European Aviation Safety Agency

COMMENT RESPONSE DOCUMENT (CRD)
TO NOTICE OF PROPOSED AMENDMENT (NPA) 2012-11

amending Decision No. 2003/12/RM of the Executive Director of the European Aviation Safety Agency of 5 November 2003 on Acceptable Means of Compliance for airworthiness of Products, Parts and Appliances
(« AMC-20 »)

'Recognition of ED-12C/DO-178C in EASA AMC 20-115
(Software Considerations for Airborne Systems and Equipment Certification)'

and
'Certification of Aircraft Propulsion Systems Equipped with Electronic Controls'
(AMC 20-1)

and
'Certification of Essential APUs Equipped with Electronic Controls'
(AMC 20-2)

and
'Certification of Engines Equipped with Electronic Engine Control Systems'
(AMC 20-3)

and
'Airworthiness Approval and Operational Criteria For the Use of Navigation Systems in European Airspace Designated For Basic RNAV Operations'
(AMC 20-4)

and

'Airworthiness Approval and Operational Criteria for RNP

APPROACH (RNP APCH) Operations Including APV BAROVNAV'

(AMC 20-27)

EXECUTIVE SUMMARY

The scope of this rulemaking activity, as outlined in ToR RMT.0462, is to upgrade a number of AMCs following upgrade of EUROCAE document ED-12 from version 'B' to version 'C' and parallel upgrade of RTCA DO-178.

Although software matters, in the current mandate of the Agency, cover several subjects, much beyond the safety considerations for software hosted in airborne systems and equipment during related initial airworthiness processes, only the latter were in the scope of NPA 2012-11, which proposed amendments to the following Acceptable Means of Compliance (AMC) for airworthiness approval (i.e. series of AMC 20-XX):

- AMC 20-115 on software considerations for airborne systems and equipment;

- AMC 20-1 on certification of aircraft propulsion systems equipped with electronic controls;

- AMC 20-2 on certification of essential APU equipped with electronic controls;

- AMC 20-3 on certification of engines equipped with electronic engine control systems;

- AMC 20-4 on airworthiness approval and operational criteria for use of navigation systems in European airspace designated for basic RNAV operations; and

- AMC 20-27 on airworthiness approval and operational criteria for RNP APPROACH (RNP APCH) operations including APV BARO-VNAV operations.

References to ED-12B and RTCA DO-178B had already been removed from CS-25 through amendment 12 published on 6 July 2012.

CS-ETSO will be updated through RMT.0206 (ETSO.011) planned to be initiated in 2013.

Based on the 122 comments received from 19 commentators and the individual responses to each of them, as contained in present CRD, the Agency concludes that:

- no stakeholder objected that option 2 (i.e. publish AMC 20-115C containing no more than five pages) preferred on the basis of the RIA, would be the way forward;

- in principle stakeholders agreed to recognise latest edition of EUROCAE Document ED-12C and associated material for software development, through issuing new edition C of AMC 20-115, however, asking for proper transition, including applicability of previous industry standards to changes to existing approved software;

- stakeholders also agreed that AMC 20-2, 20-3, 20-24 and 20-27 should be modified to refer to AMC 20-115C for software matters;

- the Agency therefore intends to adopt the proposed amendments to five mentioned AMCs in the revised text attached to this CRD;

- on the contrary, as advised by stakeholders, the Agency acknowledges that it is not necessary to amend AMC 20-1.

In addition, the Agency to may issue in the future an NPA to remove mention of specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

The resulting text of the proposed draft AMCs is contained in Appendices A to E.

After two months given to stakeholders to react to this CRD if their comments were misinterpreted or not fairly taken into account, the Agency intends to progress towards the adoption and publication of the said five AMCs, after the Decision of the Executive Director.

Explanatory Note

I. General

1. The purpose of the Notice of Proposed Amendment (NPA) 2012-11, dated 22 August 2012 was to propose amending Decision 2003/12/RM of the Executive Director of 05 November 2003[1] to replace AMC 20-115B (recognition of EUROCAE ED-12B/RTCA-178B) by the new version AMC 20-115C. The revised AMC recognises edition 'C' of EUROCAE/RTCA documents ED-12/DO-178 concerning 'Software Considerations in Airborne Systems and Equipment Certification'. In addition also other Agency's AMCs were proposed for alignement with the mentioned recent industry standards.

II. Consultation

2. The draft Executive Director Decision amending Decision 2003/12/RM of the Executive Director of 05 November 2003 was published on the web site (http://www.easa.europa.eu) on 22 August 2012.

3. By the closing date of 22 November 2012, the European Aviation Safety Agency ('the Agency') had received 122 comments from 5 National Aviation Authorities, FAA and professional organisations and private companies.

III. Publication of the CRD

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

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

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

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

5. The Executive Director Decision on new edition C of AMC 20-115 and revision of AMC 20-2, 20-3, 20-4 and 20-27 will be issued at least two months after the publication of this CRD to allow for any possible reactions of stakeholders regarding possible misunderstandings of the comments received and answers provided.

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[1] Decision No. 2003/12/RM of the Executive Director of the European Aviation Safety Agency of 5 November 2003 on Acceptable Means of Compliance for airworthiness of Products, Parts and Appliances (« AMC-20 »). Decision as last amended by Decision 2011/001/R of the Executive Director of the Agency of 30 March 2011.

6.   Such reactions should be received by the Agency not later than 13 May 2013 and should be submitted using the Comment-Response Tool at http://hub.easa.europa.eu/crt.

IV. CRD table of comments, responses and resulting text

(General Comments)	-

comment	*15*	comment by: *THALES Avionics*

THALES Avionics is very concerned by the introduction of the new version C of the AMC 20-115. Indeed, this AMC introduces not only the industrial standard ED-12C but also guidance for the use of previous versions of ED-12 for changes to pre-existing software. Due to the potential negative impact on industry that could have any differences between the final EASA AMC and FAA AC, THALES Avionics is very keen that EASA and FAA succeed in achieving a full harmonization on AMC/AC 20-115C.
As FAA plan to issue its NPRM for consultation by first quarter 2013, THALES Avionics consider that all the comments from the two EASA and FAA consultations should be available before finalizing both AMC and AC.
In addition, due to the importance of the subject, THALES Avionics suggest that EASA and FAA organize a technical workshop with industry once they get all the comments from the consultations before proceeding to CRD and final rules.

response Noted

Please refer to answer to comment 79.

comment	*63*	comment by: *UK CAA*

Please be advised that the UK CAA do not have any comments on NPA 2012-11, Recognition of ED-12C/DO-178C in EASA AMC 20-115 (Software Considerations for Airborne Systems and Equipment Certification).

response Noted

Support is noted with appreciation.

comment	*79*	comment by: *FAA*

Comment: The FAA requests that EASA postpone finalizing the NPA documents in order to allow adequate time for harmonization among authorities. The FAA has not had the opportunity to circulate its draft AC 20-115C to the general public and obtain comments critical to understanding the full impact of transition to DO-178C/ED-12C. Since EASA and FAA applicants participate in a worldwide marketplace, it is imperative that all certification authorities be harmonized in our guidance for software assurance.

response | Noted

Indeed harmonising with the FAA and other authorities around the globe is a constant process in the Agency. On 12 February 2013, there was a bilateral teleconference between EASA and FAA at expert level, where the harmonisation issue was further discussed. The teleconference generally considered that:

- the term 'harmonisation', although reflecting processes which are common practice, might not be appropriate in regulatory material;
- FAA and Agency concurred to eliminate words like 'harmonised' from the proposed text of AMC 20-115C;
- of course the harmonisation/coordination process does not mean that the Agency's AMC and other authorities equivalent guidance should be line by line identical. Indeed the EU/USA Bilateral Agreement and related Technical Implementation Procedure (TIP) have the goal to ensure this process of regulatory cooperation and harmonisation but the respective legal orders and procedures are different and, therefore, while any effort is devoted to technical harmonisation and coordination, the timing of publication of various regulatory material, unfortunately almost never coincides;
- complementary guidance material is generally introduced by FAA Order, FAA policy Memo, EASA Certification Memo, etc. which also help to achieve better coordination.

More in particular the Agency has published proposed AMC 20-115C, understanding that also the FAA and other authorities intend to implement a similar upgrade. FAA has provided several comments to the NPA, as listed below. Most of these comments have been found valid and hence accepted.

The publication of AMC 20-115C cannot, however, be delayed since all the EUROCAE versions of the RTCA relevant documents were published at the end of 2011 (more than one year ago) and should be recognised as soon as possible. In fact all the EUROCAE documents have been already approved by industry in that forum, while, according to information available to the Agency, several manufacturers are waiting for AMC 20-115C and prepared to use it. Nonetheless, as this is in line with the general Agency's philosophy to introduce transition periods for the application of any new standard, the resulting text of the AMC 20-115C will become applicable on 01 January 2014 (even for ETSO articles).

In the area of the re-use or modification of software previously approved under ED-12A/DO-178A or ED-12B/DO-178B, the Agency has defined the high level conditions in the AMC 20-115C and will soon update its detailed policy contained in the Software Certification Memorandum (in harmonisation with the future FAA AC 20-115C when available). The Agency expects that in due time also the FAA would recognise all supplements associated to the ED-12C/DO-178C, including the ED218/DO-331 to ensure safety when Model Based Development techniques are used.

Once the FAA will have completed its rulemaking action, the Agency's and FAA

regulatory material on software would then be coordinated as far as practicable using if necessary the additional Agency guidance material (FAA Order, EASA Cert Memo, etc.) or even the Bilateral agreement and TIP.

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comment | *81*   comment by: *Luftfahrt-Bundesamt*

The LBA has no comments on NPA 2012-11.

response | Noted

Support is noted with appreciation.

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comment | *84*   comment by: *Dassault Aviation*

Several Dassault-Aviation general comments:

1- In relation with the sentence page #2   *"It is anticipated that the adoption of the proposed rules will lead to improved safety"*:
However safety is already ensured by using ED-12B/DO-178B. The reason for revising this guidance was the correction of some errors and inconsistencies as well as introducing new technologies. Level of safety is equivalent, there is no evidence that it will be improved by ED-12C/DO-178C.

2- In relation with Chapter V and section 8 of proposed AMC 20-115:
Additionally, the aim of this NPA and the changes in the AMC 20-115 is also to define the criteria for using ED-12C/DO-178C for *"pre-existing software"* *"under the conditions specified in part8 of the proposed AMC 20-115c".*
It is not understood why there is a need of defining new criteria through this NPA and section 8 of AMC 20-115C where the necessary criteria to re-open the initial certification basis are already provided in Part 21A.101.

3-For application to a new type certificate, the last regulations will apply to define its certification basis.
In the frame of a change, Part 21A.101 provides the guidance and its related criteria to determine if the certification basis has to be changed. Proposal in AMC 20-115C is inconsistent with Part 21A.101.

4-Therefore, AMC 20-115C should be confined to the strict introduction of ED-12C/DO-178C as it was done for AMC 20-115B.

response | Noted

1. Removing errors and inconsistencies from standards can slightly improve safety. In any case comment 84.1 does not lead to any change in the resulting text of AMC 20-115C.
2. Rule 21.A.101 establishes general principles, including the possibility of using later or earlier airworthiness codes in case of applications for changes to type certificates (TC). Of course Part 21 takes precedence

over any AMC. In any case the proposed AMC leaves the possibility of using alternative means of compliance. The fact that the proposed text of AMC 20-115C included (i.e. paragraph 6 of the text attached to the NPA and now paragraph 8 of resulting text) more guidance on the conditions under which the use of earlier versions of ED-12 can be accepted, does not contradict 21.A.101.

3. The guidance provided in paragraph 8 of the resulting text of AMC 20-115C is based on the principles in 21.A.101 and not inconsistent with it.

4. Agency believes that, due to the growing safety relevance of airborne software, some more guidance to potential applicants in the form of non-binding AMC may be useful.

comment	*91* comment by: *DGAC FRANCE*
	DGAC France has no adverse comments on this NPA.
response	Noted
	Support is noted with appreciation.

comment	*105* comment by: *Cessna Aircraft Company*
	Attachment #1
	Please see the attached file for Cessna Aircraft Company's comments.
response	Accepted
	In relation to comment n.1 in the attachment, the Agency recognises that in some particular cases the software can produce catastrophic results; therefore, the severity of occurrence should have been rated as ' catastrophic' . However, this does neither affect the content of the proposed AMC 20-115C, nor the conclusions of the Regulatory Impact Assessment, which will not be reissued.
	Comment 2 accepted and text changed accordingly.
	Comment 3 accepted and text changed accordingly.
	Comment 4 accepted and text changed accordingly.
	Comment 5 accepted and text changed accordingly.

comment	**126** comment by: *Rolls-Royce plc (ZM)*

The document frequently makes reference to AMC 20-115, without differentiating between 20-115A, 20-115B and 20-115C where appropriate - for instance the last paragraph of page 31 states "Software which is not developed using AMC 20-115 is referred to as legacy software". Previously it said "Software which is not developed using DO-178B is referred to as legacy software". These are not consistent.

Please review if each individual reference to AMC 20-115 in the entire document is appropriate

response	Accepted

The resulting text of AMC 20-115C does not mention any previous versions of same AMC. The resulting text of the other AMC 20-XX proposed for amendment now refers to the 'latest' edition of AMC 20-115. This will avoid the need for amending them, in case a new edition D of AMC 20-115 would emerge in the future.

comment	**127** comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

Embraer appreciates the opportunity to offer the following general comments:

Although the criteria to use ED-12C is defined, a roadmap for the transition to this new means of compliance could be addressed in this NPA. Most of the companies have to adequate their process to the guidance in ED-12C and a transition criteria would allow industry to anticipate problems and be prepared to show compliance using the new guidance.

response	Noted

Please refer to answer to comment 29.

Resulting text	**CONCLUSION ON GENERAL COMMENTS**

Nine general comments have been received on NPA 2012-11.
Some of them highlighted the need to coordinate with the FAA as much as possible. Indeed the Agency shares the purpose that the technical content of its provisions should be as close as possible to that of corresponding FAA material. In this case Agency expects that also the FAA will soon recognise the latest editions of RTCA Do related to airborne software. The procedures and timing for regulatory action are, however, different in the two authorities, while the Agency believes that publication of edition C of AMC 20-115 is urgent.

Several commentators stressed the need to allow the use of earlier versions of ED-12, in particular in relation to changes to existing TCs. The principle is

accepted by the Agency and reflected in paragraph 8 of the resulting text of AMC 20-115C.

No competent authority of any EU Member State raised general comments against recognition of ED-12C.

The resulting text of AMC 20-115C is presented in Appendix A.

EXECUTIVE SUMMARY   p. 2

| comment | *10* | comment by: *CAA-NL* |

Please be advised that the Netherlands has no comments to this NPA.

| response | Noted |

Support is noted with appreciation.

| comment | *19* | comment by: *AIRBUS* |

PROPOSED   TEXT   /   COMMENT:
Modify sentence: "It is anticipated that the adoption of the proposed rules will lead to improved safety without creating undue burden or other adverse effects such as the discontinuation of established and well-proven software DAL processes for software hosted in aircraft, engine or APU systems and equipment."

RATIONALE   /   REASON   /   JUSTIFICATION   for   the   Comment:
The objective of ED-12C has been declared as "continue to promote the safe implementation of aviation software". <u>Safety is already and satisfactorily ensured</u> using ED-12B/DO-178B and previous versions already covered by existing Certification Basis (through relevant CRI/IM). ED-12C/DO-178C purpose is not to improve ED-12B/DO-178B for safety purpose, but to extend the guidance to cover specific techniques such as Software Tool Qualification, Formal Methods, Object-Oriented Technology and Related Techniques, Model-based Development and Verification.

| response | Noted |

Please refer to answer to comment 92.

| comment | *20* | comment by: *FAA* |

Comment: Spelling error noted: "…activyty…".

Recommendation: Change to: "…activity…".

Justification: For correctness of spelling.

response	*Noted*
	Correct. Apologies for the spelling error in the Executive Summary. This, however, does not affect the content of the proposed AMC 20-115C.

comment	*21*	comment by: *FAA*

Comment: 5th paragraph (1st sentence), Use of the term "DAL" which is undefined.

Recommendation: Change to "ED-12C does not change the basic approach for software assurance in comparison to previous edition 'B' published in 1992."

Justification: The term "DAL" is not defined in the document.

response	Accepted
	Please refer to answer to comment 54.

comment	*22*	comment by: *FAA*

Comment**:** 5th paragraph, Even though ED-12C did not change significantly, the introduction of the other documents (Tool Qual, FM, MBD, OOTRT) does have a fairly significant impact on the software assurance process.

Recommendation: Include a description of how the other documents have impacted the basic ED-12B approach.

Justification: Completeness

response	Noted
	However, the Executive Summary in the NPA will not be reissued.

comment	*23*	comment by: *FAA*

Comment**:** 6th paragraph, This paragraph makes statements that have no factual or necessarily provable basis; for example, it says: "…proposed rules will lead to improved safety without creating undue burden…".

Recommendation: Delete this paragraph.

Justification: There is nothing that supports the "improved safety" statement; in addition, the impact of changing long established routines could negatively impact safety for some time. Merely updating to DO-178C/ED-12C will create some level of burden on Applicants; whether it is "undue" or not is surely an arguable point.

response | Noted

Please refer answer to comment 92.

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comment | *92*   comment by: *Eurocopter*

"*It is anticipated that the adoption of the proposed rules will lead to improved safety …*"

This statement is not in line with ToR RMT.0462 (which state as an objective of ED-12C to "*continue to promote the safe implementation of aviation software*").

Safety is already ensured using ED-12B/DO-178B. ED-12C/DO-178C purpose is not to improve ED-12B/DO-178B for safety purpose, but to stick to recent issues in the SW development methodology, as highlighted by the summary given in item 33, page 9, of present NPA.

We suggest revising this sentence, to align it with the objectives identified in the ToR. We also suggest not using the term "rule", which is not suited to an AMC.

response | Noted

For correctness, the sentence should have been aligned with the objective identified in the ToR. However, this does not affect the content of the proposed AMC 20-115C.

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comment | *112*   comment by: *Rolls-Royce plc (ZM)*

Typopgraphical error "Activyty"

response | Noted

Correct. Apologies for the typographical error in the Executive Summary. This, however, does not affect the content of the proposed AMC 20-115C.

Resulting | **CONCLUSION TO COMMENTS ON EXECUTIVE SUMMARY**

text	

Eight comments have been received on the Executive Summary.

Most of them were reasonable, but they do not affect the draft text of AMC 20-115C. They have been noted.

One comment, which has been accepted, proposed to no longer refer to DAL but to 'software level' as in ED-12C.

The resulting text of AMC 20-115C is presented in Appendix A.

text

A. Explanatory Note - I. General   p. 4

comment | *24*   comment by: *FAA*

Comment**:** Paragraph A.I.7., Use of the obsolete name of "American Radio Technical Commission for Aeronautics (RTCA)" should be corrected.

Recommendation: Change "American Radio Technical Commission for Aeronautics (RTCA)" to "RTCA, Inc."

Justification: Correctness.

response | Noted

Correct. Apologies for the use of the obsolete spelling if RTCA Inc. in the Explanatory Note. This, however, does not affect the content of the proposed AMC 20-115C.

Resulting text |

CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-I. GENERAL

One comment was received on this segment of the NPA. However, This comment did not affect the text of proposed AMC 20-115C

A. Explanatory Note - IV. Content of the draft Decision   p. 5-7

comment | *25*   comment by: *FAA*

Comment**:** Paragraph 18, Typographical error noted: "…aircraft operators of by…".

Recommendation: Change to: "…aircraft operators or by…".

Justification: Correctness

response | Noted

Correct. Apologies for the typographical error in the Explanatory Note. This,

however, does not affect the content of the proposed NPA 2012-11.

comment | *26*   comment by: *FAA*

Comment: Paragraph 18, Error in use of parentheses: "…(either by aircraft operators or by Air Navigation Service Providers (ANSPs)…".

Recommendation: Change to: "…(either by aircraft operators or by Air Navigation Service Providers (ANSPs))…".

Justification: For correct use of parentheses

response | Noted

Correct. Apologies for the typographical error in the Explanatory Note. This, however, does not affect the content of the proposed NPA 2012-11.

Resulting text | **CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-IV.CONTENT OF THE DRAFT DECISION**

Two comments highlighting typographical errors where received on this segment of the NPA. None of these comments affected the resulting text of AMC 20-115C.

A. Explanatory Note - IV. Content of the draft Decision - Background of document ED-12C   p. 7-9

comment | *27*   comment by: *FAA*

Comment: Paragraph A.IV.31., Does not mention the other documents produced by the cooperative efforts of SC-205 and WG-71, i.e., Tool Qual, FM, MBD, OOTRT.

Recommendation: Add other ED document numbers produced by the joint committee: ED-215, ED-216, ED-217, ED-218.

Justification: Missing references

response	Noted
	Correct. However, the Explanatory Note of the NPA will not be reissued.

Resulting text	**CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-IV. CONTENT OF THE DRAFT DECISION-BACKGROUND OF DOCUMENT ED-12C**
	Only one comment was received on this segment of the NPA. However this comment did not affect the resulting text of AMC 20-115C.

A. Explanatory Note - IV. Content of the draft Decision - Summary of differences between ED-12C and ED-12B	p. 9-10

comment	*28* comment by: *FAA*
	Comment**:** Paragraph 34-35, This section incorrectly identifies and includes ED-94C and ED-215 as "supplements". ED-94C is not considered guidance, and ED-215 is not a supplement.

	Recommendation:
	Change "supplements" to "documents and supplements";
	Change heading to "Supplements to ED-12C and Related Documents";
	Remove ED-94C and ED-215 from listing of supplements and add below listing of supplements:
	    Related documents are:
	    ED-94C "Supporting Information for ED-12C and ED-109A";
	    ED-215 "Software Tool Qualification Considerations".

	Justification: For correctness.
response	Accepted
	References to ED-94C and ED-215 are corrected in the resulting text of AMC 20-115C as proposed by the FAA.

Resulting text	**CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-IV. CONTENT OF THE DRAFT DECISION-SUMMARY OF DIFFERENCES BETWEEN ED-12C AND ED-12B**

One comment requesting correctness of references to ED/RTCA documents was received on this segment of the NPA. The comment has been accepted.

The resulting text of AMC 20-115C is presented in Appendix A.

A. Explanatory Note - IV. Content of the draft Decision - Envisaged changes to CS-ETSO   p. 11

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comment | *29*   comment by: *FAA*

Comment**:** Paragraph 38, It is not clear if the point of the first bullet is to globally change ETSO MPS to require ED-12C and it is not clear if the point of the second bullet is to change individual ETSOs to require ED-12C.

If the intent is to require ED-12C/DO-178C for new or existing ETSOs, this may cause a hardship for ETSO applicants who have an existing ED-12B/DO-178B process and articles developed to those processes, especially for articles that will be using components developed to the previous standard. A transition period to ED-12C/DO-178C should be considered.

Recommendation: Please clarify the intent of this paragraph, and consider a transition period to ED12C/DO-178C.

Justification: TSO and ETSO holders who have an existing ED-12B/DO-178B process and articles developed to those processes may need time to convert their processes to the latest standard. We expect that there will be cases where an ETSO holder will be developing a derivative product consisting of only a very small code change from the baseline product. Requiring conversion to ED-12C may be considered an unnecessary burden on the applicant for no additional safety benefit. Some product lines may never benefit from transition to ED-12C.

response | Noted

The proposed idea is to introduce progressively, in all ETSOs not direct reference to ED-12 (any edition), but only to subpart A of CS-ETSO.

The latter is already proposed for amendment through NPA 2012-16:

'Unless otherwise stated otherwise in paragraph 3.1.3 of the specific ETSO, one Acceptable Means of Compliance for the verification and validation of the computer software is outlined in the latest revision of AMC 20-115…'

The above text refers to the latest edition of AMC 20-115, but without making it mandatory, facilitating thus the transition..

This is in line with the general Agency's philosophy to introduce transition periods for the application of any new standard. As a consequence the resulting text of the AMC 20-115C now clarifies that it will become applicable on 01 January 2014 (even for ETSO articles), but that earlier industry standards would continue to be acceptable for changes to existing software, including for

minor changes to ETSO articles.

The resulting text of AMC 20-115C is presented in Appendix A.

Resulting
text

CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-IV. CONTENT OF THE DRAFT DECISION-ENVISAGED CHANGES TO CS-ETSO

One comment was received on this segment of the NPA, asking clarification on the transition period in relation to ETSO Authorisation.
This comment led to more clarity in paragraph 8 in the proposed text of AMC 20-115C in relation to ETSO articles.

A. Explanatory Note - IV. Content of the draft Decision - Draft Decision AMC 20-115   p. 11-12

comment | *12*   comment by: *Marty Gasiorowski*

The draft points to GM 21A91 for classification of Major or Minor Software Changes. Per that GM, virtually all changes to Level A and B are classified as Major. This would require that almost all Level A and B systems will have to upgrade to DO-178C when they make a small change. There is no reason why an exisiting system, with good service history, to require upgrading to DO-178C, unless they fall into one of the other categories listed (such as new use of MBD). Also, it is not clear whether only the change needs to comply with DO-178C, or whether all of the software has to be upgraded when a change is made.

response | Accepted

Indeed per GM 21.A.91 all changes to software level A or B are major. However, according to GM 21.A.101 these changes could be non-significant, significant or substantial.

Resulting text of AMC 20-115C clarifies that earlier standards can be used if the change to software, although being major, is neither significant nor substantial.

comment | *30*   comment by: *FAA*

Comment**:** Paragraph 44, 2nd bullet, Data bases are being excluded from the scope of this AMC even though they may be included in the airborne SW.

Recommendation: Change the parenthesized text to: "(i.e., excluding SW used on the ground for ATM/ANS systems and constituents)"

Justification: Airborne data bases are software data and should be included in the scope.

response | Not accepted

In the European regulatory framework data basis are not necessarily under the responsibility of the developer of the computation software.

Management of data basis is responsibility of the aircraft operator (e.g. through the administrator of the Electronic Flight Bag). Digital data critical for the safety of navigation are supplied to operators by certified Air Navigation Service Providers (ANSP). Both the data administrators in the operators' organisation and the data providers, are organisations potentially different from the developer of the computation software and their legal responsibilities should not be confused.

comment | *93*   comment by: *Eurocopter*

Page 11 item 42

"*AMC 20-115B (and the new proposed edition C) apply to the certification of any aircraft type, other product, APU, airborne system or equipment where SW is embedded, irrespective of the Certification Specification (CS-23, CS-25, CS-29 or other) used to build the certification basis for the product.*"

We suggest stating that AMC 20-115 applies to the approval of airborne software for any product certification or ETSO authorisation.

response | Noted

The content of the comment is supported by the Agency and indeed the applicability to ETSO articles is being implemented in Subpart A of CS-ETSO (ref. NPA 2012-16). However, the Explanatory Note of NPA 2012-11 will not be reissued.

Resulting text | **CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-IV. CONTENT OF THE DRAFT DECISION-DRAFT DECISION AMC 20-115**

Three comments have been received on this segment of the NPA. The content of one is shared by the Agency, although not leading to change the proposed

text of AMC 20-115. One comment has been accepted and the proposed text accordingly adjusted.

One comment has not been accepted, since it would confuse the legal responsibilities of different certified organisations.

The resulting text of AMC 20-115C is presented in Appendix A.

A. Explanatory Note - IV. Content of the draft Decision - Draft Decision AMC 20-1   p. 12

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comment	*113*	comment by: *Rolls-Royce plc (ZM)*

"Quality Level" should read "Design Assurance Level"

response	Noted

Indeed the use of the word 'quality' was not proper in paragraph 48 of the Explanatory Note of the NPA. This word, however, does not appear in the proposed text of AMC 20-1.

Resulting text	**CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-IV. CONTENT OF THE DRAFT DECISION-DRAFT DECISION AMC 20-1**

One comment was received on this segment, however, not affecting the resulting text of the proposed rules.

A. Explanatory Note - IV. Content of the draft Decision - Draft Decision AMC 20-7   p. 13-14

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comment	*33*	comment by: *FAA*

Comment: Page 17, first bullet at top of page, The use of the term "…actors…" is not ideal for this document.

Recommendation: Change "…actors…" to one of the following more acceptable terms: "…applicants…" or "…participants…"

Justification: For clarity/correctness.

response	Noted
	The term 'actors' was only used in the Explanatory Note to the NPA, which will not be reissued. The same term appears nowhere in the text of the proposed AMCs.

Resulting text	**CONCLUSION TO COMMENTS ON EXPLANATORY NOTE-IV. CONTENT OF THE DRAFT DECISION-DRAFT DECISION AMC 20-7**
	One comment related to the text of the Explanatory Note was received on this segment of the NPA. However the text of the Explanatory Note will not be reissued. There is no effect on the text of the resulting rules.

A. Explanatory Note - V. Regulatory Impact Assessment   p. 14-22

comment	*9* comment by: *Universal Avionics Systems Corporation*
	Page 14: In the AMC, the certification liaison and approval of Parameter Data Items could be made more clear. In ED-12C the Parameter Data Items are included in the SCI and approved as part of the type design. However, for some types of data, such as separately configured option selectable data, i.e. config. files, software approval of the data may happen at a much different time and by a different individual than approval of the application software.
response	Noted
	However this comment does not oppose selection of option 2 as the preferred one.

comment	*31* comment by: *FAA*
	Comment**:** Paragraph V., and V.1.1.a, last paragraph of General section, The acronym "(RIA)" is not defined prior to its use.
	Recommendation: Change title of section V to: "Risk Impact Assessment (RIA)"
	Justification: Acronym was not defined, but should be prior to its first use.

response	Noted
	Correct. The acronym 'RIA' should have been defined prior its first use. However, this comment does not oppose selection of option 2 as the preferred one.

comment	*32*	comment by: *FAA*
	Comment**:** We have two concerns with the first two paragraphs of 1.3: (1) The statement "…nevertheless the probability of the materialization of hazards linked to improper SW processes is estimated as **extremely improbable**" appears to be an unsupported assertion. This statement should include some explanation or reference as to where it came from. (2) The second paragraph states "SW malfunctions are generally not deemed capable of causing catastrophic consequences. However, since SW applications are becoming more and more important for the functionality of essential airborne systems, the worst credible severity of the effects of a SW malfunction could be estimated as **hazardous**." Software malfunctions can cause catastrophic consequences. Recomendation: Delete this section or revise it so that it's correct and clear as to its content and purpose, and to provide justification (sources) for any statements made. Justification: It is unclear what the intent of this paragraph is. It does not seem to add substantive information regarding accepting ED-12C as an acceptable means of compliance.	
response	Noted	
	However, this comment does not oppose selection of option 2 as the preferred one, while the RIA will not be reissued.	

comment	*34*	comment by: *FAA*
	Comment: 2nd paragraph, 2nd bullet, Use of the term "…cost-efficiency…" is ambiguous. Recommendation: Change "…cost-efficiency…" to whichever of the following it applies: "cost-efficiency for applicants" or "cost-efficiency for the Agency" or "cost-efficiency for applicants and the Agency" Justification: For clarity.	
response	Noted	
	Given this comment does not oppose selection of option 2 as the preferred one,	

the RIA will not be reissued.

comment | *35* | comment by: *FAA*

Comment: Paragraphs 3, 4, 5 - in multiple table occurrences, The meaning of the phrase "As 2…" is not readily apparent; it can be made much more understandable with a minor text change to all occurrences.

Recommendation: Change all occurrences of "As 2…" to: "Same as Option number 2…"

Justification: For clarity.

response | Noted

Given this comment does not oppose selection of option 2 as the preferred one, the RIA will not be reissued.

comment | *64* | comment by: *Garmin International*

Part A, Section V (pages 14-22)

While the Regulatory Impact Assessment may be appropriate to the specific options considered in Section 3 (page 17), the changes proposed for AMC 20-115 go significantly beyond those considered in the assessment. Specifically, the narrowed scope of conditions where it is acceptable to use previous DO-178/ED-12 versions represents significant costs for previously approved SW (section iii), and almost certain negative effects on regulatory coordination and harmonization (section vi).

The Regulatory Impact Assessment should be revised to include an additional option that addresses the proposed changes to the "Use of Previous Versions" section of AMC 20-115. This additional option should be assessed against an option without such changes. The assessment of this additional option will likely show that the proposed changes to the "Use of Previous Versions" section of AMC 20-115 should not be included.

response | Partially accepted

The number of cases in which the use of previous standards may be used has been enlarged in paragraph 8 of the resulting text of AMC 20-115. In any case the AMC constitutes only one possible means of compliance. Applicants may propose alternatives any time.

Given this comment does not oppose selection of option 2 as the preferred one, the RIA will not be reissued.

| comment | *65* | comment by: *Garmin International* |

Part A, Section V.1.3 *What are the Safety Risks* and Table 1 (pages 15-16)

The closing statement of the section states "From the above safety risk matrix one can observe that the risk index is 5, which means that there is no urgent need to do anything to solve a safety issue."

This raises the question, "Why then change anything with respect to the assurance of the software development process?"

Suggest that text be added which states that continuing to use DO-178B guidance applied to approved processes will not result in appreciable safety risk such as the following:

"Thus, continued use of existing software design assurance applied by approved processes will not decrease safety."

| response | Not accepted |

The EU legislator gave to the Agency (ref. Article 2 of Regulation 216/2008) objectives additional to high and uniform safety. This objectives include alignment with the state of the art, even in the absence of an urgent safety need, as explained in paragraph 2 of the RIA.

| comment | *66* | comment by: *Garmin International* |

Part A, Section V.3. Identification of Options, Table Row No. 3 (page 17)

Option No. 3 states "As 2 for AMC 20-115 but directly refer to …". It is unclear whether "AMC 20-115" was intended to be AMC 20-115C.

Recommend the reference be corrected if intent was to reference AMC 20-115C.

| response | Noted |

For clarity, the reference intended AMC 20-115C. However, given this comment does not oppose selection of option 2 as the preferred one, the RIA will not be reissued.

| comment | *67* | comment by: *Garmin International* |

Part A, Section V.4.iii, *Economic* (page 19)

The text in each cell totally ignores the cost to industry to modify existing processes and standards to, at the very least, reference the new guidance. Undoubtedly there will be industry process and standards changes required to meet the new guidance (e.g. PDI). These cells ignore such cost to

industry.

Additionally, there is no doubt that Certification Authorities will want to evaluate and approve the altered standards and processes. Thus, there will be the cost associated with the performance of such audits. If the new guidance, as claimed, "…..does not change the basic approach for software Development Assurance Level (DAL) in comparison to previous edition 'B' published in 1992" (quoted from Executive Summary) then why go through the expense of modifying and seeking approval for any standards/process modification?

Suggest:
1. Eliminating the text which says, "None of the identified options introduces new requirements for industry". This is not a true statement as industry will be <u>required</u> to revise company standards and processes to address the new document suite versus the DO-178B suite.
2. Modifying the Assessment row to eliminate bias towards maintaining use of DO-178B and approved processes. Certainly the "No adverse economic impact identified" text is incorrect.
3. Re-evaluating the Score row to consider the industry costs associated with standards revisions and support of audits to assess and approve those revisions.

response	Noted

The content of the comment has indeed merit.

However, even if the score for economic impact of option 2 would have been evaluated as very negative (i.e. -3), the overall score of said option would still have remained positive, compared with an overall score of -4 for option 0 (i.e. 'do nothing'). In other words the preferred option would not have changed. It is therefore not necessary to reissue the RIA.

comment	*68* comment by: *Garmin International*

Part A, Section V.4.vi. *Regulatory coordination and harmonisation* (page 21)

Assumes that all of the policy and guidance to comply with the regulations will be changed simultaneously to refer to the new guidance. This is a poor assumption. Existing policy and guidance documents (e.g. AMCs, ACs, ETSOs, TSOs) reference previous-revision guidance (ED-12, DO-178). As an example of the lag in revising policy and guidance, FAA and EASA have routinely approved E/TSO deviations to use latest revision guidance.

Suggest changing the Assessment row text from "Aligned with FAA/TCCA" to "Alignment with FAA/TCCA achieved as regulation/policy/guidance documents are revised". 3

response	Noted

Fair comment. however, it does not invalidate that option 2 is the preferred one. The RIA will in any case not be reissued.

comment	*129*	comment by: *SVFB/SAMA*

After due consideration of the arguments delivered within this NPA we support Option 2 of of 5 on page 17/35 and support the attached AMC 20+115C of NO MORE THAN five pages, containing also some explanation andf reference not only to ED-12C/DO 178C, but also to the associatied documents and the restrictions to bundle all references to the AMC 20-115.

response	Noted

Support to option 2 is noted with appreciation.

Resulting text	**CONCLUSION TO COMMENTS ON V. REGULATORY IMPACT ASSESMENT**

11 comments have been received on the RIA. Some of them supported the selected option 2 as the preferred one. Several criticized single statements contained in the RIA, however, not invalidating the chosen option 2 (i.e. publish AMC 20-115C with no more than 5 pages).

One comment led to amendment of the proposed text of AMC 20-115C.
The resulting text of this AMC is presented in Appendix A.

B. Draft Decision(s) - I. Draft Decision AMC 20-115C	p. 24-27

comment	*2*	comment by: *THALES Avionics*

THALES Avionics comments on §6 BACKGROUND

"*Document ED-94C was developed to provide supporting information for ED-12C and the ED-215 document was developed to explain Software Tool Qualification Considerations. They should both be considered as supplemental documents to be used jointly with ED-12C.*"

 THALES Avionics rewording proposal:

ED-94C document was developed to provide supporting information and clarification of the guidance material in ED-12C.
ED-215 is a stand alone document that was developed to provide tool qualification guidance. ED-215 is referred by ED-12C (12.2.3 Tool Qualification Process) to define the objectives, activities, guidance, and life cycle data required for each Tool Qualification Level.

Rationale

ED-94C is not the same kind of document than ED-215, ED-94C just clarifies the ED-12C and doesn't contain any objectives and ED-215 is not a supplemental document but a stand alone one. So, both documents cannot be considered as supplemental documents.

response | Accepted

Text was changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

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comment | *3*   comment by: *THALES Avionics*

THALES Avionics comments on §8 "USE OF PREVIOUS VERSIONS"

Thales Avionics consider that the criteria to be fulfilled to continue applying previous versions of ED-12, for modifications to the software of already certified systems and equipment, are very stringent because it will lead in most of the cases to the application of the ED-12C, ED-215 and supplements.
Thales Avionics considers that a transition from previous versions to ED-12C application should normally be very limited.

Moreover, the proposed EASA paragraph §8 is not consistent with some key objectives presented in NPA 2012-11:

- *"It is anticipated that the adoption of the proposed rules will lead to improved safety without creating undue burden or other adverse effects ..." (Executive Summary Page 2 of the NPA)*
- *"The general objectives given by the EU legislator to the Agency ... (is to) promote cost-efficiency in the regulatory and certification processes" (Regulatory Impact Assessment §2 Page 16 of the NPA)*

Indeed showing compliance to ED-12C, ED-215 and supplements will represent a huge burden for industry and moreover an obstacle to build product policies. In addition, as ED-12C just clarifies ED-12B, it will not improve safety compared to existing compliance to ED-12B.

In conclusion, Thales Avionics consider that this paragraph must be reviewed and absolutely harmonized with the FAA AC 20-115 due to the potential non level playing field for industry that could result.

response | Partially accepted

It is not Agency's intention to always impose application of the new standards to modifications to already approved software modules. Resulting text of paragraph 8 of AMC 20-115C, reproduced in Appendix A, has been reviewed accordingly.

Furthermore, it has been specified that AMC 20-115C would become applicable

on 01 January 2014.

| comment | *8* | comment by: *Universal Avionics Systems Corporation* |

Page 27, second bullet on page, seventh bullet on page: The supplements are not designed to be used with DO-178B; only DO-178C. For example, the text, annex tables and sections don't line up, and glossary terms sometimes have different meanings. The supplements are written assuming that related issues in the main document are handled per DO-178C. Therefore ED-215, ED-216, ED-217 and/or ED-218 cannot be used with DO-178B.

Page 27, second bullet: What if the techniques in the supplements are already in the legacy software? This is usually the case. For example, in the case of ED-217, it is almost a given that the legacy software is using dynamic memory management on the stack and/or through some kind of manually managed buffer (the supplement is NOT exclusive to OO.)

response

Noted
First comment is noted, but it leads to no changes of the proposed text of AMC 20-115C, as each supplement indicates that it should in fact supplement the ED-12C/DO-178C .
Second comment is noted, but also leading to no change: The bullet point already covers the case. If the techniques are already used in the legacy software, the related supplement is not applicable.

| comment | *11* | comment by: *Marty Gasiorowski* |

The AC should explain the issue with the DO-178C definition of Parameter Data Items, and should limit the scope of PDI such that:
1. The structure of the PDI, and interface between the PDI and the EOC, are within the scope of DO-178C compliance.
2. If the content of the PDI file is not generated until after certification, and customizes the software for each product serial number during manufacturing of an applicance or aircraft, then it is outside the scope of DO-178C.

response

Noted

However, the comment leads to no change in the proposed text of AMC 20-115C, since the Agency believes that this kind of issues should be solved at project, not rule, level.

| comment | *17* | comment by: *AIRBUS* |

Replace existing content of paragraph 8 of the NPA by the following one:

Previous ED-12/DO-178 versions, related and relevant Certification Review

Item / Interpretative material will continue to be accepted for systems and equipment where these have been accepted as the basis for approval or certification. Exceptions to that principle apply as follows:

-        When the techniques described in the ED-12C / DO-178C supplements (Formal Methods, Object-Oriented Technology and Related Techniques, Model-based Development and Verification) are introduced but not already covered by existing Certification Basis (through relevant CRI/IM), then ED-216 and/or ED-217 and/or ED-218 shall be applied;

-        When new software development tool or verification tool needing qualification are used but not already covered by existing Certification Basis (through relevant CRI/IM), then ED-215 (Software Tool Qualification Considerations) shall be applied;

-        When new Parameter Data Item files are introduced but not already covered by existing Certification Basis (through relevant CRI/IM), sections (2.5.1 / 4.2.j / 6.6 / 11.22 / A.5.8 / A.5.9) of ED-12C relevant to Parameter Data Item shall be applied.

RATIONALE / REASON / JUSTIFICATION:
The following led Airbus to propose a new content of Paragraph 8 "Use of previous versions":

 # 1: Page 27 Paragraph 8 "Use of previous versions", about the sentence: "Early coordination with EASA is strongly recommended to validate the above assumptions":

AIRBUS has got the privilege to classify the system modifications into MAJOR or MINOR MODs and has got the privilege to certify MINOR MODs without any EASA involvement.
This sentence denies this privilege.

 # 2: Page 26 first bullet of Paragraph 8 "Use of previous versions" about the sentence: "the Software development assurance level of the software is not increased":

Transition to DO178C may be unpractical for reused data or raise a huge work not justified by the gain in safety; for example the tools used may need additional huge work to comply with DO178C Tools supplement ED-215 whereas there is not any change within the tool.

 # 3: Page 27 second bullet of Paragraph 8 "Use of previous versions" about the sentence: "the Software is installed in the same type of aircraft or engine as that in which the original software was installed":

In the case where the software developed in compliance with a previous ED12 version is installed in another type of aircraft or engine where the same previous ED12 version is accepted as means of compliance, the same previous ED12 version should be accepted (the transition to DO178C should not be required).

 # 4: Page 27 third bullet of Paragraph 8 "Use of previous versions":

The policy should be the same for previous ED-12 versions and for

previous CRIs/IMs when those can be considered as previous versions to ED-216 or ED-217 or ED-218

 # 5: Page 27 fourth bullet Paragraph 8 "Use of previous versions" about the sentence: "the software development and verification processes and environment are not significantly changed":

Introducing the notion of "development and verification processes and environment significantly changed" is confusing with respect to 21A.91, 21A.101 and associated AMC/GM.

 # 6: Page 27 fifth bullet of Paragraph 8 "Use of previous versions" about the sentence: "the initial software development and verification processes and environment have been adequately maintained and can still be used":

If the software development and verification processes and environment have not been adequately maintained and cannot be used, this 5th bullet is not relevant within paragraph 8 that is "use of previous versions (of the ED-12/DO-178)": if a piece of/a software cannot be (re)used, the applicant has no choice than developing a new software, so here the point of use of previous versions of ED/DO is not relevant.

 # 7: Page 27 sixth bullet of Paragraph 8 "Use of previous versions" about the sentence: "the Software change is not major (see the software criteria given within Appendix A to GM 21A.91) and the system change is not significant (see GM 21A.101)":

If the software change is major, the relevant criteria's to prone the use of ED-12C/DO178C shall be related to the techniques that were not covered by the previous versions of this Industrial Standard: the key reasons why a new issue [C] was considered necessary by the Industry were to address emerging trends and technologies in software development, and to provide a flexible approach and allow for changes in technology.

A system change can consist in a change of an architecture where one or more computer(s)/software(s) can be new and/or one or more computer(s)/software(s) can be re-used from previous development/certification. As per IR 21.101 such a change could be classified as significant. However, as far as re-used computer(s)/software(s) is(are) concerned, there is no industrial reason to impose reference to ED-12C/DO178C in such cases, meaning cases of iso- technologies and iso-DAL for these re-uses, referring previous version of the ED/DO shall continue to be relevant and to provide same assurance.

 # 8: Page 27 Paragraph 8 "Use of previous versions" regarding new Parameter Data Item files:

It must be allowed to take credit of certification baseline where the Certification aspects related to Parameter Data Item files were addressed in the same way than ED-12C/DO-178C do.

 # 9: Page 27 tenth bullet Paragraph 8 "Use of previous versions" about the sentence: "there are no changes in the operational use of the system":

Changes in the operational use of the system can raise small or limited changes at software level; in those cases, referring previous version of the ED/DO shall continue to be relevant and to provide same assurance.

response | Partially accepted

In general CRI/IM are project specific, i.e. not relevant at the level of rules and also not part of the certification basis. The proposals related to them, therefore, cannot be accepted.
The proposals concerning revision of text in paragraph 8 of AMC 20-115C are partially accepted and the resulting text is presented in Appendix A.

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comment | *36*   comment by: *FAA*

Comment: Use of the phrase "…this document…" is somewhat ambiguous; the intent appears to mean "…this AMC…" (as it is used elsewhere), but in a different context, it could be misconstrued to mean some other document.

Recommendation: Assuming it was the author's intent, change all occurrences of: "…this document…" to
"…this AMC…"

Justification: For clarity and consistency

response | Accepted
Resulting text of AMC 20-115C is presented in Appendix A.

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comment | *37*   comment by: *FAA*

Comment: Paragraph 4.3, It is not clear what "may be supported by the following related documents ..." means.

Recommendation: May want to specify when those other documents are applicable.

Justification: "may be supported" is somewhat ambiguous. Does it mean they "are to be used as applicable" or are they optional?

response | Accepted
Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

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comment | *38*   comment by: *FAA*

Comment: Paragraph 4.4,

We offer two comments and resolution:

(1) The paragraph states that the AMC is harmonized with FAA AC 20-115. Due to the draft status of both documents, harmonization cannot be determined at this time.

(2) We assume that EASA is removing the revision level from the AC reference so that any future revisions might not have to result in a change to the AMC. Since there is no guarantee that changes will always be coordinated between the AC and the AMC, harmonization between the documents also cannot be guaranteed.

Resolution:

(1) Omit the paragraph, or:

(2) "The technical content of this AMC is harmonised with FAA AC 20-115 to the greatest extent possible. The applicant is responsible for determining how they are affected by any differences between the documents."
Justification: Since neither the proposed FAA AC 20-115C nor the EASA AMC 20-115C has been finalized, it is not possible to determine if the published versions of the FAA AC and the EASA AMC will be harmonized.

response	Accepted Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*39* comment by: *FAA*
	Comment: Paragraph 6, Two versions of the term: "software based" and "software-based" are used herein (and in other parts of the document as well). Recommendation: Change all occurrences to either: "…software based…" or "…software-based…" Justification: For consistency.
response	Accepted Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*40* comment by: *FAA*
	Comment: Paragraph 6, 4th paragraph, The paragraph states that ED-94C and ED-215 should be considered as supplemental documents to be used jointly with ED-12C. The term "supplemental documents to be used jointly with ED-12C" may cause confusion when used in the same paragraph as other references to documents that are supplements to ED-12C.

Recommendation: Change text to: "They should both be considered as ancillary documents when using ED-12C." or "They should both be considered as supporting documents to ED-12C."

Justification: Supplements add, delete, or modify the objectives of ED-12C. ED-94C is clarification of ED-12C and is not considered guidance. ED-215 has its own set of objectives independent from ED-12C. Therefore, the term "supplemental documents to be used jointly with ED-12C" should be avoided when referring to these two documents.

response	Accepted Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*41*	comment by: *FAA*

Comment: Paragraph 6 "Background", 5th paragraph, Use of related techniques when OOT is not used is not addressed.

Recommendation: Please clarify that related techniques may need to be considered outside of OOT.

Justification: The related techniques addressed in ED-217, Annex OO.D, may apply to projects outside of OOT. For completeness, this should be mentioned to bring attention to the fact that related techniques may need to be considered.

response	Accepted Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*42*	comment by: *FAA*

Comment: Paragraph 6, 7th paragraph, Use of multiple documents together (e.g., more than one supplement or a supplement and ED-215) is not addressed.

Recommendation: Address use of mutliple documents

Justification: For completeness.

response	Noted The comment leads to no change of AMC 20-115C as the proposed text already covers this case.

comment	*43*	comment by: *FAA*

Comment: Paragraph 6 (general comment), If an applicant proposes to use ED-12B for a new project as an alternate means, including when object oriented technology, formal methods, or model-based development are used, what criteria would ensure an equivalent level of safety?

Recommendation: Please clarify.

Justification: For completeness.

response | Noted

The comment leads to no change in the proposed text of AMC 20-115C, since the Agency believes that this kind of issues should be solved at project level and not at rule level.

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comment | *44*   comment by: *FAA*

Comment: Paragraph 7, There are some issues within the MBD supplement regarding substitution of simulation for review activity that is not technically justified.

Recommendation: When using the guidance of DO-331 for certification projects utilizing model-based development techniques, with the exception of verifiability objectives, model simulation cannot be used to demonstrate satisfaction of the objectives listed in section 6.8.1.

Justification: If credit is given in the MBD supplement then credit for on-target testing for the same review objectives should be allowed. There is no technical difference between the two. None of the certification authorities have allowed substitution of testing for review objectives under 178B nor is it allowed in DO-178C.

response | Noted

ED-218/DO-331 has been accepted by Industry and Authorities and cannot be technically challenged in an AMC. The substitution of simulation for review, might be discussed as a specific project issue with potential applicants, or during future FAA-EASA harmonisation meetings, aiming at updating both FAA Order 8110.49 and EASA Certification Memorandum. This issue could also be discussed during the new EUROCAE/RTCA FAS.

In conclusion the comment leads to no change in the proposed text of AMC 20-115C.

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comment | *45*   comment by: *FAA*

Comment: Paragraph 7 (general comment), What is the applicable software lifecycle data to satisfy type design for Level D software given that objectives related to source code and low level requirements have been removed?

Recommendation: Please clarify.

Justification: For completeness.

response | Noted

However, the comment leads to no change in the proposed text of AMC 20-115C, since the Agency believes that specific issues or errors contained in a standard issued by industry bodies, should be discussed during the new EUROCAE/RTCA FAS and not unilaterally changed by the Agency itself.

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comment | *46*   comment by: *FAA*

Comment: Paragraph 8, first bullet, Use of "software development assurance level" terminology, which is inconsistent with other sections of the AMCs.

Recommendation: Change to "the System Development Assurance Level and software level(s) for the software components are not increased."

Justification: For clarity, and to ensure that the system DAL has not increased either.

response | Partially accepted

Text changed to harmonise with ED-12C (i.e. 'software level' and not 'development assurance level'). Resulting text of AMC 20-115C is presented in Appendix A.

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comment | *47*   comment by: *FAA*

Comment: Paragraph 8, manufacturers who have a set of processes and documents as part of an infrastructure based on ED-12B/DO-178B already in place and have a history of producing compliant, safe software products, should be allowed to use ED-12B/DO-178B through some reasonable transition time. The NPA should provide for this.

Recommendation: The authority needs to determine and provide the transition time and circumstances, and the effective text in the sections it deems appropriate in the NPA. This should be harmonized with the FAA's AC 20-115C.

Justification: The potential effect of switching from ED-12B/DO-178B to ED-12C/DO-178C is one of efficiency rather than safety. Moving from B to C versions may mitigate the effort of tracking CRIs/issue papers, etc. This is not necessarily a safety benefit and does not address an identified safety issue. There seems to be an assumption that the impact on industry of the switch to ED-12C/DO-178C will be minimal. At this point, any potential impact on industry is speculation as we have not yet obtained their assessment of the impact. Imposing ED-12C/DO-178C without allowing some reasonable transition period may be an unnecessary burden on industry for no identified benefit in safety.

response | Partially accepted

Resulting text of paragraph 8 of AMC 20-115C changed to allow use of earlier standards when implementing modifications to software in most cases. The Agency believes that this would facilitate the transition. The approach is similar to the one used in the AMC 20.115B and FAA AC 20.115B.

Resulting text of AMC 20-115C is presented in Appendix A.

comment	*48*	comment by: *FAA*

Comment: Paragraph 8 states the following: "Previous ED-12 versions may continue to be accepted for modifications to the software of already certified systems and equipment where these have been accepted as the basis for approval or certification provided that:
(2nd bullet) the software is installed in the same type of aircraft or engine as that in which the original software was installed."

This is too restrictive. A minor change could be made to a piece of equipment on a different aircraft, such as an autopilot gain change on a part 23 aircraft. It would not be a safety benefit to force the autopilot developer to update their software to DO-178C for a minor change.

Recommendation: Delete the bullet: "the Software is installed in the same type of aircraft or engine as that in which the original software was installed;"

Justification: This is too restrictive for no potential safety benefit.

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*49*	comment by: *FAA*

Comment: Paragraph 8, the phrase "already certified systems and equipment" is used. This is improperly worded because systems and equipment are not certified. Only aircraft, engines and propellers are certified. Systems and equipment are approved for installation into certified aircraft, or are found to be compliant to the applicable regulations governing that system.

Recommendation: Revise text to use more appropriate terminology when talking about previously developed software.

Justification: For proper use of terminology.

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	50	comment by: *FAA*

Comment: Paragraph 8, 4th bullet states: "the software development and verification processes and environment are not significantly changed;" The term "significantly changed" is ambiguous in this context and subject to interpretation.

Recommendation: Rewrite the sentence to use clearly defined terms or clearly define the intent of the bullet. Alternatively, give a reference if one is available, as is used in the 6th bullet where the term "significant" is used.

Justification: Clarification

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	51	comment by: *FAA*

Comment: Paragraph 8 states: "Previous ED-12 versions may continue to be accepted for modifications to the software of already certified systems provided that:" (last bullet) "there are no changes in the operational use of the system." We're not sure what is meant by operational use. This may be too restrictive.

Recommendation: Delete the last bullet: "there are no changes in the operational use of the system".

Justification: Forcing the supplier to upgrade to ED-12C/DO-178C for a change in operational use would likely not result in a safety benefit.

response	Accepted

Text changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	69	comment by: *Garmin International*

2 Scope, fourth bullet (page 24)

The fourth bullet exempts Electronic Flight Bags (EFBs). Why would it not apply to Class III (installed) EFBs? Or to Class II EFBs with ETSO-C165 moving map as proposed by EASA NPA 2012-02?

Proposed resolution: Specify the EFB Classes that are exempt.

response	Accepted

Indeed for installed EFB AMC 20-115C would apply. The bullet has been

suppressed, since it was only part of a non-exhaustive list of examples. Resulting text of AMC 20-115C is presented in Appendix A.

comment	70 comment by: *Garmin International*

4.3 bulleted list (page 25)

The first and second bullets don't need the word "documents" after the document title.

Suggest removing the word "documents" from the first and second bullets.

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	71 comment by: *Garmin International*

4.3 bulleted list (page 25)

The third and fifth bullets contain a hyphen in the document title prior to the word "Supplement", e.g "Formal Methods – Supplement to ED-12C and ED-109A". These hyphens don't occur in the RTCA or EUROCAE titles.

Suggest removing the hyphens.

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	72 comment by: *Garmin International*

4.3 bulleted list (page 25)

The fourth bullet needs a hyphen in "DO-332".

Suggest adding the hyphen.

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*73*	comment by: *Garmin International*

4.4 (page 25)

States "The technical content of this AMC is harmonised with FAA AC 20-115 equally based on ED-12/DO-178."

While it may be EASA's intent, the draft AMC 20-115C is not harmonized with any version of FAA AC 20-115. Furthermore, no draft of FAA AC 20-115 exists that would allow a determination to be made of whether this draft is harmonized. The changes associated with draft AMC 20-115C are so significant this it is impossible to assume that harmonization between FAA and EASA guidance can be achieved without a concurrent draft and comment period. For example, the application of major software change according to EASA GM21.91A is not aligned with the FAA position. Such misalignments in position must be reconciled for the positions to be harmonized.

It is recommended that EASA coordinate with the FAA to harmonize draft updates of EASA AMC 20-115C and FAA AC 20-115C, release for comments concurrently, and implement revisions in a manner that gives industry confidence that the guidance will indeed be harmonized.

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*74*	comment by: *Garmin International*

5 RELATED CERTIFICATION SPECIFICATIONS (CSs) (page 25)

Includes the phrase "… replaced by reference to this AMC to provide a single source of regulatory material on airborne software, applicable to any aeronautical product, APU or equipment."

To be in agreement with section 3 text, suggest this phrase be changed to:

"… replaced by reference to this AMC to provide a single source of regulatory material on the production of software for airborne systems and equipment used on aircraft, engines, propellers and auxiliary power units."

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*75*	comment by: *Garmin International*

6 BACKGROUND (page 26)

Includes the statement "EUROCAE document ED-12C was developed to establish software considerations for developers, installers and users when the aircraft system or equipment design is developed using software based techniques."

ED-12C states in the purpose and scope sections that it provides guidance for the production of software. ED-12C was not intended to address the aircraft system or equipment design development using software based techniques. This would include use of CATIA and other software-based design tools.

Suggest changing the quoted statement to:

"EUROCAE document ED-12C was developed to establish software considerations for aircraft system or equipment developers when the aircraft system or equipment design is implemented using software based techniques."

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*76* comment by: *Garmin International*

6 BACKGROUND (page 26)

Includes the statement "The EUROCAE document provides guidelines for establishing software life cycle planning, development, verification, configuration management, quality assurance and certification liaison processes to be used in software-based systems."

ED-12C no longer uses the word "guidelines" and instead uses the word "guidance" merely as the dictionary definition of the word with no regulatory basis implied.

Suggest "guidelines" be changed to "guidance".

response	Accepted

Text has been changed to 'guidance' when referring to ED-12C. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*77* comment by: *Garmin International*

6 BACKGROUND (page 26)

Includes the statement "The guidelines provided in ED-12C are in the form of:"

ED-12C no longer uses the word "guidelines" and instead uses the word "guidance" merely as the dictionary definition of the word with no regulatory basis implied.

Suggest "guidelines" be changed to "guidance".

response	Accepted Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*78*	comment by:	*Garmin International*

6 BACKGROUND (page 26)

Includes the statements "Document ED-94C was developed to provide supporting information for ED-12C and the ED-215 document was developed to explain Software Tool Qualification Considerations. They should both be considered as supplemental documents to be used jointly with ED-12C."

While ED-215 contains guidance for tool qualification, ED-94C does not contain any guidance, let alone for tool qualification, and should not be considered at the same level as ED-12C and ED-215.

Recommend adding a separate paragraph for ED-94C that better states its purpose as an explanatory document.

response	Accepted Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

comment	*80*	comment by:	*Mark Lillis*

Section 8 **Use of Previous Versions** is too restrictive. The new standard should not apply to systems that are approved previously even if there are new/deleted functionality to the software. The change to the PDI FIle should not trigger a change to the new standard since the old certification method should be adequate to assess the safety of the new PDI File. Even significant changes to existing systems should not automatically change the certification to 178C.

With regards to the tool items:
"- *no new software development or verification tools are used;*
- no new software tool qualification is needed; otherwise ED-215 should be applied;", these items do not require the use of the new 178C since the existing 178B process should work just fine here. If the supplier decides to add a tool or qualify a tool then this would be reflected in a PSAC update (and associated SECI, etc). Calling out 178C because of simply adding a new tool seems over-kill and does not directly improve safety. The existing process is plenty safe enough for a tool change.

Solution to this problem

The following bullet items should be removed since they go far beyond what is required to prove safety:

Remove the following:

a) *the Software change is not major (see the software criteria given within Appendix A to GM 21A.91) and the system change is not significant (see GM 21A.101);*
b) *no new software development or verification tools are used;*
c) *no new software tool qualification is needed; otherwise ED-215 should be applied;*
d) *no new Parameter Data Item files are introduced;*
e) *there are no changes in the operational use of the system*

At the end of the section's last paragraph add the following statment:

"*Any of the following changes will require early coordination with EASA to assure that the existing certification basis is still valid:*

- the system change is significant (see GM 21A.101);
- there are changes in the operational use of the system"

response | Partially accepted

The Agency believes that when new software criteria 1 or 2 tool qualification is necessary, ED-215 should be used. Also, the introduction of new Parameter Data Files is a criteria to introduce ED-12C; specific discussions could of course take place in the frame of a specific project.

For other parts of this comment the resulting text of AMC 20-115C is changed accordingly as presented in Appendix A.

comment | *86*   comment by: *Rockwell Collins, Inc.*

1. On page 26, Regarding Section ~~6~~ 8 USE OF PREVIOUS VERSIONS, then referring to the second bullet (i.e., top of page 27): The text reads "the software is installed in the same type of aircraft or engine as that in which the original software was installed;"

Comment: It is not clear what is meant by "type" in this context. Shall "same type of aircraft" be interpreted to mean that aircraft listed on the same Type Certificate Data Sheet (TCDS) or equivalent are acceptable (e.g., Airbus A340-211 and Airbus A340-212); or shall "type" be interpreted to mean that the aircraft are different if they have different type names (e.g., A340-211 is different than A340-212); or shall "type" be interpreted more broadly such that all in the series (e.g., A320, A330, A340) may be included as Airbus passenger transport aircraft; or is a different interpretation of "type" applicable in this context?

Request: Please clarify the meaning of "type" in this context.

2. Regarding ETSO'd appliances:

Comment: We interpret that Section ~~6~~ 8USE OF PREVIOUS VERSIONS will apply regardless of whether an appliance has ETSO approval.

Request: If the above comment is incorrect, please provide clarification.

3. Regarding transition from ED-12B to ED-12C, this transition remains unclear, particularly for ETSO approved equipment with ED-12B assured software that would be installed without change into a different aircraft. For example, if an ACAS 7.1 TCAS receiver-transmitter with ED-12B assured software has an ETSO approval and is installed in an Airbus A380, will the same ACAS 7.1 TCAS receiver-transmitter be acceptable for the A350 or subsequent aircraft, or would this aircraft change require conversion to ED-12C assurance?

Request: Please provide clarification that would make explicit the intended interpretation.

response	Partially accepted

First comment is accepted and text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

Second comment is noted. The Agency confirms the interpretation.

Third comment is partially accepted. Resulting text of paragraph 8 of AMC 20-115C is changed to allow use of earlier standards when implementing modifications to software in most cases. The Agency believes that this would facilitate the transition. The approach is similar to the one used in the AMC 20.115B and FAA AC 20.115B.

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comment | *87*   comment by: *Rockwell Collins, Inc.*

On page 25, Regarding Section ~~2.2~~ 4.4: It is noted that the FAA has not yet issued an advisory circular for DO-178C yet, so the basis for assertion that this AMC is harmonised is questioned.

Request: Please provide tangible basis for the assertion of harmonization.

response | Partially accepted

Text has been changed clarifying that harmonisation took place 'as far as practicable'. Resulting text of AMC 20-115C is presented in Appendix A.

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comment | *94*   comment by: *Eurocopter*

§ 2, pages 24-25

"Compliance with this AMC is not mandatory and hence an applicant may elect to use an alternative means of compliance. However, those alternative means of compliance must meet the relevant requirements, ensure an equivalent level of software safety and be approved by the European Aviation Safety Agency on

a product basis."
We suggest grouping these statements with 1st sentence of § 1 (Purpose).

response	Accepted Block of text moved to par. 1 of resulting text of AMC 20-115C, as presented in Appendix A.

comment	*95* comment by: *Eurocopter* § 4.4, page 25 We understand and support the intent of EASA to harmonize AMC 20-115 with FAA AC 20-115. However, the draft AC 20-115C being not yet been released by FAA for consultation, there is no evidence that AMC 20-115C and FAA AC 20-115C will be fully harmonized.
response	Partially accepted Indeed the FAA corresponding material is not yet published. The Agency, however, believes that publication of AMC 20-115C is urgent and that the referred EUROCAE/RTCA documents have already been discussed and accepted by industry. Harmonisation efforts will continue, to have first the FAA possibly considering AMC 20-115C as published once progressing their rulemaking action and for continuing harmonisation thereafter, including for associated procedures (e.g. FAA orders, EASA Certification Memos). Resulting text of par. 4.4 of AMC 20-115C is changed, clarifying that harmonisation took place 'as far as practicable'. Resulting text is presented in Appendix A.

comment	*96* comment by: *Eurocopter* § 6, page 26 "*The guidelines provided in ED-12C are in the form of:*" According to the clarification of the use of "*guideline*" and "*guidance*", ED-12C/DO-178C is considered to provide "*guidance*". We suggest using the ED-12C/DO-178C wording "*guidance*": "*The guidance provided in ED-12C is in the form of:*"
response	Accepted Text has been changed accordingly. Resulting text of AMC 20-115C is presented

in Appendix A.

| comment | *97* | comment by: *Eurocopter* |

§ 7, page 26

In the title ("*USE OF EUROCAE ED-12C AND RELATED DOCUMENTS AND SUPPLEMENTS PROCEDURES*"), the word "*PROCEDURES*" is not appropriate (these documents define objectives and guidance on process, not procedures).

Suggestion it to remove "*PROCEDURES*".

| response | Accepted |

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

| comment | *98* | comment by: *Eurocopter* |

§ 7, page 26

"An applicant for EASA certification for any software-based equipment or system may use the considerations outlined in EUROCAE document ED-12C and its related documents and applicable supplements, as a means, but not the only means, to secure approval."

Certification of equipment being not an airworthiness concept, we suggest the following wording:

"*An applicant to EASA for product certification or ETSO authorisation may use the considerations outlined in EUROCAE document ED-12C and its related supplements, as a means, but not the only means, to support approval as far as software is included in the product or equipment*."

| response | Accepted |

First line of paragraph 7 is changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

| comment | *99* | comment by: *Eurocopter* |

§ 8, pages 26-27

This paragraph introduces a set of restrictions for accepting the use of previous versions of ED-12/DO-178 in case of software modifications and proposes an early coordination with EASA in order to validate the case ("*Early coordination with EASA is strongly recommended to validate the above assumptions*").

Considering that some of the explicit restrictions might happen in case of minor software changes, this proposal denies the privileges for an approved design organization to classify design changes and to approve minor changes according to 21.A.263(c).

As a consequence, we suggest removing this set of restrictions.

| response | Accepted |

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

| comment | *100*   comment by: *Eurocopter* |

§ 8, pages 26-27

Based on the principles defined in 21.A.101(b), it is acceptable to use an earlier amendment of the applicable airworthiness code, provided it is not earlier than the one used for the type-certification basis, in the following cases:

- Changes classified as not significant (21.A.101(b)1),
- For each area, system, part or appliance that is not affected by the change (21.A.101(b)2) or for which it is found that compliance with the latest airworthiness code "*would not contribute materially to the level of safety of the changed product*" or "*would be impractical*" (21.A.101(b)3).

The same principles should be used for acceptable means of compliance, i.e. the use of a previous version of ED-12/DO-178 should be accepted by principle if this version had been accepted as the initial basis for approval, unless the change is classified major significant and it is recognized that the use of the latest version of ED-12/DO-178 would contribute materially to the level of safety and would not be impractical.

As a consequence, we suggest replacing the text of § 8 by the following:

"*Previous ED-12/DO-178 versions will continue to be accepted for installation or modification of software on products where these have been accepted as the basis for software compliance, provided that this installation or modification is not classified as a major significant change to the product, according to Part 21 sections 21.A.91 and 21.A.101.*

In case of major significant change, early coordination with EASA is strongly recommended and appropriate Certification Review Items might be raised if necessary."

| response | Accepted |

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

| comment | *111*   comment by: *Garmin International* |

8 Use Of Previous Versions (pages 26-27)

Currently, ED-12B along with EASA Certification Memos and EASA Certification Review Items are an acceptable means of compliance, yet this section effectively states that is no longer the case. The agency's own assessment states, "there is no urgent need to do anything to solve a safety issue" (ref. Part A "Regulatory Impact Assessment", Section V.1.3 "Safety Risks"). Furthermore:

- Industry _and_ the agency have invested significant resources to develop accepted processes, and
- A significant financial burden will be imposed if industry is required to show compliance to new standards, CMs and CRIs that have no appreciable impact on safety.

Consequently, the agency is strongly urged to recognize ED-12B as an acceptable means of compliance.

If the agency does not accept the recommendation to recognize ED-12B as an acceptable means of compliance, then revisions to the proposed conditions for the continued use of ED-12B are proposed. Clarification should also be provided to define the portions of previously developed software that are subject to ED-12C. Finally, an acceptable means of showing compliance to ED-12C should be provided for processes developed using previous versions of ED-12/DO-178.

Current FAA guidance for the continued use of DO-178 and DO-178A (Order 8110.49 Change 1, Chapter 10) has been in effect since 2003 and offers a good example for Draft AMC 20-115C. Aligned guidance would also contribute to harmonization with the FAA. For software approved using previous versions of ED-12/DO-178 and now subject to ED-12C, it should be clarified that the new standard is applicable to modules that incorporate significant changes only. For processes developed using previous versions of ED-12/DO-178, it should be clarified that an acceptable means of showing compliance to ED-12C is to show equivalence of current processes to ED-12C.

The following suggested changes to the text capture these recommendations:

"Previous ED-12/DO-178 versions will continue to be accepted for modifications to the software of already certified systems and equipment, provided that ED-12C/DO-178C is not applied. Cases under which ED-12C/DO-178C may be applied are:

 1. Development of a new system (one that has no prior certification baseline)
 2. Changes of an existing system that meet one or more of the following criteria:

    a. Addition of an ETSO
    b. Upgrade of a software design assurance level
    c. Significant functionality change

 3. Techniques described in ED-12C/DO-178C supplements (MBD, OOTRT, Formal Methods) are applied, in which case ED-218/DO-331 and/or ED-217/DO-332 and/or ED-216/DO-333 also may be applied
 4. A new qualified tool is used, in which case only the qualified tool may be

subject to ED-12C/DO-178C and ED-215/DO-330 depending on whether it is used on ED-12C/DO-178C objectives not present in ED-12B/DO-178B or is considered a "Criteria 2" tool

For software of already certified systems and equipment, it will be acceptable to apply ED-12C to software modules that incorporate significant changes only. Compliance to ED-12C can be achieved by showing equivalence of a combination of current processes that are compliant to previous ED-12/DO-178 versions combined with additional or modified processes to account for differences from ED-12C.

Early coordination with EASA is strongly recommended to validate the above assumptions. Appropriate Certification Review Items might be raised if necessary."

response	Partially accepted
	Some text has been changed as proposed. However, the period to transition to ED-12C and the recognition of existing CRI/IM are project specific issues. They will be discussed with individual applicants, according to the provision of paragraph 8 of the resulting text of AMC 20-115C, as presented in Appendix A.

comment	*114* comment by: *Rolls-Royce plc (ZM)*
	I don't believe the FAA has released any update to the FAA AC 20-115 recognizing D0-178C yet. Therefore remove paragraph or say the intention is to harmonize it with the FAA's AC
response	Partially accepted
	Indeed the FAA corresponding material is not yet published. The Agency, however, believes that publication of AMC 20-115C is urgent and that the referred EUROCAE/RTCA documents have already been discussed and accepted by industry.

Harmonisation efforts will continue, to have first the FAA possibly considering AMC 20-115C as published once progressing their rulemaking action and for continuing harmonisation thereafter, including for associated procedures (e.g. FAA orders, EASA Certification Memos).

Resulting text of paragraph 4.4 of AMC 20-115C changed, clarifying that harmonisation took place 'as far as practicable'. Resulting text is presented in Appendix A. |

comment	*115* comment by: *Rolls-Royce plc (ZM)*
	Proposal reads "Previous ED-12/DO-178 versions may continue to be accepted for modifications to the software of already certified systems.....provided that:....the software change is not major...and the system change is not

significant".
Current precedent on exisiting certified systems developed to previous DO-178 standards has been to allow major, but not significant, software changes to continue to use the same DO-178 standard. This proposal would appear to preclude this in future for any change to the software, since all changes to engine control system software are categorised as major.

Revise bullet point 6 to delete the reference to major software change such that it   reads;
"the system change is not significant (see GM 21A.101)"

| response | Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A. |

| comment | *120*   comment by: *Rolls-Royce plc (ZM)* |

General comment - where a modification is made to an existing product and the criteria in this section indicate the use of ED-12C/DO-178C, does this apply to the whole of the software or just the modification to the software?

Please provide additional clarification

| response | Accepted

Additional text is introduced in resulting AMC 20-115C, as presented in Appendix A. |

| comment | *121*   comment by: *Rolls-Royce plc (ZM)* |

Bullet point 2 (on page 27) - states "techniques described in ED-12C/DO-178C supplements.........are not introduced". What if such techniques are already in use - can they be carried over and used for a software modification without invoking DO-178C?

Please provide additional clarification

| response | Noted.

However, the comment leads to no change in the proposed text of AMC 20-115C, since the related discussions are project specific and therefore they do not need to be introduced at the level of AMC. The Agency recommends Rolls Royce to coordinate the approach with the Agency whenever such a case materialises in a specific project. |

| comment | *122*   comment by: *Rolls-Royce plc (ZM)* |

Bullet point 7 (on page 27) - does the term "new software tool" preclude/include modifications to an existing software tool?

Please provide additional clarification

response | Accepted

The bullet point has been deleted and text changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

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comment | *123*   comment by: *Rolls-Royce plc (ZM)*

Bullet point 9 (on page 27) - what is meant by "change in operational use of the system" How is this bounded?

Please provide additional clarification

response | Accepted

The bullet point has been deleted and text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

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comment | *128*   comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

Embraer Position:

The Embraer comments to the NPA 2012-11 (22 Aug 2012) is related to the section 8 as copied below (in italic). The bullets in the original text were replaced by an alphabetical list just to facilitate the reference to the items.

8 USE OF PREVIOUS VERSIONS

Previous ED-12/DO-178 versions may continue to be accepted for modifications to the software of already certified systems and equipment where these have been accepted as the basis for approval or certification, provided that:

(a) the Software development assurance level of the software is not increased;
(b) the Software is installed in the same type of aircraft or engine as that in which the original software was installed;
(c) the techniques described in the ED-12C / DO-178C supplements (MBD, OOTRT, Formal Methods) are not introduced into the new project; otherwise, ED-216 and/or ED-217 and/or ED-218 should be applied;
(d) the software development and verification processes and environment are not significantly changed;
(e) the initial software development and verification processes and environment have been adequately maintained and can still be used;
(f) the Software change is not major (see the software criteria given within Appendix A to GM 21A.91) and the system change is not significant (see GM 21A.101);

(g) no new software development or verification tools are used;
(h) no new software tool qualification is needed; otherwise ED-215 should be applied;
(i) no new Parameter Data Item files are introduced;
(j) there are no changes in the operational use of the system.

Early coordination with EASA is strongly recommended to validate the above assumptions. Appropriate Certification Review Items might be raised if necessary.

Embraer recognizes that ED-12C introduces several improvements in regard to ED-12B. However the compliance activities were not significantly changed as occurred in the transition from ED-12A to ED-12B. The ED-12B raised substantially the compliance requirements, in particular to the software items contributing to catastrophic and hazardous failures.

Based on that, Embraer proposes the following changes in the content of that section:

#1- Embraer consider the application of the ED-12C, to major modification, as stated in the item (f) above, could be applied under certain conditions. Embraer proposed that items (c) and (f) could be combined in a single item:

"() the Software change is not major (see the software criteria given within Appendix A to GM 21A.91) and the techniques described in the ED-12C / DO-178C supplements (MBD, OOTRT, Formal Methods) are not introduced into the new project."

The reference to "(…) *system change is not significant (see GM 21A.101);*" was intentionally removed once changes in the system level not necessarily impacts software. In some cases, even for major system modifications the impact at software level can be minor. Embraer suggests keeping the change impact analysis only in the scope of software.

In addition the EASA CM-SWCEH-002 Software Aspects of Certification, section 12.3(e) states that:

"Systems with small, simple changes should be handled as changes under r the original certification basis (i.e., ED-12B / DO-178B does not need to be applied to the changes)."

That is similar to the guidance provided in the item (f). This implicitly means that changes introduced by ED-12C are being considered in the same level of those introduced by ED-12B. Once more, Embraer consider the improvements introduced by ED-12C are very welcome, however request its application to any major change can impose an unnecessary burden to the software developers.

#2- Item (a) is redundant with the following guidance provided in item 4 of appendix A to GM 21A.91, already referenced in item (f) and the new proposed text (see #1):

… the change should be classified as major if either of the following apply, and the failure effect is Catastrophic, Hazardous or Major:
…
(2) the software is upgraded to or downgraded from Level A, Level B or Level C;

Taking into account the above considerations (introduction and comment #1) and due to the above duplication of the guidance, Embraer proposes to remove item (a).

#3- Items (d), (e) and (g) have redundant or unclear guidance.

Item (d) encompasses (g): a new development or verification tool can be understood a significant change in the environment or related processes; thus, Embraer proposes to remove item (g).

Criteria presented in item (e) seems to be unclear or inconsistent with items (d)/(g) and (c)/(f), when mentions "…adequately maintained and can still be used;", considering the existing guidance presented in section "Software Life Cycle Environment Control" of ED-12B (section 7.2.9) or ED-12C (section 7.5). Based on the existing guidance, Embraer proposes to remove item (e).

response

Accepted

Text has been changed accordingly. Resulting text of AMC 20-115C is presented in Appendix A.

Resulting text

CONCLUSION TO COMMENTS ON DRAFT DECISION −I.DRAFT DECISION AMC 20-115C

49 comments have been received on the proposed text of AMC 20-115C, virtually all proposing amendments.

41 of these comments have been at least partially accepted.
8 comments were noted, since their technical content appeared reasonable to the Agency, but not necessitating changes in the resulting text of AMC 20-115C.

No comments have been rejected.

The resulting text of AMC 20-115C is presented in Appendix A.

B. Draft Decision(s) - II. Draft Decision AMC 20-1   p. 28

comment

53   comment by: *FAA*

Comment: Paragraph 4.5.1, The potential for common mode design failures abound in the aircraft. The purpose of redundancy incorporated into systems design is not to compensate for design failures, but to compensate for potential random failures whose probabilities are less than the targets specified by

regulations and advisory material, or to prevent an accident due to a single random failure.

Recommendation: Delete section 4.5.1

Justification: Non-SW/AEH disciplines rely exclusively on design assurance as a means of assuring a satisfactory confidence that common mode design errors are acceptably small.

response	Accepted

The Agency apologizes for the mistake consisting in the use of edition 1 of AMC 20-1 (ref. Decision of the Executive Director ED 2003/12/RM_Final of 05 November2003) instead than edition 2 (ref. ED Decision 2007/019/R of 19 December 2007) as a basis for NPA 2012-11.

In this second edition any reference to EUROCAE/RTCA documents on software had already been deleted and 'old' par. 4.5.1 sharply shortened and replaced by 4(e), which reads:

'The acceptability of levels and methods used for development and verification of software and Programmable Logic Devices which are part of the Engine and Propeller type designs should have been agreed between the aircraft, Engine and Propeller designers prior to certification activity.'

Since the scope of RMT.0462 and related NPA 2011-11 was not to comprehensively revise AMC 20-1, but only to update possible reference to EUROCAE/RTCA documents on airborne software, and, since such references have already been removed from AMC 20-1, the Agency withdraws its proposal to amend AMC 20-1.

comment	*101* comment by: *Eurocopter*

The proposal is based on the initial issue of AMC 20-1, whereas AMC 20-1 has been amended in 2007 (Annex II to ED Decision 2007/019/R of 19/12/2007).

A new proposal based on the current issue is needed.

NOTE: Also notice that reference to Decision No. 2003/12/RM of 05 November 2003 on page 12 of the NPA, item 47, should be corrected.

response	Accepted

See response to comment 53 above. The Agency withdraws its proposal to amend AMC 20-1.

comment	*124* comment by: *Rolls-Royce plc (ZM)*

This section effectively recognises ED-12C/DO-178C as AMC for residual errors in the software potentially causing more than one engine to fail. It deletes the

reference back to DO-178A that talked about the "…current state of knowledge, the software disciplines…may not in themselves be sufficient to ensure the overall system safety…". However it keeps the intent and now rather than reference fly-by-wire, it explicitly references FADEC systems. The original clause in DO-178A has not been reflected in any of the subsequent issues. The first and second paragraphs appear to contradict each other.

Please provide additional clarification

response | Noted

See response to comment 53 above. The Agency withdraws its proposal to amend AMC 20-1.

Resulting text |
CONCLUSION TO COMMENTS ON DRAFT DECISION –II.DRAFT DECISION AMC 20-1

The Agency apologizes for the mistake consisting in the use of edition 1 of AMC 20-1 (ref. Decision of the Executive Director ED 2003/12/RM_Final of 05 November2003) instead than edition 2 (ref. ED Decision 2007/019/R of 19 December 2007 as a basis for NPA2012-11.

In this second edition any reference to EUROCAE/RTCA documents on software had already been deleted. Since the scope of RMT.0462 and related NPA 2011-11 was not to comprehensively revise AMC 20-1, but only to update possible reference to EUROCAE/RTCA documents on airborne software, and since such references have already been removed from AMC 20-1, **the Agency withdraws its proposal to amend AMC 20-1.**

As a consequence two of the three received comments have been accepted and the third noted.

B. Draft Decision(s) - III. Draft Decision AMC 20-2   p. 29

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comment | *52*   comment by: *FAA*

Comment: This document specifies minimum software assurance levels for specific applications. This determination should be left up to the SSA and FHA processes.

Recommendation: Do not specify minimum software assurance levels.

Justification: Leave the determination of software assurance levels to the responsible processes.

response	Not accepted
	ToR to RMT.0462 do not encompass this kind of change but only the introduction of references to ED-12C and related supplements, through AMC 20-115.
	The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

comment	*54*	comment by: *FAA*
	Comment: Section 4.3 (1st paragraph), We offer two comments and recommendations:	
	(1) The potential for common mode design failures abound in the aircraft. The purpose of redundancy incorporated into systems design is not to compensate for design failures, but to compensate for potential random failures whose probabilities are less than the targets specified by regulations and advisory material, or to prevent an accident due to a single random failure.	
	(2) Improper use of "DAL" terminology.	
	Recommendations:	
	(1) Delete section 4.3. If recommendation (1) is not accepted, then:	
	(2) Change sentence to: "The software associated with APU control, protection and monitoring functions must have a software level and architecture appropriate to the criticality of those functions (see paragraph 4.2)."	
	Justification:	
	(1) Non-SW/AEH disciplines rely exclusively on design assurance as a means of assuring a satisfactory confidence that common mode design errors are acceptably small.	
	(2) "DAL" is an undefined term.	
response	Partially accepted.	
	First comment is not accepted as the ToR of RMT.0462 do not encompass this kind of change but only the introduction of references to ED-12C and related supplements through AMC 20-115.	
	The Agency may issue in the future issue an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.	
	Second comment is accepted and text changed accordingly. Resulting text of AMC 20-2 is presented in Appendix B.	

| comment | *102* | comment by: *Eurocopter* |

"*The software associated with APU control, protection and monitoring functions must have a development assurance level (DAL) and architecture appropriate to the criticality of those functions (see paragraph 4.2).*"

Suggestion is to remove "(see paragraph 4.2)"

Justification: paragraph 4.2 of AMC 20-2 neither defines the APU control functions, nor it defines the concept of function criticality.

| response | Not accepted |

ToR of RMT.0462 do not encompass this kind of change but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

| comment | *103* | comment by: *Eurocopter* |

"*The APU software should be at least level B according to the industry documents referred in AMC 20-115. In some specific cases, level A may be more appropriate*."

First of all, it is surprising that a DAL be specified in the AMC, whereas a previous sentence states that the DAL shall be "*appropriate to the criticality of those functions*".

Also, it is not sure that transposing ED-12A/DO-178A levels 2 and 1 respectively to DAL B and A is adequate (as a counter example, AMC 20-3 proposes to replace DO-178A level 2 by DAL C).

We suggest removing this statement.

| response | Not accepted |

ToR of RMT.0462 do not encompass this kind of change but only the introduction of references to ED-12C and related supplements, through AMC20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

comment	*104*	comment by: *Eurocopter*

"*It should be noted that the software disciplines described in AMC 20-115 may not, in themselves, be sufficient to ensure that the overall system safety and reliability targets have been achieved. This is particularly true for certain critical systems, such as full authority digital control systems, In such cases it is accepted that other measures, usually within the system, in addition to a high level of software discipline, may be necessary to achieve these safety objectives and demonstrate that they have been met.*
It is outside the scope of AMC 20-115 to suggest or specify these measures, but in accepting that they may be necessary, it is also the intention to encourage the use of software techniques which could support meeting the overall system safety objectives."

The proposed change is correct. Nevertheless, a system safety approach (reference to ARP 4754A and ARP 4761) is missing in this text.

response	Not accepted

ToR of RMT.0462 do not encompass this kind of change but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

comment	*110*	comment by: *AIRBUS*

PROPOSED TEXT / COMMENT:

Delete the sentence: "The APU software should be at least level B according to the industry documents referred in AMC 20-115. In some specific cases, level A may be more appropriate."

RATIONALE / REASON / JUSTIFICATION:

It is previously stated within this proposed AMC 20-115C that the DAL shall be "appropriate to the criticality of those functions". The matter of "Development Assurance Level Assignment" in adequately framed within relevant Industry Documents (ED79A / ARP4754A, ...) and should not be assigned a priori within an AMC, independently of the product and analyses that govern DAL assignment as per those recognised Industry Documents.

response	Not accepted

ToR of RMT.0462 do not encompass this kind of change but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of

RMT.0561.

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comment | *116*   comment by: *Rolls-Royce plc (ZM)*

"Develement Assurance Level (DAL)" should read "Design Assurance Level (DAL)"

response | Partially accepted

The actual definition of DAL is 'Development Assurance Level'. However, the introduction of DAL in AMC 20-2 is inconsistent with the expression 'software level' used in ED-12C. Mention of 'Development Assurance Level' has consequently been suppressed in said AMC.

Resulting text of AMC 20-2 is presented in Appendix B.

Resulting text | **CONCLUSION TO COMMENTS ON DRAFT DECISION –III.DRAFT DECISION AMC 20-2**

Seven comments have been received on this segment of the NPA. Two were partially accepted.
The reason to reject the other five comments, was that ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-2, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

Resulting text of AMC 20-2 is presented in Appendix B.

B. Draft Decision(s) - IV. Draft Decision AMC 20-3   p. 30-33

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comment | *13*   comment by: *THALES Avionics*

THALES Avionics comments on P31 §10 b) SOFTWARE DESIGN AND IMPLEMENTATION/Approved Methods

"Software which is not developed using AMC 20-115 is referred to as legacy software."

THALES Avionics rewording proposal:

"Software which is not developed using **ED-12C+ED-215+supplements** *is referred to as legacy software."*

<u>Rationale</u>

Clarification replacing *AMC 20-115* by *ED-12C+ED-215+supplements.*

response	Partially accepted

AMC 20-115 is the only document the Agency would like to reference from other AMCs. This would avoid in the future the need to update multiple AMCs in case of advancement of the state of the art for software. Recognition of ED-12C (or subsequent editions) and associated supplements would then be present only in said AMC 20-115C.

It is, however, correct to state that 'legacy' software may have been developed according to an earlier edition of AMC 20-115C. The sentence in par. 10 b) of AMC 20-3 has been modified accordingly.

Resulting text of AMC 20-3 is presented in Appendix C.

comment	*14*	comment by:	*THALES Avionics*

<u>THALES Avionics comments on P31/32 §10 b) SOFTWARE DESIGN AND IMPLEMENTATION/Approved Methods</u>

"When legacy software is used in a new aircraft installation that requires AMC 20-115, the original approval of the legacy software is still valid, assuming equivalence to the required software level can be ascertained.
If the software equivalence is acceptable to the Agency, the legacy software can be used in the new installation that requires AMC 20-115 software. If equivalence cannot be substantiated, all the software changes should be assured using AMC 20-115.

 <u>THALES Avionics rewording proposal</u>:

"When legacy software is used in a new aircraft installation that requires **compliance to the latest edition of AMC 20-115**, *the original approval of the legacy software is still valid, assuming equivalence to the required software level can be ascertained.*
If the software equivalence is acceptable to the Agency, the legacy software can be used in the new installation that **requires compliance to the latest edition of AMC 20-115**. *If equivalence cannot be substantiated, all the software changes should be assured* ~~**using**~~ **showing compliance to the latest edition of AMC 20-115**.

<u>Rationale</u>
Clarification

response	Accepted

Text has been changed accordingly. Resulting text of AMC 20-3 is presented in

Appendix C.

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comment | *52* ❖   comment by: *FAA*

Comment: This document specifies minimum software assurance levels for specific applications. This determination should be left up to the SSA and FHA processes.

Recommendation: Do not specify minimum software assurance levels.

Justification: Leave the determination of software assurance levels to the responsible processes.

response | Not accepted

ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-3, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

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comment | *55*   comment by: *FAA*

Comment: (Pg 31, 4th paragraph, 1st bullet), Use of "DAL" terminology.

Recommendation: Use (software) "level" instead of "DAL."

Justification: "DAL" is not defined in the AMC.

response | Accepted

Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.

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comment | *56*   comment by: *FAA*

Comment: Paragraph (10)(b), States the following: "Software which is not developed using AMC 20-115 is referred to as legacy software." Legacy software is software that was developed using a version of the AMC 20-115 prior to the latest edition, AMC 20-115C.

Recommendation: Change to "Software which is developed using a version of the AMC 20-115 prior to the current recognized version is referred to as legacy software."

Justification: Definition of legacy software in draft AMC is incorrect.

response	Accepted
	Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.

comment	*57*	comment by: *FAA*
	Comment: Paragraph (1)(b) (2nd paragraph), This paragraph does not provide the criteria for legacy software as specified in Paragraph 8. This seems to be a contradiction. Also, how will reuse of development and verification tools be addressed in legacy software? Particularly, if a verification tool (in ED-12B) is used in context of a Criteria 2 tool (ED-12C)? Recommendation: Please clarify. Justification: For completeness.	
response	Accepted	
	Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.	

comment	*58*	comment by: *FAA*
	Comment: Paragraph (10)(d) (2nd to last paragraph), The listed software loading technologies (e.g., diskette, mass storage, etc.) are obsolete. Recommendation: Change to: "…(e.g., CF, SD, USB stick flash, etc.)…". Jusification: For currency.	
response	Noted	
	However, the comment leads to no changes of the proposed text of AMC 20-3, as the wording 'mass storage' includes also modern loading technologies such as USB stick, SD cards, etc.	

comment	*59*	comment by: *FAA*
	Comment: Bullet (e), Use of "design assurance level" for software, which is not defined.	

Recommendation: The words "design assurance" could just be deleted.

Justification: "design assurance" is not defined for software.

response | Accepted

Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.

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comment | *60*   comment by: *FAA*

Comment: Paragraph (10)(f) (2nd to last paragraph), The last sentence is somewhat confusing due to its negative perspective.

Recommendation: Change to: "…from adversely affecting Engine airworthiness, especially if the user modification is incorrectly implemented."

Justification: For clarity.

response | Accepted

Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.

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comment | *106*   comment by: *Eurocopter*

Page 31

"*If special EECS test software is used, that software should be developed and implemented by guidelines defined for software levels of at least DAL C as defined in the industry documents referred in the latest edition of AMC 20-115.*"

Specifying a DAL for test software is surprising. Not only the required assurance level of this test software should be defined considering the possible impact on the EECS software in case of inappropriate function or misbehaviour of this test software, but this should also be based on the tool qualification concepts and levels defined in ED-12C and ED-215.

Suggestion is to replace the sentence by the following one:

"*If special EECS test software is used, that software should be qualified according to the tool qualification guidance of ED-12C/DO-178C and ED-215/DO-330.*"

response | Not accepted

ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-3, but only the introduction of references to ED-12C and related supplements, through

AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

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comment | *107*   comment by: *Eurocopter*

§ (10), page 31

"… *an approved software development and verification processes* …"

English should be corrected (either "*an approved … process*" or "*approved … processes*").

response | Accepted

Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.

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comment | *108*   comment by: *Eurocopter*

§ (10), pages 31-32

"*Software which is not developed using AMC 20-115 is referred to as legacy software. In general, changes made to legacy software applicable to its original installation are assured in the same manner as in the original certification. When legacy software is used in a new aircraft installation that requires AMC 20-115, the original approval of the legacy software is still valid, assuming equivalence to the required software level can be ascertained. If the software equivalence is acceptable to the Agency, the legacy software can be used in the new installation that requires AMC 20-115 software. If equivalence cannot be substantiated, all the software changes should be assured using AMC 20-115.*"

As understood, "*legacy software*" was representing software not developed according to DO-178B, e.g. software developed according to DO-178 or DO-178A. If this understanding is correct, then having replaced "*DO-178B*" by "*AMC 20-115*" does not keep the original meaning of this paragraph.

response | Accepted

Text has been changed accordingly to better reflect the meaning. Resulting text of AMC 20-3 is presented in Appendix C.

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comment | *109*   comment by: *Eurocopter*

§ (10), page 32

In section "*(c) Level of software design assurance*", rationales for directly specifying DALs are missing, especially the reason for considering that a DAL C is sufficient in the case of a single-engine aircraft with a piston engine ("*in the case of a piston engine in a single-engine aircraft, level C (AMC 20-115) software has been found to be acceptable*").

response | Not accepted

ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-3, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

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comment | *117*   comment by: *Rolls-Royce plc (ZM)*

First bullet point - requires that test software should be developed to at least DAL C. Why would this be necessary for systems that may themselves have a DAL lower than C?

Clarify that the test software should be developed to a DAL appropriate for the criticality level of the system under test.

response | Not accepted

ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-3, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

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comment | *118*   comment by: *Rolls-Royce plc (ZM)*

First bullet point - the system design assurance levels are not defined in DO-178C or documents referred to by AMC 20-115

System design assurance levels are defined in ED-79/ARP-4754

response | Noted

However, the comment leads to no changes of the proposed text of AMC 20-3 as the software level are also listed in chapter 2 of ED-12C.

comment	*119*	comment by: *Rolls-Royce plc (ZM)*

The first sentence of the 2nd paragraph reads "Software which is not developed using" would be better as "Software which was not developed using"

response	Accepted

Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.

comment	*125*	comment by: *Rolls-Royce plc (ZM)*

Section IV. (10) (b) and Section I (8) seem to be inconsistent. Section IV (10) (b) still allows use of previous standards for modification to FADEC legacy software. (Quote from this section – "In general, changes made to legacy software applicable to its original installation are assured in the same manner as in the original certification." Section I (8) can be interpreted as requiring DO-178C to be applied to all changes to FADEC software.

Please provide additional clarification

response	Accepted

Text changed accordingly. Resulting text of AMC 20-3 is presented in Appendix C.

Resulting text	**CONCLUSION TO COMMENTS ON DRAFT DECISION –IV.DRAFT DECISION AMC 20-3**

17 comments have been received on this segment of the NPA.

11 comments have been partially accepted, two comments were noted and six comments were not accepted
Since ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-3, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

Resulting text of AMC 20-3 is presented in Appendix C.

B. Draft Decision(s) - V. Draft Decision AMC 20-4   p. 34

comment | *52* ❖   comment by: *FAA*

Comment: This document specifies minimum software assurance levels for specific applications. This determination should be left up to the SSA and FHA processes.

Recommendation: Do not specify minimum software assurance levels.

Justification: Leave the determination of software assurance levels to the responsible processes.

response | Not accepted

ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-3, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

comment | *61*   comment by: *FAA*

Comment: Annex 1, The acronym "(RAIM)" is not fully defined.

Recommendation: Change to: "GPS Receiver Autonomous Integrity Monitoring (RAIM) Prediction Program"

Justification: For correctness

response | Accepted

Text changed accordingly. Resulting text of AMC 20-4 is presented in Appendix D.

comment | *88*   comment by: *Boeing*

Page: 34

Paragraph:
- V. Draft Decision AMC 20-4 - Airworthiness Approval and Operational Criteria For the Use of Navigation Systems in European Airspace Designated For Basic RNAV Operations

- Annex 1, GPS Integrity Monitoring (RAIM) Prediction Program
- Paragraph 2

The proposed text states:

2. The prediction program software should be developed in accordance with at least ~~*RTCA DO-178B/EUROCAE 12B,*~~ *level D guidelines* **as defined in the industry documents referred in the latest edition of AMC 20-115**.

REQUESTED CHANGE: Retain the reference to EUROCAE ED-12()/RTCA DO-178() in the text.

JUSTIFICATION: This will allow continued use of previously qualified systems. Otherwise, such previously qualified systems will have to be unnecessarily recertified using AMC 20-115.

response | Noted

However, the comment leads to no changes of the proposed text of AMC 20-4 as the requested change is project specific and legacy systems are considered in ED-12C document referenced in AMC 20-115C.

Resulting text | **CONCLUSION TO COMMENTS ON DRAFT DECISION –V.DRAFT DECISION AMC 20-4**

Only three comments have been received on this segment of the NPA. One has been noted and one accepted.

The remaining comment was not accepted because ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-4, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

Resulting text of AMC 20-4 is presented in Appendix D.

B. Draft Decision(s) - VI. Draft Decision AMC 20-27   p. 35

comment | *52* ❖   comment by: *FAA*

Comment: This document specifies minimum software assurance levels for

specific applications. This determination should be left up to the SSA and FHA processes.

Recommendation: Do not specify minimum software assurance levels.

Justification: Leave the determination of software assurance levels to the responsible processes.

response	Not accepted ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-4, but only the introduction of references to ED-12C and related supplements, through AMC 20-115. The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

comment	*62*	comment by: *FAA*

Comment: The Format (spacing and dashes) of all listed documents is not consistent.

Recommendation: Change so all are consistent in usage of spaces and dashes.

Justification: For consistency.

response	Accepted Text changed accordingly. Resulting text of AMC 20-27 is presented in Appendix E.

comment	*89*	comment by: *Boeing*

Page: 35

Paragraph:
- VI. Draft Decision AMC 20-27 - Airworthiness Approval and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BAROVNAV Operations
- Paragraph 4.2.5 EUROCAE/RTCA, SAE and ARINC

The proposed text would delete references to EUROCAE ED-12()/RTCA DO-178().

REQUESTED CHANGE: Retain references to EUROCAE ED-12()/RTCA DO-178().

JUSTIFICATION: Retaining this reference will allow continued use of previously qualified systems. Otherwise, such previously qualified systems will

have to be unnecessarily recertified using AMC 20-115.

response	Noted
	However, the comment leads to no changes of the proposed text of AMC 20-27 as the requested change is project specific and legacy systems are considered in ED-12C document referenced in the AMC 20-115.

comment	*90* comment by: *Boeing*
	Page:35
	Paragraph: -VI. Draft Decision AMC 20-27 - Airworthiness Approval and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BAROVNAV Operations -Paragraph 6.4 Integrity
	The proposed text states:
	"Note 4: Traditionally, this requirement has not specifically addressed the airborne system operational software or airborne system databases (e.g. navigation database). However, it is expected that where the RNAV airborne software has been previously shown compliant with the criteria of ~~ED12B/DO178B,~~ *as a minimum Level C in the industry documents referred in the latest edition of AMC 20-115,* ~~as a minimum,~~ *it is acceptable for the operations associated with this AMC."*
	REQUESTED CHANGE: Retain existing language in AMC 20-27, Note 4, which states:
	"Note 4: Traditionally, this requirement has not specifically addressed the airborne system operational software or airborne system databases (e.g. navigation database). However, it is expected that where the RNAV airborne software has been previously shown compliant with the criteria of ED-12B/DO-178B, Level C, as a minimum, it is acceptable for the operations associated with this AMC."
	JUSTIFICATION: Retaining this reference will allow continued use of previously qualified systems. Otherwise, such previously qualified systems will have to be unnecessarily recertified using AMC 20-115.

response	Noted
	However, the comment leads to no changes of the proposed text of AMC 20-27 as the requested change is project specific and legacy systems are considered in ED-12C document referenced in the AMC 20-115.

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<td>Resulting text</td>
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CONCLUSION TO COMMENTS ON DRAFT DECISION –VI.DRAFT DECISION AMC 20-27

Four comments have been received on this segment of the NPA.

Two comments have been noted and one has been accepted.

The remaining comment was not accepted because ToR of RMT.0462 do not encompass comprehensive revision of AMC 20-4, but only the introduction of references to ED-12C and related supplements, through AMC 20-115.

The Agency may issue in the future an NPA to remove specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

Resulting text of AMC 20-27 is presented in Appendix E.

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V.   General conclusions on comments to NPA 2012-11

Based on the 122 comments received from 19 commentators and the individual responses to each of them, as contained in present CRD, the Agency concludes that:

- no stakeholder objected that option 2 (i.e. publish AMC 20-115C containing no more than five pages) preferred on the basis of the RIA, would be the way forward;

- in principle stakeholders agreed to recognise latest edition of EUROCAE Document ED-12C and associated material for software development, through issuing new edition C of AMC 20-115, however, asking for proper transition, including applicability of previous industry standards to changes to existing approved software;

- stakeholders also agreed that AMC 20-2, 20-3, 20-24 and 20-27 should be modified to refer to AMC 20-115C for software matters;

- the Agency therefore intends to adopt the proposed amendments to five mentioned AMCs in the revised text attached to this CRD;

- on the contrary, as advised by stakeholders, the Agency acknowledges that it is not necessary to amend AMC 20-1 .

In addition, the Agency to may issue in the future an NPA to remove mention of specific software level from AMC 20-2, AMC 20-3, AMC 20-4 and AMC 20-27, possibly in the context of RMT.0561.

The resulting text of the proposed draft AMCs is contained in Appendices A to E.

After two months given to stakeholders to react to this CRD if their comments were misinterpreted or not fairly taken into account, the Agency intends to progress towards the adoption and publication of the said AMCs, after the Decision of the Executive Director.

Appendix A – Resulting text of AMC 20-115C

AMC 20-115~~B~~C
~~**Recognition of Eurocae ED-12B / RTCA DO-178B**~~
Software considerations for certification of airborne systems and equipment

1 PURPOSE

This Acceptable Means of Compliance (AMC) provides a means that can be used to demonstrate that the safety aspects of software hosted on airborne systems and equipment comply with requirements for initial airworthiness in order to obtain an airworthiness approval, for applications filed after 01 January 2014.

Compliance with this AMC is not mandatory and hence an applicant may elect to use an alternative means of compliance. However, those alternative means of compliance must meet the relevant requirements, ensure an equivalent level of software safety and be approved by the European Aviation Safety Agency on a product basis. See paragraph 8 for changes to software whose application for approval has been filed before 01 January 2014.

In particular, the purpose of this AMC is to provide guidelines for the production of software for airborne systems and equipment that performs its intended function with a level of confidence in safety that complies with airworthiness requirements.

2 SCOPE

This AMC discusses those aspects of airworthiness certification that pertain to the production of software for airborne systems and equipment used on aircraft, engines, propellers, APU or others parts.

In discussing those aspects, the system life cycle and its relationship with the software life cycle are considered to aid in the understanding of the certification process.

Other system and software life cycle processes are out of scope of the present AMC. For instance, out of scope are:

- system safety assessment and validation processes at product level, in the context of initial airworthiness certification of aircraft and engines;
- software considerations for the verification of ground and space systems and constituents of Air Traffic Management (ATM)/Air Navigation Services (ANS);
- software considerations for services consisting of the origination and processing of data and formatting and delivering data to general air traffic for the purpose of safety-critical air navigation.

Since certification issues for initial airworthiness are discussed only in relation to the software life cycle, the operational aspects of the resulting software are not discussed. For example, the certification, approval and management aspects of user-modifiable data are beyond the scope of this AMC.

This AMC does not provide guidelines concerning the structure of the applicant's organisation, the relationships between the applicant and its suppliers, or how the responsibilities are divided.

Personnel qualification criteria are also beyond the scope of this AMC.

2 3 PROCEDURES; METHODS AND TOOLS FOR SOFTWARE CONSIDERATION

This AMC ~~acceptable means of compliance calls attention to~~ recognises that the European Organisation for Civil Aviation Equipment (EUROCAE) document ED-12~~B~~C, "Software Considerations in Airborne Systems and Equipment Certification", issued in January ~~December 1992~~ 2012, related guidance documents and supplements or equivalent RTCA Inc. documents, constitute an acceptable means of compliance for software (SW) aspects of certification that pertain to the production of software for airborne systems and equipment used on aircraft, engines, propellers and, by region, auxiliary power units. It discusses how the document may be applied to certification programmes administered by the European Aviation Safety Agency.

2 4 RELATED DOCUMENTS

4.1   EUROCAE document ED-12C, "Software Considerations in Airborne Systems and Equipment Certification", describes the acceptable processes to develop and verify SW for airborne systems and equipment.

4.2   ~~2.1~~ EUROCAE document ED-12~~B~~C is technically equivalent to RTCA Inc. document DO-178~~B~~C. A reference to one document, at the same revision level, may be interpreted to mean either document.

4.3   ED-12C/DO-178C guidance is extended with the following related documents and supplements:

- ED-94C/DO-248C "Supporting Information for ED-12C and ED-109A" ;

- ED-215/DO-330 "Software Tool Qualification Considerations";

- ED-216/DO-333 "Formal Methods Supplement to ED-12C and ED-109A";

- ED-217/DO-332 "Object-Oriented Technology and Related Techniques Supplement to ED-12C and ED-109A"; and

- ED-218/DO-331 "Model-based Development and Verification Supplement to ED-12C and ED-109A".

~~2.2~~ 4.4 The technical content of this AMC is as far as practicable ~~based on~~ similar to FAA AC 20-115~~-B, dated 11 January 1993~~ equally based on ED-12/DO-178.

3 5 RELATED CERTIFICATION SPECIFICATIONS (CSs)

Part 21, CS-22, CS-23, CS-25, CS-27, CS-29, CS-AWO, CS-E, CS-P, CS-APU, CS-ETSO and CS-VLA. Existing references to ED-12/DO-178, ~~and~~ ED-12A/DO-178A and ED-12B/DO-178B in the above CSs will be ~~amended, at the next opportunity, to take into account the principles spelt out in paragraph 6. below~~ replaced by reference to this AMC to provide a single source of regulatory material on airborne software development for airborne systems and equipment used on aircraft, engines, propellers and auxiliary power units.

4 6 BACKGROUND

4.1 EUROCAE document ED-12BC was developed to establish software considerations for ~~developers, installers and users when~~ the aircraft system or equipment developers ~~design is implemented~~ when the aircraft system and equipment design is developed using software based techniques. Current and future avionics designs ~~will~~ make extensive use of this technology. The EUROCAE document provides ~~guidelines~~ guidance for establishing ~~software level~~, software life cycle planning, development, verification, configuration management, ~~and~~ quality assurance and certification liaison processes ~~disciplines~~ to be used in software based systems.

The guidance provided in ED-12C is in the form of:

- Objectives for software life-cycle processes;

- Descriptions of activities and design considerations for achieving those objectives; and

- Descriptions of the evidence that indicates that the objectives have been satisfied.

ED-94C document was developed to provide supporting information and clarification of ED-12C.

ED-215 is a document that was developed to provide tool qualification guidance. ED-215 is invoked in ED-12C (section 12.2.3 Tool Qualification Process) and provides the objectives, activities, guidance, and life cycle data required for each Tool Qualification Level.

ED-216 is a supplement to ED-12C that was developed to provide specific guidance regarding Formal Methods.

ED-217 is a supplement to ED-12C that was developed to provide specific guidance regarding Object-Oriented Technology and Related Techniques. ED-217 Annex OO.D.2 introduced related techniques in the field of Object-Oriented Technology which may need to be considered.

ED-218 is a supplement to ED-12C that was developed to provide specific guidance regarding the techniques of Model-based Development and Verification.

Whenever one or more of the techniques addressed by these last three supplements is used in software based systems, the corresponding supplement or supplements to ED-12C should be applied in addition to ED-12C itself.

4.2 ~~The document~~ ED-12C and its related supplements ~~specifies~~ specify the information to be made available and/or delivered to the Agency. Guidance is also provided ~~also~~ for dealing with software developed to earlier standards, tool qualification and alternative methods that may be used.

5 7 USE OF EUROCAE ED-12BC AND RELATED DOCUMENTS AND SUPPLEMENTS ~~PROCEDURES~~

An applicant to EASA for product certification or ETSO authorisation ~~for EASA certification~~ for any software based equipment or system may use the considerations outlined in EUROCAE document ED-12BC and its related documents and applicable supplements, as a means, but not the only means, to secure approval. The Agency may publish acceptable means of compliance for specific CSs, stating the required relationship between the criticality of the software based systems and the software levels as defined in EUROCAE document ED-12BC. Such acceptable means of compliance will take precedence over the application of EUROCAE document ED-12BC.

6 8 USE OF PREVIOUS VERSIONS

Previous ED-12/~~DO-178 and ED-12A/DO-178A~~ versions may ~~will~~ continue to be accepted for modifications to the software of already approved systems and equipment where these have been accepted as the basis for approval or certification, provided that:

- the software level is not higher;
- the techniques described in the ED-12C supplements (MBD, OOTRT, Formal Methods) are not introduced into the new project; otherwise, ED-216 and/or ED-217 and/or ED-218 should be applied;
- the ETSO authorized article change is minor (see 21A.611);
- no new software criteria 1 or 2 tool qualification is needed; otherwise ED-215 should be applied;
- no new Parameter Data Item files are introduced.

Where a modification is made to an existing software-based equipment or system, and the criteria in this section indicate the use of ED-12C/DO-178C, these documents may apply, under justification, only to the software components affected by the modification.

For major change to ETSO authorised article, previous version may continue to be accepted under justification.

Previous ED-12 versions may continue to be accepted also for new applications, if filed before 01 January 2014.

Early coordination with EASA is strongly recommended to validate the above assumptions. Appropriate Certification Review Items might be raised if necessary.

~~7~~ 9 AVAILABILITY OF EUROCAE DOCUMENTS ~~ED-12B~~

Copies may be purchased from EUROCAE, ~~17 rue Hamelin, 75783 PARIS Cedex 16,~~ 102 rue Étienne Dolet, 92240 Malakoff , France, (Fax : 33 1 46 55 62 65 ~~4505 7230~~).

Appendix B – Resulting text of AMC 20-2

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4.3 *Precautions relating to APU control, protection and monitoring*

The software associated with APU control, protection and monitoring functions must have a ~~quality~~ software level and architecture appropriate to the~~ir~~ criticality of those functions (see paragraph 4.2).

For digital systems, any residual errors not ~~activated~~ detected during the software development and ~~certification~~ verification processes could cause an unacceptable failure. ~~(RTCA DO178A (or the equivalent EUROCAE ED 12A)~~ The latest edition of AMC 20-115 constitutes an acceptable means of compliance for software development, verification and software aspects of certification. The APU software should be at least level B~~2~~ according to ~~this~~ the industry documents referred in AMC 20-115. In some specific cases, level A~~1~~ may be more appropriate.

It should be noted ~~however that the DO178A states in paragraph 3.3 –~~
~~'It is appreciated~~ that~~, with the current state of knowledge,~~ the software disciplines described in ~~this document~~ AMC 20-115 may not, in themselves, be sufficient to ensure that the overall system safety and reliability targets have been achieved. This is particularly true for certain critical systems, such as full authority ~~fly-by-wire~~ digital control systems, In such cases it is accepted that other measures, usually within the system, in addition to a high level of software discipline, may be necessary to achieve these safety objectives and demonstrate that they have been met.

It is outside the scope of ~~this document~~ AMC 20-115 to suggest or specify these measures, but in accepting that they may be necessary, it is also the intention to encourage the ~~development~~ use of software techniques that could support meeting the overall system safety objectives.~~'~~

…

Appendix C – Resulting text of AMC 20-3

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(3) RELEVANT SPECIFICATIONS AND REFERENCE DOCUMENTS

Although compliance …

…

The following documents are referenced in this AMC 20-3:

- International Electrotechnical Commission (IEC), Central Office, 3, rue de Varembé, P.O. Box 131, CH - 1211 GENEVA 20, Switzerland
    - IEC/PAS 62239, Electronic Component Management Plans, edition 1.0, dated April 2001.
    - IEC/PAS 62240, Use of Semiconductor Devices Outside Manufacturers' Specified Temperature Ranges, edition 1.0, dated April 2001.
- RTCA, Inc. 1828 L Street, NW, Suite 805, Washington, DC 20036 or EUROCAE, 17, rue Hamelin, 75116 Paris, France
    - ~~RTCA DO-178A/EUROCAE ED-12A, Software Considerations in Airborne Systems and Equipment Certification, dated March 1985~~
    - ~~RTCA DO-178B/EUROCAE ED-12B, Software Considerations in Airborne Systems and Equipment Certification, dated December 1, 1992~~
    - RTCA DO-254/ EUROCAE ED-80, Design Assurance Guidance for Airborne Electronic Hardware, dated April 19, 2000.
- AMC 20-115 on software considerations for certification of airborne systems and equipment.

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(6) SYSTEM DESIGN AND VALIDATION

(a) Control Modes - General

…

(e) Environmental conditions

…

   (i)   Declared levels

       …

   (ii)   Test procedures

     (A) General

      …

     (B) Open loop and Closed loop Testing

HIRF and lightning tests should be conducted as system tests on closed loop or open loop laboratory set-ups.

The closed loop set-up is usually provided with hydraulic pressure to move actuators to close the inner actuating loops. A simplified Engine simulation may be used to close the outer Engine loop.

Testing should be conducted with the Engine Control System controlling at the most sensitive operating point as selected and detailed in the test plans by the applicant. The system should be exposed to the HIRF and lightning environmental threats while operating at the selected condition. There may be a different operating point for HIRF and lightning environmental threats.

For tests in open and closed loop set ups, the following factors should also be considered:

- If special EECS test software is used, that software should be developed and implemented by guidelines defined for software levels of at least ~~Level 2 in DO-178A, Level~~ software level C ~~in DO-178B, or equivalent~~ as defined in the industry documents referred in the latest edition of AMC 20-115. In some cases, the application code is modified to include the required test code features.

- The system test set-up should be capable of monitoring both the output drive signals and the input signals.

- Anomalies observed during open loop testing on inputs or outputs should be duplicated on the Engine simulation to determine whether the resulting power or thrust perturbations comply with the pass/fail criteria.

…

(10) SOFTWARE DESIGN AND IMPLEMENTATION

(a) Objective

For Engine Control Systems that use software, the objective of CS-E 50 (f) is to prevent as far as possible software errors that would result in an unacceptable effect on power or thrust, or any unsafe condition.

It is understood that it may be impossible to establish with certainty that the software has been designed without errors. However, if the applicant uses the software level appropriate for the criticality of the performed functions and uses ~~an~~ approved software development and verification processes ~~method~~, the Agency would consider the software to be compliant with the requirement to minimise errors. In multiple Engine installations, the possibility of software errors common to more than one Engine Control System may determine the criticality level of the software.

(b) Approved Methods

Methods for developing software, compliant with the guidelines contained in the latest edition of AMC 20-115 ~~documents RTCA DO-178A/EUROCAE ED-12A and RTCA DO-178B/EUROCAE ED-12B, hereafter referred to as DO-178A and DO-178B, respectively,~~ are acceptable methods. Alternative methods for developing and verifying software may be proposed by the applicant and are subject to approval by the Agency.

Software which ~~is~~ was not developed using ~~DO-178B~~ the version of ED-12 referenced in the latest edition of AMC 20-115 is referred to as legacy software. In general, changes made to legacy software applicable to its original installation are assured in the same manner as in the original certification. When legacy software is used in a new aircraft installation that requires ~~DO-178B~~ the latest edition of AMC 20-115, the original approval of the legacy software is still valid, assuming equivalence to the required software level can be ascertained. If the software equivalence is acceptable to the Agency taking into account the conditions defined in the latest edition of AMC 20-115, the legacy software can be used in the new installation that requires ~~DO-178B~~ AMC 20-115 software. If equivalence cannot be substantiated, all the software

changes should be assured ~~using~~ through the use of ~~DO-178B~~ the latest edition of AMC 20-115.

(c) Level of software design assurance

In multiple Engine installations, the design, implementation and verification of the software in accordance with ~~Level 1 (DO-178A) or~~ Level A (~~DO-178B~~ as defined in the industry documents referred in the latest edition of AMC 20-115) is normally needed to achieve the certification objectives for aircraft to be type certificated under CS-25, CS-27-Category A and CS-29-Category A.

The criticality of functions on other aircraft may be different, and therefore, a different level of software ~~design~~ development assurance may be acceptable. For example, in the case of a piston engine in a single-engine aircraft, level C (~~DO-178B~~ as defined in the industry documents referred in the latest edition of AMC 20-115) software has been found to be acceptable.

Determination of the appropriate software level may depend on the Failure modes and consequences of those Failures. For example, it is possible that Failures resulting in significant thrust or power increases or oscillations may be more severe than an Engine shutdown, and therefore, the possibility of these types of Failures should be considered when selecting a given software level.

It may be possible to partition non-critical software from the critical software and design and implement the non-critical software to a lower level as defined by the ~~RTCA~~ industry documents referred in AMC 20-115. The adequacy of the partitioning method should be demonstrated. This demonstration should consider whether the partitioned lower software levels are appropriate for any anticipated installations. Should the criticality level be higher in subsequent installations, it would be difficult to raise the software level.

(d) On-Board or Field Software Loading and Part Number Marking

The following guidelines should be followed when on-board or field loading of Electronic Engine Control software and associated Electronic Part Marking (EPM) is implemented.

For software changes, the software to be loaded should have been documented by an approved design change and released with a service bulletin.

For an EECS unit having separate part numbers for hardware and software, the software part number(s) need not be displayed on the unit as long as the software part number(s) is(are) embedded in the loaded software and can be verified by electronic means. When new software is loaded into the unit, the same verification requirement applies and the proper software part number should be verified before the unit is returned to service.

For an EECS unit having only one part number, which represents a combination of a software and hardware build, the unit part number on the nameplate should be changed or updated when the new software is loaded. The software build or version number should be verified before the unit is returned to service.

The configuration control system for an EECS that will be on-board/field loaded and using electronic part marking should be approved. The drawing system should provide a compatibility table that tabulates the combinations of hardware part numbers and software versions that have been approved by the Agency. The top-level compatibility table should be under configuration control, and it should be updated for each change that affects hardware/software combinations. The applicable service bulletin should define the hardware configurations with which the new software version is compatible.

The loading system should be in compliance with the guidelines of ~~DO-178B~~ AMC 20-115.

If the applicant proposes more than one source for loading, (e.g., diskette, mass storage, etc.), all sources should comply with these guidelines.

The service bulletin should require verification that the correct software version has been loaded after installation on the aircraft.

(e) Software Change Category

The processes and methods used to change software should not affect the ~~design assurance level~~ software level of that software. For classification of software changes, refer to §4 in Appendix A of GM 21A.91.

(f) Software Changes by Others than the TC Holder

There are two types of potential software changes that could be implemented by someone other than the original TC holder:

    option-selectable software, or

    user-modifiable software (UMS).

Option-selectable changes would have to be pre-certified utilising a method of selection which has been shown not to be capable of causing a control malfunction.

UMS is software intended for modification by the aircraft operator without review by the certification authority, the aircraft applicant, or the equipment vendor. For Engine Control Systems, UMS has generally not been applicable. However, approval of UMS, if required, would be addressed on a case-by-case basis.

~~The necessary guidance for UMS is contained in DO-178B, paragraph 2.4. In essence, it conveys the position that~~ In principle, persons other than the TC holder may modify the software within the modification constraints defined by the TC holder, if the system has been certified with the provision for software user modifications. To certify an Electronic Engine Control System with the provision for software modification by persons other than the TC holder, the TC holder should (1) provide the necessary information for approval of the design and implementation of a software change, and (2) demonstrate that the necessary precautions have been taken to prevent the user modification from adversely affecting Engine airworthiness, especially if ~~whether~~ the user modification is incorrectly implemented ~~or not~~.

In the case where the software is changed in a manner not pre-allowed by the TC holder as "user modifiable", the "non-TC holder" applicant will have to comply with the requirements given in Part 21, subpart E.

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Appendix D – Resulting text of AMC 20-4

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2 SCOPE

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Related ~~navigation~~ documents

    <u>EASA Acceptable means of Compliance</u>

    AMC 25-11   Electronic Display Systems

    AMC 20-5   Acceptable Means of Compliance for Airworthiness Approval and Operational Criteria for the use of the NAVSTAR Global Positioning System (GPS)

    AMC 20-115() Software considerations for certification of airborne systems and equipment

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ANNEX 1
GPS Integrity Monitoring (RAIM) Prediction Program
Where a GPS Receiver Autonomous Integrity Monitoring (RAIM) Prediction Program is used as a means of compliance with paragraph 5.2(a) of this document, it should meet the following criteria:

1. The program should provide prediction of availability of the integrity monitoring (RAIM) function of the GPS equipment, suitable for conducting Basic RNAV operations in designated European airspace.

2. The prediction program software should be developed in accordance with at least ~~RTCA DO 178B/EUROCAE 12B,~~ level D guidelines as defined in the industry documents referred in the latest edition of AMC 20-115.

3. The program should use either a RAIM algorithm identical to that used in the airborne equipment, or an algorithm based on assumptions for RAIM prediction that give a more conservative result.

4. The program should …

Appendix E – Resulting text of AMC 20-27

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4.2.2 EASA

AMC 25-11	Electronic Flight Deck Display
AMC 20-5	Airworthiness Approval and Operational Criteria for the use of the Navstar Global Positioning System (GPS)
AMC 20-115()	Software considerations for certification of airborne systems and equipment
ETSOC115()	Airborne Area Navigation Equipment using Multi-Sensor Inputs
ETSOC129()	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
ETSOC145()	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)
ETSOC146()	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)
ETSOC106()	Air Data Computer
EASA OPINION	Nr. 01/2005 Conditions for Issuance of Letters of Acceptance for Navigation Database Suppliers by the Agency (i.e. an EASA Type 2 LoA). EASA OPINION Nr. 01/2005 on "The Acceptance of Navigation Database Suppliers" dated 14 Jan 05

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4.2.5 EUROCAE/RTCA, SAE and ARINC

ED 26	MPS for airborne Altitude measurements and coding systems
ED 72A	Minimum Operational Performance Specification for Airborne GPS Receiving Equipment
ED75()/DO236()	Minimum Aviation System Performance Standards: Required Navigation Performance for Area Navigation
ED76/DO200A	Standards for Processing Aeronautical Data
~~ED12()/DO178()~~	~~Software considerations in airborne systems and equipment certification~~
ED77/DO201A	Standards for Aeronautical Information
DO 88	Altimetry
DO 187	Minimum operational performances standards for airborne area navigation equipment using multi-sensor inputs
DO 208	Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)
DO229()	Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne equipment
ARINC 424	Navigation System Data Base
ARINC 706	Mark 5 Air Data System

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6.4 Integrity

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Note 4: Traditionally, this requirement has not specifically addressed the airborne system operational software or airborne system databases (e.g. navigation database). However, it is expected that where the RNAV airborne software has been previously shown compliant with the criteria of ~~ED12B/DO178B,~~ as a minimum Level C in the industry documents referred in the latest edition of AMC 20-115, ~~as a minimum~~, it is acceptable for the operations associated with this AMC.
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Appendix F - Attachments

Cessna_Response.pdf
Attachment #1 to comment [#105](#105)