



Federal Aviation
Administration

FAA / CAAs “Composite Meeting”

- CMH-17 (Rev G): Volume 3, Chapter 3 - Development and Content Review

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FAA / CAAs “Composite Meeting”

- CMH-17 V3C3 Development & Content -

- Development of CMH-17 V3C3
 - Background – Environment & CMH-17
 - Working Group – Charter & Execution
 - CMH-17 V3C3 Content Outline
- CMH-17 V3C3 – Content Review
 - Regulation and Certification
 - Design Substantiation
 - Production – Essentials
 - Maintenance – Technical Issues
- CMH-17 V3C3 Tutorial – A Glance

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Background - Part 23 TC Projects with Extensive Use of Composites in Airframe Structure



Background - Technical Document “Composite Certification Roadmap”

- Building on lessons learned from certification of part 23 (GA) airplanes, a document was developed [by SAD (Angie, Lester & Larry), 2003].
- Technical content includes -
 - Characteristics of composite materials
 - Integral emphasis of design, production & maintenance
 - Airworthiness requirements of type certification
 - Substantiation/compliance of regulatory requirements
 - Considerations related to manufacturing & maintenance
- Served as a general guidance for the development of CMH-17 V3C3 (2008).

Background - Composite Aircraft Structures



Transport Aircraft

- Secondary structure
- Control Surfaces
- Empennage
- Wing & fuselage applications for new aircraft
- Some engine (e.g., fan blades)



Small Airplanes and Rotorcraft

- Most structures
 - Pressurized fuselage
 - Wing
- Dynamic components
 - Propellers & rotor blades
- Extensive bonding

Background – General Environment

- Composite utilization has extended rapidly and extensively into aviation primary and critical structures – including larger passenger structures.
- Industry knowledge has been fragmented until recent years.
- FAA has accelerated the execution of its CS&CI initiatives by using CMH-17 to link with other key organizations (e.g., CACRC, ASTM, SAMPE, etc.).
- Data is being generated in many other activities, e.g.,
 - Maintenance and Damage Tolerance Working Group (FAA/EASA/Boeing/Airbus)
 - CACRC Maintenance and Training Guidance

Background – General Environment (cont.)

- Use of composite materials in civil aviation starts to become mature. We need to develop a coherent reference to support standardization.
- CMH-17 provides the most useful means to develop, and make readily available, much of this information. [Note: CMH-17 Revision G is due for 2008.]
- Furthermore, other composite regulatory and guidance documents are due for revision (e.g., AC20-107A and AMC CS 25.603)
- Therefore, we can also use the need to revise CMH-17 as a tool to collate data and provide an industry support base for the development of regulatory guidance material.

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Background - Planning Milestones

- [2005]: To support the commercialization of CMH-17: We proposed to establish one document [for Volume 3 (Rev. G)] describing the certification essence for the composite structures of all types of aviation products (i.e., parts 23, 25, 27 & 29).
- [2006]: CMH-17 assigned Volume 3, Chapter 3 [Rev G] to house the document “Aircraft Structure Certification and Compliance”.
- [2006-2007]: Informal Attempt – “Strawman Document” by Simon (EASA) & Lester (FAA).
- [2007-2008]: Formal Development via FAA Biz Plan.
 - A great learning process of achieving a harmonized document.
 - A working model of developing AC 20-107B

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“Aircraft Structure Certification and Compliance”

- Thoughts Processes

[Building on FAA/ACE Technical Document “Composite Certification Roadmap” (2003)]

- Global Efforts:

- ^ Regulatory Authorities – FAA, EASA & TCCA

- ^ Industry Participation – OEMs & Operators

- ^ Organizations Support – (e.g., CMH-17, CACRC, ASTM, NCAMP, SAMPE, etc.)

- Certification Focus:

- ^ Integrated Approach – Design, Production & Maintenance

- ^ Potential Standardization – **Guidance & Training**

- Contents Balance (w.r.t):

- ^ Regulations (FAA, EASA, TCCA)

- ^ Aircraft Categories (Parts 23, 25, 27, 29)

- ^ Sibling V3 Chapters (e.g., C-1, C-2, C-12, C-13, C-14, C-17)

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“Aircraft Structure Certification and Compliance”

- Working Group
 - Regular Members:
 - ^ FAA: Larry_I (CS&TA), Angie_K, Lester_C
 - ^ EASA: Simon_W
 - ^ TCCA: Alain_D
 - ^ LBA: Martin_B
 - Industry Participants Including:
 - ^ Airbus : Chantal Fualdes, Paola Caracciolo
 - ^ CACRC/Operators: Carlos Blohm
 - ^ Canada Industry
 - ^ USA Industry

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“Aircraft Structure Certification and Compliance”

- Working Group - Charter
 - To Establish a Guidance (a Chapter) Aiming to:
 - ^ Provide Top Level Guidance to the Regulations
 - ^ Provide Guidance Regarding Basic Certification Process
 - ^ Provide Guidance of Showing “Means of Compliance”
 - ^ Provide a Base of Updating AC20-107A & AMC CS25.603
 - Target audience includes OEMs, Operators, Regulators, and more specifically within them:
 - ^ Those new/recent to certification
 - ^ Those new/recent to composites
 - ^ Those new/recent to particular aspects of either composites and/or certification
 - ^ Those would like to refresh their knowledge

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“Aircraft Structure Certification and Compliance”

- Development Execution
 - Working Meetings
 - ^ Cologne/Germany Meeting - Jan/2007 [EASA]
 - ^ Ottawa/Canada Meeting - Jun/2007 [TCCA]
 - ^ Chicago/USA Meeting - Aug/2007 [FAA]
 - Deliverable (CMH-17: V3C3)
 - ^ V3C3 Draft submitted to CMH for review (Yellow Page Process) in Mar/2008.
 - ^ Further review/discussion held in CMH-17 Meeting (Ottawa/Canada, Aug/08).
 - ^ V3C3 contained in CMH-17 [Rev G].

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“Aircraft Structure Certification and Compliance”

Table of Contents - Sections

- 3.1 Introduction
- 3.2 Certification Considerations
- 3.3 Regulations
- 3.4 Design Substantiation
- 3.5 Production - Essentials
- 3.6 Maintenance - Technical Issues
- 3.7 Guidance and Reports

Composite Safety & Certification Meeting - Development of CMH-17 V3C3 -

- **Thanks for Opportunity.**
- **Questions and/or Thoughts?**
- **Further Discussion.**

“CMH-17 V3C3 Content Review”
[To Be Followed]

FAA / CAAs “Composite Meeting”

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- **Thoughts Contained in Section 3.1**

3.1 Introduction

3.1.1 General (Background)

3.1.2 Purpose and Scope

- Certification requirements are used to guard the safety of civil aviation by regulators (e.g., FAA, EASA & TCCA).
- Certification processes apply to design, manufacturing and maintenance (repair).
- Integrated consideration of these certification functions would further enhance the overall aviation safety in particular for composites.
- Expanded use of composites has prompted the collaborated effort of international community (industry and regulators) to establish engineering standards and guidance.

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- **Thoughts Contained in Section 3.2**

- 3.2 Certification Considerations**
 - 3.2.1 Product Development (Initial Airworthiness)
 - 3.2.2 Continued Airworthiness (Maintenance/Repair)
 - 3.2.3 Product Modification (Changed Product)
 - 3.2.4 Qualified Workforce and Teamwork



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- **Thoughts Contained in Sub-Section 3.2.1**

3.2 Certification Considerations

3.2.1 Product Development (Initial Airworthiness)

- Safe operation of aircraft starts with aircraft airworthiness. The development and substantiation of composite aircraft structure requires close coordination between design, manufacturing, and maintenance.
- Product substantiation involves a combination of tests and analyses at different scales of study. A building block approach is often used for this substantiation.
- The successful completion of type certification implies that the aircraft design meets the airworthiness requirements. Manufacturing aircraft in a facility holding a valid production certificate implies the aircraft can be fabricated as designed.

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- Thoughts Contained in Sub-Section 3.2.2

3.2 Certification Considerations

3.2.2 Continued Airworthiness (Maintenance/Repair)

- “Continued airworthiness” is referred to when an aircraft enters service. Repairs and continued airworthiness procedures must be provided in service documents.
- Accidental damage (e.g., foreign object impact) is a critical threat for composites. Manufacturing flaws need to be considered. Degradation & damage caused by environmental effects and fluid compatibility for the particular composite material needs to be evaluated.
- **Repairs** are classified as “**major**” and “**minor**”.
- Documentation identifying all critical inspection items should be put together to support maintenance.
- Maintenance instructions need to include material and process controls, fabrication steps, cured-part tolerances, non-destructive inspection (NDI) and other quality control checks for bonded repair.

Definitions - Major/Minor Repairs

- **FAA** Definition on Major/Minor Repairs

Major repairs are those that if improperly done, might appreciably affect weight, balance, structural strength, performance, power plant operation, flight characteristics, or other qualities affecting airworthiness or that, are not done according to accepted practices or elementary operations.

Minor repair is any repair, other than a major repair.

Definitions - Major/Minor Repairs (cont.)

- **EASA** Definition on Major/Minor Repairs

A **minor repair** is one that has no appreciable effect on the mass, balance, structural strength, reliability, operational characteristics, noise, fuel venting, exhaust emissions, or other characteristics affecting the airworthiness of the airplane.

Major repairs are all other repairs that are not minor.

Definitions - Major/Minor Repairs (cont.)

- **TCCA** Definition on Major/Minor Repairs

A **major repair** is a repair to an aeronautical product in respect of which a type certificate has been issued, that causes the aeronautical product to deviate from the type design defined by the type certificate, where the deviation from the type design has other than a negligible effect on the weight and centre-of-gravity limits, structural strength, performance, power plant operation, flight characteristics or other qualities affecting the aeronautical product's airworthiness or environmental characteristics.

Minor repair is any repair, other than a major repair.

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- Thoughts Contained in Sub-Section 3.2.3

3.2 Certification Considerations

3.2.3 Product Modification (Changed Product)

- There exists the need to alter the product to accommodate changes in aircraft utilization after entering service.
- There are procedural requirements for certifying the changes of product to continue ensure the airworthiness and safe operation of the aircraft.
- Changes in type design are normally classified as “minor” and “major”.
- International community agreed to a rule on the designation of applicable regulations for **product design changes**. This rule is known as the “Changed Product Rule” [i.e., 14 CFR 21.101 for FAA, IR Part 21.101 for EASA, and Part V (Section 511.14 and 513.14) of the CARs for TCCA.
- To correct unsafe condition, a mandated design change may be required via Airworthiness Directives (ADs) [i.e., 14 CFR Part 39 for FAA, IR 21A.3B for EASA, and CAR 593 for TCCA].

Definitions - Design Changes

- **Minor change** is a change that has no appreciable effect on the weight, balance, structural strength, reliability, operational characteristics, or other characteristics affecting the airworthiness of the product.
- **Major change** is a change other than a minor one.
- **Significant change** is a change to the type certificate significant to the extent that it changes on or more or the following: general configuration, principles of construction, or assumptions used for certification, but not to the extent to be considered a substantial change.
- **Substantial change** is a change which is so extensive that a substantially complete investigation of compliance with the applicable regulations is required, and consequently a new type certificate.

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- **Thoughts Contained in Sub-Section 3.2.4**

3.2 Certification Considerations

3.2.4 Qualified Workforce and Teamwork

- Successful design, production, and continued airworthiness certification relies upon a qualified workforce that is not only skilled in its own technical activities, but is also well aware of the associated activities.
- There is a heavy reliance on inspection processes and qualified inspectors to ensure that the production of composite parts conform to the design.
- A good balance of team members with engineering experience in composite design, analysis, manufacturing and maintenance practice is needed to coordinate a product development and certification program.
- Teamwork is essential to composite maintenance, particularly as associated with the steps involved in aircraft structural inspection, disposition and repair.

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- **Thoughts Contained in Section 3.3**

3.3

Regulations

3.3.1

Structure, Design and Construction

3.3.2

Production Approval

3.3.3

Continued Airworthiness (Maintenance)



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- Thoughts Contained in Sub-Section 3.3.1

3.3 Regulations

3.3.1 Structure, Design and Construction

- For FAA, design requirements for aircraft are called out in the 14 CFR (Title 14 Code of Federal Regulations).
- In general, these requirements are grouped in four categories [i.e., part 23, part 25, part 27, and part 29].
- EASA rules are called CS (Certification Specifications); TCCA rules are called AWM (Airworthiness Manual) requirements.
- Table 3.3 groups the requirements that are deemed applicable to the various categories of aircraft using composite materials.
[Note: This Table formed the basis of the Appendix 1 in AC 20-107B.]
- AC 20-107 “Composite Aircraft Structure” was developed providing guidance on means of compliance. FAA AC 20-107B is the current revision issued in 2009. [Harmonized EASA AMC 20-29 in 2010]

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- **Thoughts Contained in Sub-Section 3.3.2**

3.3 Regulations

3.3.2 Production Approval

- Production certification ensures that the manufacturing facility has a proper quality control system for the fabrication of article that meets the design requirements.
- For FAA, the procedural requirements are contained mainly in 14 CFR part 21, Subpart G [Production Certificate].
- For EASA, IR Part 21 Subpart G covers production approval. For TCCA, the procedural requirements are contained mainly in AWM Chapter 561- Manufacture of Aeronautical Products.
- Details for production approval requirements are further described.
- Discussions relating to the specifics of composite manufacturing are presented in Section 3.5.

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- **Thoughts Contained in Sub-Section 3.3.3**

3.3 Regulations

3.3.3 Continued Airworthiness (Maintenance)

- Compliance with maintenance requirements is necessary to ensure the continued airworthiness of the aircraft and thus its safe operation.
- FAA has developed a set of regulations pertinent to maintenance. These rules include the general requirements that may apply to various aircraft types and operations [e.g., parts 43, 145], and any additional requirements that may be deemed specific to operating provisions [e.g., 91, 121, 125].
- Other authorities may use a different set of regulations to achieve the continued airworthiness oversight.
- To support continued airworthiness, ADs are issued to address the mandated requirements that relate to safe operation of aircraft.
- In general, no distinction is made between composite and metallic structures at the regulation level. Considerations specific to composites are presented in Section 3.6.

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- **Thoughts Contained in Section 3.4**

- 3.4 Design Substantiation**
 - 3.4.1 Design and Process Documentation
 - 3.4.2 Material/Adhesive Qualification
 - 3.4.3 Environmental Exposure and Fluid Compatibility
 - 3.4.4 Structural Bonding
 - 3.4.5 Tools and Part Cure
 - 3.4.6 Flaws Experienced in Production
 - 3.4.7 Structural Conformity Process
 - 3.4.8 Structural Substantiation
(Static Strength & Damage Tolerance)
 - 3.4.9 Flutter Substantiation (Aero-Elastic Stability)
 - 3.4.10 Fire Protection, Flammability and Thermal Issues
 - 3.4.11 Lightning Strike Protection
 - 3.4.12 Crashworthiness

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- **Thoughts Contained in Sub-Section 3.4.1**

3.4 Design Substantiation

3.4.1 Design and Process Documentation

- Type design of a composite structure is represented by engineering data. Drawings define structure. Analysis/testing are used to show compliance of airworthiness requirements.
- Critical materials and processes that affect the integrity of the structure must be traceable to approved material and process specifications.
- Configuration control system is required to track design changes (i.e., assigning appropriate drawing revision levels to incorporate structural changes that affect form, fit, and function of the part).
- To establish the link between engineering and production. Engineering drawings are supplemented by manufacturing instructions and plans such that production can build the part to meet type design.
- A quality program comprising of both quality assurance and quality control systems should be well established soon into the certification process.

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- **Thoughts Contained in Sub-Section 3.4.2**

3.4 Design Substantiation

3.4.2 Material/Adhesive Qualification

- Material systems used in the manufacturing of aircraft parts must be qualified to ensure the control of composite materials & repeatable processes.
- “First Time Qualification” provides “benchmark” data of key properties which are used for material and process control.
- Minor changes to materials/processes require additional testing to establish equivalency to the original data. A new qualification is needed for major changes to materials/processes or the use of substitute materials.
- Qualification should consider service environment including temperature & fluid resistance
- Certifying agencies normally do not directly certify materials. Applicant for the type certificate (e.g., TC, STC, etc.) is required to show that all material used is in compliance with regulations.

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- **Thoughts Contained in Sub-Section 3.4.3**

3.4 Design Substantiation

3.4.3 Environmental Exposure and Fluid Compatibility

- Environmental effects may change structural performance. As a result, static strength and damage tolerance evaluation must account for these environmental effects.
- Environmental effects need to be considered in material qualification & allowables testing.
- Structural detail and subcomponent tests may also evaluate environmental effects for more complex failure modes.
- At the full-scale level, the environmental effects may be directly tested, or accounted for by including an overload factor when conducting the static and damage tolerance tests.
- The maximum operating temperature (MOT) for a particular airplane structure needs to be determined to facilitate the structural substantiation.
- The MOT may be determined by thermal analysis, tests, published data, or a combination of all three.

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- **Thoughts Contained in Sub-Section 3.4.4**

3.4 Design Substantiation

3.4.4 Structural Bonding

- Stringent process control is essential to structural bonding. Qualification of the structural bonding materials and processes should include an assessment of all key properties.
- Surface preparation of pre-cured elements of a bonded joint is a critical process step. Poor surface preparation may result in interfacial failures which are an unacceptable failure mode that cannot be predicted. A robust process control must be qualified.
- Bondline thickness plays a key role on the strength of the bondline. Bondlines that are thick or with widely variable thickness generally lead to lower strengths. Shimming and spacers are used to control bondline thickness variations.
- Sufficient cure of the adhesive is essential to structural integrity, particularly when considering the service environment.

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- **Thoughts Contained in Sub-Section 3.4.5**

3.4 Design Substantiation

3.4.5 Tools and Part Cure

- Tooling or molds are used in fabrication to define the shape of composite parts. Tooling must yield repeatable results throughout a useful life, giving parts the desired shape at the end of each fabrication cycle.
- Tool configuration is dictated by a dataset that is part of the type design. Tool configuration must be verified on a regular basis.
- Tooling needs to consider: thermal matching, tolerance/dimensional stability over time, wear/longevity, ease of repair, and cost.
- Quality control steps are needed to ensure consistent and repeatable lay-up and bagging procedures.
- Curing cycle must be defined in the engineering specification. During curing, proper control and monitoring of temperature and pressure is required.

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- **Thoughts Contained in Sub-Section 3.4.6**

3.4 Design Substantiation

3.4.6 Flaws Experienced in Production

- Composite susceptible to manufacturing defects. Sources of such defects, their form, type, and impact upon static strength and fatigue and damage tolerance must be identified and understood.
- Evaluation of the impact of defects should be determined through a series of tests and analysis at the coupon, subcomponent, and/or component levels.
- Engineering, manufacturing, and quality personnel should jointly study the effects of defects and establish specific allowable defect limits for a particular material system, component, detailed part, or assembly.
- The associated quality control and inspection programs for defect detection should be created, validated, and approved.
- Each critical engineering design should consider the variability of the manufacturing process to determine the worse case effects (e.g., maximum waviness, disbonds, delaminations, etc.).

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- **Thoughts Contained in Sub-Section 3.4.7**

3.4 Design Substantiation

3.4.7 Structural Conformity Process

- Composite part construction is process dependent requiring that an in-process conformity be conducted.
- Conformity begins at the level of incoming inspection for the materials and continues with test specimens for the coupon level up to the full-scale components.
- Completion of qualification testing is generally needed to finalize requirements defined in the specification.
 - Appropriate inspection methods (i.e., visual, ultrasonic NDI) needed to control manufacturing defects must be in place prior to building conforming parts.
- Any proposed allowable defect limits are validated with tests using conformed parts.

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- **Thoughts Contained in Sub-Section 3.4.8**

3.4 Design Substantiation

3.4.8 Structural Substantiation (Static Strength & Damage Tolerance)

- Structural static strength of a composite design considers critical load cases and associated failure modes, effects of the environment, repeated loading, manufacturing tolerance, and material and process variability.
- As part of the static strength evaluation, building block tests and analyses at the coupon, element, or subcomponent levels can be used to address the issues of variability, environment, structural discontinuities, damage, and manufacturing defects.
- Damage tolerance and fatigue evaluation help establish procedures that allow the composite structure to retain the intended ultimate load capability when subjected to possible damage scenarios and expected fatigue loads during its operational life.
- Technical details on fatigue and damage tolerance compliance are further discussed in CMH-17 V3C12.

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- **Thoughts Contained in Sub-Section 3.4.9**

3.4 Design Substantiation

3.4.9 Flutter Substantiation (Aero-Elastic Stability)

- Substantiation approach similar to metallic structure (analysis supported by tests or by tests).
- Evaluation of a composite structure needs to account for the effects of repeated loading, environment exposure, and service damage scenarios (e.g., large disbonds, water ingress) on critical properties, (e.g., stiffness, mass & damping).
- Issues to be considered may include:
 - ^ accounting for possible changes in stiffness
 - ^ accounting for possible changes in mass
 - ^ manufacturing flaws and control surface clearances
 - ^ service damage scenarios

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- **Thoughts Contained in Sub-Section 3.4.10**

3.4 Design Substantiation

3.4.10 Fire Protection, Flammability and Thermal Issues

- Composites (primary) structure has highlighted the importance of managing thermal exposure issues for components subjected to high temperatures (e.g., near engines or other airplane system failures). Heat damage on the required structural integrity must be understood,
- Flammability tests need to be conducted for interior parts. Interior parts made from composites must not add to the fire or release toxic fumes that pose safety threats to the passengers.
- Exterior fire protection issues associated with fuselage structure must include the effects of an exterior pool fire following a survivable crash landing.
- Attentions are paid to engine mount & firewall, and protection of composite fuel tanks both during a fire in flight and during a post crash fire.

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- **Thoughts Contained in Sub-Section 3.4.11**

3.4 Design Substantiation

3.4.11 Lightning Strike Protection

- Carbon composite structure has a much higher electrical resistance than that of aluminum structure. A lightning strike to such a structure, without provision of the appropriate conductive paths, presents a threat to both the structure and to the attached electrical, hydraulic, avionics systems, and fuel systems.
- Composite structural design should incorporate the proper protection against lightning in each zone of the aircraft. It should be demonstrated by tests or analysis supported by test evidence that the structure can provide electromagnetic protection where required and provide an acceptable means of diverting the electrical current resulting from a lightning strike so as not to endanger the aircraft.
- Special consideration must be given to the fuel system lightning protection for an airplane with integral fuel tanks in a composite structure. Regulations for fuel system ignition prevention require lightning protection that is failure tolerant. As a result, redundant prevention of ignition sources are needed to ensure proper protection.

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- Thoughts Contained in Sub-Section 3.4.12

3.4 Design Substantiation

3.4.12 Crashworthiness

- Design of the airframe should assure that occupants have every reasonable chance of escaping serious injury under realistic and survivable impact conditions. Evaluation may be done by test or analysis supported by test evidence. Service experience may also provide substantiation support.
- Design considerations should account for unique characteristics of the composite airframe structures versus those consisting of conventional metal materials.
- The impact response characteristics of a composite transport fuselage structure must be evaluated to ensure the survivable crashworthiness characteristics are not significantly different to those of a similarly sized airplane fabricated from traditionally used metallic materials.
- Four main areas should be considered: occupants must be protected during the impact event, emergency egress paths must remain, acceleration and loads experienced by occupants must not exceed critical thresholds, and survivable volume of occupant space must be retained.

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- **Thoughts Contained in Section 3.5**

- 3.5** **Production – Essentials**
- 3.5.1 Production Implementation
- 3.5.2 Manufacturing Quality Control
- 3.5.3 Defect Disposition and Manufacturing Records
- 3.5.4 Modification of Production Process



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- **Thoughts Contained in Sub-Section 3.5.1**

3.5 Production – Essentials

3.5.1 Production Implementation

- Production substantiation is to confirm that a type design can be correctly translated into a product. Over time, the production system must ensure that the aircraft product is consistently produced within the defined tolerances in the approved specifications and other approved design data.
- Composite material & component manufacturing occur simultaneously. Thus, it requires to have a good in-process quality control for the production.
- Control of the critical process steps and appropriately trained staff are essential elements in the production substantiation process.
- Issues to be considered may include:
 - ^ key manufacturing steps
 - ^ manufacturing tolerances and any process limits, and sensitivities
 - ^ test plans that substantiate manufacturing processes
 - ^ test pyramids to best suit the material form & associated processes
 - ^ thorough manufacturing records of all products produced

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- **Thoughts Contained in Sub-Section 3.5.2**

3.5 Production – Essentials

3.5.2 Manufacturing Quality Control

- An appropriately trained and qualified workforce is essential for manufacturing control.
- Issues to be considered may include:
 - ^ engineering input and production planning
 - ^ tooling development and maintenance
 - ^ material handling (e.g., shelf life/out-time control)
 - ^ ply lay-up tolerances (e.g., size/orientation/splices/gaps/overlaps)
 - ^ autoclave and oven management
 - ^ cure control, verification and part inspection
 - ^ implementation of NDI techniques
 - ^ bond surface preparation
 - ^ bondline thickness control
 - ^ bolted joint gap tolerances and fit-up
 - ^ part transportation and storage
 - ^ quality assurance program

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- **Thoughts Contained in Section 3.5.3**

3.5 Production – Essentials

3.5.3 Defect Disposition and Manufacturing Records

- Production substantiation requires the definition and understanding of likely manufacturing defects (structural, geometric, and cosmetic) and their causes.
- Defects found during production that are outside limits should be recorded and reported to engineering via a notification and disposition process.
- All acceptable defects and approved repairs that are considered significant should form part of the manufacturing record and be stored by the OEM and/or suppliers.
- Defect records should also be communicated to the operator. This information may be of importance to future repair or modification work.

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- **Thoughts Contained in Sub-Section 3.5.4**

3.5 Production – Essentials

3.5.4 Modification of Production Process

- Suppliers should have agreed procedures with the OEM for change classification, ranging from different levels of minor to major. Any major changes will require additional structural design substantiation.
- Agreements on significant production modifications should clearly identify all changed steps and a joint assessment of the potential impact upon the product from production through to service (e.g., effect on maintenance inspection, repair, and associated design data needs).
- The revision approval process must be robust, including documentation and recording processes.

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- **Thoughts Contained in Section 3.6**

- 3.6 Maintenance - Technical Issues**
 - 3.6.1 Repair Design and Process Substantiation
 - 3.6.2 Teamwork and Disposition
 - 3.6.3 Damage Detection and Characterization
 - 3.6.4 Repair Processes (Bonded vs. Bolted)

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- **Thoughts Contained in Sub-Section 3.6.1**

3.6 Maintenance - Technical Issues

3.6.1 Repair Design and Process Substantiation

- Maintenance procedures must be developed, and substantiated, to ensure continued airworthiness of the composite aircraft structure throughout its service life.
- Substantiated repair designs and processes meet the same performance requirements as the base aircraft structure.
- All repairs should be fully documented in maintenance records as part of the individual repair substantiation process. Any repair processing defects or non-conformities that required disposition should be reported.
- Operators and repair organizations need to fully understand the limits of repair instructions and avoid extending repairs beyond previous structural substantiation.
- In the event that a documented repair is outside the limits of design substantiation data, an OEM will normally provide the timely support needed to substantiate a new repair.

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- **Thoughts Contained in Section 3.6.2**

3.6 Maintenance - Technical Issues

3.6.2 Teamwork and Disposition

- Teamwork is important to composite maintenance. Each team member should realize their skill limits and know where to go when questions arise.
- There are three main categories of teammate: engineer, inspector, repair technician. They are required to have proper training, experience & understanding of structure definition, material & OEM documentation.
- A complete disposition process is needed after composite damage is first discovered.
- Issues to be considered may include:
 - ^ special training needs for functional disciplines
 - ^ proper damage detection and inspection actions
 - ^ approved maintenance data
 - ^ disposition process for damage or defects outside approved limits
 - ^ steps to take for new repair design and process approval
 - ^ operational safety awareness of composite damage characteristics

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- **Thoughts Contained in Section 3.6.3**

3.6 Maintenance - Technical Issues

3.6.3 Damage Detection and Characterization

- A safe maintenance program relies upon successful damage detection.
- Visual inspection represents 80-90% of aircraft inspections. NDI (e.g., tap testing, ultrasonic, bond tester) is then used to determine the full extent of damage.
- After either a scheduled or event-driven inspection, and an indication of damage, it will be necessary to determine the damage type and record the dimensions, and cause.
- Damage removal should be completed so as not to cause further damage (i.e., following OEM data regarding access, paint removal, jacking, disassembly, machining).
- Further inspections should be completed to confirm that the original damage has been removed and that no new damage has resulted from the removal process.

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- **Thoughts Contained in Sub-Section 3.6.4**

3.6 Maintenance - Technical Issues

3.6.4 Repair Processes (Bonded vs. Bolted)

- Two main types of repair: bonded & bolted. Bonded repairs require strict environmental controls. Bolted repairs are applied to large and/or thick primary structure.
- Generally two types of bonded composite repairs: prepreg repair & wet lay-up repair.
- Correct procedures and processes are critical to the elimination of defects in bonded composite repairs. A bond surface preparation that adequately prepares the surface for chemical adhesion is essential.
- Bonded repairs are more difficult to inspect for structural integrity than bolted repairs. Bolted repairs require to be designed and installed with great care.
- Strict adherence to repair bond process procedures and in-process quality controls are vital for successfully bonded repairs.

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- **Data Contained in Section 3.7**

3.7 Guidance and Reports

- 3.7.1 Advisory Circulars
- 3.7.2 Policy Statements
- 3.7.3 Technical Reports

Website:

- (1) FAA Guidance (AC and PS): <http://www.airweb.faa.gov>
- (2) FAA Technical Report: <http://actlibrary.tc.faa.gov>
- (3) EASA AMC: <http://www.easa.europa.eu>
- (4) TCCA AC: <http://www.tc.gc.ca/air/>
- (5) SAE AIR Report: <http://www.sae.org>

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- **Data Contained in Sub-Section 3.7.1**

3.7 Guidance and Reports

3.7.1 Advisory Circulars

[Examples: Advisory Circulars]

- AC 20-107B "Composite Aircraft Structure" [09/09]
- AC 21-101-1A "Establishing the Certification Basis of Changed Aeronautical Products" [9/10]
- AC 23-20 "Acceptance Guidance on Material Procurement and Process Specifications for Polymer Matrix Composite Systems" [9/03]
- AC 25.571-1D, Damage Tolerance and Fatigue Evaluation of Structure [1/11]
- AC 27 MG 8 "Substantiation of Composite Rotorcraft Structure" [4/06]
- AC 29 MG 8 "Substantiation of Composite Rotorcraft Structure" [4/06]
- [EASA AMC 20-29](#) "Composite Aircraft Structure" [07/10]

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- **Data Contained in Sub-Section 3.7.2**

3.7 Guidance and Reports

3.7.2 Policy Statements

[Examples: Policy Statements]

- "Static Strength Substantiation of Composite Airplane Structure" [PS-ACE100-2001-006, December 2001]
- "Material Qualification and Equivalency for Polymer Matrix Composite Material Systems" [PS-ACE100-2002-006, September 2003]
- "Substantiation of Secondary Composite Structures" [PS-ACE100-2004-10030, April 2005]
- "Bonded Joints and Structures -Technical Issues and Certification Considerations" [PS-ACE1002005-10038, September 2005]
- "Bonded Repair Size Limits" [PS-AIR-20-130-01, November 2015]

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- **Data Contained in Sub-Section 3.7.3**

3.7 Guidance and Reports

3.7.3 Technical Reports

[Examples: Policy Statements]

- “Guidelines and Recommended Criteria for the Development of a Material Specification for Carbon Fiber/Epoxy Unidirectional Prepregs” [DOT/FAA/AR-02/109, March 2003]
- “Effects of Surface Preparation on the Long-Term Durability of Adhesively Bonded Composite Joints” [DOT/FAA/AR-03/53, July 2003]
- “Material Qualification and Equivalency for Polymer Matrix Composite Material Systems” [DOT/FAA/AR-03/19, September 2003]
- "Assessment of Industry Practices for Aircraft Bonded Joints and Structures" [DOT/FAA/AR-05/13, July 2005]
- “Teaching Points for an Awareness Class on “Critical Issues in Composite Maintenance and Repair” [SAE Airspace Information Report (AIR) 5719, XXX 2008] [Note: This document is accepted by FAA/EASA/TCCA.]

CMH-17: Volume 3 Chapter 3 - Current Update Plan & Effort -

- **CMH-17 Volume 3 Chapter 3**
 - Update Regulatory Requirements
 - Awareness of BRSL & HEWABI
 - Update Guidance & Tech Reports
 - Elevate from Rev G Level to **Rev H**
 - Others deem supportive

Composite Safety & Certification Meeting - CMH-17 V3C3 Content Review -

- **Thanks for Opportunity.**
- **Questions and/or Thoughts?**
- **Further Discussion.**

“V3C3 Tutorial – A Glance”
[To Be Followed]

FAA / CAAs “Composite Meeting”

- CMH-17 V3C3 Development & Content -

- Development of CMH-17 V3C3
 - Background – Environment & CMH-17
 - Working Group – Charter & Execution
 - CMH-17 V3C3 Content Outline
- CMH-17 V3C3 – Content Review
 - Regulation and Certification
 - Design Substantiation
 - Production – Essentials
 - Maintenance – Technical Issues
- **CMH-17 V3C3 Tutorial – A Glance**