Decision 2017/013/R and Explanatory note to ED Decision 2017/013/R; FAA, 2016, Revision of Airworthiness Standards for Normal, Utility, Acrobatic, and Commuter Category Airplanes, I. Overview of the Final Rule]
In this context, Embraer offers the following alternative text:

	Where we now read: “Note: For CS-23 Amendment 5 and higher, there is a new specification, i.e. CS 23.2515, which is similar to CS 23.1306. The associated AMC for CS 23.2515 is published separately in the AMC & GM to CS-23, based on ASTM F3061/F3061M-17. The present AMC 20.136A can still be used as guidance for CS 23.2515, if agreed with the Agency.”, Embraer suggests using “Note: For CS-23 Amendment 5 and higher, there is a new specification, i.e. CS 23.2515, which is similar to CS 23.1306. The associated AMC for CS 23.2515 is published separately in the AMC & GM to CS-23, based on ASTM F3061/F3061M-17. The present AMC 20.136A can still be used as guidance for CS 23.2515, which would be acceptable as equivalent means of compliance as AMC/GM CS-23.”
response	Partially accepted The sentence has been improved for clarification.

comment	*178* comment by: *GE Aviation* In response to the NPA 2020-09, GE Aviation is pleased to provide the comments in this Commente Response Tool on AMC 20-193. GE has no comments on AMC 20-136 nor AMC 20-158. Thank you , Allan van de Wall GE Aviation Chief Consulting Engineer allan.vandewall@ge.com 513-746-9569
response	Noted Thank you

comment	*179* comment by: *DGAC France* Please note that DGAC France has no specific comments on this NPA.
response	Noted Thank you

comment	*181* comment by: *Leonardo Helicopters* It is considered that the proposed revisions of AMC 20-136A/158A provides valuable clarifications especially in the area of HIRF/IEL Safety assessments, as well as useful harmonization of HIRF and IEL AMCs. This is very welcome from a user’s point of view, thanks. We believe that some of the proposed changes subjects deserve more discussion and clarification, having identified possible impacts to the design and certification effort. For those with such a possible impact we propose the comments below.

Suggested resolution:
Possibly extend the NPA discussion period if required.

response

Noted

The commenting period of the NPA was, however, not extended.

comment

205 comment by: *Chair SAE AE2*

Attachment #3

December 31, 2020

European Union Aviation Safety Agency

RE: SAE AE-2 (Lightning) and AE-4 (EMC) Response to EASA NPA 2020-09

Dear Colleagues:

Background

In November of 2020, the leadership teams of SAE AE-2 and AE-4 decided to collaborate on comments to EASA's NPA 2020-09. In the interests of time, the leadership teams of both committees requested comments from committee members, and the leadership teams assembled the comments into this response.

It is understood that the NPA 2020-09 is largely an update to include work that has been done by certification authorities in the CATA HIRF paper. Other venues and avenues have captured comments to the CATA HIRF paper. As the NPA 2020-09 is meant to include the CATA HIRF paper, there is a large overlap of comments that are applicable to both the CATA HIRF paper and to NPA 2020-09. The leadership teams of both the SAE AE-2 committee and AE-4 committee were involved in the creation of a paper titled "Industry Response to Certification Authorities for Large Transport Aircraft 'TCCA-001 – HIRF Testing'".

Finally, the leadership teams of the committees decided to pare down the comments to what the leadership teams felt were the most pertinent and relevant comments. This unfortunately would mean that perhaps not all comments from the committee members are included or as fleshed out as the commenter would prefer. The leadership teams of the AE-2 and AE-4 committees encouraged any members who have further comments above and beyond those captured in this document to submit through normal channels (e.g., through their companies, universities, working organizations, etc.)

Introduction to Comments

The following information is provided as an introduction to the comments and gives context for the committee positions.

1. It is assumed at this time that EASA certification authorities have access to the industry response comments to the CATA paper. It is also assumed that any comments that could have relevant impact or changes to the CATA paper would also be applied to NPA 2020-09.

2. The terms “standby”, “primary”, and “backup” are used throughout the comments. While the HIRF and lightning regulations do not use these terms, the committee group considered it helpful to provide the comments in the context of traditional aircraft systems nomenclature.
3. The committees recognize that HIRF and lightning regulations are independent of 2X.1309, in relation to the HIRF/lightning environments. 2X.1309 is mentioned in these comments as a source for information related to system functions and the impact on the crew and aircraft through the functional hazard assessment.
4. Specific comments on the examples in the NPA are not provided, however it is understood that resolution of these comments may impact the content in the examples.
5. Comments and references to the proposed lightning AMC also apply to the proposed HIRF AMC, where applicable, and vice versa.

Comments

1. Comment: New classifications have been introduced for systems and equipment. However, these classifications do not have clear definitions. The following definitions and concepts need to be provided. The rationale for why clarification is necessary is included below. The following should be addressed and added to Appendix 1 of both AMC 20-136A and 20-158A.

Recommendation:

Add definitions or clarifications for the following terms and concepts.

Availability – Section 7.a.3 states that “the lightning safety assessment should verify the reliability and availability assumptions…”, but “availability” is not defined. What are the requirements associated with “availability”? This would represent a difference from the industry convention for HIRF/Lightning safety assessments. In 7.a.4, it states that the applicant does not need to assume pre-existing failure conditions, which has been standard industry convention. The statement that pre-existing failure conditions do not need to be considered `contradicts the requirement to verify availability and reliability. If the statement requiring availability and reliability to be verified is removed, this definition is not needed.

Channel – What constitutes a “channel” is not defined. It is implied that “channel” is equipment that performs a “function”. If this is the intended case, it should be stated as such. An autopilot disconnect switch can be used as an example. Is this switch considered to be a “channel”? Further, would simple electromechanical devices (such as breakers, relays, switches) constitute channels?

Foreseeable Latent Failure Condition – Section 7.a.3 states that if a mechanical, hydraulic, and/or pneumatic channel has a foreseeable latent failure conditions, then it must be assumed that the electrical/electronic channel is the active channel during normal operations. However, all systems, including electrical or electronic systems, have foreseeable latent failure conditions. In these cases, which “foreseeable latent failure condition” would take precedence? No system is free from “foreseeable latent failure conditions” and the verbiage is therefore forcing the electrical/electronic channel to be the primary channel in all cases. Therefore,

what exactly constitutes a foreseeable latent failure condition should be defined, or the associated sentence in section 7.a.3 should be deleted.

Function – Traditionally "function" has a very specific meaning that would pertain to one of the FHA conditions associated with the aircraft. It is very important that when defining what a "channel" is with respect to what a "function" is; it is necessary to clarify if this is related to one of the FHA conditions or not. There are many cases in which the FHA conditions do not necessarily relate to a particular equipment feature associated with aircraft performance. As an example, a typical FHA condition may be "un-commanded roll of the autopilot with inability to disconnect." If this is the case, then "autopilot disconnect" is not necessarily a "function" as spelled out in the FHA's. It is something that is instead incorporated into other failure conditions. In order to ensure there is no confusion, the NPA should state what constitutes a "function" should be clearly defined with respect to the FHA conditions.

Mechanical and electrical channel – There are many different components on the aircraft that would need to be defined as either mechanical or electrical. With the difference in requirements between a mechanical and electrical "channel" in terms of reliability, it would necessitate defining what constitutes a mechanical and electrical "channel". Would a disconnect switch, such as an autopilot disconnect switch which removes ground from the autopilot servos, constitute a "mechanical channel" or an "electrical channel"? Additional questions may be raised regarding most "electro-mechanical" devices, such as relays and circuit breakers. Removing the statement in section 7.a.3 regarding foreseeable latent failures of mechanical systems will help minimize the impact of the ambiguity between electrical and mechanical.

Normal and non-normal Operation – This has been defined in the NPA's, but some additional clarification is required. It is not clear which channels and their modes apply to Normal and Non-Normal operations. As an example, the NPA statement "Automatic recovery applies to all redundant channels of the Level A system required for normal operation unless its recovery conflicts with other operational or functional requirements of the system." It is unclear which channels need to recover in reference to "all redundant". Is it just the Active channels or Active-backup and Passive-backup as well? The example 1 indicates that there are situations where the Active-back up does not need to recover.

In addition, to better understand what is considered normal vs non-normal operation, is a pilot operation that prevents a malfunction considered normal or non-normal operation? Example pilot using a disconnect switch to disengage the autopilot to prevent a hardover or slowover.

Reliable/Reliability – Section 7.a.3 states that "the lightning safety assessment should verify the reliability and availability assumptions…", but "reliability" is not defined. What are the requirements associated with "reliability"? This would represent a difference from the industry convention for HIRF/Lightning safety assessments. In 7.a.4, it states that the applicant does not need to assume pre-existing failure conditions, which has been standard industry convention. The statement that pre-existing failure conditions do not need to be considered contradicts the requirement to verify availability and reliability. If the statement

requiring availability and reliability to be verified is removed, this definition is not needed.

2. Comment: AMC 20-136A Section 7.a.6 states that any excluded elements or channels should comply with the paragraphs of the regulations that would correspond to hazardous failure conditions. This could be interpreted that all backup equipment become Hazardous classification for the HIRF/lightning safety assessment, regardless of the performance of the primary systems.

Discussion:
This is not in alignment with industry standard convention. Industry standard convention is that if the level A system is able to meet the level A requirements for the regulations without any reliance on the backup, then the backup can be assigned a HIRF and lightning hazard classification in alignment with its functional hazard classification.

It is agreed that if the backup must be utilized to meet the level A requirements, then the backup must rise to level A in the HIRF/lightning safety assessment. However, there is not agreement that if there is a backup to a level A system, it is automatically level B, regardless of the level A system performance.

Driving the backup to level B can have significant impact on cost and certification effort for many different projects.

Recommendation:
Replace the default requirement for backups to be level B hazard classification with a requirement that the HIRF and lightning hazard classification be based on the FHA of the specific aircraft and system.

3. Comment: AMC 20-158A appendix 3, section C.1 (minimum conditions) states: "All electrical and electronic system channels that perform functions whose failure would prevent continued safe flight and landing, and can operate in 'Active' mode during normal operation, should fully comply with CS 25.1317(a)." The committee's believe this statement can be misinterpreted by applicants and authorities, and should be reworded to more accurately reflect EASA's intention.

Discussion:
A standby/backup system should be allowed to maintain the level A function during the HIRF event, if the primary system recovers to normal operation after the event. The rule does not state which channel can hold up the function. This has been accepted practice to date for display of primary flight information.

Recommendation:
When considering availability of a function that is CAT the following approaches should be allowed:

1. A primary channel meets (a)(1) thru (a)(3) OR
2. Primary channel and/or STBY channel together meet (a)(1). Primary channel meets all of (a)(2)(3) independent of STBY. STBY meets all of (a)(2)(3) independent of primary channel.

4. Comment: There are cases where a non-required system performs a function whose loss does not prevent continued safe flight and landing, but some system failures may be level A. An example of this would be an optional autopilot used only for workload relief, but which can produce slowover failures that could prevent continued safe flight.

Discussion
Although this discussion focuses on the autopilot for this example, it is relevant to any system where the loss of function is lower than catastrophic, but the malfunction is catastrophic.

In many conventional autopilot designs the system will disconnect the auto-pilot in any abnormal system response. Thus, when applying the HIRF environments to the system, it is common for the autopilot to disconnect to prevent abnormal responses, such as a slowover. In most system designs, this is considered adequate to meet the requirements of 1317(a)(1), 1317(a)(2) and 1317(a)(3).

The concern is that some applicants and authorities may interpret 1317(a)(2) to require the autopilot to re-engage. For 1317(a)(3) it may be interpreted that the autopilot would not be allowed to disconnect when exposed to HIRF environment II. In both of these case, the auto-pilot disconnect would constitute level A requirements being levied on a minor/no effect function. It is only the slowover that is catastrophic.

Recommendation:
Include the following examples.

Lightning Example 9	
Function	System
Provide roll axis autopilot control	The function is produced by a system with no redundant channels.
Applicable parts of CS 25.1316	a(1)
The availability requirement for the autopilot (AP) is Minor, however a malfunction may be considered CAT. The catastrophic condition occurs when there is a malfunction in the autopilot that is not caught and results in an un-commanded servo operation with enough authority to cause a CAT condition for the aircraft. The applicable sub-part CS25.1316 a(1) should be demonstrated by showing that there is no adverse effect by preventing the malfunction. The malfunction can be prevented by an electronic monitor within the autopilot computer or by the pilot recognizing the failure and disconnecting the AP via the AP DISC switch. In both cases the autopilot is disconnected to prevent the malfunction. Since the loss of the AP is Minor this is acceptable. For CS25.1316 a(2), the system does not need to demonstrate automatic or manual recovery since the availability of the AP is Minor.	

HIRF Example 9

Function	System
Provide roll axis autopilot control	The function is produced by a system with no redundant channels.
Applicable parts of CS 25.1317	a(1),a(3)

The availability requirement for the autopilot (AP) is Minor, however a malfunction may be considered CAT. The catastrophic condition occurs when there is a malfunction in the autopilot that is not caught and results in an un-commanded servo operation with enough authority to cause a CAT condition for the aircraft.

The applicable sub-part CS25.1317 a(1) should be demonstrated by showing that there is no adverse effect by preventing the above malfunction. The malfunction can be prevented by an electronic monitor within the autopilot computer or by the pilot recognizing the failure and disconnecting the AP via the AP DISC switch. In both cases the autopilot is disconnected to prevent the malfunction. Since the loss of the AP is Minor this is acceptable.

For CS25.1317 a(2), the system does not need to demonstrate automatic or manual recovery since the availability of the AP is Minor.

CS25.1317a(3) is met since Env II is lower than Env I used in CS25.1317a(1).

Sincerely,

(the attached file is a duplicate of this overall comment, and contains my signature)

Robert Steinle
Chair
AE-2 Lightning Standards Committee

cc: Josh Bakk – Vice Chair AE-2
Jeff Phillips – Secretary AE-2
Eric Stewart – Chair AE-4
Eric Borgstrom – Vice Chair AE-4

response

Partially accepted

Comment #1 is partially accepted: some definitions are reworded for clarification.

Comment #2 is not accepted: the industry standard convention is not in line with the those of the authorities.

Comment #3 is not accepted: the examples illustrate specific cases allowing HCL alleviation for back-up channels.

Comment #4 is not accepted: the example does not seem to be realistic by proposing a Level A system based on a single channel.

comment *230* comment by: *Boeing*

General comment regarding re-use of the position and proposals of the CATA HIRF task group. Reference the following pages:
Page 4. *Paragraph 2.1.1. Why we need to amend the rules — issue/rationale*
Page: 41-49. *Appendix 2 to AMC 20-136A — Examples of lightning safety assessment considerations — Level A systems on large aeroplanes*
Page: 96-105. *Appendix 3 to AMC 20-158A — Examples of HIRF safety assessment considerations — Level A systems on large aeroplanes*

THE PROPOSED TEXT STATES:
2.1.1. Why we need to amend the rules — issue/rationale
The current indirect effects of lightning (IEL) and HIRF requirements are subject to various interpretations between authorities and industry. A task group of the certification authorities for large transport aircraft (CATA — composed of EASA, the FAA, the Transport Canada Civil Aviation (TCCA) and the Brazilian Civil Aviation National Agency (ANAC)) was convened to propose a harmonised position on the intent and interpretation of these requirements. The task group proposed clarifications on key terms and appropriate pass/fail criteria to comply with the HIRF requirements for systems performing a function whose failure could prevent the continued safe flight and landing of the aircraft according to its design/architecture. These proposals can be applied to the IEL guidance, due to the similarities between the two subjects.
EASA decided to re-use the position and proposals of the CATA HIRF task group by revising the existing EASA AMC 20-136 and AMC 20-158.

REQUESTED CHANGE:
General comment: A group of individuals from across the aircraft industry involved in aircraft HIRF and lightning certification (primarily OEMS, manufacturers, and regulatory authorities) conducted a series of ad-hoc meetings and reviewed the guidance commonly referred to as the CATA HIRF paper, i.e. “HIRF Testing” by Certification Authorities for Large Transport Aircraft (CATA), dated October 24, 2019. The CATA HIRF paper provides a harmonized position, and is very helpful to the industry. This recognized harmonization is a substantial effort, and it is greatly appreciated. The ad hoc group is in agreement with the majority of the CATA HIRF paper, and wanted to offer a few comments. These comments were offered on 7/27/2020 to gain clarification and ensure a proper understanding among the industry participants. In addition to the comments file, specific changes to the CATA HIRF paper were proposed in an accompanying file with cross reference to these comments.
It is requested that EASA allows CATA to respond to these comments and proposed changes prior to including the position and proposals of the CATA HIRF task group.

	JUSTIFICATION: A group of individuals from across the aircraft industry involved in aircraft HIRF and lightning certification has recommended clarification to the position and proposals of the CATA HIRF task group. By including updates to the CATA HIRF position, it would provide for economic efficiency gains by streamlining the certification process. As the proposed AMCs are currently written, there will continue to be industry confusion on the HIRF and Lightning certification process.
response	Noted The final text of the AMC takes into account the final discussion within the CATA HIRF task group.

comment	*231* comment by: *LBA* The LBA has no comments.
response	Noted

Notice of Proposed Amendment 2020-09 — Regular update of AMC- p. 1

comment	*35* comment by: *Airbus-Regulations-SRg* General comment Airbus Commercial Aircraft is pleased to participate in the commenting of NPA 2020-09. Our matter experts and certification manager have carefully reviewed this proposal. Our comments are given in the following (comments # 36 to 47).
response	Noted

1. About this NPA p. 3

comment	*206* comment by: *IATA* • General ○ The Agency initiative to harmonize the AMC20-193 with future revision of FAA AC20-193 from the CRD level is commendable and we're looking forward to a positive outcome. Incorporating the CATA position and proposals in the proposed rev A of EASA AMC 20-136 and AMC 20-158 is a meritorious step (we acknowledge) towards a more effective harmonization between EASA – FAA – TCCA and ANAC.
response	Noted

2. In summary — why and wh p. 4-6

comment *64* comment by: *General Aviation Manufacturers Association*

Section 2.1.3:
Text In Question From NPA - "..a proposal for the Lightning and HIRF Certification Level for the protection of systems according to the probability of occurrence of the threat event.."

The new CS-23 guidance took the above into consideration, but it was not clear in the NPA whether the increased requirements had any bearing on the above.

Clarify whether the text in question is only for CS-23 or also applies to the other CS parts.

response Noted

This text will not appear in the final deliverable.

However, it applies to all products.

comment *65* comment by: *General Aviation Manufacturers Association*

Attachment #4

Section 2.1.4:
Text In Question From NPA - "..The present AMC 20.136A can still be used as guidance for CS 23.2515, if agreed with the Agency…"

Proposing to remove "if agreed with the Agency…".

See: Industry Feedback to CATA Closed Decision Papers (Nov. 17, 2020) - response to CATA CWI TCCA-001-HIRF paper (attached) for background to this and other comments [Note: referenced within these comments as "Industry Response to CATA HIRF paper Dated July 27, 2020"].

response Partially accepted

The sentence has been improved for clarification.

comment *98* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment

1		4	2.1.1	reference to CATA activity	The CATA released a harmonized guidance document 10/24/19 addressing HIRF testing criteria and definitions, which have since been adopted into the proposed AMCs (included in this review document) for both HIRF and Lightning. The CATA has already received comments from industry to the CATA HIRF guidance paper. Similar comments should be anticipated to the proposed AMC's, and the corresponding proposed FAA AC's.	information only - no action requested	information only	
2	2020-09 Regulatro Update Of AMC-20	Page 7 - 3.1 Lightning Guidance and 3.2 HIRF	Both Sections 3.1 and 3.2	Too much to copy.	Flow of both these sections and content are well organized. Great job on providing examples for	No change recommended.	Editorial and Conceptual	

		Guidance			both sections.			

response: Noted

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 2. SCOPE AND APPLICABILI p. 8

comment *7* comment by: *Airbus Helicopters*

Section, table, figure:	**Page:**	**Comment summary**:	**Suggested resolution**:
AMC 136 &158 §2	8 & 51	The two paragraphs AMC 136 &158 §2 are not consistent	The two paragraphs should address the same considerations and with similar level of depth.

response: Noted

The text of both sections has been harmonised to the greatest extent possible.

comment *182* comment by: *Leonardo Helicopters*

Part 23 rule and AMC have been reorganized in a single content EAR CS-23 AMC/GM Issue 1. Within this reorganization, new guidance material from ASTM “simplified” methods for HIRF/Lightning have been proposed. This NPA confirms AMC 20-136A as alternate means of compliance for Part 23.
Simplified methods have also been recently proposed as Means of Compliance for VTOL.

Is EASA open to consider future extension of “simplified” approaches (ASTM or with similar scope) to other vehicle types, such as Part 27?

If this was not possible within this AMC update program: could EASA advice about possible way forward for Part 27 AMC update in this direction (including coordination with FAA) and could EASA advice about possible use of “simplified” methods for Part 27 for individual certification programs as alternate means of compliance, and under which boundaries (e.g. single/dual engines, IFR/VFR approval, level of control for specific protections/design).

response: Noted

This revision of the AMC does not introduce proportionality for CS-23 / CS-27 aircraft at this Amendment. This can be considered for a future amendment of the AMC.

Today, proportionality may be introduced through dedicated Certification Memoranda.

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 3. DOCUMENT HISTO p. 8

comment *8* comment by: *Airbus Helicopters*

Section, table, figure: AMC 136 §3	**Page:**8	**Comment summary**: Did AMC 20-136 address HIRF?	**Suggested resolution**: Shall be corrected

response Accepted

comment *66* comment by: *General Aviation Manufacturers Association*

Paragraph 2.a.

Text In Question From NPA - "..The present AMC 20.136A can still be used as guidance for CS 23.2515, if agreed with the Agency…"

Proposing to remove "if agreed with the Agency…".

Seems like there should not be a need to coordinate with agency to use the AMC. The AMC is acceptable for P25/27/29 and therefore should automatically be acceptable for P23 if Applicant to chooses to use it.

Remove "if agreed by the agency" from the last sentence of Section 2.a.

Also, correct "AMC 20.136A" to "AMC 20-136A" in this sentence.

response Partially accepted

The sentence has been improved for clarification.

comment *67* comment by: *General Aviation Manufacturers Association*

Under document history, it specifies HIRF and lightning for AMC 20-136. HIRF should be removed.

AMC 20-136 is a lightning document.

Remove the reference to HIRF.

response Accepted

comment	*201* comment by: *Leonardo Helicopters* Section 3 Proposed to remove reference to HIRF from AMC 20-136A: "*This AMC replaces and cancels AMC 20-136, ~~High-Intensity Radiated Fields (HIRF) and~~ Lightning, 15 July 2015*“
response	Accepted

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 4. RELATED MATERI p. 9-11

comment	*36* comment by: *Airbus-Regulations-SRg* Section 3.1. AMC 20-136, chapter 4: Related Material EUROCAE and SAE references, page 9 - chapter 4.c and page 10 - chapter 4.e Airbus proposal: Chapter 4.c: Airbus propose to add the document “EUROCAE ED-158” (published in April 2020) to the paragraph 4.c. The title of the document: “*User’s Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning*”. Chapter 4.e.5: Airbus propose to update the reference of ARP 5415**A** to ARP 5415**B**. Rationale: These two documents have been either published or updated before the release of the NPA. They should be referenced as they are fully in the scope addressed by the NPA.
response	Accepted

comment	*68* comment by: *General Aviation Manufacturers Association* Item #5, ARP 5415A is referenced here, however ARP 5415B is the current version. Latest guidance material should be referenced Change to ARP 5415B.
response	Accepted

comment	*69* comment by: *General Aviation Manufacturers Association* ED-158 should be added to the list of related EUROCAE materials.

ED-158 is referenced multiple times in the text of the AMC.

Add ED-158 to the list of related EUROCAE materials.

response: Accepted

comment: *70* comment by: *General Aviation Manufacturers Association*

Section 5

There is no guidance on where exposure to lightning is likely.
If applicants are to use this, they must know where exposure is likely.

Either define the conditions where exposure is likely, or point to the document that has those definitions.

response: Not accepted

The determination of the criteria for the likelihood of exposure to lightning is not needed because it relates to aircraft type of operation (VFR v IFR).

comment: *189* comment by: *Leonardo Helicopters*

Paragraph 4.c

EUROCAE ED-158 and ED-234 should be added to the list

response: Accepted

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 6. APPROACHES TO COMPLIAN p. 12-20

comment: *9* comment by: *Airbus Helicopters*

Section, table, figure:AMC 136 §6)c)2) & AMC 158 6)b)1)	**Page:**13 & 54	**Comment summary**: Point (c) of 6)b)1) for HIRF: "any corrective actions required by the flight crew " is not mentioned for LIE in 6)c)2)	**Suggested resolution**: The two paragraphs should be similar or the reason for the needed difference in the approach should be provided in order to allow a comprehensive application of this requirement.

response | Noted

The text of both sections has been harmonised to the greatest extent possible.

comment | *11* comment by: *Airbus Helicopters*

Section, table, figure:AMC 136 §6)c)2)	**Page:**14	**Comment summary**: Note: “Normally” may be understood as implying that if not, a justification is required. The LCL and HCL may depend on the protection design choice, or actual level achieved during D&D, and therefore can be different witout any reason to require a justification why they differ as this will not influence the final system design compliance.	**Suggested resolution**: Modify the note as follows: NOTE: Considering that lightning and HIRF environments may have similar effects on electro-electronic systems (disturbing electrical signals, causing upsets or damage to circuits) and that the applicable regulations are similarly structured, in many cases the system LCL and HCL will be the same.

response | Partially accepted

The text has been improved for clarification.

comment | *12* comment by: *Airbus Helicopters*

Section, table, figure:AMC 136 §6)c)3)	**Page:**15	**Comment summary**: It seems that first paragraph of 3) address a more detailed aspect of the safety analysis than the rest of 3)	**Suggested resolution**: Move first paragraph at the end of 3)

response | Accepted

comment | *13* comment by: *Airbus Helicopters*

Section, table, figure:AMC 136 §6)c)4)	**Page:**16	**Comment summary**: Example of sensor seems to be purely LDE,, as attachment damage is considered, and therefore not relevant here	**Suggested resolution**: Replace with a more LIE relevant example.

response

Partially accepted

The example has been deleted.

comment

14 comment by: *Airbus Helicopters*

AMC 136 §6)c)4)	**Page:**16	**Comment summary**: For Lightning common effect, wire routing is as important as equipment location itself. Should be clarified that systems includes wiring.	**Suggested resolution**: if multiple Level B or C systems **and their wirings** are installed within the same location in the aircraft…

response

Accepted

The text has been modified accordingly.

comment

37 comment by: *Airbus-Regulations-SRg*

Section 3.1. AMC 20-136, chapter 6.c.2: Lightning safety assessment
Page 15 – Table 1 (title)

Airbus proposal:
The title of table 1 refers to “HIRF”.
Airbus propose to change the title to “Lightning Indirect Effects”

Rationale:
Airbus assumes an editorial error (copy/paste from CATA document).

response

Accepted

comment

38 comment by: *Airbus-Regulations-SRg*

Section 3.1. AMC 20-136, chapter 6.c.3: Level A systems
Page 15, 2nd section, 5th sentence.

Airbus proposal #1, to replace:
"[…] ~~*The system defined for CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a) is not required to include the electrical and electronic equipment, components and electrical interconnections required only for non-normal situations, provided that none of the electrical and electronic equipment, components and electrical interconnections required for normal operation are susceptible when they comply with paragraph (a)*~~."
By following text
"[…] The system defined for CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a) is not required to include the electrical and electronic equipment, components and electrical interconnections required only for non-normal situations. In the case one of the electrical and electronic equipment, components and associated electrical interconnections required for normal operation is found not compliant with paragraph (a) of the referenced CSs, electronic equipment, components and electrical interconnections required only for non-normal situations could be considered in complying with paragraph (a) of the referenced CSs. In such a case, the applicant should obtain the Agency's concurrence."

Airbus proposal #2, alternatively:
Airbus propose to delete the second part of the initial sentence to read as follows:

"[...] The system defined for CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a) is not required to include the electrical and electronic equipment, components and electrical interconnections required only for non-normal situations." ~~*provided that none of the electrical and electronic equipment, components and electrical interconnections required for normal operation are susceptible when they comply with paragraph (a).*~~

Rationale:
At the stage of the document, the statement is opening the possibility to rely on back-up systems which suggests that this option can be taken from the beginning in the design process. However, this looks in contradiction with the sentence given at chapter 6.c.1.2 which states that it is not appropriate to use immunity data as an information to drive the safety assessment and to make decision on the LCL categorization. The option of relying on backup systems for demonstrating the compliance to the paragraph (a) of the referenced CSs should be considered only after having performed the development and verification of the systems used for normal operations. As taking this option deviates from the general understanding of the performance allocation between systems developed in the previous paragraphs, it looks appropriate to mention the need to draw the attention of the Agency on this point.

response

Partially accepted

The paragraph will be reworded according to the CATA Paper Discussions (please, refer also to the response to comment #73).

comment	*71* comment by: *General Aviation Manufacturers Association* Section 6. c. 2. Should the lightning safety assessment include a reference to 23.2510? Are the new amendment levels included in the lightning assessment. Include the reference to the new regulation.
response	Not accepted In this section, reference is made to the guidance material for the safety assessment, but not to the requirement itself.

comment	*72* comment by: *General Aviation Manufacturers Association* Section 6. c. 2. Text In Question From NPA - "..NOTE: Considering that lightning and HIRF environments may have similar effects on electro-electronic systems (disturbing electrical signals, causing upsets or damage to circuits) and that the applicable regulations are similarly structured, normally the system LCL and HCL will be the same." HIRF and Lightning CL do not need to be the same. Change "will be" to "can be" in the NOTE. i.e., "..NOTE: Considering that lightning and HIRF environments may have similar effects on electro-electronic systems (disturbing electrical signals, causing upsets or damage to circuits) and that the applicable regulations are similarly structured, normally the system LCL and HCL can be the same."
response	Partially accepted The text has been improved for clarification.

comment	*73* comment by: *General Aviation Manufacturers Association* Section 6.c.3. Text In Question From NPA - "This electrical and electronic system must also automatically recover normal operation of the Level A functions in a timely manner to comply with paragraph (a)(2) of these specifications." The impact of integrity of a function is not considered in the above and in general throughout the NPA. Malfunctions may be CAT and would need to address a(1), but it should not need to recover per a(2) if the availability is less than CAT. The automatic or manual recovery should only be required when the availability of the function is considered to be CAT.

Suggest changing to "This electrical and electronic system must also automatically recover normal operation of the Level A functions in a timely manner when the availability of the function is considered to be CAT, to comply with paragraph (a) (2) of these specifications.".

response

Partially accepted

The related text has been deleted.

comment *99* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
3	2020-09 Regularo Update Of AMC-20	Page 13 3.1 Lightning Guidance	Paragraph 6 c.2.	Table 1 provides the corresponding failure condition classification and system lightning certification level (LCL) for the appropriate lightning regulations.	Should be most severe failure condition of the function.	Replace referenced text with: Table 1 provides the corresponding most severe failure condition classification of the function and system lightning certification level (LCL) for the appropriate lightning regulations.	Editorial	
4	2020-09 Regul	Page 14 3.1	Paragraph 6 c.2.	Based on the failure	Should be based on the safety	Replace referenced text	Editorial	

	aro Updat e Of AMC-20	Light ning Guida nce		condition classificat ion establish ed by the safety assessme nt, the systems should be assigned appropria te system LCLs, as shown in Table 1.	classification of the failure condition of the function.	with: Based on the safety classificat ion of the failure condition establish ed by the safety assessme nt, the systems should be assigned appropria te system LCLs, as shown in Table 1.		
5	2020-09 Regul aro Updat e Of AMC-20	Page 14 3 .1 Light ning Guida nce	Paragra ph 6 c.2.	The safety assessme nt should consider the common cause effects of lightning, particular ly for highly integrate d systems and systems with redundan t elements.	Should refer to lightning safety assessment.	Replace reference d text with: The lightning safety assessme nt should consider the common cause effects of lightning, particular ly for highly integrate d systems and systems with redundan t elements.	Editoria l	
6	2020-09 Regul aro Updat	Page 14 3 .1 Light ning	Paragra ph 6 c.2.	The system LCL classificat ion	Replace complex electronic hardware with	Replace reference d text with: The system	Editoria l	

	e Of AMC-20	Guidance		assigned to the systems and functions can be different from the Development Assurance Level (ED-79A/ARP 4754A) / Design Assurance Level (ED-80/DO-254) Assurance Level (DAL) assigned for equipment redundancy, software, and complex electronic hardware.	airborne electronic hardware (AEH) since AMC 20-152A refers to AEH and provides guidance for both simple and complex devices	LCL classification assigned to the systems and functions can be different from the Development Assurance Level (ED-79A/ARP 4754A) / Design Assurance Level (ED-80/DO-254) Assurance Level (DAL) assigned for equipment redundancy, software, and airborne electronic hardware (AEH).		
7	2020-09 Regularo Update Of AMC-20	Page 14 3.1 Lightning Guidance	Paragraph 6 c.2.	The term DAL should not be used to describe the system LCL because of the	Replace complex electronic hardware with airborne electronic hardware (AEH) since AMC 20-152A refers	Replace referenced text with: The term DAL should not be used to describe the system	Editorial	

				potential differences in the assigned classifications for software, complex electronic hardware, and equipment redundancy.	to AEH and provides guidance for both simple and complex devices.	LCL because of the potential differences in the assigned classifications for software, airborne electronic hardware (AEH), and equipment redundancy.		

response: Partially accepted

comment: *130* comment by: *Embraer S.A.*

We suggest use the latest document revision of SAE standard, which is ARP 5415B.

response: Accepted

comment: *131* comment by: *Embraer S.A.*

[6.g.2.] "Appropriate margins to account for uncertainties in the verification techniques may be necessary as mentioned in paragraph 8.l. of this AMC."

The references to Section 8 are inaccurate. It should be to section 7.

response: Accepted

comment: *140* comment by: *Embraer S.A.*

[6.c.(3)] "This electrical and electronic system must also automatically recover normal operation in a timely manner to comply with CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2)."

Automatic recover is not required on CS 23.2515(a)(2). Therefore, direct compliance with AMC 20-136A for CS-23 aircraft would be stricter than the requirement itself.

response	Noted The text has been improved for clarification.

comment	*202* comment by: *Leonardo Helicopters* Section 6.c Table 1 Table 1 title suggested to be changed replacing reference of HIRF with reference to Lightning: "~~HIRF~~ Lightning failure conditions and system ~~HIRF~~ Ligthtning certification levels"
response	Partially accepted The title has been updated.

comment	*203* comment by: *Leonardo Helicopters* Section 6.c Table 1 27.1316(b) and 29.1317(b) are limited to "For rotorcraft approved for instrument flight rules operation" Proposal to add a note to point (b) of the table stating: "For rotorcraft approved for instrument flight rules operation"
response	Accepted

comment	*209* comment by: *Boeing* Page:12 Paragraph: *6.a* **THE PROPOSED TEXT STATES:** Identify the systems to be assessed (See Section 6.c) **REQUESTED CHANGE:** *Identify the systems to be assessed* (i.e. to be shown compliant) *(*See Section 6.c) **JUSTIFICATION:** There has been confusion on whether the cited "assessment" was to determine which airplane systems are assigned a particular LCL, or whether the "assessment" was showing that already-identified Level A, B, C systems were compliant with the regulation. This commenter believes the intent of the assessment is to identify the systems that are subject to the cited regulation
response	Not accepted

EASA considers that no confusion is possible. The mentioned 'assessment' corresponds to the aeroplane system to be considered with its dedicated LCL.

comment *210* comment by: *Boeing*

Page: 13
Paragraph: *6.c.1*

THE PROPOSED TEXT STATES:
The aircraft systems that require lightning assessment should be identified.

REQUESTED CHANGE:
~~The aircraft systems that require lightning assessment should be identified.~~ A lightning safety assessment should be performed to identify the aircraft systems that must show compliance with the lightning regulations.
JUSTIFICATION: Revised to clarify that the "lightning assessment" is
• the assessment to be used to determine the compliance of systems that the lightning safety assessment identified as the systems that are required to show compliance and
• not an input to the lightning safety assessment

response Partially accepted

The paragraph has been improved for clarification.

comment *211* comment by: *Boeing*

Page:15
Paragraph: *6.c.2*

THE PROPOSED TEXT STATES:
Table 1 — HIRF failure conditions and system HIRF certification levels

REQUESTED CHANGE:
Table 1 — Lightning failure conditions and system Lightning certification levels

JUSTIFICATION: Table 1 references Lightning Requirements, but the Title references HIRF. Replace "HIRF" (two places) with "Lightning" in this Lightning Assessment.

response Partially accepted

The title has been updated.

comment *212* comment by: *Boeing*

Page: 15
Paragraph: *6.c.3*

THE PROPOSED TEXT STATES:

When demonstrating compliance with CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a), the electrical and electronic system is the one required to perform the function whose failure would prevent continued safe flight and landing.

REQUESTED CHANGE:
When demonstrating compliance with CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a), the electrical and electronic system is the one required, under the lightning safety assessment, to perform the function whose failure would prevent continued safe flight and landing.

JUSTIFICATION: Edit intended to clarify that the lightning safety assessment determines which systems, of potentially multiple systems that provide a particular function, are "required" to perform the function with respect to these lightning considerations. Not all systems that perform that function (i.e. those that provide the function in non-normal operations) will be required to perform that function under this lightning assessment.

response

Not accepted

The proposal is of no added value since this paragraph is part of the lightning safety assessment.

comment

215 comment by: *Boeing*

Page:16
Paragraph: *6.c.4*

THE PROPOSED TEXT STATES:
Simultaneous and common failures due to lightning exposure generally do not have to be assumed for Level B or C systems incorporating redundant, spatially separated installations in the aircraft.

REQUESTED CHANGE:
Simultaneous and common failures due to lightning exposure generally do not have to be assumed for ~~Level B or C~~ systems, incorporating redundant, spatially separated installations in the aircraft. If such systems were assigned a Level B or C, the failure of these systems would reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition,

JUSTIFICATION: Prior to conducting the lightning safety assessments, it is not known which of the systems are assigned as Level B or C. The proposed text resolves the perceived circular logic that refers to LCL B or C systems as an input to a safety assessment that will determine the LCL assignment.

response

Accepted

The text has been improved according to the proposal.

comment

217 comment by: *Boeing*

Page: 16

Paragraph: *6.c.4*

THE PROPOSED TEXT STATES:
However, if multiple Level B or C systems are installed within the same location in the aircraft, or share a common wiring connection, then the combined failure due to lightning exposure should be assessed to determine whether the combined failures are catastrophic

REQUESTED CHANGE:
However, if multiple ~~Level B or C~~ systems, for which the failure would reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition, are installed within the same location in the aircraft, or share a common wiring connection, then the combined failure due to lightning exposure should be assessed to determine whether the combined failures are catastrophic

JUSTIFICATION: Prior to conducting the lightning safety assessments, it is not known which of the systems are assigned as Level B or C. The proposed text resolves the perceived circular logic that refers to LCL B or C systems as an input to safety assessment which will determine the LCL assignment.

response

Accepted

The text has been improved in accordance with the proposal.

comment

218 comment by: *Boeing*

Page: 18
Paragraph: *6.g.*

THE PROPOSED TEXT STATES:
The TCLs should be equal to or greater than the maximum expected aircraft ATLs.

REQUESTED CHANGE:
~~The TCLs should be equal to or greater than the maximum expected aircraft ATLs~~. The ATLs should be no greater than the TCLs

JUSTIFICATION: The NPA text implies that the TCL is established after an estimate is made of the ATL. Airplane design typically starts with establishing the allocation of the lightning protection burden to the equipment vs the installations, and assignment of TCLs to the system/equipment. Verification that the (as built/realized) ATLs are less than the (as-designed) TCLs is accomplished after the TCLs are established.

response

Accepted

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 7. STEPS TO LEVEL A SYSTEM LIGHTNING COMPLIAN p. 21-30

comment *15* comment by: *Airbus Helicopters*

Section, table, figure:AMC 136 §7)a)3)	**Page:**21	**Comment summary**: The paragraph may be understood as requiring protection per 1316 (a) for electrical system with failure that by themselves cannot be catastrophic, due to possible combination with failure unrelated to LIE. Regardless of the relevance of the intent, this introduce formal contradiction with former statement that only LIE related failure are considered and that the safety assessment for 1316 only apply to functions performed by electrical systems. 4) just after is also stating that pre existing failure conditions is not considered. Last part of the paragraph about reliability of non electric system, their possible latent failure and the consideration of active channel is not understood as it will not change the consequence of the electrical failure considered alone. The safety benefit is understood but the way the rule is written it seems difficult to interpret it as requiring more than protection level B for the lectrical part of the function.	**Suggested resolution**: Modify: If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must comply with requirement of CSs 23.1306/2515(**b**), 25.1316(**b**), 27.1316(**b**), and 29.1316(**b**) **applicable to hazardous failure conditions**. It may be worth considering revising the rule itself at a later stage if the above proposal at AMC level is not sufficient**.**

response | Not accepted

However, the section will be reworded for clarification.

comment | *16* comment by: *Airbus Helicopters*

Section, table, figure:AMC 136 §7)e)3)	**Page:**23	**Comment summary**: The paragraph first focus of bundle injection test but then introduce pin injection test for aspect of damage verification. It is not cklear if pin to case test is required and under which condition it may be used. Indeed pin to case ETDL is definitely an equipment data when ETDL at cable bundle level may be different at equipment or sytem level thanks to additional wire shielding. It may be worth clarifying the aspect of consistency between system and equipment ETDL.	**Suggested resolution**: Modify: No equipment damage should occur during these system tests or during single stroke pin injection tests using the defined ETDLs. It should be verified during system test that the equipment ETDL declared by the supplier is not exceeded. EUROCAE ED…

response | Not accepted

comment | *17* comment by: *Airbus Helicopters*

Section, table, figure:Table 43 Level3	**Page:**28	**Comment summary**: metal aircraft structure or composite aircraft structure whose shielding without improvements is as effective as metal aircraft structure According to the description of level 2 I believe the sentence is not correct	**Suggested resolution**: Modify: metal aircraft structure or composite aircraft structure whose shielding is as effective as metal aircraft structure, and without particular measures to reduce lightning coupling to wires.

response | Partially accepted

The text has been improved for clarification.

comment *29* comment by: *Airbus Helicopters*

Section, table, figure:	**Page**	**Comment summary :**	**Suggested resolution**
AMC20.1367.a.5.	:Page 22	"CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2) require that Level A systems automatically recover normal operation in a timely manner after exposure to lightning." It is not mentioned that this automatic recovery is only required for the level A functions	The sentence should be rewritten like this: CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2) require that Level A systems automatically recover normal operation <u>of the level A functions</u> in a timely manner after exposure to lightning.

response Accepted

comment *30* comment by: *Airbus Helicopters*

Section, table, figure:	**Page**:Page	**Comment summary :**	**Suggested resolution**
AMC20.136 7.a.2 & 7.a.6	21/22	In 7.a.2 it is written: "The system defined for paragraph (a) of these regulations is not required to include: (a) equipment, components and electrical interconnections required only for non-normal situations, or (b) equipment, components and electrical interconnections required only for dispatching under minimum equipment lists. " And in 7.a.6 "Elements or channels that are operational only in non-normal situations are not required to be recovered in normal operation for demonstrating compliance with CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2). " In 7.a.2 flight under minimum equipment lists is distinguished of a non normal situation. As a result, in 7.a.6 this flight configuration should be mentioned in addition of non –normal situations.	The sentence should be rewritten like this: in 7.a.6 "Elements or channels that are operational only in non-normal situations and under minimum equipment lists are not required to be recovered in normal operation for demonstrating compliance with CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2).

response Partially accepted

7.a.2 defines the boundary of the Level A system, and has been slightly reworded.

	7.a.6 has been deleted to avoid redundant wording.

comment	*39* comment by: *Airbus-Regulations-SRg* Section 3.1. AMC 20-136, chapter 7.a, bullet 2, page 21 Airbus propose to replace: Quote "~~*The system defined for paragraph (a) of these specifications is not required to include:*~~ ~~*(a) equipment, components or electrical interconnections required only for non-normal situations,*~~ ~~*(b) equipment, components or electrical interconnections required only for dispatching under minimum equipment lists*~~." Unquote by the following: "The system defined for paragraph (a) of the referenced CSs is not required to include equipment, components or electrical interconnections required only for non-normal situations. The specific system configuration represented by equipment, components or electrical interconnections required only for dispatching under minimum equipment lists must be considered for both identifying the items in the scope of paragraph (a) of the referenced CSs and defining the minimum system test configuration in step 5." Rationale: Dispatching the A/C under MMEL is an acceptable flight condition. It is under dedicated control and as such, this configuration should be addressed in the lightning safety assessment. Per se, it cannot be excluded that one applicant would have to define the LCL of a given system in a more stringent way than the FDAL. However, to Airbus experience, the minimum equipment list has never been a driver for identifying the systems required to comply with paragraph (a) of the referenced CSs. The consequence of the minimum equipment list is more on the definition of the system test configurations than the categorization.
response	Not accepted However, the sentence will be enhanced to better consider the CATA HIRF Paper discussion.

comment	*40* comment by: *Airbus-Regulations-SRg* Section 3.1. AMC 20-136, chapter 7.a, bullet 2, page 21

	Airbus propose to replace: […] for paragraph (a) of ~~*these specifications*~~ […] By: … for paragraph (a) of the referenced CSs …. RATIONALE: To ease the reading.
response	Partially accepted The titles of the related specifications have been included.

comment	*41* comment by: *Airbus-Regulations-SRg* Section 3.1. AMC 20-136, chapter 7.a, bullet 6, page 22 Airbus propose to change wording from: “These excluded elements or channels *should* comply with CSs….25.1316(b)” To: “These excluded elements or channels must comply with CSs….25.1316(b)” Rationale: The paragraph (b) of 25.1316 refers to all systems a failure of which would “reduce the capability of the aeroplane or the ability of the flight crew to respond to an adverse operating condition”. Airbus understanding is that the adverse conditions referenced in this sentence are not necessarily conditions resulting from the lightning event itself, but conditions possibly resulting from any other potential risk or failure. In that respect, the rule is understood as requiring having all these means, systems and components which are not active in normal operations, available after the lightning event. This is exactly the intent of paragraph (b) of 25.1316 but this paragraph is a requirement with a “must”. Therefore, a “must” should be used for the sentence above referenced.
response	Partially accepted The related text has been deleted.

comment	*42* comment by: *Airbus-Regulations-SRg* Section 3.1. AMC 20-136, chapter 7.e, bullet 3, page 23 Airbus comment. The compliance approach for Level A mixes the notion of verification at equipment level (e.g. reference to pin injection) and notion of verification at system level. However, beyond the need to perform a system level verification (MoC 4), equipment qualification is also mandatory (MoC 9). Both verifications being successful gives a high level of confidence on the immunity of the system.

	It would have been preferred to make a clear distinction in the process between these two levels of verification (it is worded like that since the first version of the AC 20.136). Amazingly, this confusion has been addressed for HIRF as both steps are explicitly identified in the compliance process given at page 63. The revision of the AMCs could have been the opportunity to harmonize further HIRF and Lightning Indirect Effects by making the equipment qualification an explicit step of the process.
response	Accepted The approach in the compliance demonstration has been harmonised between both AMC.

comment	*74* comment by: *General Aviation Manufacturers Association* Section 7. a. 2. Text In Question From NPA - "This electrical and electronic system must also automatically recover normal operation of the Level A functions in a timely manner to comply with paragraph (a) (2) of these specifications." The impact of integrity of a function is not considered in the above and in general throughout the NPA. Malfunctions may be CAT and would need to address a(1), but it should not need to recover per a(2) if the availability is less than CAT. The automatic or manual recovery should only be required when the availability of the function is considered to be CAT. Suggest changing to "This electrical and electronic system must also automatically recover normal operation of the Level A functions in a timely manner when the availability of the function is considered to be CAT, to comply with paragraph (a) (2) of these specifications.".
response	Partially accepted The text has been improved for clarification.

comment	*75* comment by: *General Aviation Manufacturers Association* Table 1: This references HIRF, should be lightning. Remove HIRF reference, rename it to lightning.
response	Accepted

comment	*76* comment by: *General Aviation Manufacturers Association* Section 7. a. 3.

The word "monitor" in the text "used to assist, augment, or monitor" indicates that annunciation aspects of Level A functions are always required to meet Level A Display, even if it can be shown that there is no electrical contribution to the failure itself.

The proposed changes to the CATA paper included with "Industry Response to CATA HIRF paper" Dated July 27, 2020 changed "assist, augment, or monitor" to "necessary for".

Change "used to assist, augment, or monitor" to "necessary for" in 7.a.3 and Appendix 2.c, Minimum conditions for complying with CS 25.1316, #3.

See Comment, item 22 (Line #40) in attached spreadsheet for related details.

response

Partially accepted

The related paragraph has been deleted from the appendix, and the related text in 7.a.3 has been improved for clarification.

comment

78 comment by: *General Aviation Manufacturers Association*

Section 7. a. 3.

See Industry Response to CATA HIRF paper Dated July 27, 2020 for additional details.

response

Noted

comment

79 comment by: *General Aviation Manufacturers Association*

Section 7. a. 3.

Text In Question From NPA -
"For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations."

This is a new requirement. Current guidance has no requirement for having a certain amount of reliability, where reliability is also not defined by the NPA, before it can be counted on. The section 5.2 ED017A/ARP5583A specifically states "The EEHWG, which was tasked by FAA to draft the proposed HIRF regulation, focused on system performance effects when exposed to the HIRF environment and did not intend for unrelated system failure conditions to be addressed in combination with that HIRF exposure."

The text in NPA page 22 Item 4 says something similar also…"CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a) do not require the applicant to assume pre-existing failure conditions when classifying the functional failure conditions and the scope of the Level A systems."

By having a need for reliability, the implication is that it might have failed (random failure and not related to HIRF/Lightning) and because of this, we can no longer rely on it for lightning which contradicts the above.

To comply with the text in question would now result in additional burden on the electrical systems. This additional cost burden is in the form of additional equipment design, integrated system test, and potentially aircraft level HIRF/lightning testing. All of these have high cost impact.

There is also impact to fielded aircraft with the prior certification method if an update is needed to the system that may add cost to recertifying the electrical portion if the mechanical or hydraulic system is no longer compliant wrt reliability.

There is no evidence of in field service where HIRF or lightning was an issue because of relying on mech or hyd systems in lieu of electrical equipment.

Propose removing the requirement to have a certain level of reliability for any mechanical or pneumatic systems used to prevent the CAT cases.

response

Accepted

The paragraph has been deleted to avoid any misunderstanding.

comment

81 comment by: *General Aviation Manufacturers Association*

Section 7. a. 5.

Text In Question From NPA -
"…Automatic recovery applies to all redundant channels of the Level A system required for normal operation unless…"

"All redundant channel" as written above conflicts with text in other areas of the NPA.

The definition of all redundant channels in normal operation is unclear. Example 1 on page 43 of the NPA has 3 redundant channels that are all "Active" with one as a backup and termed "Active-backup". The Applicable parts of the rule for the backup is only CS25.1316(b) per the example and not (a)(2) from where the above text comes from.

Provide additional clarification on which redundant channels are required to meet a(2).

response

Partially accepted

The text has been improved for clarification.

comment

82 comment by: *General Aviation Manufacturers Association*

Section 7. a. 5.

	Text In Question From NPA - "..The exception for recovery conflicts must be based on aircraft operational or functional requirements independent of lightning exposure. The exception should not be a mitigation for Level A system effects observed after exposure to lightning.." It the intent of the above is unclear, especially related to exposure period of lightning. Clarify the intent.
response	Partially accepted The text has been improved for clarification.

comment	*83* comment by: *General Aviation Manufacturers Association* Section 7. a. 6. See Industry Response to CATA HIRF paper dated July 27, 2020 for addditional details.
response	Accepted

comment	*84* comment by: *General Aviation Manufacturers Association* Section 7. a. 6.: The 2X.1316(a)(1) rule or current guidance does not stipulate which system (eg Active or Active back up) can be used to require the function to be not adversely affected. If the intent of this is to show primary systems to meet 25.1316(a)(1) only, then this is something new. In the past STBY display has been used to hold up a function, so long as the primaries returned normal operation. This is a new change that increases the cost of certification. There does not seem to be any service history that previous practice is failing in the field. It also has an impact on aircraft that were certified to previous practice. Any changes to Active channels now have to assessed against the NPA, which could cause additional re-design/certification efforts. Propose to change text to continue previous practice that allows at least the Active - backup system in meeting a(1). This applies to page 97 5th paragraph also.
response	Not accepted In the updated AMC, it is not required that only the primary system meet 2X.1316(a). However, it is proposed to reduce the certification level of the stand-by system with the condition that the primary system fully complies with 2X.1316(a).

comment	*85* comment by: *General Aviation Manufacturers Association* Section 7. a. 6. The last sentence says "These excluded elements or channels should comply with CSs 23.1306/2515(b), 25.1316(b), 27.1316(b), and 29.1316(b)." IEL regulations only have subparts (a) and (b). As described in Table 1, with the exception of 23.2515, subpart (b) addresses both Hazardous and Major. Based on the corresponding section in AMC 20-158A and on the CATA paper, it appears that the intent here was to have these elements or channels meet Hazardous requirements. This lack of clarity is also present in the examples in Appendix 2. Subpart (b) addresses Hazardous and Major, but the text in this section and the examples in Appendix 2 don't make it clear which is applicable. While the error in EASA's intent is identified, the Active back up should meet the hazardous classification associated with the loss or malfunction of the backup channel only since the Active channels are working. Change the last sentence of Section 7.a.6 to: "These excluded elements or channels should comply with classification associated with the loss or malfunction of the backup channel only since the Active channels are working." Update example accordingly.
response	Partially accepted 7.a.6 has been deleted to avoid redundant wording.

comment	*87* comment by: *General Aviation Manufacturers Association* Section 7. a. 6. Example 6 says "For the electronic engine thrust reverse control and the electronic spoiler control systems, the applicable parts of CS 25.1316 would depend on the specific failure condition." This matches the logic in Item #1 of "Industry Response to CATA HIRF paper" Dated July 27, 2020. This appears to contradict the logic in Section 7.a.6, which indicates that these items should meet 25.1316(b) (Hazardous), at a minimum. The determination of HCL/LCL for items that are involved in, but not the primary means of mitigation for a Catastrophic failure condition should be determined by the system safety assessment process for the applicable aircraft. The last sentence of Section 7.a.6 should be changed to:

	"For these excluded elements or channels, the applicable parts of CSs 23.1306/2515, 25.1316, 27.1316, and 29.1316 should be determined by the hazard classification of the specific failure conditions for each channel by itself in the system safety assessment."
response	Partially accepted 7.a.6 has been deleted to avoid redundant wording.

comment	*89* comment by: *General Aviation Manufacturers Association* Section 7. d. Typographical error: Should read ETDL, instead reads EDTL Remove EDTL, and replace with ETDL.
response	Accepted

comment	*90* comment by: *General Aviation Manufacturers Association* Section 7. g. 1. The last sentence talks about Level A Display systems. It seems that it should reference Step 11 (7.k), rather than Table 3. Step 11 provides the complete picture for Level A Display, instead of just the table of levels. Change "Table 3" at the end of 7.g.1 to "Step 11" or "Section 7.k".
response	Partially accepted 'Table 3' has been changed to 'this step'.

comment	*91* comment by: *General Aviation Manufacturers Association* Section 7. g. 2. Change the phrase "Significant testing, including aircraft level testing, is required to support the analysis." This is a new requirement, previous analysis could be substantiated through rigorous testing, but aircraft testing was not necessarily required. Change to "Significant testing, including aircraft level testing, may be required to support the analysis."
response	Accepted

comment *103* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/ Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition /Response to Comment
8	2020-09 Regularo Update Of AMC-20	Page 23 3.1 Lightning Guidance	Paragraph 7 e.2	Too much to copy.	Good addition	No change recommended.	Editorial	
9	2020-09 Regularo Update Of AMC-20	Page 24 3.1 Lightning Guidance and Page 33 3.1 Lightning Guidance	Paragraph 7 f.2.(e) and Paragraph 8 f.2.(e)	system software, firmware, and hardware.	Replace complex electronic hardware with airborne electronic hardware (AEH) since AMC 20-152A refers to AEH and provides guidance for both simple and complex devices.	Replace referenced text with: system software and AEH.	Editorial	

response Accepted

comment *132* comment by: *Embraer S.A.*

[7.a.1.] "(…) in order to perform the ETDL verification mentioned in paragraphs 8.g and 8.h."

The references to Section 8 are inaccurate. It should be to section 7.

response: Accepted

comment: *133* comment by: *Embraer S.A.*

[7.a.3.] "If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must comply with CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a)."

[Appendix A.c.] "Minimum conditions for complying with CS 25.1316 (…) (3) (…) The aircraft lightning safety assessment should consider electrical or electronic failures that would adversely affect the function of the mechanical, hydraulic and/or pneumatic channel(s). If electrical or electronic equipment, components and electrical connections are used to assist, augment, or monitor the mechanical, hydraulic and/or pneumatic channel(s) to perform functions with failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must comply with CS 25.1316(a)."

Several non-electrical and non-electronic systems are monitored by electrical and electronic components, whose failure would not prevent continued safe flight and landing of the aircraft. In this case, the effect could be aggravated only after a failure of the mechanical/ hydraulic/ pneumatic system. According to the AMC, those systems are subject to the compliance with CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a).

However, this approach would not be aligned with the guidelines, which do not require considering other failures before lightning event (ref. "Compliance with CS 25.1316 does not consider or assume pre-existing failure conditions" - Appendix A, c., (4)).

Embraer understands that the intent of the text is to require compliance only for equipment "used to monitor" that are required *along with* the operation of mechanical, hydraulic and/or pneumatic system, and, therefore, whose failure would indeed contribute to the function and could affect continued safe flight and landing.

In order to address this point, we suggest replacing the term "monitor" by "real time monitor for feedback to a control loop", to clarify the fact that the other system is part of the function being performed by the non-electrical/electronic system. Hence, we propose the following text: "If electrical or electronic equipment, components and electrical interconnections are used to *real time* assist, augment, or monitor *for control loop feedback for* the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued (…)".

response: Partially accepted

The text has been improved for clarification.

	Please, refer also to the response to comment #79.
comment	*134* comment by: *Embraer S.A.* *[7.a.5.] "CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2) require that Level A systems automatically recover normal operation in a timely manner after exposure to lightning. Automatic recovery applies to all redundant channels of the Level A system required for normal operation unless its recovery conflicts with other operational or functional requirements of the system. The exception for recovery conflicts must be based on aircraft operational or functional requirements independent of lightning exposure."* Embraer agrees with the text about exception for the automatic recovery, because we understand that there are some systems that are designed to do not automatically recover from a malfunction (due to any reason), in order to maintain safety and normally request pilot interaction / action.
response	Noted
comment	*141* comment by: *Embraer S.A.* *[7.a.(2)] "This electrical and electronic system must also automatically recover normal operation of the Level A functions in a timely manner to comply with paragraph (a) (2) of these specifications."* *[7.a.(5)] "CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2) require that Level A systems automatically recover normal operation in a timely manner after exposure to lightning. Automatic recovery applies to all redundant channels of the Level A system required for normal operation unless its recovery conflicts with other operational or functional requirements of the system."* Automatic recover is not required on CS 23.2515(a)(2). Therefore, direct compliance with AMC 20-136A for CS-23 aircraft would be stricter than the requirement itself.
response	Accepted Reference to 2515 has been deleted, as proposed.
comment	*183* comment by: *Leonardo Helicopters* Section 7.a.3 Paragraph (a) of the XX.1316 rule addresses protection of Level A systems limited to effects to the associated Catastrophic Function(s). The following extract of the NPA appears to extend the scope of the requirement (a) to electronic systems "assisting, augmenting or monitoring" Level A mechanical/hydraulic/pneumatic systems: "…If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic

channel(s) must comply with CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a)….”

The applicability of 1316 (whether –a- or –b-) should be based on the specific criticality of the functions associated to the electronic system as determined by the specific safety assessment. There could be examples of electronic systems providing assistance/augmentation/monitoring but whose specific malfunction/loss is not associated to safety critical functional failures.

It is proposed to reword the paragraph to be consistent with the rule xx.1316(a), as follows:
“…If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must be considered within the Lightning Safety Assessment, and comply with CSs 23.1306/2515~~(a)~~, 25.1316~~(a)~~, 27.1316~~(a)~~, and 29.1316~~(a)~~ in accordance to the specific safety assessment….”

response

Partially accepted

The text has been improved for clarification.

Please refer also to the response to comment #79.

comment

184 comment by: *Leonardo Helicopters*

Section 7.a.3
The guidance following to consider possible latent failures of mechanical/hydraulic/pneumatic channels as an input to the lightning certification process appears in conflict with the rule (which is not requiring to consider pre-existing failures not related to lightning effects):
“For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations.”
It also appears in conflict with Section 7.4 of the proposed AMC amendment, which states: “…CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a) do not require the applicant to assume pre-existing failure conditions when classifying the functional failure conditions and the scope of the Level A systems…”

It is proposed to remove the following wording:
“~~For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations.~~”

response

Partially accepted

Please refer to the response to comment #79.

comment

185 comment by: *Leonardo Helicopters*

Section 7.a.5

The following sententence:
CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2) require that Level A systems automatically recover normal operation in a timely manner after exposure to lightning
Appears to extend the scope of the requirement to the whole system, while the actual requirement is limited to the catastrophic functions. See for instance from 29.1316:
"the system automatically recovers normal operation of that function, in a timely manner, after the rotorcraft's exposure to lightning"

Propose to reword consistently with the rule/requirement:
"CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2) require that Level A systems automatically recover normal operation of functions whose failure would prevent the continued safe flight and landing, in a timely manner after exposure to lightning"

response: Partially accepted

comment: *187* comment by: *Leonardo Helicopters*

Section 7.a.6

Bullet 6 is unclear:
"*Elements or channels that are operational only in non-normal situations are not required to be recovered in normal operation for demonstrating compliance with CSs 23.1306/2515(a)(2), 25.1316(a)(2), 27.1316(a)(2), and 29.1316(a)(2). Their failures should be obvious to the flight crew, and the elements or channels that are active in normal operation should comply with CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a) without their support. These excluded elements or channels should comply with CSs 23.1306/2515(b), 25.1316(b), 27.1316(b), and 29.1316(b).*"
On one side it states that channels which are operational only in non-normal situations are not required to recover the critical function(s), on the other sides it recommends for them compliance to .1316(b), which requires the recovery of the critical function(s).

It is considered that the specific Lighting Safety Assessment should allocate the proper Lightning Certification Level to the specific channels, so the following rewording is proposed:
"…These excluded elements or channels should comply with CSs 23.1306/2515(b), 25.1316(b), 27.1316(b), and 29.1316(b) if a failure condition identifies their failure as reducing the capability of the rotorcraft or the ability of the flight crew to respond to an adverse operating condition."

response: Partially accepted

7.a.6 has been deleted to avoid redundant wording.

comment: *190* comment by: *Leonardo Helicopters*

Section 7.2

In the following statement:

"*The system defined for paragraph (a) of these specifications is not required to include: …*
… (b) equipment, components or electrical interconnections required only for dispatching under minimum equipment lists."

it is not clear which could be an example of an equipment required "only" for dispatching under minimum equipment list, and it is not clear whether the reference is made explicitely to the MMEL certification process.

It is proposed for EASA to clarify whether the reference is made to the MMEL certification process (in which case MMEL should be mentioned) and whether lightning protection should be considered when defining the MMEL equipment perimeter.

response Accepted

Section B has been reworded for clarification.

comment *219* comment by: *Boeing*

Page: 21
Paragraph: *7.a.3*

THE PROPOSED TEXT STATES:
If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must comply with CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a).

REQUESTED CHANGE:
Append proposed text with: "Monitoring systems that simply alert the flight crew of failures within the mechanical, hydraulic and/or pneumatic channels, but do not invoke automated mitigation of the failure, would not be assigned as LCL A systems as long as their malfunction does not adversely affect the function. This is due to the fact that their operation is not relied upon to perform the function of the mechanical, hydraulic and/or pneumatic channels.''

JUSTIFICATION: Not all monitoring systems associated with Critical systems need be Level A. Some monitoring systems are not performing the function of the mechanical, hydraulic and/or pneumatic channels, whose failure would prevent CSF&L and are not part of a mechanical, hydraulic and/or pneumatic control loop that provides a particular function, and are therefore not required to perform that function. The integrity of such monitoring systems must be evaluated to show that malfunction of the monitoring system (e.g. false indication of failure in the control loop) would not result in an adverse effect of the function being assessed.

response

Partially accepted

Please refer to the response to comments #79 and #184.

comment

220 comment by: *Boeing*

Page: 22
Paragraph: *7.a.3*

THE PROPOSED TEXT STATES:
For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations.

REQUESTED CHANGE:
For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures **that would extend to or beyond the next flight,** then the electrical/electronic channel would be the active channel during normal operations **during that next or subsequent flights**.

JUSTIFICATION: Failures of the non-electrical/non-electronic would be considered as a non-normal operating condition for the duration of the flight on which that failure was incurred. If the failure were latent, it is recognized that performance of the function would be reliant on the electrical/electronic system for subsequent and flights.

response

Partially accepted

The related text has been deleted.

comment

221 comment by: *Boeing*

Page: 23
Paragraph: *7.e.3*

THE PROPOSED TEXT STATES:
No equipment damage should occur during these system tests or during single stroke pin injection tests using the defined ETDLs.
REQUESTED CHANGE:
No equipment damage that adversely affects the function or system should occur during these system tests or during single stroke pin injection tests using the defined ETDLs.

JUSTIFICATION: Damage that doesn't affect the function under consideration would be allowed.

response

Partially accepted

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 8. STEPS TO LEVEL B AND C SYST p. 31-33

comment	*222* comment by: *Boeing* Page: 31 Paragraph: *8.b* **THE PROPOSED TEXT STATES:** The applicant should define the lightning protection features incorporated into the system designs, based on the ATLs applicable to their aircraft and its Level B and C systems **REQUESTED CHANGE:** The applicant should define the lightning protection features incorporated into the system designs. , ~~based on the ATLs~~ applicable to ~~their aircraft and it's the~~ Level B and C systems **JUSTIFICATION:** The obligation should be to demonstrate that requirements are consistently met.
response	Accepted

comment	*223* comment by: *Boeing* Page: 32 Paragraph: *8.e* **THE PROPOSED TEXT STATES:** No equipment damage should occur during these equipment qualification tests or during single stroke pin injection tests using the defined ETDLs. **REQUESTED CHANGE:** No equipment damage that adversely affects the function/system should occur during these equipment qualification tests or during single stroke pin injection tests using the defined ETDLs. **JUSTIFICATION:** Damage that only affects functions of the system that are not catastrophic/hazardous/major would be allowed...
response	Partially accepted

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 9. LIGHTNING COMPLIANCE DEMONSTRATI p. 33-36

comment	*92* comment by: *General Aviation Manufacturers Association* Section 9. a. Recommend saying the documentation described here is guidance and applicants should adapt their documentation based on their specific project. This is prescriptive, and it may not be applicable in all cases. Add a statement that this is guidance, and may be able to adapt based upon their project.
response	Partially accepted

comment	*93* comment by: *General Aviation Manufacturers Association* Section 9. a. A detailed lightning safety assessment is not mature before a lightning compliance plan is generally submitted. A detailed lightning assessment is only fully matured towards the end of the program, after flight testing and system safety aspects have been completed. It is more appropriate to say the overall method used for the lightning safety assessment will be defined in the lightning compliance plan.
response	Partially accepted

comment	*94* comment by: *General Aviation Manufacturers Association* Section 9. a. This should say the "planned or expected internal lightning environment". The actual internal lightning environment may not be known at the time of writing the lightning compliance plan. Change statement 3 to say the "planned or expected internal lightning environment".
response	Accepted

comment	*95* comment by: *General Aviation Manufacturers Association* Section 9. c.

There needs to be an explanation for the expected application of these plans.

A typical system or equipment qualification does not fit neatly into "test", "analysis" or "similarity". Many projects will use aspects of all three. Creating three individual plans for 1 piece of equipment that utilizes the three different methods is unnecessary.

Ensure section 9 is provided as guidance material only, and not necessarily a requirement.

response: Noted

comment *96* comment by: *General Aviation Manufacturers Association*

Section 9. c. 1. a.

While it may be a good idea to include the schedule, the items required for an adequate test plan can change from authority to authority and this content may be used by multiple authorities.

Items such as test schedule are not required to show compliance.

Change "should" to "may".

response: Accepted

comment *97* comment by: *General Aviation Manufacturers Association*

Section 9. d.

This should say the "planned or expected internal lightning environment".

The actual internal lightning environment may not be known at the time of writing the lightning compliance plan.

Change statement 3 to say the "planned or expected internal lightning environment".

response: Accepted

comment *112* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment

10	2020-09 Regularo Update Of AMC-20	Page 33 thru 36 3.1 Lightning Guidance	Paragraph 8 f.2.(e)	Too much to copy.	Good addition	No change recommended.	Editorial	

response: Noted

comment: *191* comment by: *Leonardo Helicopters*

Paragraph 9.c

Consider removing reference to SAE ARP5415A, and replace with SAE ARP5415B and the equivalent EUROCAE ED-158.

response: Accepted

comment: *224* comment by: *Boeing*

Page: 34
Paragraph: *9.c.1*

THE PROPOSED TEXT STATES:
A lightning compliance test plan should include….
(2) a description of the aircraft and/or system being tested
(3) system configuration drawings,

REQUESTED CHANGE:
A lightning compliance test plan should include….
(2) a description of the aircraft and/or system being tested (if not referenced to such a description in the compliance plan),
(3) system configuration drawings (if not referenced to such a description in the compliance plan),

JUSTIFICATION:
We recommend adding this text for clarification because the system description should already be in the compliance plan described in section 9.a.2

response: Partially accepted

AMC20-136A Aircraft Electrical and Electronic System Lightning Protection — 10. MAINTENANCE, PROTECTION ASSURANCE, AND MODIFICATIO p. 36

comment *43* comment by: *Airbus-Regulations-SRg*

Section 3.1. AMC 20-136, chapter 10.a last sentence, page 36

Airbus propose to modify the wording:
"A lightning protection assurance programme ~~*may be necessary to verify that the maintenance procedures are adequate. See ED-158 for more information on these topics*~~."
New:
"A lightning protection assurance programme should be proposed in the certification plan to identify all actions necessary to justify or to verify that the maintenance procedures are adequate. This assurance programme may propose a surveillance programme based on a sampling of the fleet for monitoring the effectiveness of the protection features and/or maintenance procedures. See ED-158 for more information on these topics."

Rationale:
To clarify that the assurance plan is not directly verifying the adequacy of the maintenance procedures but that it defines a set of actions and measures themselves aimed at providing the right evidences.
The assurance plan is usually part of the overall certification dossier.
It is also a question of introducing the notion of a surveillance programme which is something separate from the assurance plan.

response Accepted

comment *207* comment by: *IATA*

- Section 3 Proposed amendments 3.1. AMC 20-136A - (see NPA page 36/128) – "10. Maintenance, Protection Assurance, and Modifications", paragraph "a."
  - Since the NPA is clearly stating that "…minimum maintenance required to support lightning certification should be identified in the instructions for continued airworthiness as specified in CSs 23.1529/2625, 25.1529, 25.1729, 27.1529, and 29.1529, as appropriate…", the obligation is implied to be resting with the certification applicant who must address the respective CS provisions.
  - In the same paragraph, it is subsequently stated that "A lightning protection assurance programme may be necessary to verify that the maintenance procedures are adequate". It should be made clear that this program is part

	of certification and any resulting elements which must be subsequently considered by the operator/maintainer of the aircraft/system/component should be captured by the certification applicant in the form of ICAs issued by the (S)TCH
response	Partially accepted The text has been improved for clarification.

Appendix 1 to AMC 20-136A — Definitions and acrony p. 37-40

comment *18* comment by: *Airbus Helicopters*

Section, table, figure:Appendix 1 a. Defnitions	**Page:**39	**Comment summary**: Timely manner definition remain extremely vague. Prioviding the purpose of the timely recovery of the system after lightning could help in assessing it case by case for systems. The proposal is clarifying that the duration covered by "timely manner" is only linked to the system reconfiguration process and does not contain any aspect of duration requirement.	Add first sentence: Timely recovery has been introduced to account for the necessary period for complex systems to reconfigure safely after a disruption. The meaning of "in a timely manner" therefore depends…

response Accepted

comment *44* comment by: *Airbus-Regulations-SRg*

Section 3.1, Appendix 1 to AMC 20-136A, chapter a Definitions,
"Normal Operations", 2nd sentence – last part, page 39

Airbus proposal:
Delete the part of the sentence:
"…while other functions, […] are not required to be recovered." To read as follows:

"Normal operation: A status where the system is performing its intended function. When addressing compliance with CSs 23.1306/2515(a)(2), 25.1316 (a)(2), 27.1316(a)(2), 29.1316(a)(2), the function whose failure would prevent the continued safe flight and landing should be in the same undisturbed

state as before exposure to the lightning threat." ~~*while other functions, performed by the same system, subject to CSs 23.1306/2515(b), 25.1316 (b), 27.1316(b), 29.1316(b), are not required to be recovered.*~~

Rationale:
This last part of the 2nd sentence is very confusing. It is stated that the system subject to paragraph (b)of the referenced CSs are not required to be recovered. But paragraph (b) of the referenced CSs ask for a recovery after the event.
As it has been stated that a backup system needs to be recovered after the event, in a way to restore the capability to cope with further adverse conditions that would require these systems, the sentence is not understood.
Maybe there is an ambiguity on "automatic recovery" as these systems would not require to be automatically recoverable as required in paragraph (a)(2) of the referenced CSs.
The other functions performed by the system have to be addressed in accordance with the outcome of the lightning safety
assessment. If they have been found Level B or C, the paragraph (b) of the referenced CSs applies and they must be recovered after the event but not necessarily automatically.
As these notions have been clarified in the core of the document, an option is to delete the part of the sentence having created the confusion.

response

Partially accepted

The text of the definition has been improved for clarification.

comment *100* comment by: *General Aviation Manufacturers Association*

Text In Question From NPA -
"Adverse effect: A lightning effect that results in a system failure, malfunction, or misleading information to a degree that is unacceptable for the specific aircraft function or system addressed in the system lightning protection regulations."

The intent of the proposed change is to delineate that equipment may have multiple functions and that an adverse affect of a system may be MAJ/HAZ/CAT and not any adverse affect should automatically be CAT. They should be considered in relation to the sub parts of the rule. There are also varying degrees of malfunction that play into whether something is MAJ/HAZ/CAT.

Suggest changing to "Adverse effect: A lightning effect that results in a system failure, malfunction, or misleading information to a degree that is unacceptable in meeting the appropriate sub-part of the rule for the specific aircraft function or system addressed in the system ..."

response

Accepted

The text of the definition has been improved for clarification.

comment *101* comment by: *General Aviation Manufacturers Association*

	For the Normal Operation that is required to meet sub-part (a)(2), which type of modes as defined in "redundant channels" (Active channel, Active-backup or passive-backup) is this referring to? It would be good to update the Normal and Non-Normal operation definition as to what type of channels/mode is being referred to. The definition of "redundant channels" could include all 3 types of modes (ref page 41 of NPA), yet there are places where all redundant channels are required to recover and in other places only certain modes of channels are required to recover. Example Normal operation (ref page 22 of NPA) vs non-normal operation (ref page 22 of NPA). Update the Normal and Non-Normal operation definition as to what type of channel/mode is being referred to.
response	Accepted Both definitions have been amended to introduce the channel involved.

comment	*102* comment by: *General Aviation Manufacturers Association* Text In Question From NPA - "Timely manner: The meaning of 'in a timely manner' depends upon the function performed by the system being evaluated, the specific system design, interaction between that system and other systems, and interaction between the system and the flight crew. The definition of 'in a timely manner' must be determined for each specific system and for specific functions performed by the system. The applicable definition should be included in the certification plan for review and approval by the certification authorities." Need more guidance on the above. Proposed text helps to add more decisive criteria to determine timely manner. Suggest changing to: "Timely manner: At a functional level 'in a timely manner' should be the time it takes for the loss or malfunction to result in a hazard classification that is CAT/HAZ/MAJ when the term is used by appropriate sub-parts of the rule. The specific system design, interaction between that system and other systems, and interaction between the system and the flight crew should be considered in determining the appropriate hazard classification. For the system recovery where redundant channels are required to recover in a timely manner it could use the same time criteria also although it could be longer because the function is not lost. The latter should be coordinated with the appropriate certification authority." This applies to HIRF page 87.
response	Not accepted The definition should not be too descriptive.

comment	*114* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/ Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition /Response to Comment
11	2020-09 Regular Update Of AMC-20	Page 37 3.1 Lightning Guidance and Page 85 3.2 HIRF Guidance	Paragraph Appendix 1 a. and Paragraph Appendix 1 a.	Adverse effect: A HIRF effect that results in a system failure, malfunction, or misleading information to a degree that is unacceptable for the specific aircraft function or system addressed in the HIRF regulations. A determination of whether a system or	CATA HIRF paper worked with Part 25 regulators to come up with simple and clear definition.	Replace referenced text with the following or add the following to the definition: "Adverse Effect: A response that results in an unexpected and unacceptable operation of an aircraft system, or in an unexpected and unacceptable operation of a function performed by the system."	Editorial	

				function is adversely affected should consider the HIRF effect in relation to the overall aircraft and its operation.				
12	2020-09 Regularo Update Of AMC-20	Page 38 3.1 Lightning Guidance	Paragraph Appendix 1 a.	Adding definitions for Immunity and Non-normal situation,	Good addition	No change recommended.	Editorial	

response

Accepted

Comment #11 is accepted: the definition of 'adverse effect' has been improved.

Comment #12 is noted.

comment

139 comment by: *Embraer S.A.*

[Appendix 1. a.] Definitions.

Embraer concurs with detailed definition of "Adverse Effects" when it considers the effects in relation to overall aircraft and its operation.

Embraer concurs with definition of "Normal Operation" where it specifies that "function whose failure would prevent the continued safe flight and landing should be in the same undisturbed state as before exposure to the lightning threat", while other functions are subjected to their HLCL requirement.

response

Accepted

The text of the definition has been improved for clarification.

Please see the response to comment #11.

comment

225 comment by: *Boeing*

Page: 39
Paragraph: *Appendix 1.a*

THE PROPOSED TEXT STATES:
Normal operation: A status where the system is performing its intended function. When addressing compliance with CSs 23.1306/2515(a)(2), 25.1316 (a)(2), 27.1316(a)(2), 29.1316(a)(2), the function whose failure would prevent the continued safe flight and landing should be in the same undisturbed state as before exposure to the lightning threat, while other functions, performed by the same system, subject to CSs 23.1306/2515(b), 25.1316 (b), 27.1316(b), 29.1316(b), are not required to be recovered

REQUESTED CHANGE:
Normal operation: A status where the system is performing its intended function. When addressing compliance with CSs 23.1306/2515(a)(2), 25.1316 (a)(2), 27.1316(a)(2), 29.1316(a)(2), the function whose failure would prevent the continued safe flight and landing should be in the same undisturbed state as before exposure to the lightning threat, while other functions, performed by the same system, subject to CSs 23.1306/2515(b), 25.1316 (b), 27.1316(b), 29.1316(b), are not required to be recovered. The system that performs the function may be in a different state (e.g. the system may switch from channel A to channel B) as long as the function is not adversely affected. In such a case channel A would need to recover its ability (availability) to perform the function after exposure.

JUSTIFICATION:
We recommend the text clarifies that system state changes are allowed even though state changes in function are not allowed. For example, the electronic engine control system could switch from channel A to channel B, during exposure without automatically reverting back to channel A after exposure, since the function of thrust has not been affected.

response

Partially accepted

The definition has been improved for clarification.

Appendix 2 to AMC 20-136A — Examples of lightning safety assessment considerations — Level A systems on large aeropl p. 41-49

comment

19 comment by: *Airbus Helicopters*

Section, table, figure:Appendix 2 c)	**Page:**42	**Comment summary**: May need to be reviewed after comment 8 disposition

response	Noted

comment	*77* comment by: *General Aviation Manufacturers Association* Ref.: Minimum conditions for complying with CS 25.1316, item (3) The word "monitor" in the text "used to assist, augment, or monitor" indicates that annunciation aspects of Level A functions are always required to meet Level A Display, even if it can be shown that there is no electrical contribution to the failure itself. The proposed changes to the CATA paper included with "Industry Response to CATA HIRF paper" Dated July 27, 2020 changed "assist, augment, or monitor" to "necessary for". Change "used to assist, augment, or monitor" to "necessary for" in 7.a.3 and Appendix 2.c, Minimum conditions for complying with CS 25.1316, #3. See Comment, item 22 (Line #40) for related details.
response	Partially accepted The related paragraph has been deleted from the appendix, and the related text in 7.a.3 has been improved for clarification.

comment	*80* comment by: *General Aviation Manufacturers Association* Ref: c - Minimum conditions for complying with CS 25.1316, item (3) Text In Question From NPA - "For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations." This is a new requirement. Current guidance has no requirement for having a certain amount of reliability, where reliability is also not defined by the NPA, before it can be counted on. The section 5.2 ED017A/ARP5583A specifically states "The EEHWG, which was tasked by FAA to draft the proposed HIRF regulation, focused on system performance effects when exposed to the HIRF environment and did not intend for unrelated system failure conditions to be addressed in combination with that HIRF exposure." The text in NPA page 22 Item 4 says something similar also…"CSs 23.1306/2515(a), 25.1316(a), 27.1316(a), and 29.1316(a) do not require the applicant to assume pre-existing failure conditions when classifying the functional failure conditions and the scope of the Level A systems."

By having a need for reliability, the implication is that it might have failed (random failure and not related to HIRF/Lightning) and because of this, we can no longer rely on it for lightning which contradicts the above.

To comply with the text in question would now result in additional burden on the electrical systems. This additional cost burden is in the form of additional equipment design, integrated system test, and potentially aircraft level HIRF/lightning testing. All of these have high cost impact.

There is also impact to fielded aircraft with the prior certification method if an update is needed to the system that may add cost to recertifying the electrical portion if the mechanical or hydraulic system is no longer compliant wrt reliability.

There is no evidence of in field service where HIRF or lightning was an issue because of relying on mech or hyd systems in lieu of electrical equipment.

Propose removing the requirement to have a certain level of reliability for any mechanical or pneumatic systems used to prevent the CAT cases.

response

Accepted

The text has been improved for clarification.

Please see the responses to comments #79 and #184.

comment

86 comment by: *General Aviation Manufacturers Association*

Examples:

The last sentence says "These excluded elements or channels should comply with CSs 23.1306/2515(b), 25.1316(b), 27.1316(b), and 29.1316(b)."

IEL regulations only have subparts (a) and (b). As described in Table 1, with the exception of 23.2515, subpart (b) addresses both Hazardous and Major. Based on the corresponding section in AMC 20-158A and on the CATA paper, it appears that the intent here was to have these elements or channels meet Hazardous requirements.

This lack of clarity is also present in the examples in Appendix 2.

Subpart (b) addresses Hazardous and Major, but the text in this section and the examples in Appendix 2 don't make it clear which is applicable.

While the error in EASA's intent is identified, the Active back up should meet the hazardous classification associated with the loss or malfunction of the backup channel only since the Active channels are working.

Change the last sentence of Section 7.a.6 to:

"These excluded elements or channels should comply with classification associated with the loss or malfunction of the backup channel only since the Active channels are working."

	Update example accordingly.
response	Partially accepted 7.a.6 has been deleted to avoid redundant wording.

comment	*88* comment by: *General Aviation Manufacturers Association* Example #6: Example 6 states: "For the electronic engine thrust reverse control and the electronic spoiler control systems, the applicable parts of CS 25.1316 would depend on the specific failure condition." This matches the logic in Item #1 of "Industry Response to CATA HIRF paper" Dated July 27, 2020. This appears to contradict the logic in Section 7.a.6, which indicates that these items should meet 25.1316(b) (Hazardous), at a minimum. The determination of HCL/LCL for items that are involved in, but not the primary means of mitigation for a Catastrophic failure condition should be determined by the system safety assessment process for the applicable aircraft. The last sentence of Section 7.a.6 should be changed to: "For these excluded elements or channels, the applicable parts of CSs 23.1306/2515, 25.1316, 27.1316, and 29.1316 should be determined by the hazard classification of the specific failure conditions for each channel by itself in the system safety assessment."
response	Partially accepted 7.a.6 has been deleted to avoid redundant wording.

comment	*104* comment by: *General Aviation Manufacturers Association* See Industry Response to CATA HIRF paper dated July 27, 2020 for additonal details.
response	Noted

comment	*105* comment by: *General Aviation Manufacturers Association* Ref.: c, Assumptions, item (2) Text In Question From NPA - "The lightning safety assessment must include all electrical and electronic equipment and components, assuming that they are potentially affected by lightning. It is not appropriate to use the lightning immunity data for electrical and electronic equipment or components as information input to the lightning safety assessment." The 2nd sentence contradicts the red text. The red text implies that if it is not affected then it should not be considered in the safety assessment. The safety assessment should also include any mechanical and pneumatic systems.

Suggest changing to:

"The lightning safety assessment must include all electrical and electronic equipment, components and electrical interconnections. It can also include mechanical and pneumatic systems in the assessment. It is not appropriate to use the lightning immunity data for electrical and electronic equipment, components and electrical interconnections as information input for the lightning safety assessment."

response Partially accepted

The text has been improved for clarification.

comment *106* comment by: *General Aviation Manufacturers Association*

Ref.: c, Minimum conditions for complying with CS 25.1316, item (1)

Text In Question From NPA -
"Minimum conditions for complying with CS 25.1316
(1) All electrical and electronic system channels that perform functions whose failure would prevent continued safe flight and landing, and can operate in 'Active' mode during normal operation, should fully comply with CS 25.1316(a)."

The current rule or guidance does not stipulate which channel has to be used to prevent the CAT case. This is a big departure from current practices where channels in Active-backup mode have been certified to prevent the loss of a function as an example. This would now put all the burden on Active channels (eg Primary Systems) to work throughout and cannot rely on any backup channel.

The objective of the executive summary states that the proposed changes "reflect the current state of the art" and that it would provide "economic benefit by streamlining the certification process". For P25/27/29 this is not in line with either of the above:
1) You lose the flexibility of using the back up channel that was allowed previously.
2) Often the Active- back up channel is much more simple than the Active channel and easier/cheaper to protect.

The desire to have the Active channel work throughout is the ideal situation; however, in practice the aircraft does not get struck very often and given how infrequent one might have to rely on a Active-backup channel this should still be an acceptable path. We already do this today and have good field history. Note that in other areas of safety we do not make the Active channel meet the CAT requirement by themselves (eg DO178, DO254).

Suggest removing this requirement, and restoring the previous method of compliance. It seems that passive backup caused a lot of concerns in the creation of the new method of compliance. As a minimum, the Active-backup should still be allowed.

Similar comment applies to HIRF also.

This also applies to Example 1 for Lightning & HIRF.

	See also Industry response sent to EASA July 2nd 2020 on this same issue.
response	Partially accepted The related text has been deleted.

comment	*107* comment by: *General Aviation Manufacturers Association* Ref.: c, Minimum conditions for complying with CS 25.1316, item (2) Text In Question From NPA - "Channels that operate only in non-normal situations and are dissimilar should comply with CS 25.1316(b), and ..." Its unclear what the requirement is if the system isi in non-normal situation and is not dissimilar. Item 1 only talks to channel in “Active” mode which would not include “Active-backup” per the definition. There may also be multiple backup channels and not all should be required to meet a default requirement of Level B. Clarify requirements for channels that are not dissimilar and requirement on multiple back up channels.
response	Partially accepted The related text has been deleted.

comment	*108* comment by: *General Aviation Manufacturers Association* Example 1: Text In Question From NPA - "Compliance with CSs 25.1316(a)(1), and (a)(2) should demonstrate that neither pilot display of aircraft attitude, altitude, and airspeed is adversely affected and that each of them recovers normal operation when the aircraft is exposed to lightning." Update the above to reiterate that only the CAT functions need to recover. The proposed change is intended to ensure that functions that are not CAT are not required to recover. Suggest changing to "Compliance with CSs 25.1316(a)(1), and (a)(2) should demonstrate that neither pilot display of aircraft attitude, altitude, and airspeed is adversely affected and that each of them recovers normal operation <u>of the function (ATT/ALT/AS)</u> after the aircraft is exposed to lightning. The Active channels should return to its original non-disturbed state."
response	Partially accepted

comment	*109* comment by: *General Aviation Manufacturers Association* Example 3:

Text In Question From NPA -
"If the mechanical channel is independent of the electronic engine control speed control and overspeed protection, and has no electrical or electronic components, then the engine overspeed protection function is not adversely affected when the aircraft is exposed to lightning."

It is possible to have some electronics and if it has no contribution to the failure mode that would be CAT then this should be acceptable.

Suggest changing to "If the mechanical channel is independent of the electronic engine control speed control and overspeed protection, and has no electrical or electronic components that have failure modes that could prevent overspeed protection, then the engine overspeed protection function is not adversely affected when the aircraft is exposed to lightning."

response Accepted

comment *110* comment by: *General Aviation Manufacturers Association*

Example 7:

The pneumatic channel in this example does not need to meet any IEL requirement due to it being mechanical in nature. Mechanical system such as these would have a very hard time meeting HAZ requirements under 2X.1309 especially for availability, yet under example 1 that has an electronic backup it is required to meet a classification of HAZ by default and not what is associated with the failure condition of the backup while the Active channel is working correctly.

Apply CL appropriate to the hazard classification for the back up only.

Seems like we accept lower reliability system when it is pneumatic and should consider the same for the electronic Active-backup channel also that is driven by the safety requirements of the back up channel. When considering example 1 the AC25-11A Table 3 shows that the highest criticality of any upset on the STBY display only is MAJ. Therefore the Active-backup in the example should only need to meet MAJ requirement.

Update example 1 to meet 2X.1316(c) in lieu of 25.1316(b)

response Not accepted

- 2X.1316(c) does not exist.

The examples cover architectures of large aircraft. In addition, the stand-by needs to be considered as a system level B.

comment *111* comment by: *General Aviation Manufacturers Association*

All the examples provided are for functions that have a Level A availability requirement. These examples do not convey, and even confuse, requirements for functions that have

a requirement that is less than CAT for availability but have integrity (or malfunction) that are CAT. A proposed Example 9 is provided.

response

Not accepted

The system has a single certification level (A, B or C). For such system, the lightning safety assessment needs to consider its worst failure condition.

comment

113 comment by: *General Aviation Manufacturers Association*

Each example should be fully contained on a single page. Examples 3 and 6 have page breaks in them.

This applies to Example 8 also.

Make sure that each example does not span multiple pages when it can fit on one page.

response

Noted

comment

117 comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment /Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition /Response to Comment
13	2020-09 Regular Update Of AMC-20	Page 41 3.1 Lightning Guidance and Page 96 3.2 HIRF Guidance	Paragraph Appendix 2 b.(1) and Paragraph Appendix 3 b.(1)	Redundant Channels: The multiple channels consist of equipment, components, electrical interconnections and configur	Similar Redundant Channels is a better label and more consistent with bullet 3 that follows.	Replace referenced text with: Similar Redundant Channels: The multiple channels consist of equipment, components, electrica	Editorial	

				ations that are similar, typically with pieces of equipment that have identical part numbers.		l interconnections and configurations that are similar, typically with pieces of equipment that have identical part numbers.		
14	2020-09 Regular Update Of AMC-20	Page 42 3.1 Lightning Guidance and Page 97 3.2 HIRF Guidance	Paragraph Appendix 3 c.(3) and Paragraph Appendix 3 c.(3)	The applicant identifies the redundant channels (similar, dissimilar, active or passive) implemented in their system design using the above definitions.	Channels are different the modes so shoud be separated for clarity.	Replace referenced text with: The applicant should identify the redundant channels (similar or dissimilar channel) and modes (active, active-backup, or passive backup mode) implemented in its system design	Editorial	

						using the above definitions.		
15	AMC-20-136A	49	Example 8, 4	The FDAL for each channel or member (SAE ARP 4754A/EUROCAE ED-79A nomenclature) was defined for a catastrophic top-level failure condition based on the 'Option 2' column of Table 3 'DEVELOPMENT ASSURANCE LEVEL ASSIGNMENT TO MEMBERS OF A FUNCTIONAL FAILURE SET' of SAE ARP 4754A/EUROCAE	The proposed FDAL assignment does not follow the guidelines established in 4754A section 5.2.3.2 and sub-paragraphs. Option 2 assignment is allowed only if the Functional Independence is satisfied. Functional Independence occurs where functions are different in order to minimize likelihood of common mode requirement error. The pneumatic system channels are part of a single function	Change FDAL B assignments to FDAL A assignments. Add IDAL B assignments to pneumatic controller #1 & #2; IDAL C to backup. The FDAL for the function is assigned based on column 2 of ARP 4754A/EUROCAE ED-79A Table 3 'DEVELOPMENT ASSURANCE LEVEL ASSIGNMENT TO MEMBERS OF A FUNCTI	Conceptual	

				ED-79A, which allows the combination of FDALs B+B+C for independent channels. In contrast, the respective LCLs would be A+A+B.	therefore no independence and should be assigned FDAL A.	ONAL FAILURE SET' for a catastrophic top-level failure condition. Each channel or member (SAE nomenclature) IDAL was defined based on the 'Option 2' column of Table 3 of SAE ARP 4754A/EUROCAE ED-79A, which allows the combination of IDALs B+B+C based on Item Development Independence. In contrast, the respective LCLs		

						would be A+A+B.		
16	AMC-20-136A	49	Example 8, 5	Considering that lightning can simultaneously affect all channels, the considerations used for FDAL assignment cannot be used, and compliance with CS 25.1316(a) is required for both the Active channels performing a function with the catastrophic top-level failure condition.	See comment EP-1. FDAL assignment incorrect.	Considering that lightning can simultaneously affect all channels, the considerations used for IDAL assignment cannot be used, and compliance with CS 25.1316(a) is required for both the Active channels performing a function with the catastrophic top-level failure condition.	Conceptual	
17	AMC-20-136A	49	Example 8, 7	The FDAL for the passive backup channel may be C, in this example	The FDAL for the backup satisfies the Functional independence attribute	The FDAL and IDAL for the passive backup channel may be	Conceptual	

				. However, for lightning, the applicable part of CS 25.1316 is (b), similarly to Example 5.	and may be assigned FDAL C. Need to highlight IDAL assignment in discussion as well.	C, in this example. However, for lightning, the applicable part of CS 25.1316 is (b), similarly to Example 5.		

response: Partially accepted

comment: *135* comment by: *Embraer S.A.*

[7.a.6.] "Elements or channels that are operational only in non-normal situations are not mandated to be recovered in normal operation for demonstrating compliance with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2). Their failures should be obvious to the flight crew, and the elements or channels that are active in normal operation should comply with CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) without their support. These excluded elements or channels should comply with CSs 23.1308(b), 25.1317(b), 27.1317(b), and 29.1317(b)."

The guidance here directs that other channels that operate the functions, but on non-normal situations, should be classified as Level B, disregarding System Safety Assessment. (HIRF and) Lightning Certification Level C requires the application of adequate qualification levels to the system components, shown to be robust on all Level C systems that have being flying. Attaining to Systems Safety Assessment definitions as much as possible helps on the interaction of H/L, Systems and Safety specialists, and it is aligned with specification process on early phases of the program, including qualification campaign. Additionally, HIRF (and Lightning) Certification Levels defined for systems, based on System Safety Assessment, are considered enough to guarantee Safety Level for the aircraft, as does the system reliability itself.

Therefore, Embraer proposes to maintain SSA definition for systems that operate in non-normal situations.

response: Partially accepted

The related text has been deleted.

comment	*136* comment by: *Embraer S.A.* Appendix 2 only mentions CS 25.1316, it does not mention other requirements applicable to other Certification Specifications. However, it is important to highlight that we have considerations about the applicability of this AMC to CS-23, as stated in our comment below.
response	Not accepted As indicated in its title, Appendix 2 provides examples only for large aeroplane architectures.

comment	*137* comment by: *Embraer S.A.* *[Appendix 2. Example 1.] "Compliance with CSs 25.1316(a)(1), and (a)(2) should demonstrate that neither pilot display of aircraft attitude, altitude, and airspeed is adversely affected and that each of them recovers normal operation when the aircraft is exposed to lightning. The dissimilar standby display should comply with CS 25.1316(b)."* *[Appendix 2.b.Notes] "(5) These examples are theoretical and intended to facilitate a discussion from which universal guidelines may be derived to help develop useful guidance material. It is not the intention to account for all possible configurations, but only to represent the most common system architectures or those that present unique challenges."* Embraer does understand that, per disclaimer on "Notes", the Examples do not intend to cover every configuration, but one specific example on the guidance could be seen as a consolidated condition in some certification discussions. Additionally, Example 1 does not harmonize with example described on SAE ARP 5415B, which allows for standby display to comply with 25.1316(a)(1) when pilot displays would comply with 25.1316(a)(2) (see SAE ARP 5415B, page 188). In this case, Standby System is an Active-backup system that could support the function of "Display of attitude, altitude, and airspeed information to the pilots during IFR operations" during a Lightning event, with no adverse effects to aircraft. Return to Normal Operation would require pilots displays to operate normally after the Lightning event Therefore, Embraer proposes changing Example 1 by using other function and systems, where Active-backup really could not support the function during HIRF/Lightning event in place of an Active system. Alternatively, we suggest removing this example.
response	Not accepted Example 1 describes an architecture where the primary system fully complies with subparagraph (a), without the support of a back-up channel. It was not the intent of the Appendix to cover the case where there is a need to rely on the back-up channel to perform the level A function.

comment	*138* comment by: *Embraer S.A.*

[Appendix 2. Example 5.] "All active electrical power generation channels should comply with CSs 25.1316(a)(1), and (a)(2)."

In this case, the document requires that Lightning Protection should warrant integral compliance with the power source requirement for ETOPS 180s, even after a lightning event. It is more conservative than the lightning requirement itself, which tolerates reduction on SSA numbers, as long as the Level A functions and Normal Operation are recovered after the event.

Embraer understands that Lightning requirement is already very stringent. Also, the (HIRF and) Lightning Certification Level defined for APU driven generator (for this example), as per System Safety Assessment, is enough to guarantee Safety Level for the aircraft, as does the APU system reliability itself.

response

Noted

The text has been improved for clarification.

comment

186 comment by: *Leonardo Helicopters*

Appendix 2, point c, Minimum condition (3)

Same as comments 183 and 184

response

Partially accepted

Please refer to the response to comment #79.

comment

188 comment by: *Leonardo Helicopters*

Appendix 2, Example 1
(related to comment 186 above)

In the example, the Active-backup channel (dissimilar standby equipment) is required to comply with 1316.b.
However, the allocation should be based on the specific safety assessment, which might be aircraft specific.

It is proposed to modify the last sentence as follows:
"If a failure condition identifies loss of the standby display is hazardous, t~~T~~he dissimilar standby display should comply with CS 25.1316(b). The adverse effects must include both a loss of, and hazardously misleading, attitude, altitude, and airspeed information.

response

Partially accepted

The sentence has been improved for clarification.

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 1. PURPO p. 50

comment *115* comment by: *General Aviation Manufacturers Association*

AMC 20-158 - General

Numerous mentions of CS 23.1308 are made throughout the document, but only 1 mention of 23.2520.

Is CS 23.2520 covered by this document?

Include the reference to the new regulation.

response Not accepted

This is covered by a note in paragraph 2 (Scope and applicability of the AMC).

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 2. SCOPE AND APPLICABILI p. 51

comment *33* comment by: *Airbus Helicopters*

Section, table, figure:	**Page:**	**Comment summary**:	**Suggested resolution**:
AMC 136 &158 §2	8 & 51	The two paragraphs AMC 136 &158 §2 are not consistent	The two paragraphs should address the same considerations and with similar level of depth.

response Noted

The text of both sections has been harmonised to the greatest extent possible.

comment *116* comment by: *General Aviation Manufacturers Association*

Text In Question From NPA -
"This AMC could nevertheless be used as guidance for CS 23.2520, if agreed with the Agency."

Proposing to remove the latter part of the sentence since AMC should be acceptable for use by default since the AC is acceptable for P25/27/29 if Applicant to chooses to use it.

Suggest changing to "This AMC could nevertheless be used as guidance for CS 23.2520~~, if agreed with the Agency~~."

response Partially accepted

The sentence has been improved for clarification.

comment *192* comment by: *Leonardo Helicopters*

(same as comment 182)

Part 23 rule and AMC have been reorganized in a single content EAR CS-23 AMC/GM Issue 1. Within this reorganization, new guidance material from ASTM “simplified” methods for HIRF/Lightning have been proposed. This NPA confirms AMC 20-158A as alternate means of compliance for Part 23.
Simplified methods have also been recently proposed as Means of Compliance for VTOL.

Is EASA open to consider future extension of “simplified” approaches (ASTM or with similar scope) to other vehicle types, such as Part 27?

If this was not possible within this AMC update program: could EASA advice about possible way forward for Part 27 AMC update in this direction (including coordination with FAA) and could EASA advice about possible use of “simplified” methods for Part 27 for individual certification programs as alternate means of compliance, and under which boundaries (e.g. single/dual engines, IFR/VFR approval, level of control for specific protections/design).

response Noted

This revision of the AMC does not introduce proportionality for CS-23 / CS-27 aircraft at this Amendment. This can be considered for a future amendment of the AMC.

Today, proportionality may be introduced through dedicated Certification Memoranda.

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 3. DOCUMENT HISTO p. 51

comment *119* comment by: *General Aviation Manufacturers Association*

Ref.: paragraph 6. Approaches to Compliance; g. Take corrective measures (if needed) 1st paragraph

"lightning" at the end of the sentence should be "HIRF".

Change "lightning" to "HIRF".

response Accepted

comment *121* comment by: *General Aviation Manufacturers Association*

Section 3.2, Figure 1

In the "System safety assessment" box, there is an underline caused by misplacement of the arrow to the next box.

Correct figure to align arrows with the boxes.

response	Noted

comment	*123* comment by: *General Aviation Manufacturers Association* Section .2 Figure 1 In the "Define aircraft and system HIRF protection" box, "(2)" is cut off and not visible. Resize the box to allow "(2)" to be visible.
response	Noted

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 4. RELATED MATERI p. 51-53

comment	*144* comment by: *General Aviation Manufacturers Association* Section 5. a. 5. Text In Question From NPA - “The increased severity of the HIRF environment because of an increase in the number and radiated power of radio frequency (RF) transmitters; and..” The above implies that it is being used to justify the changes. The above should be better defined to understand the relative nature of the increase in field strength, including the frequency spectrum impacted. Provide additional text to help understand the relative nature of the increase in field strength, including the frequency spectrum impacted.
response	Not accepted This sentence only provides a qualitative statement substantiating the need to comply with the HIRF requirements.

comment	*199* comment by: *Leonardo Helicopters* Paragraph 4.c EUROCAE ED-234 should be added to the list
response	Accepted The text of both sections has been harmonised to the greatest extent possible.

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 5. BACKGROU p. 53

comment *146* comment by: *General Aviation Manufacturers Association*

Section 5. a. 6.

Text In Question From NPA -
"… The adverse effects experienced by some aircraft when exposed to HIRF."

Since the general nature of the proposed guidance is considered to be an increase in requirements, additional clarification should be provided to help in the assessment of the proposed changes.

To provide some context to the nature of the HIRF upset, the NPA should provide information as to whether the HIRF upset was on equipment qualified or not qualified to the HIRF regulations and the criticality of resulting upset.

response Not accepted

This sentence only provides a qualitative statement substantiating the need to comply with the HIRF requirements.

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 6. APPROACHES TO COMPLIAN p. 53-64

comment *10* comment by: *Airbus Helicopters*

Section, table, figure:AMC 136 §6)c)2) & AMC 158 6)b)1)	**Page:**13 & 54	**Comment summary**: Point (c) of 6)b)1) for HIRF: "any corrective actions required by the flight crew " is not mentioned for LIE in 6)c)2)	**Suggested resolution**: The two paragraphs should be similar or the reason for the needed difference in the approach should be provided in order to allow a comprehensive application of this requirement.

response Noted
The text of both sections has been harmonised to the greatest extent possible.

comment *20* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 5)b)1)	**Page:**54	**Comment summary**: Correction	**Suggested resolution**: Modify: (b) all **HIRF related** failure conditions and their subsequent effects on aircraft operations and the flight crew; and

response: Accepted

comment *21* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 5)b)1)	**Page:**54	**Comment summary**: clarification	**Suggested resolution**: Modify (c) any corrective actions required by the flight crew **during or after occurrence of a HIRF related failure**.

response: Accepted

comment *22* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 5)b)2)	**Page:**55	**Comment summary**: Clarify that wires are not part of the HIRF safety assessement	**Suggested resolution**: Modify The HIRF safety assessment must include all electrical and electronic equipment, components and electrical interconnections, **except wires themselves**, assuming that they are potentially affected by HIRF

response: Not accepted.

The wording is considered clear enough. The list of elements (electronic equipment, interconnections, etc.) is exhaustive and does not include wires.

comment *23* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 5)b)2)	**Page:**55	**Comment summary**: Correct note same as LIE, see comment 4	**Suggested resolution**: Modify: in many cases the system HCL and LCL will be the same

response: Partially accepted

comment *24* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 F 3) after table 5	**Page:**62	**Comment summary**: Ref should be to paragraph 7 and 8 instead of 8 and 9	**Suggested resolution**: Modify

response: Accepted

comment *45* comment by: *Airbus-Regulations-SRg*

Section 3.2, AMC 20-158A, chapter 6, bullet b, item 3: Level A Systems - page 56

Airbus proposal #1:
Replace the last sentence of item 3:
Quote
"[…] ~~The system defined for CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) is not required to include the electrical and electronic equipment, components and electrical interconnections required only for non-normal situations, provided that none of the electrical and electronic equipment, components and electrical interconnections required for normal operation are susceptible when they comply with paragraph (a).~~"
Unquote
By:
"…The system defined for CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) is not required to include the electrical and electronic equipment, components and electrical interconnections required only for non-normal situations. In the case one of the electrical and electronic equipment, components and associated electrical interconnections required for normal operation is found not compliant with paragraph (a) of the referenced CSs, electronic equipment, components and electrical interconnections required only for non-normal situations could be

considered in complying with paragraph (a) of the referenced CSs. In such a case, the applicant should obtain the
Agency's concurrence."

Airbus proposal #2:
Delete last part of that initial proposed sentence to read as follows:
"[…] The system defined for CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) is not required to include
the electrical and electronic equipment, components and electrical inter-connections required only for non-normal
situations. ~~*provided that none of the electrical and electronic equipment, components and electrical interconnections*~~
~~*required for normal oper-ation are susceptible when they comply with paragraph (a).*~~"

Rationale:
Similar to rationale given for comment 38 to drafted AC20.136A.

response

Partially accepted

The text has considered the CATA Paper discussion and has been improved for clarification.

Please see the response to comment #38.

comment

58 comment by: *UK CAA*

Page No: 63, 78

Paragraph No: Figure 1, Figure 3

Comment: These Figures seem to be missing some of the step numbers in some of the blocks and some of the arrows do not line up with the blocks. We suggest these should be rectified.

Justification: Clarity.

response

Noted

comment

118 comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/ Response to Comment

18	2020-09 Regular Update Of AMC-20	Page 54 3.2 HIRF Guidance	Paragraph 6.b.1	The process used for identifying these systems should be similar to the process for demonstrating compliance with CSs 23.1309, 25.1309, 27.1309, and 29.1309, as applicable. These paragraphs address any system failure that may cause or contribute to an effect on the safety of flight of an aircraft.	Additional info that may confuse applicants with SSA and equipment levels of safety assessment. The aircraft function and corresponding safety classification is he only part used from XX.1309. The safety classification of the function must be made without mitigation.	Replace referenced text with: "The aircraft function and corresponding safety classification is he only part used from XX.1309 for the HIRF safety assessment. The safety classification of the function must be made without mitigation."	Conceptual	
19	2020-09 Regular Update Of AMC-20	Page 55 3.2 HIRF Guidance	Paragraph 6.b.2	NOTE: Considering that HIRF and lightning environments may	LCL is not defined nor explained. It is the only location that LCL is used for HIRF guidance.	Replace referenced text with: "NOTE: Considering that HIRF and	Editorial	

				have similar effects on electro-electronic systems (disturbing electrical signals, causing upsets or damage to circuits), and that the applicable certification specifications are similarly structured, normally the system HCL and LCL will be the same.		lightning environments may have similar effects on electronic systems (disturbing electrical signals causing upsets or damage to circuits) and that the regulations for each are similarly structured, normally the system HCL and lightning certification level will be the same."		
20	2020-09 Regular Update Of AMC-20	Page 62 3.2 HIRF Guidance	Paragraph 6.g.	If tests and analyses show that the system did not meet the pass/fail criteria, the applicant	Guidance is for HIRF and not lightning.	Replace referenced text with: "If tests and analyses show that the system did not meet the pass/fail criteria, the	Editorial	

				should review the aircraft, installation or system design and improve the protection against lightning.		applicant should review the aircraft, installation or system design and improve the protection against HIRF."		

response: Partially accepted

comment *147* comment by: *General Aviation Manufacturers Association*

A general comment that the HIRF section is written differently to the lightning section. It would be good to have commonality in the text.

Example text in b.1 "... The process used for identifying these systems should be similar to the process for demonstrating compliance with CSs 23.1309, 25.1309, 27.1309, and 29.1309, as applicable …" is good text but not in the lightning section.

Provide a more harmonized harmonized approach in layout of sections and text that are common between HIRF & Lightning.

response: Partially accepted

The text of both sections has been harmonised to the greatest extent possible.

comment *148* comment by: *General Aviation Manufacturers Association*

Section 6. b. 2.
Text In Question From NPA -
"The HIRF safety assessment must include all electrical and electronic equipment, components and electrical interconnections, assuming that they are potentially affected by HIRF. It is not appropriate to use the HIRF immunity data for electrical and electronic equipment, components and electrical interconnections as information input for the HIRF safety assessment."

The 2nd sentence contradicts the red text. The red text implies that if it is not affected then it should not be considered in the safety assessment. The safety assessment should also include any mechanical and pneumatic systems.

Suggest changing to "The HIRF safety assessment must include all electrical and electronic equipment, components and electrical interconnections. It can also include mechanical and pneumatic systems in the assessment, ~~assuming that they are potentially affected by HIRF~~. It is not appropriate to use the HIRF immunity data for electrical and electronic equipment, components and electrical interconnections as information input for the HIRF safety assessment."

response

Partially accepted

The text has been improved for clarification.

Please see also the response to comment #105.

comment

149 comment by: *General Aviation Manufacturers Association*

Section 6. b. 3.

Text In Question From NPA -
"This electrical and electronic system must also automatically recover normal operation in a timely manner to comply with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2)."

The impact of integrity of a function is not considered in the above and in general throughout the NPA. Malfunctions may be CAT and would need to address a(1), but it should not need to recover per a(2) if the availability is less than CAT.

The automatic or manual recovery should only be required when the availability of the function is considered to be CAT.

Suggest changing to "This electrical and electronic system must also automatically recover normal operation in a timely manner when the availability of the function is considered to be CAT, to comply with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2)."

response

Partially accepted

The text has been improved for clarification.

comment

151 comment by: *General Aviation Manufacturers Association*

Section 6. e. 2.

Text In Question From NPA -
"This should include failures which could negate any system redundancy or influence more than one system performing the same function."

Align with the notion of a system with multiple channels producing the same function.

	Suggest changing to "This should include failures which could negate any system redundancy or influence more than one ~~system~~ channel performing the same function."
response	Accepted

comment	*152* comment by: *General Aviation Manufacturers Association* Section 6. g. This should reference HIRF and not lightning in the first paragraph. It is in the HIRF AMC. Change the reference from lightning to HIRF.
response	Partially accepted

comment	*226* comment by: *Boeing* Page: 54 Paragraph: *7.a.3* **THE PROPOSED TEXT STATES:** If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must comply with CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a). **REQUESTED CHANGE:** Append proposed text with: “Monitoring systems that simply alert the flight crew of failures within the mechanical, hydraulic and/or pneumatic channels, but do not invoke automated mitigation of the failure, would not be assigned as LCL A systems. This is due to the fact that their malfunction does not adversely affect the function, since their operation is not relied upon to perform the function of the mechanical, hydraulic and/or pneumatic channels.” **JUSTIFICATION:** We recommend clarifying that not all monitoring systems associated with Critical systems need be Level A. Some monitoring systems are not performing the function of the mechanical, hydraulic and/or pneumatic channels, whose failure would prevent CSF&L and are not part of a mechanical, hydraulic and/or pneumatic control loop that provides a particular function, and are therefore not required to perform that function. The integrity of such monitoring systems must be evaluated to show that malfunction of the monitoring system (e.g. false indication of failure in the control loop) would not result in an adverse effect of the function being assessed.
response	Partially accepted 7.a.3 has been improved for clarification.

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 7. STEPS TO DEMONSTRATE LEVEL A SYSTEM HIRF COMPLIAN p. 64-78

comment *25* comment by: *Airbus Helicopters*

Section, table, figure:§7)a)5) AMC 158 p66 & AMC 136 p22	**Page:**22&66	**Comment summary**: It would be beneficial for a comprehensive approach of the rule application to provide the rationale for level A system recovery. In order to avoid presenting it as the intent behind the rule, it could be just the status of what the rule allows. This can be 1 - recovery of redundancy for the flight after the encounter of the threat in order to remain robust to random failure after Ligthning and certification environment and within the normal environment. This one is less understandable for the LIE rule because the aircraft may not be robust to random failure of the protected channel that ensure th level A function during ligthning. - recovery of system status that maintain the crew workload to an acceptable level in particular during approach of the airport and landing.	**Suggested resolution**: The lightning rule should be improved to required at least two hardened channel for ensuring level A function during Lightning strike. Espescially for aircrfaft with high rate of Ligthning encounter. Until then only the crew workload aspect can be provided in the AC for LIE.

response Partially accepted

The text has been improved for clarification.

comment *26* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 Step 4) 1.	**Page:**66	**Comment summary**: The equipment design and performances is a key element of the system robustness. The HIRF protection level of the equipment shall be maintained at the level that allowed to pass the system test successfully. It order to ensure this aspect, the equipment supplier should be driven by a specification that reflect the level of protection needed to pass the sustem test.	**Suggested resolution**: Modify sentence: The equipment should be **specified** and tested in accordance with the test procedure (wire bundle currents **injection** and RF field **illumination**) of RTCA/DO-160/EUROCAE ED-14, Section 20 **at levels that are consistent with the estimated one** for the aircraft and equipment installation using the applicable external HIRF environment.

response Partially accepted

The text has been improved for clarification.

comment *27* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 Step 4) 2.	**Page:**67	**Comment summary**: This paragraph seems to indicate that the result of the system test, possibly performed by other than the system supplier, is sufficient to claim for the imunity level. The imunity level of the system is only robust in time if the supplier commitment to maintain that immunity level is contractualized. Either the equipment specified HIRF protection level is consistent with the thereat developed during the system test, possibly after a contractual upgrade, or an extremely accurate process for equipment modification follow on, and possibly system test replay, need to be in place.	**Suggested resolution**: Add at the end of 2. In such case the HIRF imunity level demonstrated should be guarantied by equipment supplier. If not, a very accurate equipment modification follow-on process will be required, including system test replay as needed.

response | Not accepted

The responsibility as regards the way to demonstrate HIRF immunity between aircraft and equipment manufacturers does not lie with EASA.

comment | *28* comment by: *Airbus Helicopters*

Section, table, figure:AMC 158 9.	**Page:**68	**Comment summary**: Bor both radiated and conducted threat are injected locally during the system test, at level A equipment connector or on an area including the equipment and half a wavelength of the wiring. The important aspect of the test is therefore to have representative harness and system interfaces. As such it is not understood why the statement in step 9 is limited to step 5 (conducted) and does not include step 6 (radiated)	**Suggested resolution**: The equipment tests in Step 4, using the techniques in RTCA/DO-160G/EUROCAE ED-14G (or latest version), Section 20, normally are not sufficient to show HIRF compliance for Step 5 **and Step 6.**

response | Accepted

comment | *31* comment by: *Airbus Helicopters*

Section, table, figure: AMC20.158 7.a.5.	**Page**:Page 66	**Comment summary :** "CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2) require that Level A systems automatically recover normal operation in a timely manner after exposure to HIRF Environment I. " It is not mentioned that this automatic recovery is only required for the level A functions	**Suggested resolution** The sentence should be rewritten like this: CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2) require that Level A systems automatically recover normal operation <u>of the level A functions</u> in a timely manner after exposure to HIRF Environment I.

response	Accepted

comment	*32*	comment by: *Airbus Helicopters*

Section, table, figure:AMC20.1587.a.2 & 7.a.6	**Page**:Page 65/66	**Comment summary :** In 7.a.2 it is written: The system defined for paragraph (a) of these regulations is not required to include: (a) equipment, components and electrical interconnections required only for non-normal situations, or (b) equipment, components and electrical interconnections required only for dispatching under minimum equipment lists. And in 7.a.6 “Elements or channels that are operational only in non-normal situations are not mandated to be recovered in normal operation for demonstrating compliance with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2).” In 7.a.2 flight under minimum equipment lists is distinguished of a non normal situation. As a result, in 7.a.6 this flight configuration should be mentioned in addition of non –normal situations.	**Suggested resolution** The sentence should be rewritten like this: in 7.a.6 “Elements or channels that are operational only in non-normal situations and under minimum equipment lists are not mandated to be recovered in normal operation for demonstrating compliance with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2).”

response

Not accepted

However, the sentence has been improved to better consider the CATA HIRF Paper discussion.

Please see also the response to comment #39.

comment *46* comment by: *Airbus-Regulations-SRg*

Section 3.2, AMC 20-158A, chapter 7, bullet a, item 2 (b) - page 65

Airbus propose to replace:
Quote
"~~*The system defined for paragraph (a) of these specifications is not required to include:*~~
~~*(a) equipment, components or electrical interconnections required only for non-normal situations,*~~
~~*(b) equipment, components or electrical interconnections required only for dispatching under min-imum equipment lists*~~."
Unquote

by the following:
"The system defined for paragraph (a) of the referenced CSs is not required to include equipment, components or
electrical interconnections required only for non-normal situations.
The specific system configuration represented by equipment, components or electrical interconnections required
only for dispatching under minimum equipment lists must be considered for both identifying the items in the scope
of paragraph (a) of the referenced CSs and defining the minimum system test configuration in step 5."

Rationale:
Same rationale than comment #39 to drafted AC20.136A.

response

Not accepted

However, the sentence has been improved to better consider the CATA HIRF Paper discussion

Please see also the response to comment #39.

comment *51* comment by: *UK CAA*

Page No: 63, 78

Paragraph No: Figure 1, Figure 3

Comment: These Figures seem to be missing some of the step numbers in some of the blocks and some of the arrows do not line up with the blocks. We suggest these should be rectified.

Justification: Clarity.

response: Noted

comment: *120* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
21	AMC-20-158A	71	j-1(a)	Detailed descriptions are available in the User's Guide.	What user's guide?	Add document or paragraph reference.	Editorial	

response: Not accepted

The reference of the user's guide appears in the step before.

comment: *142* comment by: *Embraer S.A.*

[7.a.6.] "Elements or channels that are operational only in non-normal situations are not mandated to be recovered in normal operation for demonstrating compliance with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2). Their failures should be obvious to the flight crew, and the elements or channels that are active in normal operation should comply with CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) without their support. These excluded elements or channels should comply with CSs 23.1308(b), 25.1317(b), 27.1317(b), and 29.1317(b)."

The guidance here directs that other channels that operate the functions, but on non-normal situations, should be classified as Level B, disregarding System Safety Assessment. (HIRF and) Lightning Certification Level C requires the application of adequate qualification levels to the system components, shown to be robust on all Level C systems that have being flying. Attaining to Systems Safety Assessment definitions as much as possible helps on the interaction of H/L, Systems and Safety specialists, and it is aligned with specification process on early phases of the program, including qualification campaign. Additionally, HIRF (and Lightning) Certification Levels

	defined for systems, based on System Safety Assessment, are considered enough to guarantee Safety Level for the aircraft, as does the system reliability itself. Therefore, Embraer proposes to maintain SSA definition for systems that operate in non-normal situations.
response	Partially accepted 7.a.6 has been deleted to avoid redundant wording.

comment	*150* comment by: *General Aviation Manufacturers Association* Section 7. a. 2. Text In Question From NPA - "This electrical and electronic system must also automatically recover normal operation in a timely manner to comply with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2)." The impact of integrity of a function is not considered in the above and in general throughout the NPA. Malfunctions may be CAT and would need to address a(1), but it should not need to recover per a(2) if the availability is less than CAT. The automatic or manual recovery should only be required when the availability of the function is considered to be CAT. Suggest changing to "This electrical and electronic system must also automatically recover normal operation in a timely manner <u>when the availability of the function is considered to be CAT,</u> to comply with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2)."
response	Partially accepted The text has been improved for clarification.

comment	*153* comment by: *General Aviation Manufacturers Association* Section 7. a. 3. All mechanical, hydraulic and/or pneumatic channels have forseeable latent failures. Therefore, the way this is worded, they cannot be utilized. These other non electrical/electronic systems can often be utilized as the primary path for meeting catastrophic requirements. This statement does not allow this. Remove the statement about foreseeable latent failures or define acceptable rate of failure for those paths to be utilized for level A systems.
response	Accepted Please see also the response to comment #79.

comment	*154* comment by: *General Aviation Manufacturers Association* Section 7. a. 3. See Industry response to CATA HIRF paper dated July 27, 2020 for additonal details.
response	Noted

comment	*155* comment by: *General Aviation Manufacturers Association* Section 7. a. 3. The word "monitor" in the text "used to assist, augment, or monitor" indicates that annunciation aspects of Level A functions are always required to meet Level A Display, even if it can be shown that there is no electrical contribution to the failure itself. The proposed changes to the CATA paper included with "Industry Response to CATA HIRF paper" dated July 27, 2020 changed "assist, augment, or monitor" to "necessary for". Change "used to assist, augment, or monitor" to "necessary for" in 7.a.3 and Appendix 3.c, Minimum conditions for complying with CS 25.1317, #3.
response	Partially accepted The related paragraph has been deleted from the appendix, and the related text in 7.a.3 has been improved for clarification.

comment	*156* comment by: *General Aviation Manufacturers Association* Section 7. a. 3. Text In Question From NPA - "The HIRF aircraft safety assessment should verify the reliability and availability assumptions for mechanical, hydraulic and/or pneumatic channel(s), if these assumptions would affect whether the electrical/electronic or mechanical, hydraulic, and/or pneumatic channel(s) is the active channel during normal operation. For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations." This is new requirement. Current guidance has no requirement for having a certain amount of reliability before it can be counted on. The section 5.2 ED017A/ARP5583A specifically states “The EEHWG, which was tasked by FAA to draft the proposed HIRF regulation, focused on system performance effects when exposed to the HIRF environment and did not intend for unrelated system failure conditions to be addressed in combination with that HIRF exposure.” The text in NPA page 65 Item 4 says something similar also ”... CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) do not require the applicant to assume pre-

existing failure conditions when classifying the functional failure conditions and the scope of the Level A systems. ...”

By having a need for reliability, the implication is that it might have failed (random failure and not related to HIRF/Lightning) and because of this we can no longer rely on it, which contradicts to the above.

To comply with the text in question would now result in additional burden on the electrical systems. This additional cost burden is in the form of additional equipment design, integrated system test, and potentially aircraft level HIRF/lightning testing. All of these have high cost impact.

There is also impact to fielded aircraft that used the prior certification method if an update is needed to the system that may add cost to recertifying the electrical portion if the mechanical or hydraulic system is no longer compliant wrt reliability.

There is no evidence in field service where HIRF or lightning was an issue because of relying on mechanical or hydraulic systems in lieu of electrical equipment. Recommend removing this requirement.

Propose removing the requirement to have a certain level of reliability for any mechanical or pneumatic systems used to prevent the CAT cases.

response

Partially accepted

Please see also the response to comment #79.

comment

157 comment by: *General Aviation Manufacturers Association*

Section 7. a. 4.

The statement "CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) do not require the applicant to assume pre-existing failure conditions when classifying the functional failure conditions and the scope of the Level A systems." directly contradicts the sentence that precedes it, which states that I must consider latent failure conditions of the other possible channels.

Resolve the conflict between the two statements.

response

Partially accepted

The text has been improved.

Please see also the response to comment #79.

comment

158 comment by: *General Aviation Manufacturers Association*

Section 7. a. 5.

Text In Question From NPA -
“… Automatic recovery applies to all redundant channels of the Level A system required for normal operation unless …”

	The definition of all redundant channels in normal operation is unclear. Example 1 on page 98 of the NPA has 3 redundant channels that are all “Active” with one as a backup and termed “Active-backup”. The Applicable part of the rule for the backup is only CS25.1317(b) per the example and not (a)(2) where the above text comes from. Provide additional clarification on which redundant channels are required to meet a(2).
response	Partially accepted Please see also the response to comment #79.

comment	*159* comment by: *General Aviation Manufacturers Association* Section 7. a. 6. Example 6 says "For the electronic engine thrust reverse control and the electronic spoiler control systems, the applicable parts of CS 25.1316 would depend on the specific failure condition." This matches the logic in Item #1 of "Industry Response to CATA HIRF paper" dated July 27, 2020. The determination of HCL/LCL for items that are involved in but not the primary means of mitigation for a Catastrophic failure condition should be determined by the system safety assessment process for the applicable aircraft. The last sentence of Section 7.a.6 should be changed to: "For these excluded elements or channels, the applicable parts of CSs 23.1308, 25.1317, 27.1317, and 29.1317 should be determined by the hazard classification of the specific failure conditions for each channel by itself in the system safety assessment."
response	Partially accepted 7.a.6 has been deleted to avoid redundant wording.

comment	*161* comment by: *General Aviation Manufacturers Association* Section 7. a. 6. See Industry response to CATA HIRF paper dated July 27, 2020 for additional details.
response	Noted

comment	*162* comment by: *General Aviation Manufacturers Association* Section 7. a. 7. See Industry response to CATA HIRF paper dated July 27, 2020 for additional details.
response	Noted

comment	*163* comment by: *General Aviation Manufacturers Association* Section 7. g. Is there any intention to address the FAA policy PS-ACE-23-10? Which allows for defined levels for Class I, II, and III aircraft. Currently, there seems to be some disconnect between EASA and the FAA regarding the usage of the FAA policy. Clarification of EASA position would be useful.
response	Not accepted EASA does not fully recognise FAA policy PS-ACE-23-10. In addition, it is not the intent to introduce any proportionality for small aircraft in this update of AMC 20-158 and AMC 20-136.

comment	*164* comment by: *General Aviation Manufacturers Association* Section 7. j. 2. a. Low Level swept current testing should be 7.j.3. It is a test technique just like the LLDD and LLSF. Make this paragraph 7.j.3.
response	Accepted

comment	*193* comment by: *Leonardo Helicopters* Paragraph 7.a.3 (same as comment 183) Paragraph (a) of the XX.1317 rule addresses protection of Level A systems limited to effects to the associated Catastrophic Function(s). The following proposed AMC updates appear to extend the scope of the requirement (a) to electronic systems "assisting, augmenting or monitoring" Level A mechanical/hydraulic/pneumatic systems: "…If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must comply with CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a)…." The applicability of 1317 (whether –a- or –b-) should be based on the specific criticality of the electronic system as determined by the specific safety assessment. There could be examples of electronic systems providing assistance/augmentation/monitoring but whose specific malfunction/loss is not associated to safety critical functional failures.

It is proposed to reword the paragraph to be consistent with the rule xx.1317(a), as follows:
"…If electrical or electronic equipment, components and electrical interconnections are used to assist, augment, or monitor the mechanical, hydraulic, and/or pneumatic channels to perform functions with potential failures that would prevent continued safe flight and landing during normal operation, then the electrical and electronic channel(s) must be considered within the Lightning Safety Assessment, and comply with CSs 23.1308~~(a)~~, 25.1317~~(a)~~, 27.1317~~(a)~~, and 29.1317~~(a)~~ in accordance with the specific safety assessment…."

response

Partially accepted

The text has been improved for clarification.

Please refer also to the response to comment #79.

comment *194* comment by: *Leonardo Helicopters*

Paragraph 7.a.3

(same as comment 184)

The guidance to consider possible latent failures of mechanical/hydraulic/pneumatich channels as an input to the HIRF certification process appears in conflict with the rule (which is not requiring to consider pre-existing failures not related to lightning effects):
"For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations."
It also appears in conflict with Section 7.4 of the proposed AMC amendment, which states: "…CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) do not require the applicant to assume pre-existing failure conditions when classifying the functional failure conditions and the scope of the Level A systems…"

It is proposed to remove the following wording:

"~~For example, if the mechanical, hydraulic, and/or pneumatic channel(s) has/have foreseeable latent failures, then the electrical/electronic channel would be the active channel during normal operations.~~"

response

Partially accepted

Please refer also to the response to comment #79.

comment *195* comment by: *Leonardo Helicopters*

Paragraph 7.a.5

(same as comment 185)

The following sententence:

"CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2) require that Level A systems automatically recover normal operation in a timely manner after exposure to lightning"

Appears to extend the scope of the requirement to the whole system, while the actual requirement is limited to the catastrophic functions. See for instance from 29.1317: "the system automatically recovers normal operation of that function, in a timely manner, after the rotorcraft's exposure to lightning"

Propose to reword consistently with the rule/requirement:
"CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2) require that Level A systems automatically recover normal operation of functions whose failure would prevent the continued safe flight and landing, in a timely manner after exposure to lightning"

response Partially accepted

comment *197* comment by: *Leonardo Helicopters*

Paragraph 7.a.6

(linked to comment 187)

The following part:

"*Elements or channels that are operational only in non-normal situations are not mandated to be recovered in normal operation for demonstrating compliance with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), and 29.1317(a)(2). Their failures should be obvious to the flight crew, and the elements or channels that are active in normal operation should comply with CSs 23.1308(a), 25.1317(a), 27.1317(a), and 29.1317(a) without their support. These excluded elements or channels should comply with CSs 23.1308(b), 25.1317(b), 27.1317(b), and 29.1317(b).*"

appears to define a-priori HIRF Certification Level B for channels of a Level A system, regardless of their specific safety assessment.

It is considered that the specific HIRF Safety Assessment should allocate the proper HIRF Certification Level to the specific channels, so the following rewording is proposed:
"*…These excluded elements or channels should comply with CSs 23.1308(b)/(c), 25.1317(b)/(c), 27.1317(b)/(c), and 29.1317(b)/(c) if a failure condition identifies their failure as significantly-reducing / reducing the capability of the rotorcraft or the ability of the flight crew to respond to an adverse operating condition.*"

response Partially accepted

7.a.6 has been deleted to avoid redundant wording.

comment *200* comment by: *Leonardo Helicopters*

Section 7.a.2

(same as comment 190)

In the following statement:
"*The system defined for paragraph (a) of these specifications is not required to include:*
…
… (b) equipment, components or electrical interconnections required only for dispatching under minimum equipment lists."
It is not clear which could be an example of an equipment required "only" for dispatching under minimum equipment list, and it is not clear whether the reference is made explicitely to the MMEL certification process.

It is proposed for EASA to clarify whether the reference is made to the MMEL certification process (in which case MMEL should be mentioned) and whether lightning protection should be considered when defining the MMEL equipment perimeter.

response

Partially accepted

The text has been improved to better consider the CATA HIRF Paper discussion on Level A boundary.

Please see also the response to comment 190.

comment

204 comment by: *Leonardo Helicopters*

Section 7.e.9

Reference unclear:
"9. The equipment tests in Step 4, using the techniques in RTCA/DO-160G/EUROCAE ED-14G (or latest version), Section 20, normally are not sufficient to show HIRF compliance for Step 5. However, these standard RTCA/DO-160G/EUROCAE ED-14G, Section 20 tests may be sufficient if paragraph 8. e. (2) and (3) of this step are met."

Suggest to check the reference. It is assumed that the correct referenence should be Section 7.e Step 5 (2) and (3); in which case proposed change is:
"*9. The equipment tests in Step 4, using the techniques in RTCA/DO-160G/EUROCAE ED-14G (or latest version), Section 20, normally are not sufficient to show HIRF compliance for Step 5. However, these standard RTCA/DO-160G/EUROCAE ED-14G, Section 20 tests may be sufficient if Section 7.e Step 5 (2) and (3) ~~paragraph 8. e. (2) and (3) of this step~~ are met.*"

response

Accepted

comment

227 comment by: *Boeing*

Page: 71
Paragraph: *7.j.b*

THE PROPOSED TEXT STATES:
The low-level swept-field test (see Step 10d) is used for frequencies at and above 100 MHz. There is an overlap of test frequencies from 100 MHz to 400 MHz in the low-level swept-current test and the low-level swept-field test. The division at 400 MHz is not

absolute but rather depends on when HIRF penetration of the equipment case becomes a significant factor.

REQUESTED CHANGE:
The low-level swept-field test (see Step 10d) is used for frequencies at and above 100 MHz. The division at 100 MHz is not absolute and depends on the aircraft being tested and the resonance of the wiring and instrumentation limitations. There is an overlap of test frequencies from 100 MHz to 400 MHz in the low-level swept-current test and the low-level swept-field test. The division at 400 MHz is not absolute but rather depends on when HIRF penetration of the equipment case becomes a significant factor.

JUSTIFICATION:
Historically Boeing has only tested to 30-50MHz for the LLCW testing. The data gathered above 30/50MHz is not meaningful above the 1st resonance during low-level direct-drive testing

response Accepted

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 8. STEPS TO DEMONSTRATE LEVEL B AND C SYSTEM HIRF COMPLIAN p. 79-81

comment *122* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
22	2020-09 Regular Update Of AMC-20	Page 79 3.2 HIRF Guidance	Paragraph 8.a.	The applicant should determine the system failure condition classification for the systems being certified on their aircraft,	Safety classification of the function should be used. Then determine the system that supports that function in normal operation. Some applicants confuse the words system safety	Replace referenced text with: " The applicant should determine the safety classification of the function being certified on their	Conceptual	

				using a system safety assessment as discussed in paragraph 6.b.(2).	assessment with SSA in the XX.1309 requirement.	aircraft, using a safety assessment as discussed in paragraph 6.b.(2)."		

response

Partially accepted

The text has been improved for clarification.

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 9. HIRF COMPLIANCE DEMONSTRATI p. 81-84

comment *165* comment by: *General Aviation Manufacturers Association*

See comments #24 - #29 of this comment sheet, as they are applicable to the HIRF section as well.

response

Noted

comment *228* comment by: *Boeing*

Page: 82
Paragraph: *9.c.1*

THE PROPOSED TEXT STATES:
A HIRF compliance test plan should include….
(2) a description of the aircraft and/or system being tested
(3) system configuration drawings,

REQUESTED CHANGE:
A HIRF compliance test plan should include….
(2) a description of the aircraft and/or system being tested (if not referenced to such a description in the compliance plan),
(3) system configuration drawings (if not referenced to such a description in the compliance plan),

JUSTIFICATION:
The system description should already be in the compliance plan described in section 9.a.2.

response | Partially accepted

The final wording of the paragraph offers more flexibility on the content of the HIRF compliance test plan.

AMC 20-158A Aircraft electrical and electronic system high-intensity radiated fields (HIRF) protection — 10. MAINTENANCE, PROTECTION ASSURANCE, AND MODIFICATIO p. 84

comment | *47* comment by: *Airbus-Regulations-SRg*

Section 3.2, AMC 20-158A, chapter 10, bullet a, 4th sentence - page 84

Airbus proposal to modify the wording as shown below:
"A HIRF protection assurance programme ~~may be necessary to verify that the maintenance procedures are adequate."~~
Replaced by:
"A HIRF protection assurance programme should be proposed in the certification plan to identify all actions necessary to justify or to verify that the maintenance procedures are adequate. This assurance programme may propose a surveillance programme based on a sampling of the fleet for monitoring the effectiveness of the protection features and/or maintenance procedures."

Rationale:
Same rationale than comment #43 to drafted AC20.136A.

response | Accepted

comment | *208* comment by: *IATA*

- Section 3 Proposed amendments 3.2. AMC 20-158A - (see NPA page 84/128) – "10. Maintenance, Protection Assurance, and Modifications", paragraph "a."
  - Since the NPA is stating that "The minimum maintenance required to support HIRF certification should be identified in the instructions for continued airworthiness as specified in CSs 23.1529, 25.1529, 25.1729, 27.1529, 29.1529, as appropriate", the obligation is implied to be resting with the certification applicant who must address the respective CS provisions.
  - In the same paragraph, it is subsequently stated that "…Appropriate maintenance procedures should be defined for these devices and features to ensure in-service protection integrity. A HIRF protection assurance programme may be necessary to verify that the maintenance procedures

	are adequate...” It should be made clear that both the maintenance procedures and the protection assurance programme are part of certification and any resulting elements which must be subsequently considered by the operator/maintainer of the aircraft/system/component should be captured by the certification applicant in the form of ICAs which must be issued by the (S)TCH
response	Partially accepted The text has been improved for clarification.

Appendix 1 to AMC 20-158A — Definitions and acro p. 85-88

comment *124* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
23	2020-09 Regular Update Of AMC-20	Page 86 3.2 HIRF Guidance	Paragraph Appendix 1 a.	Normal operation: A status where the system is performing its intended function. When addressing compliance with CSs 23.1308(a)(2), 25.1317(a)(2), 27.1317(a)(2), 29.1317(a)(2), the	This adds on to CATA HIRF report definition. It does not add info for the definition of the term 'Normal operation' but does help clarify a point that applicants can get confused about.	Good addition and no proposed change.	Editorial	

				function whose failure would prevent the continued safe flight and landing should be in the same undisturbed state as before exposure to the lightning threat, while other functions, performed by the same system, subject to CSs 23.1308(b) and (c), 25.1317(b) and (c), 27.1317(b) and (c), 29.1317(b) and (c), are not required to be recovered.				
24	2020-09	Page 87 3.	Paragraph	Timely manner:	This is a good definition of	Replace referen	Editorial	

	Regular Update Of AMC-20	2 HIRF Guidance	Appendix 1 a.	The meaning of 'in a timely manner' depends upon the function performed by the system being evaluated, the specific system design, the interactions between that system and other systems, and interactions between the system and the flight crew. The definition of 'in a timely manner' must be determined for each specific system and for the specific	'Timely manner'. The certification plan seems perscriptive and a HIRF compliance plan could also achieve the intent. Recommend to revise wording to concurred with certification authorities.	ced text with: Timely manner: The meaning of 'in a timely manner' depends upon the function performed by the system being evaluated, the specific system design, the interactions between that system and other systems, and interactions between the system and the flight crew. The definition of 'in a timely manner		

				functions performed by the system. The applicable definition should be included in the certification plan for review and approval by the certification authorities.		' must be determined for each specific system and for the specific functions performed by the system. The applicable definition should be in the HIRF compliance plan and concurred with certification authorities.		

respo nse

Partially accepted

The text has been improved for clarification.

comment

166 comment by: *General Aviation Manufacturers Association*

Normal Operations

This should reference HIRF and not lightning - It is in the HIRF AMC.

Change the reference from lightning to HIRF.

response | Accepted

comment | *229* comment by: *Boeing*

Page: 86
Paragraph: Appendix 1 to AMC 20-158A – Definitions and acronyms

THE PROPOSED TEXT STATES:
Normal operation: A status where the system is performing its intended function. When addressing compliance with CSs 23.1308(a)(2), 25.1317 (a)(2), 27.1317(a)(2), 29.1317(a)(2), the function whose failure would prevent the continued safe flight and landing should be in the same undisturbed state as before exposure to the lightning threat, while other functions, performed by the same system, subject to CSs 23.1308(b) and (c), 25.1317(b) and (c), 27.1317(b) and (c), 29.1317(b) and (c), are not required to be recovered.

REQUESTED CHANGE:
Normal operation: A status where the system is performing its intended function. When addressing compliance with CSs 23.1308(a)(2), 25.1317 (a)(2), 27.1317(a)(2), 29.1317(a)(2), the function whose failure would prevent the continued safe flight and landing should be in the same undisturbed state as before exposure to the lightning threat, while other functions, performed by the same system, subject to CSs 23.1308(b) and (c), 25.1317(b) and (c), 27.1317(b) and (c), 29.1317(b) and (c), are not required to be recovered. The system that performs the function may be in a different state (e.g. the system may switch from channel A to channel B) as long as the function is not adversely affected. In such a case, channel A would need to recover its ability (availability) to perform the function after exposure.

JUSTIFICATION:
We recommend to add the appendage above to clarify that system state changes are allowed even though state changes in function are not allowed. For example, the electronic engine control system could switch from channel A to channel B, during exposure without automatically reverting back to channel A after exposure, since the function of thrust has not been affected.

response | Partially accepted

This point has also been considered in the frame of the definitions list.

Please see also the response to comment #205.

Appendix 3 to AMC 20-158A — Examples of HIRF safety assessment considerations — Level A systems on large aeropl p. 96-105

comment | *125* comment by: *FAA*

#	Document Name	Page Number	Paragraph	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conce	Disposition/Response to Comment

			Number				**ptual, Editorial, or Format)**	
25	AMC-20-158A	105	Example 8,4	The FDAL for each channel or member (SAE ARP 4754A/EUROCAE ED-79A nomenclature) was defined for a catastrophic top-level failure condition based on the 'Option 2' column of Table 3 'DEVELOPMENT ASSURANCE LEVEL ASSIGNMENT TO MEMBERS OF A FUNCTIONAL FAILURE SET' of SAE ARP 4754A/EUROCAE ED-79A, which allows the combination of FDALs B+B+C for independent	The proposed FDAL assignment does not follow the guidelines established in 4754A section 5.2.3.2 and sub-paragraphs. Option 2 assignment is allowed only if the Functional Independence is satisfied. Functional Independence occurs where functions are different in order to minimize likelihood of common mode requirement error. The pneumatic system channels are part of a single function therefore no independence and should be assigned FDAL A.	Change FDAL B assignments to FDAL A assignments. Add IDAL B assignments to pneumatic controller #1 & #2; IDAL C to backup. The FDAL for the function is assigned based on column 2 of ARP 4754A/EUROCAE ED-79A Table 3 'DEVELOPMENT ASSURANCE LEVEL ASSIGNMENT TO MEMBERS OF A FUNCTIONAL FAILURE SET' for a catastrophic top-level failure condition.	Conceptual	

				channels. In contrast, the respective HCLs would be A+A+B.		Each channel or member (SAE nomenclature) IDAL was defined b ased on the 'Option 2' column of Table 3 of SAE ARP 4754A/EUROCAE ED-79A, which allows the combination of IDALs B+B+C based on Item Development Independence. In contrast, the respective HCLs would be A+A+B.		
26	AMC-20-158A	105	Example 8,5	Considering that HIRF can simultaneously affect all the channels, the considerations used for FDAL assignment cannot	See comment EP-5. FDAL assignment incorrect.	Considering that HIRF can simultaneously affect all the channels, the considerations used for IDAL assignment cannot	Conceptual	

				be used, and compliance with CS 25.1317(a) is required for both the active channels performing a function with the catastrophic top-level failure condition.		be used, and compliance with CS 25.1317(a) is required for both the active channels performing a function with the catastrophic top-level failure condition.		
27	AMC-20-158A	105	Example 8,6	The FDAL for the passive backup channel may be C, in this example. However, for HIRF, the applicable part of CS 25.1317 is (b), similarly to Example 5.	The FDAL for the backup satisfies the Functional independence attribute and may be assigned FDAL C. Need to highlight IDAL assignment in discussion as well.	The FDAL and IDAL for the passive backup channel may be C, in this example. However, for HIRF, the applicable part of CS 25.1317 is (b), similarly to Example 5.	Conceptual	

response: Partially accepted

comment: *160* comment by: *General Aviation Manufacturers Association*

Example #6

Example 6 states: "For the electronic engine thrust reverse control and the electronic spoiler control systems, the applicable parts of CS 25.1316 would depend on the specific failure condition." This matches the logic in Item #1 of "Industry Response to CATA HIRF paper" dated July 27, 2020.

The determination of HCL/LCL for items that are involved in but not the primary means of mitigation for a Catastrophic failure condition should be determined by the system safety assessment process for the applicable aircraft.

The last sentence of Section 7.a.6 should be changed to:

"For these excluded elements or channels, the applicable parts of CSs 23.1308, 25.1317, 27.1317, and 29.1317 should be determined by the hazard classification of the specific failure conditions for each channel by itself in the system safety assessment."

response

Partially accepted

7.a.6 has been deleted to avoid redundant wording.

comment *167* comment by: *General Aviation Manufacturers Association*

See Industry response to CATA HIRF paper dated July 27, 2020 for additional details.

response

Noted

comment *168* comment by: *General Aviation Manufacturers Association*

Section b. 1.

Text In Question From NPA -
"Redundant Channels: The multiple channels consist of equipment, components, electrical interconnections and configurations that are similar, typically with pieces of equipment that have identical part numbers. The channels should be independent. They may be configured in active, active-backup and passive-backup modes."

You could have completely different wiring and equipment and be considered a redundant channel. All the examples show that typically the backup channel would be very different; even dissimilar.

Suggest changing to "Redundant Channels: Equipment, components, electrical interconnections that produce the same or similar function. The equipment and components are typically the same."

response

Partially accepted

The definition will not be changed, but the text now reads ‘Similar Redundant Channels’ instead of ‘Redundant Channels’.

comment *169* comment by: *General Aviation Manufacturers Association*

Section c. Minimum conditions for complying with CS 25.1317, item 1

Text In Question From NPA -
"All the electrical and electronic system channels that perform functions whose failure would prevent continued safe flight and landing, and can operate in 'Active' mode during normal operation, should fully comply with CS 25.1317(a)."

Remove the need for Active channels only needing to be used to meet (a)

The current rule or guidance does not stipulate which channel has to be used to prevent the CAT case. This is a big departure from current practices where channels in Active-backup mode have been certified to prevent the loss of a function as an example. This would now put all the burden on Active channels (eg Primary Systems) to work throughout and cannot rely on any backup channel.

The objective of the executive summary states that the proposed changes "reflect the current state of the art" and that it would provide "economic benefit by streamlining the certification process". For P25/27/29 this is not in line with either of the above:
1) You lose the flexibility of using the back up channel that was allowed previously.
2) Often the Active- back up channel is much more simple than the Active channel and easier/cheaper to protect.

The desire to have the Active channel to work through HIRF is the ideal situation however in practice the aircraft does encounter the highest HIRF levels each flight otherwise we would see upsets on equipment qualified for MAJ/MIN regularly. Given we do not see this that reliance on Active-backup would be infrequent and therefore should be acceptable; we already do this today and have good field history. Note that in other areas of safety we do not make Active channel meet the CAT requirement by themselves (eg DO178, DO254).

Suggest removing this requirement, and restoring the previous method of compliance. It seems that passive backup caused a lot of concerns in the creation of the new method of compliance. As a minimum the Active-backup should still be allowed.

response

Partially accepted

The requirement has been deleted.

comment

170 comment by: *General Aviation Manufacturers Association*

All the examples provided are for functions that have Level A availability requirement. These examples do not convey, and even confuse, requirements for functions that have a requirement that is less than CAT for availability but have integrity (or malfunction) that are CAT. A proposed Example 9 is provided.

response

Noted

comment

196 comment by: *Leonardo Helicopters*

Appendic 3, point 5, Minimum condition (3)

	same as comment 193 and 194
response	Noted Please refer to the responses to comments #193 and #194.

comment	*198* comment by: *Leonardo Helicopters* Appendix 3, Example 1 (related to comment 197) In the example, the Active-backup channel (dissimilar standby equipment) is required to comply with 1317.b. However, the allocation should be based on the specific safety assessment, which might be aircraft specific. It is proposed to modify the last sentence as follows: "If a failure condition identifies loss of the standby display is hazardous, t~~T~~he dissimilar standby display should comply with CS 25.1316(b). The adverse effects must include both a loss of, and hazardously misleading, attitude, altitude, and airspeed information.
response	Partially accepted The text has been improved for clarification.

[AMC 20-193 The Use of Multi-Core Processors] | [AC 20-193 Use of Multi-Core Processors] — 1. PURPOSE [OF THIS ADVISORY CIRCULAR (AC p. 106

comment	*177* comment by: *GE Aviation* General Comments • There is no mention of firmware within the proposed AC; is firmware treated as an external to the MCP, even though it may provide services like bus arbitration or memory access arbitration? • Use of "software applications" and "software component": Unlike CAST-32A, AMC defines both software application as "generally designates the software part of a function installed on an MCP" and software component as "any part of the software which may access MCP shared resources. It may designate either a software application or an operating system or a hypervisor". The AMC needs to be reviewed to ensure that after port from CAST-32A the use of both software applications and software components is consistent with their definition.
response	Noted Thank you for your response. a) The firmware that is embedded into an MCP, and that provides the services you mentioned, is treated in this guidance in exactly the same way as in the existing

	software guidance. The software that is loaded onto the processor has to be tested and shown to function correctly in the context of the processor and its embedded firmware. b) In updating the guidance from CAST-32A to produce the AMC/AC, the reviewers found it necessary to use both the term 'software component' and 'software application'. Having checked the document, we believe we have used these terms consistently and correctly.

comment	*180* comment by: *Thales* Thales thanks EASA for streamlining the existing guidance for the use of MCP into this new AMC 20-193 and for the harmonization with FAA.
response	Noted Thank you for your comment.

[AMC 20-193 The Use of Multi-Core Processors] | [AC 20-193 Use of Multi-Core Processors] — 2. APPLICABILI p. 106-108

comment	*2* comment by: *Liem Vo Quang* <u>Section §2.1</u> 1. Please provide a reference or a certification way forward for applicant that use MCP for IDALs D or E if this document is not applicable. How can an avionic system with DAL-D/E be certified? 2. "Error! Reference source not found" on page 107 last text block. Should it be refer to §5.7? <u>Section §2.2.2</u> 3. First text block: the term "simultaneous multithreading" is not defined in section §4. Please provide fefinition of this term for common understanding <u>Section §2.3</u> 4. Are Soft-IP cores that have link via conventional bus or no link to each other belong to the exceptions described in section §2.3?
response	Partially accepted Thank you for your comments. 1. From the very first authority guidance for MCPs, it has been considered that MCP guidance only needed to be provided for safety-related software and systems, which meant that only DALs A, B and C were considered. If a system and its software are DAL D and they, therefore, have only minor safety effects, then it is not considered that the extra time and effort involved in applying the MCP guidance is appropriate to or commensurate with the possible safety effects. EASA would suggest that, as for DAL D software in DO-178B or C, the DO-178B/C objectives for DAL D should be met. This would include verification of the high-level software requirements. If the software/AEH is DAL E, then none of the objectives of the existing guidance documents apply, so none should apply for the software/AEH of an MCP.

2. EASA agrees that the reference on page 107 should read 'Section 5.7 of this document'; it has been corrected.

3. Section 2.2.2 now explains this term, as text has been added after simultaneous multithreading to read: '…which is when virtual cores are used to execute more than one execution thread on a single physical core'. The same definition has been added in Section 4.

4. Section 2.3 clearly states that the MCP objectives do not apply to cores that are linked by conventional databuses and not by the listed mechanisms of an MCP.

comment *52* comment by: *UK CAA*

Page No: 107

Paragraph No: 2.2.2

Comment: The equivalent part of the current EASA MCP CRI requires applicants to contact EASA if they are using this type of technology.

It might be helpful for less experienced applicants if a requirement to contact the NAA was added to this document too. It might also be helpful if the note wasn't limited to simultaneous multithreading to limit the potential need for future updates

Justification: Adding this requirement will ensure that applicants understand the need to discuss the use of implementations such as simultaneous multithreading with their regulator prior to using them.

Proposed Text: We recommend the following should be added to the end of this paragraph:
… "Applicants should inform their regulator if they intend to use simultaneous multithreading, or similar implementations that are not covered by this [AMC]/[AC]".

response Noted

Thank you for your comment.

This text has been amended to briefly explain what simultaneous multithreading is. EASA considers that the fact that it is not covered in this document should make it clear that applicants should contact their authority if they wish to use it.

comment *54* comment by: *UK CAA*

Page No: 107

Paragraph No: 2.3, Bullet 1

Comment: The current EASA CRI contains some additional explanatory material related to why MCPs using lock-step mode are exempted. We believe it may help less experienced applicants if this material was included.

Justification: Adding this explanation would help less experienced applicants understand the reasoning behind this exemption, which will help them with their risk analyses.

Proposed Text: We recommend the following text should be added as a note:

"Lock-step processors with two or more activated cores in which the cores host the same software and execute that same software in lock-step so that their outputs, based on identical input data, can be compared for use in a safety-critical application. (An additional core is sometimes provided for input/output.) These lock-step processors are designed for safety-critical applications and to provide the determinism required, rather than the fast calculations and fast data transfers needed in servers or mobile devices, for which most MCPs are designed. The architectures of lock-step devices do not, therefore, contain features such as shared memory and shared cache that could cause interference. If interference did occur and caused one of the cores to produce a different result from the other(s) or to be delayed in its computations by time interference, these processors are designed to detect differences between the results produced by the cores, so any interference would be detected. The system could then be made safe or could continue to be available if three cores are used with a voting mechanism. For these reasons, this [AMC]/[AC] does not need to apply to lock-step processors that operate in the manner described above."

response

Partially accepted

Thank you for your comment.

EASA has modified the text to briefly explain what a lock-step processor is; however, EASA considered that it was no longer necessary to include the lengthy description that was previously included.

comment *59* comment by: *Safran Electronics and Defense*

2.1/ Unresolved section reference with text "Error! Reference source not found"

response

Accepted

Thank you for your comment.

The reference should read: 'Section 5.7 of this document'; it has been corrected.

comment *126* comment by: *FAA*

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment

28	AMC-20-193	107	2	Section Error! Reference source not found. of this document describes the objectives that apply according to the assigned IDAL (A, B, or C) of the hosted software or of the hardware item containing the MCP.	Reference source error. Errant paragraph mark in middle of word "apply".		Editorial	

response

Accepted

Thank you for your comment.

The reference should read: ‘Section 5.7 of this document’; it has been corrected.

comment

171 comment by: *General Aviation Manufacturers Association*

Section 2.2.1, First Paragraph

The paragraph states, “An assumption in this [AMC]/[AC] is that software applications are statically allocated to cores during the start-up of the MCP software, but not during the subsequent operation of the software.” The wording is confusing.

The wording of the sentence is not clear. It is assumed the intent is that applications are allocated to cores during start-up, and not allocated during the subsequent operation.

Change "but" to "and" in the sentence.

response

Not accepted

Thank you for your comment.

The word 'but' was deliberately used to show the contrast between the allocation of applications to cores during start-up and after it. The use of 'but' in this manner is normal and acceptable in English, so EASA does not consider it necessary or desirable to change the text.

See the Oxford English Dictionary meaning of 'but' at: https://www.lexico.com/definition/but, which says: 'conjunction used to introduce a phrase or clause contrasting with what has already been mentioned (e.g. 'he stumbled but didn't fall').

comment *175* comment by: *GE Aviation*

- 2.3 Exceptions: AMC just says "The activated cores are set up in lock-step mode" which seems an oversimplification of the long CAST-32A 5.3.i rationale paragraph on the same topic. Maybe AMC does not list rationales that CAST papers have to.

response

Partially accepted

Thank you for your comment.

A note has been added to briefly explain lock-step processors. EASA did not consider that this AMC/AC needed to explain the details of lock-step processors.

comment *213* comment by: *FAA*

Section 2.2.2 Simultaneous multithreading support within processors
This [AMC]/[AC] does not cover simultaneous multithreading~~., as industry and the authorities' knowledge and experience of such features are currently insufficient to provide [AMC]/[AC] guidance for their certification. This issue is not specific to MCPs.~~

Recommend deleting last part of text because it is not necessary to provide this explanation in an AMC/AC and there could be disagreement.

response

Noted

Thank you for your comment.

EASA has deleted the text about industry and the authorities' experience in this area, but have kept the last part to explain why it is not covered in this AMC/AC.

comment *232* comment by: *Airbus-Regulations-SRg*

	AMC 20-193 The use of Multi-Core processor PDF page 106, Item 2.1, 2nd section, last sentence: "The deactivation of cores is handled through the applicable Airborne Electronic Hardware (AEH) guidance" Airbus propose to add the following clarification to read as follows: "The deactivation of cores is handled through the applicable Airborne Electronic Hardware (AEH) guidance. *For this purpose the deactivation of cores may be handled in a similar manner as deactivation of unused functions*" Ratinale: This added sentence clarifies the link with the AEH considering deactivation of cores. For unused functions of the COTS device, it is recommended that an effective deactivation means is used and verified, when available. Here the words "recommended" and "when available" weakens the requirement, so that it does not become prescriptive. In addition we propose the wording "may be handled" not to have a fix requirement considering the link with the AEH. It should just serve as a guidance for interpretation.
response	Not accepted The text relating to this topic is in A(M)C 20-152A, and applicants should refer to that document. EASA does not wish to duplicate that text. Moreover, Section 2.1 is only the applicability section, so EASA does not consider that it is the proper place to introduce actual guidance.

comment	*233* comment by: *Airbus-Regulations-SRg* AMC 20-193 The use of Multi-Core processor PDF page 108, Item 2.3 - Exceptions, *last* sentence: "[…] The objectives of this [AMC]/[AC] apply to the interactions between all the other activated cores of an MCP." Airbus proposal: To move this sentence at the end of item 2.1 for a better understanding and consistency. Rationale: This sentence is bringing confusion if positioned at the end of item 2.3
response	Not accepted Thank you for your comment. The sentence that you mentioned was deliberately placed where it is, and EASA considers that it is correct there. The exceptions in the middle of that paragraph give examples of cores to which the AMC/AC does not apply because they do not produce the kinds of interference referred to in this AMC/AC. Some of those cores could be resident on the same processor as other cores that can interfere with each other. Then the text that you questioned is necessary in the place where it is to point out

that the objectives of the AMC/AC apply to the interactions between all the other activated cores.

[AMC 20-193 The Use of Multi-Core Processors] | [AC 20-193 Use of Multi-Core Processors] — 3. BACKGROU p. 108

comment *176* comment by: *GE Aviation*

- MCP_Software_1 – Given the complexities and especially the unknowns involved with the proprietary internal mechanisms of an MCP, is it truly sufficient for an 'MCP platforms with robust partitioning' to only "verify software applications separately and determine their WCETs separately", and not verify and measure the entire final configuration as a whole? Given the unknowns surrounding the MCP, it would seem that "WCET should be determined by analysis and confirmed by test on the target MCP with all the software components executing in the intended final configuration" as is the case for MCPs without robust partitioning.

response Noted

Thank you for your comment.

The separate verification of an application and the determination of its WCET would only apply if the applicant has demonstrated that their MCP platform provides robust partitioning, as defined in the AMC/AC. This separate verification would be analogous to what is already allowed for each application on a single-core processor platform that is an IMA and, therefore, has robust partitioning, because the interference between the applications has been proven to have been sufficiently mitigated.

However, even so, the overall objective of the text in the first paragraph of the objective still has to be met, so even when the functional and WCET aspects of each application have been verified, the applicant still has to be able to show that all the hosted software components 'have sufficient time to complete their execution when all the hosted software and hardware of the MCP is executing in the intended final configuration'.

[AMC 20-193 The Use of Multi-Core Processors] | [AC 20-193 Use of Multi-Core Processors] — 4. DEFINITIO p. 108-110

comment *3* comment by: *Liem Vo Quang*

1. Missing definition of "Bare Metal Multi Processing" architecture (considered as AMP?) and "prequalified configuration" of MCP, which can also be usefull for understanding of this A(M)C-20-193.
2. Safety net definition has been provided in this section but guidance for safety net (objectives & activities) found in this document are not enough for planning, development & design and certification of avionic system with safety net.

response

Not accepted

Thank you for your comment.

1. The term 'bare-metal multi processing' has never been used in the AMC/AC, so EASA did not include it in the definitions.

2. More detail about safety nets was included in earlier versions of the MCP guidance, but that text mostly repeated descriptions that can be found in FAA reports on safety nets. As a general principle, EASA has tried to avoid duplicating the text of other documents, so EASA removed the text that was a duplication of other documents.

comment

5 comment by: *Rapita Systems*

Modify the definition of "Robust time partitioning (on an MCP)" (additions in **bold**, deletions ~~struck through~~):

this is achieved when, as a result of mitigating the time interference between partitions hosted on different cores, **each** ~~no~~ software partition **meets its critical deadlines within** ~~consumes more than~~ its allocation of execution time on the core(s) on which it executes, irrespective of whether partitions are executing on none of the other active cores or on all of the other active cores.

Justification: The current wording in this definition could be misinterpreted to mean that the partition simply is scheduled for a given time slot on a core. The change makes it clear that the allocation of time must be sufficient to meet requirements, in particular the Worst Case Execution Time (WCET) must still be within the system requirements as quantified in critical deadlines.

response

Not accepted

Thank you for your comment.

The current definition of 'robust partitioning' talks about the allocation of execution time of an application, i.e. the amount of time that the application has to execute. It does not say anything about any given time slot or being scheduled for a given time slot on a core, and EASA does not think it is likely to be misinterpreted in the way you described. EASA does not, therefore, agree with your comment, and does not consider it necessary to amend the text in this respect.

comment

55 comment by: *UK CAA*

Page No: 108

Paragraph No: 4 - Definitions

Comment: The EASA CRI has a definition of Critical Configuration Settings which is very useful.
It would help less experienced applicants if that definition was included.
Justification: This will help less experienced applicants deal with a critical aspect of MCP management.

Proposed Text: We recommend a definition of Critical Configuration Settings in the list of definitions should be included, e.g:

"Critical Configuration Settings: those configuration settings that the applicant has determined to be necessary for the deterministic execution of the software or any settings that, if inadvertently altered, could change the behaviour of the processor so as to cause the hosted software to no longer comply with its requirements."

response

Noted

Thank you for your comment.

The term 'critical configuration settings' is no longer used in the AMC/AC, so EASA no longer defines that term. This issue is now dealt with in A(M)C 20-152A, which defines this term.

Instead, Section 5.2 states: 'In the context of MCPs, some of the configuration settings are especially relevant to the MCP hardware and software architectures', and it then gives examples of those so that the reader can understand which settings are particularly important.

comment *174* comment by: *GE Aviation*

- Section 4- IMA Definition: "Integrated Modular Avionics (IMA) platform: an integrated modular avionics MCP platform that provides both robust resource partitioning and robust time partitioning (as defined in this document)." IMA definition uses IMA in the definition. Is this trying to state that when referencing IMA in this doc in only means a robustly partitioned IMA?
- Robust Time Partitioning definition – change "irrespective of whether partitions are executing on none of the other active cores or on all of the other active cores." to "irrespective of whether partitions are executing on none of the other active cores or on one or more of the other active cores."

response

Partially accepted

Thank you for your comment.

- IMA definition: EASA has amended the definition to state that in the context of this AMC/AC, an IMA platform is one that is based on an MCP and provides robust partitioning in terms of the definitions of the AMC/AC (which are different from the definitions in other documents).

- EASA has amended the text so that it now reads: 'are executing on none of the other active cores or on one, more than one, or all of the other active cores'.

This includes your suggestion of 'one or more'.

[AMC 20-193 The Use of Multi-Core Processors] | [AC 20-193 Use of Multi-Core Processors] — 5. MULTI-CORE PROCESSOR GUIDAN p. 110-118

comment *4* comment by: *Liem Vo Quang*

	1. Objective MCP_Planning_2, page 112, item 4.: "*Identify the aspects of the use of the MCP that may require a safety net ...*" => The following considerations should be usefull for planning activity: "the aspects of the use of MCP that may have adversely affects for system/equipment function that may require a safety net mitigations not only at MCP level, but also at CBA level, equipment level and aircraft level if necessary. 2. Objective *MCP_Planning_2*, page 112, Notes a) last line of the text block: please provide example for "*... shared interconnect*" e.g. on-chip multi masters bus matrix, on-chip multi-clusters interconnects, corenet fabric ... to help the applicant understanding for this issue. 3. Section §5.2 *Setting of MCP resources* page 112, 4th dash ("-") items: please provide considerations for the following - partly usage of activated peripheral - non-deactivable functional part of peripheral, which all function of the peripheral have to be activated even partly use of this function e.g. ethernet functions" 4. Section §5.3 sub-section *MCP_resource_Usage_3* page 114, Notes item b): The description "*If the applicant identifies interference channels that **cannot affect** the software* ..." => Does it means that the interference channels that have **non-significant (neglegible impact) affect** should also have mitigation and verification? Please confirm or clarify. 5. Section §5.4 sub-section *MCP-Software_1*, page 115: The description "...*have sufficient time to complete their execution **when all the hosted software and hardware** of the MCP is executing in the intended final configuration*" => ***all the hosted software*** is ambiguous in this context, because the timing intererences that contribute to WCET may exist under **analysed WCET scenario (WCET Analysis Results)**, which must not execute all SW components but those components are runing only in worst case functional paths. Please clarify or precise the description. 6. Section §5.5 sub-section *MCP_Error_Handling_1*, page 117: The description "... *These means may include a 'safety net' independent from the MCP*." => Please provide additional guidance or reference to EASA paper for "safety net". 7. Section §5.7, page 118, table row "*MCP_Resource_Usage_2*" The table stated that it is **n/a** whereas in §5.2 sub-section *MCP_Resource_Usage_2* stated that **this objective is covered by A(M)C 20-152A objective COTS 8**. => please clarify for consistency
response	Partially accepted Thank you for your comments. 1. The text that you suggested may be useful in some situations; however, EASA does not consider it necessary to include it in the AMC/AC.

2. Section 5.3 mentions: 'many MCPs include an "interconnect"/ "coherency fabric", through which the demands for MCP resources, e.g. from the software applications hosted on the MCP, are [channelled]/[channeled] and the demands are arbitrated'.

EASA considers that this is sufficient additional explanation of a term that is widely used and has caused no confusion to users of the existing guidance.

3. Partial use of an activated peripheral device is a possibility, but EASA thinks it is too detailed for this AMC/AC. If part of a peripheral is always active, then the applicant should declare that peripheral as active in the answer to bullet 4 anyway.

4. EASA considers that it is for the applicant to decide whether an interference channel that does contribute some interference needs to be mitigated. This item confirms that channels that do not cause interference do not need to be mitigated, and does not address channels that only contribute small amounts of interference.

5. EASA considers that 'all the hosted software and hardware of the MCP is executing in the intended final configuration' is clear enough, as it is obvious that not every single software component is executing simultaneously. It is for the applicant to determine which are the worst-case situations for the determination of the WCET.

6. Details of some FAA safety net research papers were provided in earlier versions of the MCP guidance, but were removed from the AMC/AC draft, as they were no longer considered necessary, and EASA wanted to avoid duplication of data available in other documents.

7. EASA has changed the applicability per DAL of this objective. It now shows 'n/a' for DAL C, and 'Covered by [AMC]/[AC] 20-152A objective COTS-8' for DALs A and B. This reflects the applicability of the objective shown in A(M)C 20-152A.

comment *6* comment by: *Rapita Systems*

In section 5.7 "Applicability of the MCP objectives according to their IDALs", indicate which objectives should be verified with independence under the column "IDAL A or B" by adding the symbol "(i)" in the corresponding cell and adding a note after the table: "Objectives marked '(i)' must be verified with independence." We recommend the following objectives be verified with independence:
.

- MCP_Planning_2
- MCP_Resource_Usage_2
- MCP_Resource_Usage_3
- MCP_Resource_Usage_4
- MCP_Software_1
- MCP_Software_2
- MCP_Error_Handling_1

Justification: To align with DO-178C/ED-12C, objectives that require verification with independence should be clearly identified.

response Partially accepted

Thank you for your comment.

While EASA understands your suggestion, the MCP guidance that has been in use successfully for several years did not consider the independence aspect, and no applicants have ever requested clarification of this — so EASA, the FAA and industry did not consider it when producing this AMC/AC. EASA suggests that each applicant should apply independence as they consider it to be necessary in the context of their project. EASA may consider that aspect in any future update of this AMC/AC.

CREATE ALTERNATIVE AS WELL:

EASA has considered your useful suggestion, and has amended the table in Section 5.7 to show that objectives:

MCP_Resource_Usage_3,
MCP_Resource_Usage_4,
MCP_Software_1, and
MCP_Software_2

should be met with independence.

comment *56* comment by: *UK CAA*

Page No: 116

Paragraph No: 5.4, (1st bullet on page 116) `MCP Platforms with Robust Partitioning'

Comment: It may be helpful to less experienced applicants to include a note to the effect that:

any subsequent modification will need demonstrate that robust partitioning has not been compromised

or, if that can't be done,

the impact analysis associated with the modification will need to include the additional, target based verification that wasn't performed during the initial approval.

Justification: This will help less experienced applicants to avoid unexpected increases in the work associated with future modifications.

Proposed Text: As above.

response Noted

Thank you for your comment.

While EASA understands your point, the AMC/AC does not cover any extra considerations regarding modifications to MCP platforms, or the impact analyses that may be conducted during modifications. Those will be dealt with under the existing system, software and AEH guidance and the processes for modifications. If an applicant claims credit for robust partitioning, then they will have to demonstrate that the robust partitioning is still present after any modification, whether or not EASA includes your suggested text.

comment	*57* comment by: *UK CAA* **Page No:** 118 **Paragraph No:** 5.7, MCP Objectives Table – MCP Objective "**MCP_Resource_Usage_2"** **Comment:** There is a typographical error in the "IDAL A or B" Column. It currently reads "n/a", we believe it should read "Yes". **Justification:** Correction of objective applicability. **Proposed Text:** Amend "n/a" to read "Yes".
response	Accepted Thank you for your comment. EASA has changed the applicability per DAL of this objective. It now shows 'n/a' for DAL C, and 'Covered by [AMC]/[AC] 20-152A objective COTS-8' for DALs A and B. This reflects the applicability of the objective shown in A(M)C 20-152A.

comment	*60* comment by: *Safran Electronics and Defense* MCP_Resource_Usage_2: AMC/AC 20-193 is applicable to DAL A,B & C, however, objective MCP_Resource_Usage_2 references AMC/AC 20-152A objective COTS-8 which is applicable only if the "COTS devices contributes to DAL A or B functions". The reviewers expectation is 20-193 does not extend objective COTS-8 scope to DAL C, however, that is not clear (see 5.7 chapter).
response	Accepted Thank you for your comment. EASA has changed the applicability per DAL of this objective. It now shows 'n/a' for DAL C, and 'Covered by [AMC]/[AC] 20-152A objective COTS-8' for DALs A and B. This reflects the applicability of the objective shown in A(M)C 20-152A.

comment	*61* comment by: *Safran Electronics and Defense* MCP_Resource_Usage_2: Applicability of "MCP_Resource_Usage_2" is "n/a" for IDAL A & B and IDAL C which does not help clarify the concern in 5.2 (COTS-8 is applicable only for DAL A & B devices).
response	Accepted Thank you for your comment. EASA has changed the applicability per DAL of this objective. It now shows 'n/a' for DAL C, and 'Covered by [AMC]/[AC] 20-152A objective COTS-8' for DALs A and B. This reflects the applicability of the objective shown in A(M)C 20-152A.

comment	*62* comment by: *Safran Electronics and Defense* MCP_Software_1 At the time of this comment WCET determination for MCPs by analysis is not practical - testing is more valuable as noted in section 5.4 paragraph 4, however, the WCET guidance for "All other MCP platforms" includes the text "... otherwise, the WCET should be determined by analysis and confirmed by test on the target MCP ..." rather than stating "... otherwise, the WCET should be determined and confirmed on the target MCP ...".
response	Noted Thank you for your comment. If it is not possible to determine the WCET by analysis, due to the difficulties that you pointed out, then the WCET still has to be confirmed on the target MCP with all the software components executing in the intended final configuration.

comment	*172* comment by: *General Aviation Manufacturers Association* Section 5.1, Objective MCP_Planning_1, item 5 Item 5 of MCP_Planning_1 states, “Identify whether or not the MCP will be used to host software applications from more than one system, and whether it will be used in an integrated modular avionics (IMA) platform.” This item creates two things to identify where CAST 32A had only one- “Identify whether or not the MCP device will be used in an IMA platform to host software applications from more than one system.” We cannot identify any objective that is directly affected by this new information. CAST 32A specifies identification when MCP is used in an IMA platform, while AMC 20-193 adds identification of MCP used to host software applications from more than one system, whether in an IMA platform or not. We suggest a change to use the CAST 32A meaning- “Identify whether or not the MCP will be used in an integrated modular avionics (IMA) platform to host software applications from more than one system.”
response	Noted Thank you for your comment. During discussions with industry while revising the existing MCP guidance to produce this AMC/AC, industry insisted that EASA should make a distinction between applicants that provide robust partitioning, which would allow applications from more than one system to be hosted, and applicants that wish to take credit for their platform being an IMA platform, and can therefore host applications from more than one system. As a result, it was necessary to ask both whether applications from more than one system would be hosted, and whether the MCP will be used in an IMA platform.

comment *173* comment by: *GE Aviation*

- Section 5.2, Objective MCP_Planning_2 (b) – change “deactivating one or more cores” to “activating or deactivating one or more cores”
- Section 5.2 - “the priorities and allocation of shared interconnect,“ is new in regard to CAST-32A. Probably not a concern because it was understood before (MCFA as well as targeted IP supplier meetings are needed to understand this fully)
- Section 5.3, fourth paragraph – reword “Moreover, the complexity of the MCP, executing tasks in parallel and the interference could lead to the demands for resources exceeding the available resources.” to “Moreover, tasks executing in parallel on the MCP and the resulting interference could lead to the demands for resources exceeding the available resources.”
- Section 5.3, Interferences channels and resource usage: First paragraph seems to paraphrase last paragraph on document page 111. Opportunity for simplification
- Section 5.4, fourth paragraph – change “Interference and interactions between software applications or tasks occur via the proprietary internal mechanisms of an MCP.” to “Interference and interactions between software applications or tasks may occur via the proprietary internal mechanisms of an MCP.”
- Section 5.5, MCP_Error_Handling_1: “fail-safe” is undefined (Not defined in CAST-32A either)
- Section 5.7, Applicability of the MCP objectives according to their IDALs (2 comments): (1) MCP_Resource_Usage_2 shows “N/A” for IDAL A or B and “N/A” for IDAL C while CAST-32A shows “Yes” and “No” respectively. This needs to be reconciled. Note that N/A in both category would mean that MCP_Resource_Usage_2 should completely be removed since per this AMC (and CAST-32A) the proposed MCP guidance applies to neither IDAL D nor IDAL E. (2) MCP_Resource_Usage_2 shows “Refer to NOTE d”. Unlike CAST-32A, the IDAL table in AMC does not recall the MCP objectives and related notes. Therefore, the text should be clarified to say “Refer to section 5.3, NOTE d”

response Not accepted

Thank you for your comments.

- The text refers to deactivating one or more cores because that is one of the energy-saving features. Activating a core would use more energy, so EASA has not added that to the text.

- Noted

- EASA has not changed the text, as it still considers that the complexity of the MCP is a consideration here.

- EASA has generally attempted to eliminate any duplication in the text; however, in this case, EASA considered it useful to mention certain aspects of these considerations in both places in the text, using different wording.

- The interference and interactions between software applications do occur via the proprietary internal mechanisms of the MCP. If EASA introduced ‘may occur’, as you

suggested, that would imply that they could occur in some other manner, which would probably lead to further questions and more uncertainty.

- The term 'fail-safe' has been in widespread use in both the US and Europe since FAA AC 25-1309 was published in 1988, so it was not considered necessary to explain the term.

- EASA has changed the applicability per DAL of this objective. It now shows 'n/a' for DAL C, and 'Covered by [AMC]/[AC] 20-152A objective COTS-8' for DALs A and B. This reflects the applicability of the objective shown in A(M)C 20-152A.

comment *214* comment by: *FAA*

5.1. Planning
Objective MCP_Planning_1
…
7. Identify the methods and tools to be used to develop and verify all the individual software components hosted on the MCP so as to meet the objectives of this document and ~~comply with~~ the applicable software guidance, including any methods or tools needed due to the use of an MCP or the selected MCP architecture.

"Comply" should only be used in reference to the airworthiness regulations. The term "comply with" could be deleted without changing the meaning of the objective.

response Accepted

Thank you for your comment.

The text has been modified as you suggested.

comment *216* comment by: *FAA*

5.4. Software verification
MCP_Software_1:
The applicant has verified that all the software components hosted by the MCP ~~comply with~~ meet the objectives of the applicable software guidance. In particular, the applicant has verified that all the hosted software components function correctly and have sufficient time to complete their execution when all the hosted software and hardware of the MCP is executing in the intended final configuration.

"Comply" should only be used in reference to the airworthiness regulations. The term "comply with" could be replaced with "meet the objectives of" without changing the meaning of the objective and to be consistent with the wording in section 5.1.

response Accepted

Thank you for your comment.

The text has been modified as you suggested.

comment *234* comment by: *Airbus-Regulations-SRg*

	AMC 20-193 The use of Multi-Core processor PDF page 115, Item 5.4 - Software verification, section "MCP_Software_1" Airbus proposal: Airbus propose to add the word "representative" before hardware to read as follows: "*The applicant has verified that all the software components hosted by the MCP comply with the applicable* *software guidance. In particular, the applicant has verified that all the hosted software components function* *correctly and have sufficient time to complete their execution when all the hosted software and* ***representative*** *hardware* *of the MCP is executing in the intended final configuration"* Rationale: We should open the doors of using simulators for which representativeness vs real hardware can be demonstrated.
response	Not accepted Thank you for your comment. The text just before objective MCP_Software_1 states: 'Interference and interactions between software applications or tasks occur via the proprietary internal mechanisms of an MCP. Any simulation of those mechanisms is therefore less likely to be representative in terms of functionality or execution time than testing conducted on the target MCP in the intended final configuration, and thus is less likely to detect errors.' EASA, therefore, considers that it is advisable for applicants to execute their software on the target MCP. However, EASA would like to point out that the objective uses the words 'has verified' rather than 'has tested'. Applicants may, therefore, conduct this verification in whichever manner they consider most appropriate, providing that the authority agrees with the method proposed and its validity.

comment	*235* comment by: *Airbus-Regulations-SRg* AMC 20-193 The use of Multi-Core processor PDF page 116, Item 5.4 - Software verification, section "Objective MCP_Software_1": >>Note e)<< Airbus comment to Note e), quote: "*Interference may occur between tasks of a single component when the tasks execute* *on different cores*" - unquote Airbus agrees that interference may occur between tasks. However, we understand that the compliance to this objective should be performed at application level. Rationale: EASA clarification for better understanding is required.
response	Noted

Thank you for your comment.

The text of Note e) that you mentioned was added in response to a specific request from a particular applicant in industry, who insisted that a software component could, in some particular cases, have tasks on more than one core, and insisted on the note being added.

Note e) merely explains what the applicant requested, and does not alter the text of objective MCP_Software_1 or the way in which verification should be conducted.

3. Appendix — Attachments

GAMA20-64 Comment Response to EASA NPA 202-09_2020December23rd_final.pdf
Attachment #1 to comment #63

Industry Feedback to CATA Closed Decision Papers_20201117.pdf