

- (viii) Loading Instructions. Complete instructions relative to the loading procedure or to the use of the loading schedule should be included.
- (ix) Compartment and floor load limits.

7 CONFIGURATION DEVIATION LIST (CDL)

Operation of the aeroplane without certain secondary airframe and engines parts is allowed through the use of an approved CDL. The CDL should be included in the AFM as a separate appendix. The following guidance should be followed when preparing the CDL.

- a. *The parts or combinations of parts* permitted to be missing, together with the associated performance penalties and other limitations should be determined and presented in the same format as the Master Minimum Equipment List (MMEL).
- b. *Unless it can be established* that a zero or negligible performance degradation occurs as a result of a part missing from the aeroplane (see paragraph 8.b of this AMC), a performance penalty should be presented for each part or for each combination of parts.
- c. *Performance penalties are normally presented* as weight or percent weight decrements. Equivalent penalties expressed as other parameters are also acceptable. A single performance penalty applicable to all AFM performance limitations may be presented for a missing part or, subject to certain restrictions, performance penalties may be presented for each phase of flight as follows:
 - (1) Only a single performance penalty for take-off and a single performance penalty for landing will be permitted. For take-off, the penalty shall be the most restrictive of the take-off field length, first, second and final segment climbs, and take-off flight path considerations. For landing, the penalty shall be the most restrictive of approach climb, landing climb, and landing distance considerations.
 - (2) Only a single weight penalty for en route climb performance, applying to both the one-engine-inoperative and two-engine-inoperative cases, as applicable, will be permitted.
 - (3) The CDL should contain the explanations of take-off performance penalty, landing performance penalty and en route performance penalty, as appropriate for the aeroplane, when individual penalties are used.
- d. *General Limitations.* The following information should be presented in the CDL appendix:
 - (1) When the aeroplane is operated using the CDL, it must be operated in accordance with the limitations specified in the AFM, as amended in the CDL.
 - (2) The associated limitations must be listed on a placard affixed in the cockpit in clear view of the pilot in command and other appropriate crew member(s).
 - (3) The pilot in command should be notified of each operation with a missing part(s) by listing the missing part(s) in the flight or dispatch release.
 - (4) The operator should list in the aeroplane logbook an appropriate notation covering the missing part(s) on each flight.
 - (5) If an additional part is lost in flight, the aeroplane may not depart the airport at which it landed following this event, until it again complies with the limitations of the CDL. This, of course, does not preclude the issuance of a ferry permit to allow the aeroplane to be flown to a point where the necessary repairs or replacements can be made.

- (6) No more than one part for any one system may be missing, unless specific combinations are indicated in the CDL. Unless otherwise specified, parts from different systems may be missing. The performance penalties are cumulative, unless specifically designated penalties are indicated for the combination of missing parts.
- (7) No more than three parts that have each been determined to cause a negligible performance degradation may be missing for take-off without applying a performance penalty. When more than three such parts are missing, a performance penalty of either 0.05 percent of the maximum take-off weight or 50 kg, whichever is less, must be applied for take-off, en route, and landing for each missing part.
- (8) Take-off performance penalties should be applied to the take-off weights that are limited by performance considerations (i.e. take-off field length, first, second, or, final segment climb, or take-off flight path). If the performance limited take-off weight is greater than the maximum certified take-off weight, the take-off performance penalties should be applied to the maximum certified take-off weight to ensure compliance with the noise requirements.
- (9) Landing performance penalties should be applied to the landing weights that are limited by performance considerations (i.e. landing field length, landing climb or approach climb). If the performance limited landing weight is greater than the maximum certified landing weight, the landing performance penalties should be applied to the maximum certified landing weight to ensure compliance with the noise requirements.
- (10) En route performance penalties apply only to operations that are limited by the one- or two-engine(s) inoperative en route climb performance.
- (11) The numbering and designation of systems in the CDL appendix is based on Air Transport Association (ATA) Specification 100. The parts within each system are identified by functional description and, when necessary, by part numbers.

8 ACCOUNTABILITY OF PERFORMANCE DEGRADATION RELATIVE TO BOTH MINOR DESIGN CHANGES AND CDL ITEMS

- a. *General.* Whenever a minor change to the type design aerodynamic configuration or a CDL proposal (e.g. installation of wing tip mounted emblem lights, missing flap hinge covers, etc.), has been submitted for EASA approval, the applicable performance degradation needs to be determined. In lieu of a complete flight test analysis to determine the performance degradation, simple criteria are prescribed below for establishing an acceptable level of airworthiness for the affected items.
- b. *Criteria.*
 - (1) Estimated Drag. The aerodynamic drag of the type design change or CDL item should be evaluated. Design changes or CDL items that have no impact on, or actually improve, the aerodynamic drag of the aeroplane are considered to have no performance penalty. In cases where there are quantifiable effects on aerodynamic drag (no matter how small), the drag value should be estimated and then increased by a factor of 2, unless the estimate drag was determined with equivalent conservatism.

- (2) Performance Penalty. Performance penalties (usually expressed in kg or percent weight) should be determined for all appropriate performance limitations (take-off, en route and landing) based on the effects of the estimated drag. If the resulting weight penalty is less than the smaller of 0·05 percent of the maximum certified take-off weight or 50 kg, the performance degradation may be considered negligible. The AFM supplement or CDL appendix should identify those type design changes or CDL items that result in a negligible performance degradation. If the performance degradation is not considered negligible, the appropriate performance penalty should be provided as a limitation in the AFM supplement or in the CDL appendix.

[Amendt 25/2]

[Amendt 25/21]

[Amendt 25/22]

[Amendt 25/26]

[Amendt 25/27]

AMC 25.1581, Appendix 1 Computerised Aeroplane Flight Manual

ED Decision 2020/024/R

1 PURPOSE

This appendix presents guidelines for obtaining approval of a computerised version of an AFM that would replace or supplement parts of the conventional paper AFM. These guidelines also apply to computerised AFM appendices and supplements. The criteria provided in the main body of this AMC remain applicable except where modified by this appendix. These guidelines do not cover:

- a. Systems used on board the aeroplane during flight.
- b. Systems that provide direct input to other aeroplane systems or equipment.
- c. Supplementary software or software functions used to prepare documentation suitable for use in the operation of the aeroplane under the applicable operating rules (e.g. airport analysis software).

2 APPLICABILITY

This appendix applies to aeroplanes eligible to be certificated to CS 25. The guidelines contained herein pertain to generating and presenting AFM performance information required by CS 25 by means of computer software. This appendix may be amended to include relevant aspects for other EASA approved information that is stored and presented through computer software.

3 DEFINITIONS

- a. *Computerised AFM*. The computerised AFM software application used in conjunction with the hardware and software environment in which it is installed to generate computerised AFM information.
- b. *Computerised AFM Software Application*. The computer programs and data, installation information and operating guide that are used in generating computerised AFM information.
- c. *Computerised AFM Information*. The information generated by the EASA approved computerised AFM in lieu of or supplementing parts of the conventional paper AFM.

- d. *Software Environment.* The additional computer programs (e.g. operating system) that provide services to the computerised AFM software application to input, process and output the information to the user.
- e. *Hardware Environment.* The equipment (e.g. terminal, printer, keyboard, math co-processor, central processing unit, etc.) that enables the operation of the software environment and the computerised AFM software application to input, process and output the information to the user.
- f. *Commercial-Off-the-Shelf (COTS) Computer.* A multi-purpose computer (e.g. a standard personal computer) that is available, or can be made available, to all potential users of the respective computerised AFM.
- g. *Calculation.* Data generation by means of combination of table-lookup or arithmetic operations.
- h. *First Principles Calculation.* A Calculation using basic parameters such as lift, drag, thrust, etc. with the equations of motion.

4 GENERAL GUIDELINES

The criteria herein do not affect the status of computerised AFMs that have previously been EASA or JAA approved. When such manuals are amended in the future, the concepts of this appendix should be applied, where practicable.

- a. *Official Reference*
 - (1) The conventional paper portion of the AFM should contain appropriate references about applicability of the EASA approved computerised AFM software application. This reference should be revised each time the EASA approved computerised AFM software application is changed (see paragraph 6.d of this appendix).
 - (2) The AFM should contain a statement similar to the following:

The computerised AFM replaces or supplements portions of the paper AFM, and is an EASA approved source for that AFM information. Any modification to the EASA approved computerised AFM software application, or subsequent alteration to the generated output, will cancel the airworthiness approval of the information, unless this change was approved by the EASA. This statement applies regardless of any approval notation printed on a generated output.
- b. *Approved and Unapproved Information.* Paragraph 25.1581 of the CS requires that the EASA approved information be segregated, identified and clearly distinguished from any unapproved information in the AFM. Therefore, the approval status of generated output should be clearly indicated on the screen and printed on each printout page of any calculated results by indication of:
 - (1) Approved program version.
 - (2) Approved data version, if applicable.
 - (3) Approval status of results with respect to requirement basis of the computation (e.g. FAR/Certification Specifications (CS)).
 - (4) Applicable certification basis, if the program is capable of generating results for more than one certification basis (e.g. FAR/Certification Specifications (CS)).
 - (5) Date of output data generation.

- c. *Software Usage Aspects.* The applicant should substantiate that the computerised AFM is designed to:
- (1) Provide a generated output containing all the information required to be in the conventional paper AFM by CS 25 for the part that is replaced or supplemented by the computerised AFM. This includes all relevant information (e.g. variables used for a specific condition) to determine operating condition and applicability of the generated output.
 - (2) Provide equivalent or conservative results to that obtained by direct use of a first principles calculation using certified baseline parameters (e.g. lift, drag, thrust).
 - (3) Preclude calculations that would generate results identified as EASA approved by:
 - (i) Extrapolating data beyond computational bounds agreed to by the Agency and the applicant; or
 - (ii) Using unapproved flight test analysis or AFM expansion methods.
 - (4) Provide at least the standard of transparency (e.g. understanding of performance relations and limitations) that is available from a conventional paper AFM presentation.
 - (5) Minimise mistakes or misunderstanding by a trained user during data input and interpretation of output.

5 COMPUTERISED AEROPLANE FLIGHT MANUAL CONTENTS

- a. *General*
(Reserved.)
- b. *Limitations Section*
(Reserved.)
- c. *Procedures Sections*
(Reserved.)
- d. *Performance Section*
 - (1) The computerised AFM may be used to generate all of the EASA approved performance information required to be in the AFM.
 - (2) The operating rules require operators to carry, in each transport category aeroplane, either the AFM or an operator-prepared manual that contains all of the information required to be in the AFM. The computerised AFM is not intended for use on board the aeroplane. Thus, any portions of the AFM that are provided only in computerised (i.e. electronic) form may not be used to satisfy these operating requirements. This does not preclude printing out information calculated by the EASA approved computerised AFM and subsequently using the paper printout on board the aeroplane.
 - (3) Configuration Deviation List (CDL) and Master Minimum Equipment List (MMEL) effects on performance may be included if they are EASA approved and applications are clearly identified on the generated output.

- (4) Although the output from the computerised AFM should be usable without adjustment, applying corrective factors that are provided in the paper AFM may be acceptable in the following cases:
 - (i) CDL or MMEL information.
 - (ii) Urgent temporary EASA approved revisions made mandatory for safety reasons.
 - (iii) Any case in which the appropriate data are unavailable from the computerised AFM and it is clear to the user that corrective factors must be applied.
 - (iv) Supplements produced by STC applicants.
- (5) Supplementary performance information may be included in accordance with paragraph 4.b of this appendix (e.g. for operation on runways contaminated with standing water, slush, snow or ice).
- (6) The applicant may request EASA approval of supplementary computerised AFM applications (e.g. optimised runway performance). This supplementary software application will not be required by the EASA for type certification.

6 SOFTWARE INTEGRITY, DEVELOPMENT AND DOCUMENTATION REQUIREMENTS

The computerised AFM consists of the AFM software application used in conjunction with the hardware and software environment in which it is installed. This paragraph provides guidelines that address the integrity, development process, and documentation requirements of the software.

a. Software Integrity

- (1) The potential safety effect at the aeroplane level of the computation of hazardously misleading primary information such as take-off speeds, landing approach speeds, engine thrust or power, engine limit data or other related aeroplane performance data, should be assessed. This assessment should be the basis for determining the software architecture and the level of integrity of the AFM software application. The AFM software application should, as far as practicable, be protected from inadvertent, deliberate, or unauthorised alterations. For example, self-check features could be used to provide software verification and protection against deliberate or inadvertent alteration.
- (2) The level of integrity established for the computerised AFM is the basis for the software development process and should be addressed in the plan for software aspects of certification (see paragraph 6.b of this appendix).
- (3) Each part of the EASA approved AFM software application (e.g. program, data) should bear a unique notation, a unique date, or a revision number.
- (4) A means to check the programs and data to avoid undetected failures should be provided (e.g. a checksum routine, tabular data to verify a check case, or provisions for a line-by-line file comparison).

- (5) Commercially available software, such as operating systems (e.g. MS-DOS), word-processors and spreadsheets, will not be approved by the EASA. However, this software can be used to run the computerised AFM software application or process (i.e. edit, format, manipulate, etc.) AFM data to produce approved AFM information if:
- (i) the applicant demonstrates that the unapproved software does not interfere with the correct functioning of the EASA approved computerised AFM software application;
 - (ii) the applicant demonstrates that the unapproved software produces reliable results when used with the specified hardware environment and the computerised AFM software application; and
 - (iii) the applicant specifies, in the paper AFM or a user's guide, the title, manufacturer, and version number of such software. The version number may refer to future versions of the software (e.g. 'Version XX and later') if the verification check performed under paragraph 6.c(1) of this appendix is designed such that improper operation of these later software versions would be detected.
- b. *Software Development.* The integrity of the software components of the computerised AFM is achieved through the software development processes used.
- (1) The applicant should propose the software development process in the plan for software aspects of certification. The application should document the methods, parameters and allowable range of conditions contained in the computerised AFM. The results obtained from the computerised AFM should be shown to meet all applicable CS-25 requirements. This compliance may be shown using substantiation documentation, demonstrations, or other means mutually agreed to by the Agency and the applicant. The software development process described in AMC 20-115 (Software Considerations for Airborne Systems and Equipment Certification) is valid, in general, for developing either airborne or ground based software. It represents one acceptable approach, but not the only acceptable approach, for developing software for the computerised AFM. Some of the specific guidance provided in AMC 20-115, however, may not apply to the computerised AFM.
 - (2) The applicant should submit a description of the computerised AFM and the plan for software aspects of certification to the Agency for review early in the certification process. This plan proposes the schedule and means by which compliance with the requirements will be achieved and the means by which certification data and supporting records will be made available to the Agency for review.
- c. *Hardware and Software Environment.* The computerised AFM software application may be EASA approved independent of the hardware and software environment in which it is installed. A common example of this would be the development of a computerised AFM software application to be run in a commercial-off-the-shelf (COTS) hardware and software environment. The applicant should provide for item (1) as follows, plus either item (2) or (3), as appropriate.

- (1) A mechanism, such as an installation utility function or test set, that verifies the proper functioning of the computerised AFM software application in the target software and hardware environment. The verification check should include, but not be limited to, proper functioning with hardware specified in the AFM, including input and output devices, and with resident software, including terminate-to-stay-resident or other control programs such as Microsoft Windows, and with any operating system calls made by the AFM software.
- (2) If the computerised AFM is intended for a COTS hardware and software environment, installation information that describes the minimum requirements, including limitations and constraints, for the software and hardware environment.
- (3) If the computerised AFM is intended for a specific hardware/software system, installation information that describes the specific hardware and software environment in which the computerised AFM software application must be installed. Additionally, the applicant should provide a configuration management scheme that ensures the hardware and software environment that will be used in service is identical to the environment specified in the EASA approved installation data.

d. *Revisions to a Computerised AFM Software Application*

- (1) Revisions to a EASA approved computerised AFM should be submitted for evaluation and EASA approval in accordance with software development methodology established in paragraph 6.b of this appendix. A log of EASA approved AFM software application parts should be furnished by the applicant. For historical purposes, the applicant should maintain records from which the information from any approved revision level of the computerised AFM can be reproduced, unless none of the affected aeroplanes remain in operational service.
- (2) The applicant should submit a description of the proposed changes and an updated plan for software aspects of certification. In addition, the applicant should:
 - (i) re-assess the software integrity level (paragraph 6.a of this appendix) of the revised computerised AFM;
 - (ii) demonstrate that revisions do not affect any of the unrevised portions of the computerised AFM; and
 - (iii) demonstrate that the revisions are compatible with the hardware and software environment intended for the computerised AFM software application.
- (3) Revisions to a computerised AFM can be made only by the TC or STC holder of that computerised AFM. The STC applicant may supplement but not revise a TC holder's computerised AFM.
- (4) When revisions are incorporated, a means (e.g. document) of indicating those parts of the software that have been changed should be provided.
- (5) Each revised software element should be identified in the same manner as the original, with the exception of the new date or revision notation (see paragraph 6.a(3) of this appendix).

e. *Submittal and EASA Approval of Software*

- (1) The applicant will be considered the responsible party for all matters pertaining to the computerised AFM software application, including submittal to the Agency and obtaining EASA approval.
- (2) The applicant and the Agency shall discuss and agree on the data structures and calculation models.
- (3) The applicant should provide any part of the hardware environment necessary for operating the computerised AFM that is not readily available to the Agency.

f. *Documentation Requirements.* Documentation containing the following information should be provided by the applicant to the Agency.

- (1) Approval plan that describes the software aspects of certification, including time schedules, an outline of the desired applications, and design objectives for software and data integrity.
- (2) Software development plan, including the methods used to accomplish the design objectives.
- (3) Software descriptions, including justifications that program structures and calculation models are appropriate to their intended function.
- (4) Data verification document, including a description of the scope and depth of the review, analysis, and tests used to determine that the developed software and generated output accurately reflect the aeroplane performance characteristics. This description should include the purpose of each test case and the set of inputs, expected results, test environment and calculated results.
- (5) Operating instructions, including all information for proper use of the computerised AFM, installation instructions, and identification of the suitable hardware and software environment.
- (6) Software configuration reference, including a log of the approved software elements and a statement that design objectives of the approval plan and compliance with the guidelines of this appendix have been demonstrated.

7 PROVISIONS FOR EASA POST CERTIFICATION ACCESS TO COMPUTERISED AFM

In the plan for software aspects of certification, the applicant should propose which components of the computerised AFM will be submitted to the EASA. In cases where the AFM software application can be installed on EASA equipment, the applicant need only provide the computerised AFM software application, which includes the installation data and operating guide. However, if the computerised AFM software application requires a hardware and software environment that is not available to the EASA, the applicant should also provide the EASA with the necessary components to access the AFM software application.

[Amendt 25/2]

[Amendt 25/12]

[Amendt 25/26]

AMC 25.1581, Appendix 2 Aeroplane Flight Manual Specification

ED Decision 2003/2/RM

1 PURPOSE

This appendix to the [AMC 25.1581](#) is a guideline for preparation of the AFM specification required early in the certification process to allow judgement about acceptability of various peculiarities of the proposed flight manual.

2 APPLICABILITY

This acceptable means of compliance applies to aircraft eligible to be certificated to CS 25.

3 DEFINITIONS Reserved.**4 GENERAL GUIDELINES**

Following information should be presented in form of a document:

- a. Constructors Name.
- b. Contact person: Name, Address, Telephone, Telefax.
- c. Aircraft Description, including kinds of operation for which certification is intended.
- d. Basic Approval Authority.
- e. Certification Basis (e.g. FAR 25 amendment or CS 25 change no.).
- f. Flight manual compliance proposal (e.g. FAA AC or EASA AMC etc.).
- g. Type of AFM (i.e. multi-regulation).
- h. Intended document number.
- i. Means of identification for draft pages and revisions thereto.
- k. Size of final AFM pages.
- l. Example pages:

Title sheet and approval provision

Preface

List of Effective Pages

Page layout, including identification and approval status

- m. Units of measure proposed.
- n. Amendment system (e.g. temporary revision identification and normal revision identification).
- o. Breakdown of the manual (e.g. topics, sequence, dividers).
- p. Performance charts layout.
- q. Digital performance data proposal, if applicable.
- r. References to other information required by the certification basis but not contained in the basic AFM.

The document presented may include more than the proposed amount of information, if deemed necessary.