

***The Substantiation Dilemma
Associated with Major
Composite Repairs &
Alterations***

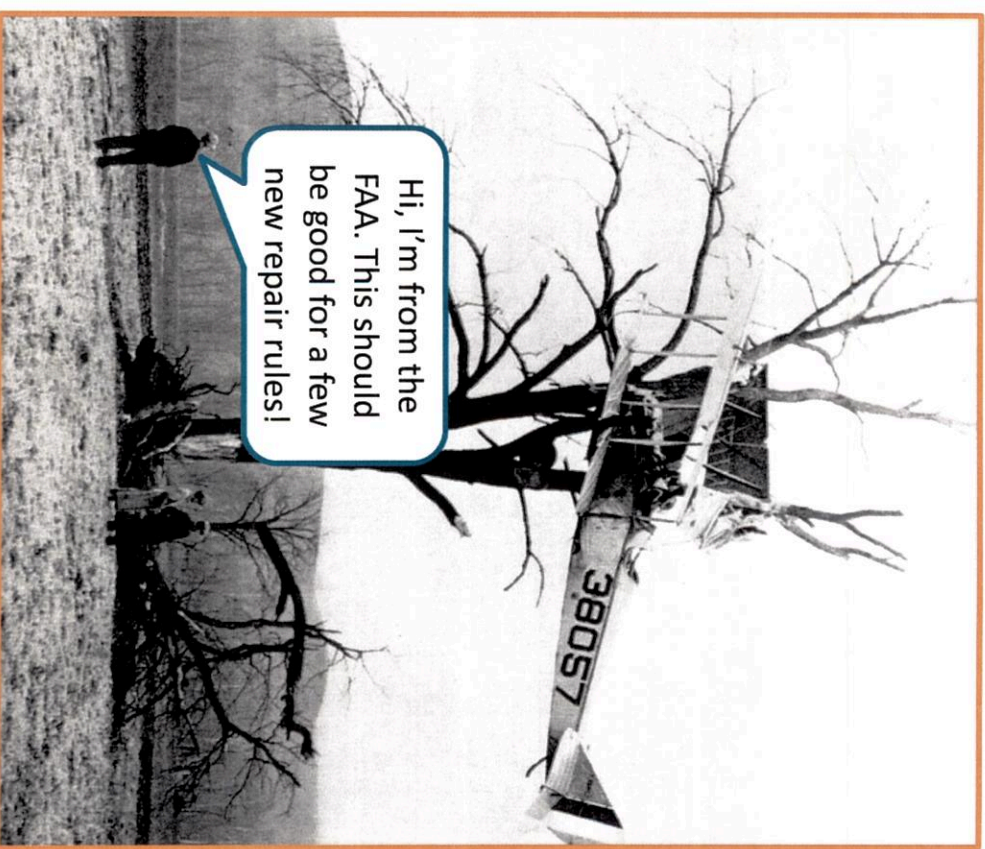
**FAA Composite Modifications Workshop
July 19-20, 2016**

Presented by:

**James R. Epperson
FAA Structures DER**

The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Unlike past simpler times, in today's complex world of Advanced Composite Aircraft Design, the Maintenance, Repair, and Overhaul (MRO) Community struggles in developing an Autonomous Capability of substantiating Repairs or Alterations of a Composite Structure and/or Component without reliance on OEM Intervention.



The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Refresher: Repair Rules MRO's Live By:



8110.37E (DER Handbook) Defines a Repair as:

» The restoration of a damaged product or article accomplished in such a manner and using material of such quality that its restored condition will be at least equal to its original or properly altered condition (with regard to aerodynamic function, structural strength, resistance to vibration and deterioration, and other qualities affecting airworthiness)

14 CFR Subchapter A, Part 1, Repair Classification Definitions:

- Major Repair means a repair that if improperly done might appreciably affect weight, balance, structural strength, performance, powerplant operation, flight characteristics or other qualities affecting airworthiness; or that is not done according to accepted practices or cannot be done by elementary operations.
 - Major repairs must be accomplished in accordance with technical data APPROVED by the Administrator
- Minor Repair means a repair other than a major repair.
 - Minor Repairs are accomplished in accordance with technical data ACCEPTABLE to the Administrator

The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Refresher: Alteration Rules MRO's Live By:



8110.37E (DER Handbook) Defines an Alteration as:

» An alteration is the modification of an aircraft from one *sound state to another sound state*; the aircraft meets the applicable airworthiness standards both before and after the modification

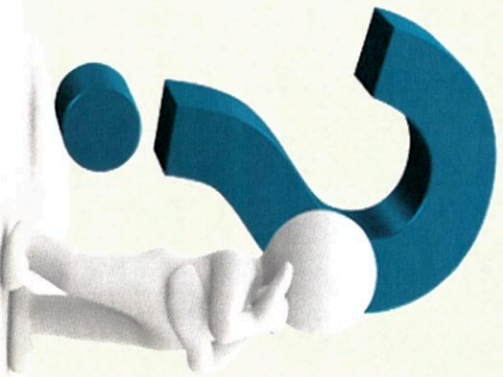
14 CFR Subchapter A, Part 1, Definitions, Defines Major Alteration as:

- Major alteration means an alteration not listed in the aircraft, aircraft engine, or propeller specifications that might appreciably affect weight, balance, structural strength, performance, powerplant operation, flight characteristics or other qualities affecting airworthiness; or that is not done according to *accepted practices or cannot be done by elementary operations*.
 - Major alterations must be accomplished in accordance with technical data *APPROVED* by the Administrator
- Minor Alteration means a repair other than a major alteration.
 - Minor Repairs are accomplished in accordance with technical data *ACCEPTABLE* to the Administrator

The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

What validates how the stated FAA regulatory rules are satisfied?

How does the MRO Community show compliance with the subjectivity associated with the FAA's definitional use of phrases such as:



- *“will be at least equal to”*
- *“that if improperly done might appreciably affect”*
- *“not done according to accepted practices”*
- *“from one sound state to another sound state”*
- *“cannot be done by elementary operations”*

**The MRO demonstrates compliance by creating:
“A Supportive Engineering Substantiation Analysis”**

The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Determining a Substantiation Approach

1. *The MRO organization establishes the substantiation approach by making a Major or a Minor Repair/Alteration classification determination:*
 - Within accepted practice: Repair/Alteration accomplishment is classified as Minor
 - Beyond accepted practice: Repair/Alteration accomplishment is classified as Major
2. *Engineering substantiates accordingly:*
 - Major repairs must be accomplished in accordance with technical data APPROVED by the Administrator
 - Minor Repairs are accomplished in accordance with technical data ACCEPTABLE to the Administrator



The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

A **Major** classification presents a significant challenge to the non-OEM related approval organization. What are the substantiation provider's options when OEM data is unavailable yet still comply with the criteria?



FAA Approval Resources:

- ✓ FAA Regional Aircraft Certification Office (ACO)
- ✓ OEM ODA Approval Release via FAA Form 8100-9
- ✓ MRO ODA Approval Release via FAA Form 8100-9
- ✓ FAA Designated Engineering Representative Release via FAA Form 8110-3

The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Situations Commonly Occurring at the MRO:

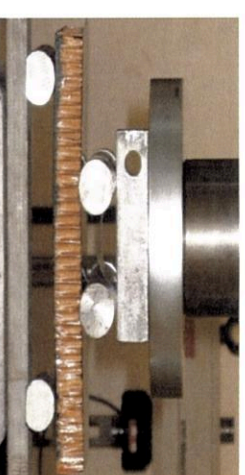
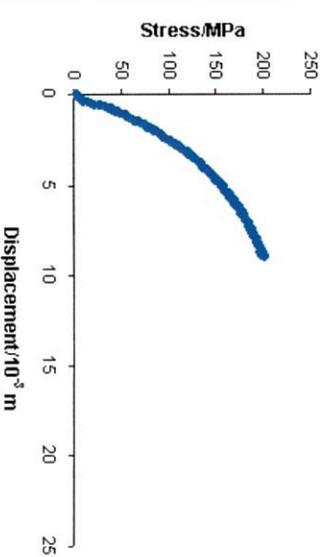
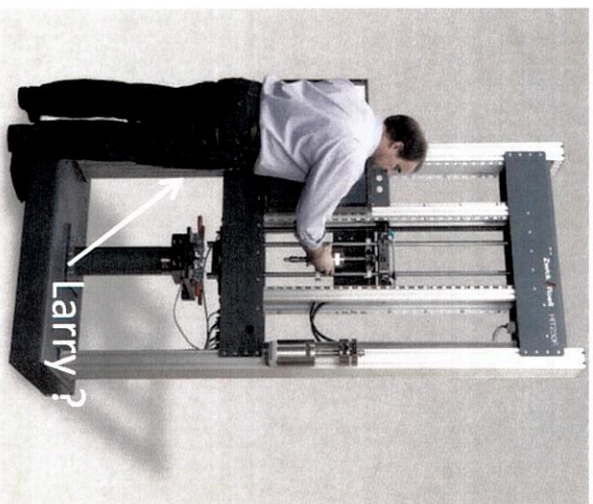
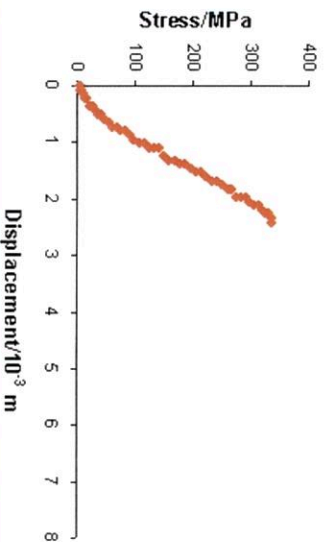
1. The base composite material is known (i.e. OEM Spec #) but not available for purchase and access to the OEM material allowables database (IP) does not exist.
2. The base OEM composite material is unknown and access to the OEM material allowables database (IP) does not exist:



The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

The Primary Pathway to Substantiation Development for the MRO without the Convenience of having Access to OEM Material Design Data (IP) is:

TESTING! **TESTING!** **TESTING!** **TESTING!**



The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Dealing with the Unknown, A Substantiation Approach

1. Categorize the component by the degree of functional risk with an associated knock-down factor:
 - **Low:** Secondary structure – Analysis knock-down factor = XX%
 - **Medium:** Flight controls – Analysis knock down-factor = YY%
 - **High:** SRM listed PSE's, Fuselage, etc. - Analysis knock-down factor = ZZ%
2. Utilizing any available remnant taken from the component, forensically analyze the unknown material as required to validate the material's base composition.
3. Select a commonly used industry material of similar composition that can be used as a stand-in standard for the unknown OEM base material properties.
 - The mechanical and processing allowables must be known for the stand-in material.
 - Most prepreg types utilize a common fiber type, thus base properties will not vary significantly from one prepreg to another.
 - Incorporate a knockdown factor applicable to the assigned risk category and complete the analysis.

The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Dealing with the Unknown, A Substantiation Approach (Con't)

5. Select a readily available repair/alteration material that can be used in multiple applications. The allowables for this material must also be known or created via testing (i.e. create a process unique allowables database utilizing a public domain NCAMP material).
 - NOTE: FAA repair/alteration data testing requirements differ from those associated with the certification process. The testing regimen may be abbreviated as required to support the requirement of using material of such quality that its restored condition will be at least equal to its original or properly altered condition with regard to structural strength.
6. Using the stand-in material allowable for the base component material and the repair/alteration material allowable (knockdowns applied for vacuum vs. autoclave) run the necessary calculations to determine the MS associated with the repair methodology.
7. Assign minimum substantiation MS expectations based on Component Risk:
 - Low: (i.e.. 0.02 MS or greater)
 - Medium: (i.e.. 0.15 MS or greater)
 - High: (i.e.. 0.25 MS or greater)

The Substantiation Dilemma Associated with Major Composite Repairs & Alterations

Summary:

- ✓ Major Repairs/Alterations must be supported with Approved Data
- ✓ Outside of the availability of OEM IP, the MRO is driven to create their own supportive Major Repair/Alteration IP
- ✓ A significant resource challenge (cost, personnel, time) to any MRO organization is how to create repair/alteration substantiation IP for a wide variety of components from scratch
- ✓ The MRO's willingness to independently invest in supportive validation testing would appear to be the preeminent path towards the creation of needed approval IP
- ✓ FAA repair/alteration data testing requirements differ from those associated with the certification process