

AEROSPACE INFORMATION REPORT

AIR5552™

Issued 2010-10
Reaffirmed 2020-09

Development and Qualification of Composite Landing Gears

RATIONALE

AIR5552 has been reaffirmed to comply with the SAE five-year review policy.

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Purpose.....	3
1.2	Application.....	3
1.3	Composite Design References.....	3
1.4	Further development of this AIR.....	3
2.	REFERENCES.....	4
2.1	SAE Publications.....	4
2.2	FAA Publications.....	4
2.3	Other Publications.....	4
3.	APPROACH.....	4
4.	REQUIREMENTS.....	6
4.1	Composite Landing Gear Requirements.....	6
4.2	Environmental Considerations.....	7
5.	DEVELOPMENT APPROACH.....	8
5.1	Means of Compliance.....	8
5.1.1	Enhanced Safe Life Method.....	8
5.1.2	Damage Tolerance Method.....	8
5.2	Reliability.....	8
6.	DAMAGE TOLERANCE.....	9
6.1	Characterization of Damage.....	9
6.2	Inspections.....	10
7.	THREAT ASSESSMENT.....	10
7.1	Intrinsic Flaws.....	11
7.1.1	Delamination.....	11
7.2	Manufacturing Process Induced Damage.....	11
7.3	Service Damage.....	12
7.4	Maintenance Induced Damage.....	12
7.5	Discrete Source Damage.....	12

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Documents

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8.	MATERIAL AND PROCESS CHARACTERISATION.....	12
8.1	Material and Process Specification.....	13
8.2	Coupons.....	13
8.3	Elements	13
8.4	Manufacturing Location.....	13
9.	COMPONENT DESIGN.....	13
9.1	Analysis.....	13
9.2	Protection from Environments.....	13
10.	HYBRID ASSEMBLY	14
11.	COMPONENT TESTING	14
11.1	Strength Evaluation.....	14
11.1.1	Limit Load.....	14
11.1.2	Ultimate Load	15
11.2	Fatigue Evaluation	15
11.2.1	Fatigue Spectrum.....	15
11.2.2	Spectrum Truncation.....	15
11.3	Endurance Evaluation.....	15
11.4	Factors	16
11.4.1	Environment.....	16
11.4.2	Fatigue	16
12.	CONTINUING AIRWORTHINESS.....	16
12.1	Repairs	16
12.2	Overhaul.....	16

1. SCOPE

This information report provides general guidance for the design considerations, qualification in endurance, strength and fatigue of landing gear using composite components as principle structural elements.

The information discussed herein includes the development and evaluation of design data considering: the potential for imbedded manufacturing defects, manufacturing process variations, the component operating environment, potential damage threats in service, rework and overhaul, and inspection processes.

This AIR mainly discusses the use of thick composites for landing gear structural components. Considerations and recommendations provided in this AIR may therefore differ greatly from considerations and recommendations found in widely accepted composite design references such as CMH-17 and Advisory Circulars such as AC 20-107(B).

1.1 Purpose

The purpose of this AIR is to provide general guidance in the qualification of composite components for landing gears. Compliance with this report is not considered approval for installation on any category aircraft or helicopter.

The Certifying Authority for the platform for which the equipment is intended should be consulted for concurrence with the approaches proposed herein as an acceptable qualification demonstration for composite landing gear components.

1.2 Application

This AIR is applicable to the qualification of the composite landing gear structural elements in strength, fatigue and endurance. The current version of this document focuses on the use of Polymer Matrix Composites, but might also be applicable for other composite materials such as Metal Matrix Composites although they are not explicitly discussed herein.

Compliance with this information report by manufacturers, installers, and users may be used as a means of assuring that the equipment will have the minimum capability to satisfactorily perform its intended function(s).

1.3 Composite Design References

In the development of this AIR, close interaction is sought with other composite guideline development such as within the CMH-17 and AC 20-107 committees.

It should be noted that the majority of documentation on composite materials concerns thin walled structures. The application in landing gear principle structural element primarily focuses on thick walled structures.

1.4 Further development of this AIR

It is recognized that the guidance provided in this document on composite application to a landing gear principle structural element is general in nature and limited in scope. It is the intent that this document will be further developed over time where active feedback from industry and authority specialists is sought to expand the scope to other category aircraft and provide more specific guidance to composite component development in landing gear principle structural elements.

2. REFERENCES

The following publications form a part of this document specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws or regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AIR1494	Verification of Landing Gear Design Strength
ARP1311	Landing Gear Structures and Mechanisms
ARP5914	Landing Gear Fatigue Spectrum Development for Part 25 Aircraft
ARP5644	Impact Testing of Aircraft Landing Gear

2.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

Title 14, Code of Federal Regulations (14 CFR) part 25 – Airworthiness Standards: Transport Category Airplanes (§25.301 through 307, §25.471 through 25.519, §25.571, and 25.723 through 25.729)

Advisory Circular (AC) 20-107B, Composite Aircraft Structure

Metallic Materials Properties Development and Standardization (MMPDS), Version 3, 2006

DOT/FAA/AR-03/19 Material Qualification and Equivalency for Polymer Matrix Composite Material Systems

2.3 Other Publications

CMH-17-F	Department of Defense Handbook, Composite Materials Handbook
AC23-13A	Fatigue, Fail Safe, and Damage tolerance evaluation of metallic structure for normal, utility acrobatic and commuter category airplanes
AC25-571-1B	Damage tolerance and fatigue evaluation of structure
AFS-120-73-2	Fatigue evaluation of wing and associated structure on small airplanes, May 1973.

3. APPROACH

In order to define the strength and fatigue capabilities of composite components, its properties must be determined by structural analysis and/or test. Typically, a pyramid or building block approach is employed where analyses are combined with tests at various levels of structural complexity. Going up this pyramid, the number of test specimens decreases, while the test complexity increases. During a program, these building block levels are linked with supporting technologies and design considerations. This is depicted in Figure 1.

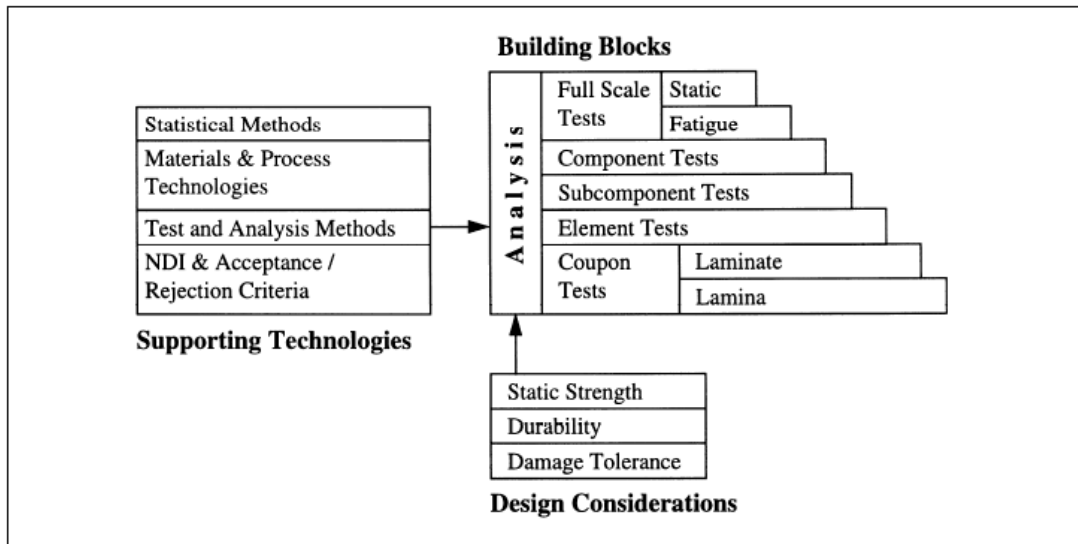


FIGURE 1 - BUILDING BLOCK APPROACH FROM CMH-17

Simple coupons or specimens are tested at the lowest level to statistically determine the material strength and stiffness allowables. Once the simple coupon values are determined, more complex multi-directional coupon properties are developed by test until ultimately the component level properties are defined. The building block approach should include the critical service environmental conditions in deriving the material properties and allowables. The number of tests should be sufficient to ensure statistically significant results.

Because of the complex, anisotropic mechanical response of composite materials, modifying factors as traditionally used in metal components, like stress concentration factors found in handbooks, cannot be used. Instead the properties of critical details are substantiated by using structural element or sub-component tests representing local composite architecture and design details. Also scaling of structural elements as seen in metal design solutions is generally not possible in composite designs. Instead, extensive testing and analyzing is required.

Although the building block approach is widely acknowledged, details are far from universal and may be program and component specific. Figures 2 and 3 depict a typical building block strategy for aircraft defined in CMH-17-F.

For more information on the Building Block approach, please refer to CMH-17.

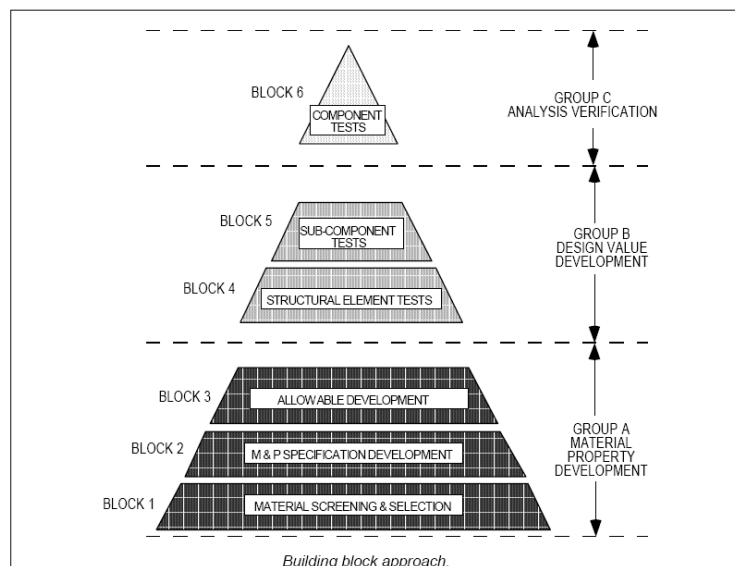


FIGURE 2 - TYPICAL BUILDING BLOCK APPROACH FOR AIRCRAFT (FROM CMH-17)