Certification Memorandum

Certification, Type Design Definition, Material and Process Qualification for Composite Light Aircraft

EASA CM No.: CM-S-006 Issue 01 issued 13 July 2017

Regulatory requirement(s):	**Part 21.A.4, Part 21.A.20(b), Part 21.A.31, Part 21.A.33,** **CS LSA.15,** **CS VLA.572, CS 22/VLA.603, CS 22/VLA.605, CS 22/VLA.613,** **CS 22/VLA.615, CS 22/VLA.619, CS 22/VLA.627,** **CS 23.2240, CS 23 2250, CS 23.2260.**

EASA Certification Memoranda clarify the European Aviation Safety Agency's general course of action on specific certification items. They are intended to provide guidance on a particular subject and, as non-binding material, may provide complementary information and guidance for compliance demonstration with current standards. Certification Memoranda are provided for information purposes only and must not be misconstrued as formally adopted Acceptable Means of Compliance (AMC) or as Guidance Material (GM). Certification Memoranda are not intended to introduce new certification requirements or to modify existing certification requirements and do not constitute any legal obligation.

EASA Certification Memoranda are living documents into which either additional criteria or additional issues can be incorporated as soon as a need is identified by EASA.

Log of issues

Issue	Issue date	Change description
01	13.07.2017	First issue.

Table of Content

1. Introduction

1.1. Purpose and scope

This Certification Memorandum provides an interim EASA position regarding acceptance of compliance demonstration using composite materials and provides guidance on the relevant requirements for the following aircraft:

- Light Sport Aeroplanes CS-LSA,
- Very Light Aeroplanes CS-VLA,
- ELA1 aeroplanes where the certification basis references CS-VLA requirements for materials and fatigue,
- Sailplanes and Powered Sailplanes CS-22.

This Certification Memorandum applies to monolithic, sandwich, and bonded structures which use established materials and material forms, e.g. wet lay-up, prepreg, etc., and which have been used successfully by the small aeroplane community at the date of release of this CM. It does not necessarily apply to new materials and processes. Intent to use new materials and processes (either new to the industry or the applicant) should be discussed with EASA early in the certification process.

This CM also recognises that small composite aircraft designs address a very broad range of material and processes. Furthermore, the existing experience and databases available to applicants varies significantly. Therefore, the extent of application of the intent of this CM will be very case dependent.

Note: CS-23 Amendment 5 is in force from 15th August 2017, and also incorporates aircraft formerly covered by CS-VLA. Existing CS-23 AMC guidance may be moved and/or changed as it is transferred to ASTM documentation (refer to work produced by ASTM technical committee F44). Please check the status of this process and any potential applicability of the revision to the product. This CM may be revised accordingly. Please clarify any potential uncertainty regarding interpretation with EASA.

This Certification Memorandum provides an interim EASA position regarding acceptance of compliance demonstration.

1.2. References

It is intended that the following reference materials be used in conjunction with this Certification Memorandum:

Reference	Title	Code	Issue	Date
Part 21.A.4	Coordination between design and production	Part 21	---	---
Part 21.A.20(b)	Certification Programme	Part 21	---	---
Part 21.A.31	Type Design Definition	Part 21	---	---
Part 21.A.33	Inspection and tests	Part 21	---	---
CS LSA.15 (F2245-10c 5.1.2 – 5.1.4	Factor of safety Strength and deformation Proof of structure	CS-LSA	---	---

Reference	Title	Code	Issue	Date
CS LSA.15 (F2245-10c 6.1, 6.2 & 6.3)	Materials, Fabrication Methods	CS-LSA	---	---
CS LSA.15 (F2245-10c 6.8)	Proof of Design	CS-LSA	---	---
CS VLA.572	Parts of structure critical to safety	CS-VLA	---	---
CS 22/VLA.603	Materials	CS-22/CS-VLA	---	---
CS 22/VLA.605	Fabrication Methods	CS-22/CS-VLA	---	---
CS 22/VLA.613	Material Strength Properties and Design Values	CS-22/CS-VLA	---	---
CS 22/VLA.615	Design properties	CS-22/CS-VLA	---	---
CS 22/VLA.619	Special Factors	CS-22/CS-VLA	---	---
CS 22/VLA.627	Fatigue strength	CS-22/CS-VLA	---	---
CS 23.2240	Structural durability	CS-23 Amdt 5		
CS 23.2250	Design and construction principles	CS-23 Amdt 5		
CS 23.2260	Materials and processes	CS-23 Amdt 5		

1.3. Abbreviations

AGATE	Advanced General Aviation Transport Experiment
AFF	Arbeitskreis Faserverbund Flugzeuge
AMC	Acceptable Means of Compliance
ANF	Arbeitskreis Neue Fasern
CS	Certification Specification
CM	Certification Memorandum
CMH	Composite Material Handbook
DO	Design Organisation
EKDF	Environmental Knockdown Factor
HFF	Handbuch Faserverbund Flugzeuge
KDF	Knockdown Factor

FAA	Federal Aviation Administration
LBA	Luftfahrt Bundesamt (CAA Germany)
LSA	Light Sport Aeroplane
MOC	Means of Compliance
NCAMP	National Centre for Advanced Materials Performance
NDT	Non Destructive Testing
PO	Production Organisation
SOP	Standard Operating Procedure (e.g. Standard Procedures or test methods used to populate database).
Tg	Glass Transition Temperature
VLA	Very Light Aeroplane

2. Background

Only limited guidance material and standards are available which address certification of light composite aeroplanes.

Due to the strong dependence of composite structure ‘engineering properties’ upon manufacturing process, material properties, and configuration complexity it is of paramount importance to guarantee proper identification of the design properties and to maintain conformity of manufactured parts with the design data.

One approach to the development of representative engineering properties is to use the building block approach, ref. EASA AMC 20-29, CMH-17, etc., This is typically used extensively in the certification of larger airframes and is not mandatory for small aircraft (CS-22, CS-LSA and CS-VLA, CS-23 partially), partly because it may not be appropriate for the small scale and relative simplicity of light composite aeroplane designs. In particular, the mid-pyramid test and analysis processes, typical of larger designs, may not be appropriate because the definition of representative tests between details, such a joints, and the full component and/or complete airframe may be difficult for small aeroplanes.

Therefore, the certification of small composite aeroplanes typically relies upon full scale component test supported by tests at the base of the pyramid e.g. coupons, joints etc.

Work at the base of the test and analysis pyramid is necessary to establish statistically credible confidence regarding stable material and process selection and to establish variability and environmental factors, whilst testing of the components and/or the complete airframe is intended, partly, to address process variability resulting from the more complex configuration at that level. The latter requires testing of an adequate number of load cases to ensure that all likely damage modes have been investigated, noting the limited test and analysis possible in the mid-pyramid.

As the approach to small composite aeroplanes differs in some respects relative to that used and described in other guidance and literature for larger aeroplanes , the intention of this Certification Memorandum is to identify and collate existing accepted guidance and also provide further guidance for the certification of small aircraft.

The development of detailed harmonised guidance and practices regarding the definition and use of composite materials remains relatively immature compared to the well-established metallic protocols.

However, composite materials have been used successfully in small aeroplane and sailplane designs since 1950’s and well established simple processes have been developed in several areas. Current examples are:

- Design allowables and qualification procedures (RHV [8]) have been developed by the LBA and sailplane manufactures, together with research facilities, which have been approved by the authority for specific defined applications. Furthermore, industry working groups (e.g., AFF - Working Group Composite Aircraft) have established guidance and procedures to certify materials and composite design solutions which have been provided to working group members (e.g., –HFF - Handbuch Faserverbund Flugzeuge)
- Shared databases (e.g. NCAMP) and procedures to establish material data at the project level have been established mainly for prepreg materials in the framework of EASA AMC 20-29.

3. EASA Certification Policy

3.1. EASA Policy on Airworthiness Certification of Composite Aircraft Structures

3.1.1. Part 21.A.31 Type design

Essential for a successful certification project is the exact definition of the type design at an early phase of the project. The type design should include drawings and specifications but also information on materials and processes, including methods of manufacture and assembly of the product as necessary according to paragraph 3.1.3.

The material has to be specified and identified at the level of material supplied (e.g., resin, fabric, prepreg) as well as at a the raw material level (e.g. fibres, coating), e.g. by form, type, grade, class, standards, properties and applicable key process parameters.. Some materials are available in different qualities using the same marketing name (e.g., rovings in aviation and industry quality or fabrics using different fibre specifications).

3.1.2. Part 21.A.20(b) Certification programme and project familiarisation

The objective of the EASA Certification familiarization is for the applicant to provide the Agency with sufficient information to agree upon the certification basis, the certification programme, and to establish the Agency’s level of involvement.

The basic structural design principles, including material and process definition and management, and the approach that will be followed for the certification of composite structural parts should be presented to EASA, including:

- Basic design principles for primary structure,
- Load introduction into composites (e.g., connections, secondary bonding),
- Critical structural elements,
- Company experience with chosen technologies in design and production,
- Procedures to ensure conformity of test specimen and test set-up,
- Specifications of the composite materials and processes,
- Production of test articles and prototypes,
- Approach to composite as defined in this Certification Memorandum.

3.1.3. Part 21.A.4 Coordination between design and production

Stabilized and controlled processes for production of composite parts are essential to ensure conformity with applicable design data and repeatability of composite material properties and behaviour. Therefore each design approval holder should collaborate with the production organisation to ensure satisfactory coordination between design and production.

In the absence of an existing approved production organisation, it is essential to establish the relevant procedures and initiate the production approval with the competent authority for production oversight at the beginning of the project. Only after ensuring that stabilized and controlled manufacturing processes are in place, can the production of a test specimen representative of the finished product begin.

The Design Organisation applying for certification of a product should provide to the Production Organisation drawings and specifications as well as information on materials and processes as included in the type design definition. It is the full responsibility of the Production Organisation to ensure conformity with the type design but the DOA needs to identify the critical processes where quality of production has an effect on the airworthiness of the final product, considering items such as:

(a) Work instructions (step-by-step process instructions),

(b) Personnel competence,

(c) Materials specification (consumable and structural, storage conditions, life limits),

(d) Equipment specification (ovens, autoclaves, thermocouples,…including required accuracy),

(e) Facility minimum requirements (humidity and temperature limits, positive pressure, clean room, …),

(f) Tooling (base plates, marks for ply orientation,…),

(g) Process specification (lay-up, cure cycle, product identification).

(h) Criteria for incoming material and supplier production acceptance,

(i) Criteria for supplier qualification,

(j) Criteria for process monitoring (personnel, what is inspected, test methods, including check thickness, ply lay-up, cure cycle, functional characteristics, NDT….),

(k) Maintenance and calibration of tooling, facility and test equipment,

(l) Identification, configuration control, maintenance and inspection of molds.

It is the final responsibility of the POA to implement procedures to ensure conformity with the defined type design.

3.1.4. Part 21.A.33 Inspection and tests

For any kind of testing during the certification process, including testing to develop material properties, the DO should assure that materials and processes adequately conform to the specifications, and finally the test article adequately conforms to the proposed type design. Any intended or unintended deviation should be assessed by the DO and the resulting assessment documented in the conformity statement.

Therefore the proper definition of the type design (as per 3.1.1) and established procedures under control of the DO, as necessary to ensure conformity of test specimen and prototypes, are essential. Production and release under POA procedures is the preferred solution.

3.2. EASA Policy on Certification Requirements Affecting Composite Materials

3.2.1. Material properties and design allowables

The regulations typically allow certification by test, or analysis supported by test. The design objective is to demonstrate acceptable margins with respect to expected loads in operation. Even when this demonstration is mainly done through structural testing there is a still the need for stable material properties and minimum design allowables to be established.

Material properties of a composite structure are the result of the component manufacturing process. Therefore, material and process specifications used to produce composite structure should contain sufficient information to ensure that critical parameters in the manufacturing process are identified and controlled during production and recorded for final inspection and verification.

3.2.1.1. Material qualification according EASA AMC 20-29 “Composite Aircraft Structure”

EASA AMC 20-29 describes the building block approach to develop a set of material properties and design allowables for composite materials and is applicable to CS-23, CS-25, CS-27 and CS-29 aircraft. The guidance of EASA AMC 20-29 might be helpful to develop a qualification programme for materials.

3.2.1.2. Use of existing material data and shared databases

EASA AMC 20-29 ‘Composite Aircraft Structure’ para 6.a.(7) ‘Material and Process Control’ states:

‘…the Agency does not certify materials and processes. However, materials and processes specifications are part of the type-design subject to type-certification. Appropriate certification credit may be given to products and organisations using the same materials and processes in similar applications subject to substantiation and applicability. In some cases, material and processing information may become part of accepted shared databases used throughout the industry. New users of shared qualification databases must control the associated materials and processes through proper use of the related specifications and demonstrate their understanding by performing equivalency sampling tests for key properties.’

The concept of the shared database is broad, ranging from sharing simple properties at the base of the test pyramid using international standards through to sharing design values specific to design details. Typically, the use of the shared database only addresses part of the certification process and the criteria defining limitations of the database, e.g. applicability and use with other factors etc, should be clearly understood by the applicant. Furthermore, the acceptability criteria necessary to use, or contribute to, the database need to be followed, e.g. in accordance with appropriate Standard Operating Procedures (SOPs). SOPs will include the need for the applicant to show ‘equivalency’ if wishing to simply reference the database if using a material already within it.

Examples of the shared database approach include:

1) NCAMP shared database
EASA Certification Memorandum CM-S-004 on ‘Composite Materials – Shared Databases - Acceptance of Composite Specifications and Design Values Developed using the NCAMP Process’ provides clarification regarding the acceptability of material specifications, material strength properties and material design values (allowables) developed by the National Centre for Advanced Materials Performance (NCAMP) for composite materials. NCAMP has published a document with Standard Operating Procedures (SOPs) detailing the organisation, methods and processes that NCAMP uses with regard to material suppliers, manufacturers, and regulatory bodies to develop composite material specifications and limited associated material allowables. These procedures are based on experience gained from the Advanced General Aviation Transport Experiment (AGATE) and NCAMP.

2) HFF – Manual Composite Aircraft
   The well-established German small airplane industry within the working group composite materials (AFF - Arbeitskreis Faserverbund Flugzeugbau) published its manual for composite aircraft called HFF (Handbuch Faserverbund Flugzeuge). The HFF contains established guidance and procedures intended to support certification of composite designs and is made available to members of the AFF.

3) LBA/ANF
   Data established by the German ANF (Arbeitskreis Neue Fasern) a working group composed of glider manufactures, material suppliers, research institutions and authorities, is shared between participating companies. Some data has been approved by the German National Aviation Authority (LBA). This was done according to a material qualification process defined by an industry working group and supported by a high number of component fatigue tests [9].

4) reserved
   Industry is invited to provide available information to amend this list.

In any case it is essential to demonstrate that the chosen approach is fully understood and applicable at the project level. All conditions (design principles, material qualifications, manufacturing processes,…) have to be regarded, keeping in mind that small deviations, e.g. fibre coatings, might have significant effect on the static or fatigue behaviour.

3.2.2. Fatigue

Certification specifications require that the structure should be designed “as far as practicable” to avoid points of stress concentration where variable stresses above the fatigue limit are likely to occur in normal service.

EASA AMC VLA 572 accepts that structural items have adequate safe lives, when in conjunction with good design practices intended to eliminate stress concentrations, certain stress levels are not exceeded. The applicant should show that the most critical points have been investigated. At least the wing main spar, the horizontal tail and their attachments have to be investigated for stress concentrations.

Note: Use of EASA AMC VLA 572 (b)(1) is not acceptable for aircraft in the aerobatic category.

In the absence of a detailed structural analysis, the measurement of stress levels during structural tests can be accepted. Points for measurement with expected critical stress levels should be identified before testing and the rationale behind selection of the stress measurement locations should be clearly described.

In the field of CS-22 a common approach is to refer to representative fatigue tests, e.g. provided in LBA document “ I 4 - FVK/91 Standards for Structural Substantiation of Sailplane and Powered Sailplane Components Consisting of Glass or Carbon Fibre Reinforced Plastics” - issued July 1991.

Wherever reference is made to similarity, established design practise, representative tests or established material properties it should be assured that all conditions are met, e.g. defined material qualifications or process specifications. The “referenced” structure or test should be assessed with regard to

- Operating stress levels (including all operational or life limits),
- Load spectrum,
- Construction, detailed design including effects of stress concentration,
- Materials, including variability, environmental effects and fabrication methods.

Suitable sources for the development of spectra for fatigue testing are

- KoSMOS load spectra
  Kossira H. and Reinke W., ”Determination of load spectra for the design of sailplanes”, OSTIV publication XVI

Kossira H., "Determination of load spectra and their application for keeping the operational life proof of sporting airplanes", ICAS-Proc. 8/1982; ICAS-82-2.8.2; page 1330-1338

- Thielemann and Franzmeyer load spectra

  Thielemann W., Franzmeyer F.K., „Statische und dynamische Festigkeits-untersuchungen an einem Tragflügel des Segelflugzeuges „Cirrus", Institut für Flugzeugbau und Leichtbau, TU Braunschweig, 1969, IFL-Bericht-Nr.: 69-02

- General Aviation Aircraft Normal Acceleration Data Analysis and Collection Project

  J. E. Locke and H. W. Smith, Flight Research Laboratory, The University of Kansas Flight Research Laboratory, February 1993, Report Number: DOT/FAA/CT-91/20

Currently, constant amplitude testing is only accepted for relative testing to demonstrate that a new or replacement material is as suitable and durable as the old one and conservatively addresses damage accumulation. Even if some research shows that the approach used in the early days of composite fatigue certification (e.g. 10000 limit load cycles) is conservative, applicability is to be demonstrated for each application, ensuring that the load spectrum is conservative with regard to operation.

3.2.3. Structural testing

It is recommended that no certification test should be performed before the relevant test plan is accepted or EASA has decided to not be involved and conformity of the test specimen and test setup is ensured by accepted procedures. When test witnessing is requested by EASA, the schedule should be provided to EASA well in advance.

3.2.3.1. Most critical loading conditions

The ultimate load test should show that the structure is able to withstand maximum loads in operation with an adequate safety factor. The critical loads should be applied to test critical structures for at least 3 seconds without structural failure.

The most critical loading conditions as well as the critical sections should be identified and assessed. The applied loads should be representative for the critical combination of loads in the tested component. When it is possible to demonstrate that one test setup is conservatively covering the operational envelope (e.g., positive and negative manoeuvre loads) a single test might be acceptable.

3.2.3.2. Limit load test

The absence of permanent detrimental deformations and the absence of interference of the deformation with safe operation should be demonstrated with maximum expected loads in operation (limit load) without the need to apply additional safety factors.

3.2.3.3. Special factors for ultimate load testing

It is possible to certify small aircraft mainly based on static structural testing without detailed analyses of the complete structure and prediction of failure modes. EASA AMC 23.307 states 'Static testing to ultimate load may be considered an adequate substitute for formal stress analysis where static loads are critical in the design of the component'. Nevertheless it is of high importance to design the structure in a conservative way taking into account

- Most critical loading conditions,
- critical locations,
- environmental factors (e.g., temperature, humidity),
- material variability (raw material, process tolerances),

- bonding design, material and process,
- stress concentrations.

The development of the static test conditions should account for the above points.

For composite structures, a special test factor which takes into account material variability and the effects of temperature and absorption of moisture should be used. Uncertainties of material properties and variability including environmental influence should be compensated by higher test factors. In the absence of exact statistical determination of variations of material properties a super safety factor should be applied.

When statistical data is available and effects of temperature, moisture and production/material variability are known, the determined factor should be applied at the ultimate load test.

The following basic approaches (pedigrees) to consider material and production variability have been shown to be reliable in the past as listed in table 1. These factors have been used successfully in the context of each database and its SOPs (note: it is not recommended to 'mix and match' data between databases without appropriate substantiation):

Shared Database, 'A'-'B'-Values

When statistical data is available and effects of temperature, moisture and production/material variability are known, adequate factors can be established.

It should be assured that such factors are applicable to the actual material and production process and that all conditions are met, e.g., defined material qualifications or process specifications. An additional factor due to specific implementation of the production process (typically associated with design specific detail and complexity) by the company might be necessary.

LBA Approach

Material data has been approved in the past by the German National Aviation Authority. This was done by a material qualification process (known as RHV] defined by industries working group "ANF" and supported by a high number of component fatigue tests [9].

The material data that have been used by a high number of certification projects were partly incorporated into several other standards (CS-VLA fatigue limits, wind turbine bonding allowables).

Within this well-defined system of material qualification, design principles and manufacturing technologies, a standard for structural substantiation has been established. For the ultimate load testing under 54°C (established for a white paint finish) an additional safety factor of 1,15 was found sufficient to take the possible effect of stress concentrations into account when all conditions of the specific material and process have been met.

No statistical Data

An additional factor of 1,5 for specimens with white surfaces tested without specific allowance for moisture and temperature might be acceptable, or an additional factor of 1,2 for moisture conditioned specimen tested at maximum service temperature, provided that a well-established manufacturing and quality control procedure is used. For structures cured at room temperature without any heat treatment, it may be assumed that the completed structure is fully moisture conditioned.

A test factor following EASA AMC VLA 619, based on the coefficient of variation the manufacturer, can be used.

Even when the compliance demonstration is purely based on structural testing, the materials have to be properly specified and it has to be assured that the test specimen is representative for the type design.

Table 1: Minimum test factors for ultimate load testing:

Pedigree				Safety Factor	
	Stat. Basis	Env.	Prod.	Test - Room Temperature	Test hot
1	A/B hot&wet Shared Database	EKDF	KDF	1,5 x EKDF x KDF	1,5 x KDF
2	“LBA”	1,25	1,15	1,5 x 1,25 x 1,15 (2,156)	1,5 x 1,15 (1,725)
3	no statistical data	No	No	1,5 x 1,5 (2,25)	1,5 x 1,2* (1,8) *moisture conditioned specimen

3.2.3.4. Test repetition after failure

Following test failure, it is not acceptable to repeat the test without design change until a pass is achieved unless it is possible to show that the failure was not related to the proposed type design (e.g. failure of test rig).

3.2.4. Bonded joints

Special attention should be given to bonded joints. The design should follow standard practise (e.g. LN 29 936, VDI 2014) to minimize peel loading on the bonding.

There is no explicit requirement to assure limit load capacity after failure of critical bonding or to include disbonding in any structural testing. Therefore, it is even more important to choose conservative bonding allowables and design the bonding according to established practices ensuring adequate process definition and control. Any variation of process or design parameters can significantly affect the bonding capability. For sailplanes, and VLA, bonding allowables have been established [9] based on extensive testing in combination with detailed limitations for design principles and material and process definition.

As part of the type design and manufacturing process the following aspects should be addressed:

- Adhesives (mixing, application),
- Bondline thickness,
- Definition of processes, surface preparation, cure cycle and tolerances,
- Degradation in service.

Attention should also be given to consumables (e.g. peel ply, acetone, compressed air) as these are a common source for contamination (e.g. silicon, oil) during preparation of bonding surfaces.

The potential for manufacturing defects (e.g. voids, adhesive problems) should be minimised by adequate process control and inspection methods, including inspection of the production articles.

A simplified approach might be appropriate, based on availability and appropriateness of

- Alternative load path,
- Ultimate load testing with defects or additional safety factor,
- Conservative bonding allowables.
- Adequate bonded joint overlap

Mechanical fasteners might be seen as alternative load path or method to limit the failure size in case of adhesive failures. As mechanical fasteners could create additional problems and decrease the bonding strength they should only be used when the load path is fully understood . Alternative design arrest feature solutions may also be considered, e.g. use of stringers to limit the “free” bond length.

Special attention should be given to metallic bonded joints and bonded joints using materials that, due to the poor chemical reaction, might be more sensitive to deficits in surface preparation and process variations as well as to environmental effects in operation.

3.2.5. Environmental effects

The continuing performance of composite structures is affected by environmental conditions, such as:

- Temperature,
- Humidity,
- Chemicals, fuel, etc.

Unless already covered by established factors and experience, the effect on material properties and degradation in operation should be considered.

To cover temperature effects, for white painted surfaces, a test temperature of 54°C is accepted. For other colours or colours schemes a test temperature of 54°C is only acceptable when it can be demonstrated that the temperature of the main structure in operation is below 54°C.

If testing cannot be performed at 54°C, an additional factor of 1,25 may be used to cover the difference between room temperature and 54°C. Otherwise the test temperature is determined according to EASA AMC VLA 613(c) or by representative test unless a lower temperature factor (established on specimen level) is available and agreed with the Agency. Furthermore, more recent paint types, e.g. metallic paints, may require additional factors.

When the test is performed at room temperature the principle suitability of materials at least up to an operating temperature of 54°C without appreciable degradation of properties has to be shown; A minimum margin of 27.8°C should be maintained between the maximum operating temperature and Tg wet, unless otherwise demonstrated, e.g. RHV propose another suitable approach [8].

3.2.6. Damage tolerance

For aircraft which are part of the scope of this Certification Memorandum, damage tolerance does not need to be demonstrated as there is no equivalent requirement to CS 23.573 applicable to these aircraft. However, some applicants have chosen to demonstrate simplified damage tolerance capability because design using damage tolerance concepts typically increase robustness and reliability of the structure.

When implemented properly, this Certification Memorandum should help to ensure that the materials and processes used result in a structure that is tolerant to undetected damages and built-in defects which may occur during production.

3.2.7. Material and process changes

Any change of material specifications or processes during, or following, certification should be assessed as this could invalidate previous tests or compliance demonstration and would require structural re-evaluation for the design change.

Subsequent to the certification any change of material specifications or processes needs to be assessed and might require an approved design change, this could include a change of POA or its suppliers.

In some fields test procedures (e.g. RHV) are established to ensure that a changed material (e.g. changed fibre coating) has no negative effect and the new composite meets the defined standard.

3.3. List of Documents regarding Composite Materials

Many other useful references exist on the subject of qualification and manufacturing of composite parts. The following is not an exhaustive list, but these documents are considered as acceptable to EASA:

(1) FAA AC 21-26A "Quality System for the Manufacture of Composite Structure"

(2) FAA AC 23-20 "Acceptance Guidance on Material Procurement and Process Specifications for Polymer Matrix Composite Systems"

(3) FAA AC 43-214 'Repairs and Alterations to Composite and Bonded Aircraft Structure' (previously AC 145-16 "Repair Stations for Composite and Bonded Aircraft Structure")

(4) DOT/FAA/AR-02/109 "Guidelines and Recommended Criteria for the Development of a Material Specification for Carbon Fiber/Epoxy Unidirectional Prepregs"

(5) DOT/FAA/AR-02/110 "Guidelines for the Development of Process Specifications, Instructions, and Controls for the Fabrication of Fiber-reinforced Polymer Composites"

(6) PS-ACE100-2005-10038 "Bonded Joints and Structures - Technical Issues and Certification Considerations"

(7) "I4-FVK/91 Standards for Structural Substantiation of Sailplane and Powered Sailplane Components Consisting of Glass or Carbon Fiber Reinforced Plastics" - LBA July 1991

(8) "Richtlinien zur Führung des Nachweises für die Anerkennung von Harz-Faser-Verbundsystemen im Anwendungsbereich der Herstellung und Instandhaltung von Segelflugzeugen und Motorseglern (RHV)" Luftfahrt-Bundesamt Ausgabe Januar 1999

(9) „Dimensionierungsrichtwerte für den Segel- und Motorsegelflugzeugbau", idaflieg, March 1988

(10) VDI 2014 "Design and construction of FRP Components"

(11) "Handbuch Faserverbund Flugzeuge" – Arbeitskreis Faserverbund-Flugzeuge (AFF)

(12) "Luftfahrttechnisches Handbuch (LTH)" - Arbeitskreis Faserverbund-Leichtbau

3.4. Who this Certification Memorandum Affects

This Certification Memorandum affects applicants who need to demonstrate compliance with structure and material requirements for composite structures of light aircraft.

4. Remarks

1. Suggestions for amendment(s) to this EASA Certification Memorandum should be referred to the Certification Policy and Safety Information Department, Certification Directorate, EASA. E-mail CM@easa.europa.eu.

2. For any question concerning the technical content of this EASA Certification Memorandum, please contact:

   Name, First Name: RONIG, Stefan

   Function: RPAS VLA LSA Balloons Airship Section Manager

   Phone: +49 (0)221 89990 4107

   E-mail: stefan.ronig@easa.europa.eu