

AMC 20-115D**Airborne Software Development Assurance Using EUROCAE ED-12 and RTCA DO-178****Contents**

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- 1. Purpose**
 - a.** This AMC describes an acceptable means, but not the only means, for showing compliance with the applicable airworthiness regulations with regard to the software aspects of airborne systems and equipment in the domain of product certification or European technical standard orders (ETSOs) authorisation. Compliance with this AMC is not mandatory and therefore an applicant may elect to use an alternative means of compliance (AltMoC). However, the AltMoC must meet the relevant requirements, ensure an equivalent level of software safety as this AMC, and be approved by the European Aviation Safety Agency (EASA) on a product or ETSO article basis.
 - b.** This AMC recognises the following European Organisation for Civil Aviation Equipment (EUROCAE) and Radio Technical Commission for Aeronautics (RTCA) documents:
 1. EUROCAE ED-12C, Software Considerations in Airborne Systems and Equipment Certification, 1 January 2012, and RTCA DO-178C, Software Considerations in Airborne Systems and Equipment Certification, 13 December 2011;

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2. EUROCAE ED-215, Software Tool Qualification Considerations, 1 January 2012, and RTCA DO-330, Software Tool Qualification Considerations, 13 December 2011;
3. EUROCAE ED-216, Formal Methods Supplement to ED-12C and ED-109A, 1 January 2012, and RTCA DO-333, Formal Methods Supplement to DO-178C and DO-278A, 13 December 2011;
4. EUROCAE ED-217, Object-Oriented Technology and Related Techniques Supplement to ED-12C and ED-109A, 1 January 2012, and RTCA DO-332, Object-Oriented Technology and Related Techniques Supplement to DO-178C and DO-278A, 13 December 2011; and
5. EUROCAE ED-218, Model-Based Development and Verification Supplement to ED-12C and ED-109A, 1 January 2012, and RTCA DO-331, Model-Based Development and Verification Supplement to DO-178C and DO-278A, 13 December 2011.

Note: EUROCAE ED is hereinafter referred to as 'ED'; RTCA DO is hereinafter referred to as 'DO'. Where the notation 'ED-XXX/DO-XXX' appears in this document, the referenced documents are recognised as being equivalent.

c. This AMC identifies the following as supporting documents:

- ED-94C, Supporting Information for ED-12C and ED-109A, 1 January 2012; and
- DO-248C, Supporting Information for DO-178C and DO-278A, 13 December 2011.

ED-94C/DO-248C contains a collection of frequently asked questions (FAQs) and discussion papers (DPs) compiled and approved by the authors of ED-12C and DO-178C to provide clarification of the guidance contained in ED-12C/DO-178C.

- d.** References to the use of ED-12C/DO-178C in this AMC include the use of ED-215/DO-330 and supplements ED-216/DO-333, ED-217/DO-332 and ED-218/DO-331, as applicable.
- e.** This AMC establishes guidance for using existing ED-12B/DO-178B processes for new software development.
- f.** This AMC also establishes guidance for transitioning to ED-12C/DO-178C when making modifications to software previously approved using ED-12/DO-178, ED-12A/DO-178A, or ED-12B/DO-178B.

2. Applicability

This AMC applies to applicants, design approval holders (DAHs), and developers of airborne systems and equipment containing software to be installed on type-certified aircraft, engines, and propellers, or to be used in ETSO articles.

3. Replacement

This AMC replaces and cancels AMC 20-115C, Software Considerations in Airborne Systems and Equipment Certification, 12 September 2013.

4. Background

- a.** ED-12C/DO-178C, Appendix A, Section 3, provides a summary of the differences between ED-12C/DO-178C and ED-12B/DO-178B. The EUROCAE and RTCA Inc. documents listed in subparagraph 1.b. of this AMC provide guidance for establishing software life cycle planning,

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development, verification, configuration management, quality assurance and certification liaison processes to be used in the development of software for airborne systems. The guidance provided in these documents is in the form of:

1. objectives for software life cycle processes;
 2. activities that provide a means for satisfying the objectives; and
 3. descriptions of the evidence indicating that the objectives have been satisfied.
- b.** The technical content of this AMC is, as far as practicable, harmonised with Federal Aviation Administration (FAA) AC 20-115D, which is also based on ED-12C/DO-178C.

5. Using ED-12B/DO-178B processes and procedures for new software development

- a.** Applicants who have established software development assurance processes using ED-12B/DO-178B may continue to use those processes (including tool qualification processes) for new software development and certification projects, provided that the following criteria are met:
1. The software development assurance processes are shown to have no known process deficiencies, such as those discovered during internal or external audits or reviews, or identified in open problem reports (OPRs), resulting in non-satisfaction of one or more ED-12B/DO-178B objectives. Evidence of resolution and closure of all process-related OPRs and of all process-related audit or review findings may be requested.
 2. The processes were previously used to develop software that was used in a certified product at a software level at least as high as the software level of the software to be developed.
 3. If model-based development (MBD), object-oriented technology (OOT), or formal methods (FMs) are to be used, existing processes incorporating these methods should have been evaluated and found to be acceptable by EASA on a previous certified project. These processes should have been developed in accordance with EASA guidance specific to the technique, such as that contained in an associated certification review item (CRI) or a published certification memorandum (CM).
 4. If configuration data is used, as defined in ED-12C/DO-178C under 'Parameter data item', existing processes for such data should have been evaluated and found to be acceptable by EASA on a previous certified project. In the absence of processes for using configuration data, the applicant should establish new processes for using PDIs in accordance with ED-12C/DO-178C.
 5. There are no significant changes to the software processes described in the plans or to the software development environment. This should be supported through analysis of the changes to the previously accepted software development processes and environment.
 6. The applicant does not intend to declare the proposed software as having satisfied ED-12C/DO-178C.
- b.** If the criteria of subparagraph 5.a. are not met, the applicant should upgrade their processes and develop the new software using ED-12C/DO-178C; tool qualification processes should be addressed in accordance with Section 12.2 of ED-12C/DO-178C and paragraph 10(c) of this AMC.
- c.** Applicants or developers should establish new software life cycle processes in accordance with ED-12C/DO-178C.

6. Using EUROCAE ED-12C and RTCA DO-178C

ED-12C/DO-178C is an acceptable means of compliance (AMC) with regard to the software aspects of product certification or ETSOs authorisation. When using ED-12C/DO-178C, the following should apply:

- a. The applicant should satisfy all of the objectives associated with the software level assigned to the software, and develop all of the associated life cycle data to demonstrate compliance with the applicable objectives, as listed in the Annex A tables of ED-12C/DO-178C and, where applicable, of ED-215/DO-330, ED-216/DO-333, ED-217/DO-332, and ED-218/DO-331. The applicant should plan and execute activities that satisfy each objective.
- b. The applicant should submit to EASA the life cycle data specified in Section 9.3 of ED-12C/DO-178C, and Section 9.0 a. of ED-215/DO-330, as applicable to tool qualification. It is the applicant's responsibility to perform the planned activities and produce the life cycle data necessary to satisfy all the applicable objectives.
- c. Section 9.4 of ED-12C/DO-178C specifies the software life cycle data related to the type design of the certified product. However, not all of the specified data applies to all software levels; specifically the design description and the source code are not part of the type design data for Level D software.
- d. The applicant should make available to EASA, upon request, any of the data described in Section 11 of ED-12C/DO-178C, applicable tool qualification data, data outputs from any applicable supplements, and any other data needed to substantiate the satisfaction of all the applicable objectives.
- e. EASA may publish an AMC to specific certification specifications (CSs), stating the required relationship between the criticality of the software-based systems and the software levels, as defined in ED-12C/DO-178C. Such AMC takes precedence over the application of Section 2.3 of ED-12C/DO-178C.

7. Reserved**8. Guidance applicable to ED-12B/DO-178B or ED-12C/DO-178C****a. The use of supplements with ED-12C/DO-178C**

The applicant should apply the guidance of supplements to ED-216/DO-333, ED-217/DO-332 and ED-218/DO-331 when incorporating the addressed software development techniques. If the applicant intends to use multiple software development techniques together, more than one supplement applies. The applicant should not use supplements as stand-alone documents.

1. When using one or more supplements, the applicant's plan for software aspects of certification (PSAC) should describe:
 - a. how the applicant applies ED-12C/DO-178C and the supplement(s) together; and
 - b. how the applicant addresses the applicable ED-12C/DO-178C objectives and those added or modified by the supplement(s): which objectives from which documents apply to which software components, and how the applicant's planned activities satisfy all the applicable objectives.

2. If the applicant intends to use any techniques addressed by the supplements to develop a qualified tool (for tool qualification levels (TQLs) 1, 2, 3, and 4 only), then the tool qualification plan (TQP) should describe:
 - a. based on supplement analysis, which tool qualification objectives are affected by the use of the technique(s); and
 - b. how the planned activities satisfy the added or modified objectives.
3. The intent of this subparagraph is to provide clarification of Section MB.6.8.1 of ED-218/DO-331. If the applicant uses models as defined in Section MB.1.0 of ED-218/DO-331 as the basis for developing software, the applicant should apply the guidance of ED-218/DO-331. When applying Section MB.6.8.1 of ED-218/DO-331, the applicant should do the following:
 - a. identify which review and analysis objectives are planned to be satisfied by simulation alone or in combination with reviews and analyses; all other objectives should be satisfied by reviews and analyses, as described in Section MB.6.3 of ED-218/DO-331; and
 - b. for each identified objective, justify in detail how the simulation activity, alone or in combination with reviews and analyses, fully satisfies the specific review and analysis objective.

b. Guidance on field-loadable software (FLS)

This Section supplements ED-12C/DO-178C and ED-12B/DO-178B. The applicant should use this guidance in addition to ED-12C/DO-178C and ED-12B/DO-178B when using FLS in their project.

1. As the developer, the applicant should provide the necessary information to support the system-level guidance identified in items a, b, c and d of ED-12C/DO-178C, Section 2.5.5, and items a, b, c and d of ED-12B/DO-178B, Section 2.5.
2. The FLS should be protected against corruption or partial loading at an integrity level appropriate for the FLS software level.
3. The FLS part number, when loaded in the airborne equipment, should be verifiable by appropriate means.
4. Protection mechanisms should be implemented to prevent inadvertent enabling of the field-loading function during cruising or any other safety-critical phase.

c. Guidance on user-modifiable software (UMS)

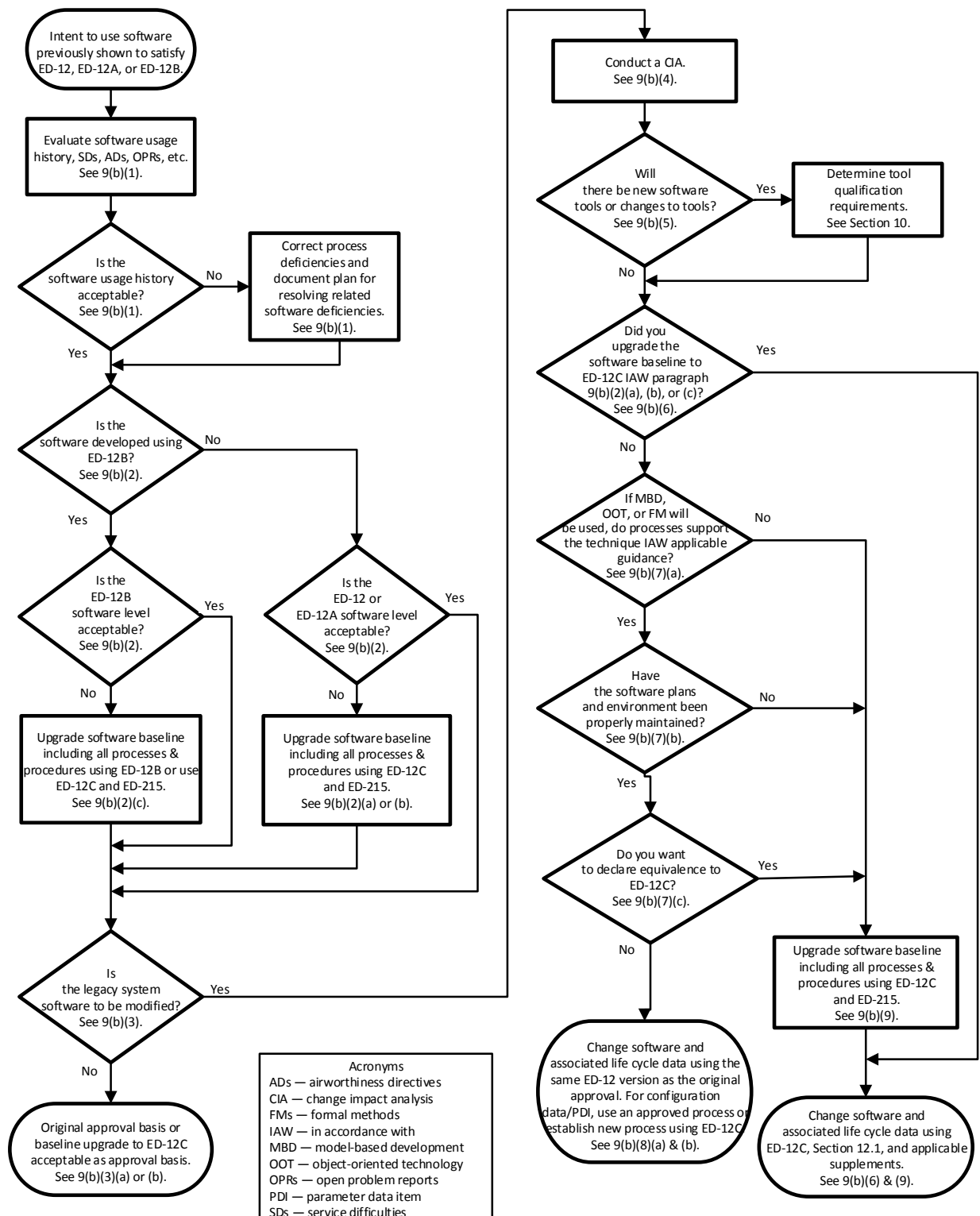
This Section supplements ED-12C/DO-178C and ED-12B/DO-178B. The applicant should use this guidance in addition to ED-12C/DO-178C and ED-12B/DO-178B when using UMS in their project.

1. As the developer, the applicant should provide the necessary information to support the system-level guidance identified in items a, b, c and f of ED-12C/DO-178C, Section 2.5.2, and items a and b of ED-12B/DO-178B, Section 2.4.
2. The modifiable part of the software should be developed at a software level at least as high as the software level assigned to that software.

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- 9. Modifying and reusing software approved using ED-12/DO-178, ED-12A/DO-178A, or ED-12B/DO-178B**
- a.** EASA previously approved the software for many airborne systems using ED-12/DO-178, ED-12A/DO-178A, or ED-12B/DO-178B as a means of compliance. In this AMC, reference to legacy software includes the previously approved software or component(s) that makes up the software used in legacy systems. In this subparagraph, it is described how to demonstrate compliance with the software aspects of certification for an application that includes modifications to legacy software or the use of unmodified legacy software.
- b.** Figure 1 presents a flow chart for using legacy software. The applicant should use the flow chart while following the procedures in this subparagraph if the applicant modifies or reuses legacy software. Although these procedures apply to the majority of projects, the applicant should coordinate with EASA any cases that do not follow this flow.

Figure 1 — Legacy software process flow chart



Note: references to RTCA documents are intentionally omitted for formatting purposes.

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1. The applicant should assess the legacy software to be modified or reused for its usage history from previous installations. If the software has safety-related service difficulties, airworthiness directives, or OPRs with a potential safety impact on the proposed installation, the applicant should establish plans to resolve all related software deficiencies. Prior to modifying or reusing the legacy software, the applicant should correct any related development process deficiencies, such as those discovered during internal or external audits or reviews, or identified in OPRs resulting in non-satisfaction of one or more ED-12B/DO-178B objectives. Evidence of resolution and closure of all process-related OPRs and of all process-related audit or review findings may be requested.
2. The system safety process assigns the minimum development assurance level based on the severity classifications of failure conditions for a given function. The ED-12B/DO-178B software levels are consistent with the ED-12C/DO-178C software levels. However, ED-12/DO-178 and ED-12A/DO-178A were published prior to the establishment of the software levels addressed in ED-12B/DO-178B and ED-12C/DO-178C. The applicant should use Table 1 to determine whether their legacy software level satisfies the software level assigned by the system safety process for the proposed installation. A '✓' in the intersection of the row and column indicates that the legacy software level is acceptable. For example, legacy software with development assurance for ED-12A/DO-178A software Level 2 can be considered to satisfy software Levels B, C, and D. A blank indicates that the software level is not acceptable. Therefore, the ED-12A/DO-178A software developed for software Level 2 would not be acceptable where software Level A is required.

Table 1 — Software level relationships

Assigned software level	Legacy software level per ED-12B				Legacy software level per ED-12A			Legacy software Level per ED-12		
	A	B	C	D	1	2	3	Critical	Essential	Non-Essential
A	✓				✓			✓		
B	✓	✓			✓	✓		✓		
C	✓	✓	✓		✓	✓		✓	✓	
D	✓	✓	✓	✓	✓	✓		✓	✓	

- a. If the legacy software was developed at software level 'Essential' using ED-12/DO-178 and was previously accepted by the certification authority as acceptable for software Level B, it remains acceptable for the new project. If the ED-12/DO-178 legacy software was not previously assessed, or the software level is not acceptable, then the applicant should upgrade the software development baseline, including all processes and procedures (as well as tool qualification processes), using Section 12.1.4 of ED-12C/DO-178C, and ED-215/DO-330.
- b. If the legacy software was developed using ED-12A/DO-178A, and the software level is not acceptable, the applicant should upgrade the software development baseline, including all

- processes and procedures (as well as tool qualification processes), using Section 12.1.4 of ED-12C/DO-178C, and ED-215/DO-330.
- c. If the legacy software was developed using ED-12B/DO-178B, and the software level is not acceptable, the applicant should upgrade the software development baseline, including all processes and procedures (as well as tool qualification processes), using Section 12.1.4 of ED-12B/DO-178B or ED-12C/DO-178C, and ED-215/DO-330.
3. If the criteria of 9(b)(1) and 9(b)(2) are satisfied and modifications to the software are not required, then:
 - a. the original approval may serve as the basis for the software in the installation approval of the proposed system; and
 - b. if the applicant upgraded the software development baseline using ED-12C/DO-178C and updated all processes and procedures, as well as tool qualification processes, to ED-12C/DO-178C and ED-215/DO-330, then the applicant may declare their software as equivalent to satisfying ED-12C/DO-178C; however, the applicant cannot declare their unmodified tools as equivalent to satisfying ED-12C/DO-178C and ED-215/DO-330. The applicant should make all subsequent modifications to all their software and tools using their processes and procedures that satisfy ED-12C/DO-178C and ED-215/DO-330.
 4. If modifications to the software are required, the applicant should conduct a software change impact analysis (CIA) to determine the extent of the modifications, the impact of those modifications, and what verification is required to ensure that the modified software performs its intended function and continues to satisfy the identified means of compliance. The applicant should:
 - a. identify the software changes to be incorporated and conduct a CIA consisting of one or more analyses associated with the software change, as identified in ED-12C/DO-178C, Section 12.1;
 - b. conduct the verification, as indicated by the CIA; and
 - c. summarise the results of the CIA in the plan for software aspects of certification (PSAC) or in the software accomplishment summary (SAS).
 5. If new software tools or modifications to tools are needed, please refer to paragraph 10 of this AMC to determine the tool qualification requirements.
 6. If the applicant upgraded the software baseline to ED-12C/DO-178C in accordance with subparagraph 9(b)(2), they should make all modifications to the software using ED-12C/DO-178C, Section 12.1. If the applicant wants to declare their software as equivalent to satisfying ED-12C/DO-178C, the applicant's equivalence declaration applies to both modified and unmodified software and is valid even if the applicant uses unmodified tools that have not been qualified using ED-12C/DO-178C. However, the applicant cannot declare their unmodified tools as equivalent to satisfying ED-12C/DO-178C and ED-215/DO-330. All subsequent modifications to all their software and tools are to be made using processes and procedures satisfying ED-12C/DO-178C and ED-215/DO-330.

7. If the applicant wants to use their existing processes to make modifications to their legacy software using the version of ED-12/DO-178 (i.e. ED-12/DO-178, ED-12A/DO-178A, or ED-12B/DO-178B) used for the original software approval, the applicant may do so, provided that all of the following conditions are met:
 - a. If MBD, OOT, or FMs are to be used, existing processes incorporating these methods should have been evaluated and found to be acceptable by EASA on a previous certified project. These processes should have been developed in accordance with EASA guidance specific to the technique, such as that contained in an associated CRI or a published CM.
 - b. The applicant has maintained, and can still use, the software plans, processes, and life cycle environment, including improvements to processes or to the life cycle environment as captured in revised plans.
 - c. The applicant does not intend to declare the proposed software as satisfying ED-12C/DO-178C.
8. If the conditions of subparagraph 9(b)(7) are satisfied:
 - a. the applicant may accomplish all modifications to the software using the same ED-12/DO-178 version as for the original approval. However, the applicant may not declare their software as equivalent to satisfying ED-12C/DO-178C; and
 - b. if configuration data is used, as defined under 'Parameter data item' in ED-12C/DO-178C, the applicant may use existing processes for such data if the processes were evaluated and found to be acceptable by EASA on a previous certified project; in the absence of processes for using configuration data, the applicant should establish new processes for using parameter data items (PDIs) in accordance with ED-12C/DO-178C.
9. If any of the conditions of subparagraph 9(b)(7) is not satisfied, the applicant should update all their processes and procedures, as well as tool qualification processes, using ED-12C/DO-178C and ED-215/DO-330, and make all modifications to the software using ED-12C/DO-178C, Section 12.1. If the applicant wants to declare their software as equivalent to satisfying ED-12C/DO-178C, their declaration applies to both the modified and unmodified software and is valid even if the applicant uses unmodified tools that have not been qualified using ED-12C/DO-178C and ED-215/DO-330. However, the applicant cannot declare their unmodified tools as equivalent to satisfying ED-12C/DO-178C and ED-215/DO-330. The applicant should make all subsequent modifications to all their software and tools using their processes and procedures that satisfy ED-12C/DO-178C and ED-215/DO-330.

10. Tool qualification

Sections 12.2 of ED-12C/DO-178C and ED-215/DO-330 provide an acceptable method for tool qualification. ED-215/DO-330 contains its own complete set of objectives, activities, and life cycle data for tool qualification.

- a. If the applicant's legacy software was previously approved using ED-12/DO-178 or ED-12A/DO-178A, and the applicant intends to use a new or modified tool for modifications to the legacy software, they should use the criteria of ED-12C/DO-178C, Section 12.2 to determine whether tool qualification is needed. If the applicant needs to qualify the tool, they should use the software level assigned by the

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system safety assessment for determining the required TQL, and should use ED-215/DO-330 for the applicable objectives, activities, and life cycle data. The applicant may declare their qualified tool as satisfying ED-215/DO-330, but not the legacy software as equivalent to satisfying ED-12C/DO-178C.

- b.** If the applicant's legacy software was previously approved using ED-12B/DO-178B, and they do not intend to declare equivalence to satisfying ED-12C/DO-178C, the applicant can either:
 1. use their ED-12B/DO-178B tool qualification processes for qualifying new or modified tools in support of modifications to ED-12B/DO-178B legacy software, or
 2. update their tool qualification processes and qualify the tool using ED 215/DO-330, referring to Table 2 of this document for determining the required TQL; the applicant may then declare their qualified tool as satisfying ED-215/DO-330.
- c.** If the applicant's legacy software was previously approved using ED-12B/DO-178B, the applicant intends to declare equivalence to satisfying ED-12C/DO-178C, and has ED-12B/DO-178B legacy tools that need to be qualified, the applicant should follow the guidance of this subparagraph.
 1. ED-12C/DO-178C establishes five levels of tool qualification based on the tool use and its potential impact on the software life cycle processes (see Section 12.2.2 and Table 12-1 of ED-12C/DO-178C). However, ED-12C/DO-178C does not address the use of tools previously qualified according to the ED-12B/DO-178B criteria. For a tool previously qualified as an ED-12B/DO-178B development tool or verification tool, the applicant should use Table 2 below to determine the correlation between the ED-12B/DO-178B tool qualification type and the ED-12C/DO-178C tool criteria and TQLs.

**Table 2 — Correlation between ED-12B/DO-178B tool qualification type
and ED-12C/DO-178C tool criteria and TQLs**

<i>ED-12B/DO-178B Tool Qualification Type</i>	<i>Software Level</i>	<i>ED-12C/DO-178C Tool Criteria</i>	<i>ED-12C/ED-215 TQL</i>
Development	A	1	TQL-1
Development	B	1	TQL-2
Development	C	1	TQL-3
Development	D	1	TQL-4
Verification	A, B	2	TQL-4
Verification	C, D	2	TQL-5
Verification	All	3	TQL-5

2. Development tools previously qualified using ED-12B/DO-178B
 - a. If the ED-12B/DO-178B software level assigned to the tool correlates with or exceeds the required TQL established by ED-12C/DO-178C, the applicant may continue to use their ED-12B/DO-178B tool qualification processes. If there are changes to the tool's operational environment or to the tool itself, then the applicant should conduct a tool CIA in

accordance with Section 11.2.2 or 11.2.3 of ED-215/DO-330, respectively, and perform changes using their ED-12B/DO-178B tool qualification processes.

- b. If the ED-12B/DO-178B software level assigned to the tool does not satisfy the required TQL, the applicant should update their tool qualification processes and requalify the tool using ED-215/DO-330.
 - c. The applicant may declare their tool as equivalent to satisfying ED-215/DO-330 if all the changes to the tool and to their tool qualification processes satisfy ED-215/DO-330.
3. Verification tools previously qualified using ED-12B/DO-178B
- a. If TQL-5 is required, and the applicant's verification tool was previously qualified using ED-12B/DO-178B:
 - i. the applicant may continue to use their ED-12B/DO-178B tool qualification process; and
 - ii. If there are changes to the tool or the tool's operational environment, the applicant should conduct a tool CIA and reverify the tool using their ED-12B/DO-178B tool qualification processes or requalify the tool using ED-215/DO-330.
 - b. If TQL-4 is required, the applicant should requalify their verification tool using ED-215/DO-330.
 - c. The applicant may declare their tool as equivalent to satisfying ED-215/DO-330 if all changes to the tool (if applicable) and to their tool qualification processes satisfy ED-215/DO-330.

11. Related regulatory, advisory, and industry material

a. Related EASA CSs

- 1. Decision No. 2003/14/RM of the Executive Director of the Agency of 14 November 2003 on certification specifications, including airworthiness codes and acceptable means of compliance for normal, utility, aerobatic and commuter category aeroplanes ('CS-23').
- 2. Decision No. 2003/2/RM of the Executive Director of the Agency of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes ('CS-25').
- 3. Decision No. 2003/15/RM of the Executive Director of the Agency of 14 November 2003 on certification specifications for small rotorcraft ('CS-27').
- 4. Decision No. 2003/16/RM of the Executive Director of the Agency of 14 November 2003 on certification specifications for large rotorcraft ('CS-29').
- 5. Decision No. 2003/9/RM of the Executive Director of the Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for engines ('CS-E').

6. Decision No. 2003/7/RM of the Executive Director of the Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for propellers ('CS-P').
7. Decision No. 2003/10/RM of the Executive Director of the Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for European Technical Standard Orders ('CS-ETSO').
8. Decision No. 2003/5/RM of the Executive Director of the Agency of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for auxiliary power units ('CS-APU').
9. Decision No. 2003/12/RM of the Executive Director of the Agency of 5 November 2003 on general acceptable means of compliance for airworthiness of products, parts and appliances ('AMC-20').

b. FAA advisory circulars (ACs)

1. AC 23.1309-1E, System Safety Analysis and Assessment for Part 23 Airplanes, 17 November 2011.
2. AC 27.1309A, Equipment, Systems, and Installations (included in AC 27-1B, Certification of Normal Category Rotorcraft), 4 February 2016.
3. AC 29.1309A, Equipment, Systems, and Installations (included in AC 29-2C, Certification of Transport Category Rotorcraft), 4 February 2016.

c. Industry documents

1. EUROCAE ED-12, Software Considerations in Airborne Systems and Equipment Certification, May 1982 (no longer in print).
2. EUROCAE ED-12A, Software Considerations in Airborne Systems and Equipment Certification, October 1985 (no longer in print).
3. EUROCAE ED-12B, Software Considerations in Airborne Systems and Equipment Certification, 1 December 1992.
4. EUROCAE ED-12C, Software Considerations in Airborne Systems and Equipment Certification, 1 January 2012.
5. EUROCAE ED-94C, Supporting Information for ED-12C and ED-109A, 1 January 2012.
6. EUROCAE ED-215, Software Tool Qualification Considerations, 1 January 2012.
7. EUROCAE ED-216, Formal Methods Supplement to ED-12C and ED-109A, 1 January 2012.
8. EUROCAE ED-217, Object-Oriented Technology and Related Techniques Supplement to ED-12C and ED-109A, 1 January 2012.
9. EUROCAE ED-218, Model-Based Development and Verification Supplement to ED-12C and ED-109A, 1 January 2012.
10. RTCA DO-178, Software Considerations in Airborne Systems and Equipment Certification, January 1982 (no longer in print).
11. RTCA DO-178A, Software Considerations in Airborne Systems and Equipment Certification, 1 March 1985 (no longer in print).

12. RTCA DO-178B, Software Considerations in Airborne Systems and Equipment Certification, 1 December 1992.
13. RTCA DO-178C, Software Considerations in Airborne Systems and Equipment Certification, 13 December 2011.
14. RTCA DO-248C, Supporting Information for DO-178C and DO-278A, 13 December 2011.
15. RTCA DO-297, Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations, 8 November 2005.
16. RTCA DO-330, Software Tool Qualification Considerations, 13 December 2011.
17. RTCA DO-331, Model-Based Development and Verification Supplement to DO-178C and DO-278A, 13 December 2011.
18. RTCA DO-332, Object-Oriented Technology and Related Techniques Supplement to DO-178C and DO-278A, 13 December 2011.
19. RTCA DO-333, Formal Methods Supplement to DO-178C and DO-278A, 13 December 2011.

12. Availability of documents

- EASA CSs and AMC are available at: www.easa.europa.eu.
- FAA ACs are available at: www.faa.gov.
- EUROCAE are available on payment at:
European Organisation for Civil Aviation Equipment
102 rue Etienne Dolet, 92240 Malakoff, France
Telephone: +33 1 40 92 79 30; Fax +33 1 46 55 62 65
Email: eurocae@eurocae.net, website: www.eurocae.net.
- RTCA documents are available on payment at:
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1150 18th Street NW, Suite 910, Washington DC 20036, USA
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13. GM to AMC 20-115D

GM1 to AMC 20-115D — Software change impact analyses (CIAs)

- a. These practices provide complementary information to ED-12C/DO-178C and ED-12B/DO-178B, Sections 12.1.1, 12.1.2, and 12.1.3, and AMC 20-115D, subparagraph 9(b)(4). The applicant may use these practices when they need to conduct a software CIA.
- b. A CIA identifies the released software baseline upon which the proposed software is to be built, providing:
 1. a summary of the changes and the impact of those changes;

2. a listing and descriptions of the problem reports to be corrected as part of the intended change and/or change requests related to those changes; and
 3. a listing of new functions to be activated and/or implemented.
- c.** A CIA addresses changes to the following items, where applicable:
1. the software level;
 2. the development or verification environment;
 3. the software processes;
 4. the tools (e.g. when a new tool version is introduced or a tool's use is modified);
 5. the processor or other hardware components and interfaces;
 6. the configuration data, especially when activating or deactivating functions;
 7. the software interface characteristics and input/output (I/O) requirements; and
 8. the software requirements, design, architecture, and code components, where such changes are not limited to the modified life cycle data, but should also consider the items affected by the change.
- d.** For each applicable item of subparagraph 13(c) above, a CIA describes the resulting impact of the change(s) and identifies the activities to be performed to satisfy ED-12C/DO-178C or ED-12B/DO-178B and continue to satisfy the requirements for safe operation.

GM2 to AMC 20-115D — Clarification of data coupling and control coupling

These practices provide complementary information to ED-94C/DO-248C FAQ#67 for satisfying objective A-7 (8) of ED-12C/DO-178C and ED-12B/DO-178B.

- a.** Data coupling analysis is of a different type and purpose than control coupling analysis. Both analyses are necessary to satisfy said objective.
- b.** Although they support a verification objective, data coupling and control coupling analyses rely on good practices in the software design phase, for example, through the specification of the interfaces (I/O) and of the dependencies between components.

GM3 to AMC 20-115D — Error-handling at design level

- a.** These practices provide complementary information to ED-12C/DO-178C and ED-12B/DO-178B, Sections 6.3.2, 6.3.3, and 6.3.4. Section 6.3.4.f., and identifies potential sources of errors that require specific activities focused at the source code review level. However, in order to protect against foreseeable unintended software behaviour, it is beneficial and recommended to handle these sources of error at the design level.
- b.** The possibility of unintended software behaviour may be reduced by considering the following activities:
 1. identification of foreseeable sources of software errors, which include:

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- a. runtime exceptions or errors, such as fixed/floating-point arithmetic overflow, stack/heap overflow, division by zero, or counter and timer overrun/wrap-around;
 - b. data/memory corruption or timing issues, such as those caused by a lack of partitioning or improper interrupt management or cache management; and
 - c. features leading to unpredictable programme execution, such as dynamic allocation, out-of-order execution, or resource contention;
2. for each foreseeable source of software error, identification of the associated mitigation;
 3. specification of protection mechanisms in the software requirements (high-level or low-level requirements) which should in particular include the specification of error-handling mechanisms; and
 4. for software Levels A and B, it is recommended that consideration be given to incorporating runtime protection mechanisms since reliance on probabilistic approaches or static analyses alone may not be appropriate; it may be a good practice to implement such runtime protection mechanisms for the other software levels as well.
- c. The use of FMs in accordance with ED-216/DO-333 may enhance the detection of runtime errors.