

Composite Modification Workshop

AC Appendices

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Federal Aviation
Administration



Appendix A – Modification vs Alteration

- **Definitions in the body of the AC say:**
 - **Alteration** – Changes to structure from one airworthy condition to another, for instance, the installation of an antenna, antenna pod, or aerodynamic fairings in an effort to improve aircraft performance or passenger/crew convenience. For the purposes of this AC, an “alteration” is synonymous with “modification” unless specifically noted otherwise (for additional discussion, see Appendix A).
 - **Modification** – The incorporation of a change to type design of an aircraft or article, either through an amended type certificate or supplemental type certificate. For the purposes of this AC, an “alteration” is synonymous with “modification” unless specifically noted otherwise (for additional discussion, see Appendix A).

Appendix A – Modification vs Alteration

- Historically, “alterations” have been defined as an activity defined in 14 CFR, Part 43, specifically Part 43 Appendix A. The term “alteration” is also specifically cited in many regulations including, but not limited to 14 CFR 91.407 (General Operating and Flight Rules), 135.425/.427 (Operating Requirements – Commuter and On-Demand), and 121.163/.365/.367 (Operating Requirements – Domestic, Flag and Supplemental Operations), and 145.103/.201 (Repair Stations).
- The term “modification” also appears in 14 CFR 91 in regards to noise levels, and several 121 regulations speak about “modifying” the fleet. 14 CFR 21.225 talks specifically about “modifications” as the work is being performed prior to an Airworthiness Certificate, presumably under a PC, or PC-type program.
- Regulations such as 14 CFR 26.1 refer to alterations and repairs, whereas 14 CFR 26.5/.47 (Aging Aircraft Safety Rule) refer only to alterations, and 14 CFR 26.21/.23 (Widespread Fatigue Damage) refer only to modifications, based at least in part on when the change would be incorporated.

Appendix A – Modification vs Alteration

- Advisory Circulars such as 120-104 and 25.571-1D have included definitions (for the purposes of the AC only), that alteration and modification can be considered the same. AC 120-93 further notes that, “An alteration is a design change that is made to an airplane; however, various segments of industry have also defined these changes as “modifications.” In this AC an alteration is all-inclusive of any design change.” AC 20-188 simply states that a “Modification is a change is a change to the type design installed on the aircraft.”
- In reality, whether the incorporation is designated as a “modification” or “alteration” has little to do with the certification requirements, but rather when the change will be incorporated into the product. Typically the certification requirements for an alteration being documented in either an Aircraft Logbook (minor alterations) or FAA Form 337 (major alterations) without an STC are based on the FAA Type Certificate Data Sheet (TCDS). However, it is possible that modifications or major alterations based on an STC could have an updated certification basis from the original TCDS .

Appendix A – Modification vs Alteration

- The purpose of this AC is to address the certification requirements for anyone seeking approval for design or aircraft/product change. In this manner, other than differences in determining the appropriate amendment level, the terms alteration and modification can be used synonymously herein. The term “modification” is chosen to be used based in part on definitions provided in AC 120-104, 120-93, 25.571-1D, and AC 20-188.
- **Is this appendix needed?**

Appendix B – Examples

Common Modifications (current outline)

- **Part 23:** Radome, Floats and skis, Winglets, Fairings
- **Part 25:** Large antenna, Winglets, Large monuments, Special mission (fairings)
- **Parts 27 and 29:** General, Rotor blade, External items of mass
- **Repairs:** Expanding the size of an existing repair, Reskinning a control surface, ICAs after a repair, Helicopter repairs
- **Example General Methodology**



Appendix B – Examples

- **This outline / format is not set in stone**
- **Requesting workshop feedback**
- **Do we keep multiple examples broken out by product?**
 - Or should there only be one for, say, Winglet that is for both general aviation and transport aircraft?
- **Do we have only three examples?**
 - A composite part, modified composite structure, repair OR
 - Critical structure, secondary structure, non-structural
- **Include any reference to repairs? Proposed subjects have included:**
 - Expanding the size of an existing repair, Reskinning a control surface, Thoughts on ICAs for a repair, Helicopter Repairs

Appendix B – Examples

- **For each example, do we...? :**
 - Identify critical / secondary structure / non-structural
 - Identify applicable regulations (example compliance checklist) or only have general comments for that application
 - Only discuss the replacement part or discuss the probable base structure being modified
 - “Case Study” style where one project is reviewed, although the methods aren’t necessarily generic – can be an example of what did or didn’t work
- **What is the correct level of detail?**
- **Are there other documents that can be referenced instead of creating the appendix or to supplement it?**

Appendix B - Example

- **This information has been provided as a case study for a major wing repair substantiation without OEM support. Should we include something like this?**
- **The repair consisted of the following steps:**
 1. A scrapped wing was obtained to be used to develop baseline data, such as wing construction, laminate configurations and, using test coupons cut from the scrapped wing, establish existing strength levels for the wing details. In addition, sections of the wing were sent to an NDI lab to establish NDI techniques and determine acceptable standards based on the results of the NDI inspection.

Appendix B - Example

2. The material was purchased to the material manufacturers part number, qualified to the manufacturers material specifications.
3. The repair process specifications were written based on the repair manual procedures and industry practice.
4. A set of wing loads was computed to be used for structural evaluation and stress analysis
5. Damage tolerance analysis of the wing spar was based on the strength of the wing spar being at or above limit load with unrepaired damage and periodic inspections, and for the leading edge, which was also part of an integral fuel tank, damage tolerance inspections, consisting of looking for fuel leakage were performed.

Appendix B - Example

6. Laminate repair test specimens were made up of the repair material, processed to our developed repair specifications, with layups established by using the information obtained from examination of the scrapped wing were fabricated and tested, along with bonded joints.
7. Using this information, the repair was designed and implemented. Process control panels and specimens were cured along with the repair.



Appendix C - Reverse Engineering and Using OEM Design Philosophies

Modification Design Considerations

- **Modifiers should have a clear picture of the intent and impact of the modification, with answers to the following questions:**
 - What is the intent and impact of the modification?
 - What is the purpose of the modification?
 - What flight and ground conditions are affected?
 - How is aircraft performance affected?
 - What systems are affected?
 - What load paths are affected?
 - What are the critical environmental considerations?
 - What are the failure modes and effects?

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Certification Considerations

- **As the modification is certified, the FAA will ask:**
 1. Did the modification consider ADs and service history?
 2. What load assumptions were used and what conditions were considered? How were they calculated and how were they validated?
 3. If the modification did not do full scale structural tests (fatigue and static), how is this justified?
 4. If the modification did full scale tests, how were the critical load conditions selected from the thousands of load conditions?

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Certification Considerations

- **As the modification is certified, the FAA will ask:**
 5. If the modification used coupon/element/subcomponent tests, how did the modifier validate the test article represents the modified structure. Was the thickness, form (extrusion, sheet, etc.), and all loads (all load directions, not just the primary direction - especially out of plane loads) represented? Was more than one batch lot of material tested?
 6. Were any structural analyses methods validated and how? How were the critical locations determined? There are thousands of load cases, why did the analysis only consider a few of these cases? How were the critical load cases selected?

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Certification Considerations

- **As the modification is certified, the FAA will ask:**
 7. How were the allowables established?
Coupon/element/subcomponent tests?
 8. The modification is applicable to all models and configurations, how was this justified, considering only one model/configuration was conformed/flown?

Appendix C - Reverse Engineering and Using OEM Design Philosophies

The regulations set a minimum standard of safety and using the OEM philosophy is one of many means to accomplish the required level of safety. A big advantage in using the OEM philosophy is the modifier is less likely to make an error that causes a safety problem. In as much as practical, the design philosophy of the OEM should be used. However, it is understood that not all of the design philosophy is available to the modifier and use of the OEM design philosophy is recommended, but not mandatory.

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Types of OEM Design Philosophy

This AC has emphasized the benefits of having access to OEM data in substantiating modifications to baseline composite structure.

The information below is a short list of examples of OEM philosophy. This list is not complete, but provides some insight into the situation. It should be understood that the modifier may or may not be aware of these design philosophies.

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Types of OEM Design Philosophy

1. Minimum Bolt/Rivet size - Many of the large OEMs have minimum sizes for fasteners. This is not as common for small OEMs.
2. Do not design rivets in tension - This is a good philosophy but it is violated by OEMs and modifiers frequently.
3. Strain Criteria - It is not common for the modifier to know the OEM strain criteria but the information is sometimes available.

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Types of OEM Design Philosophy

4. BVID/CVID - FAA Policy Statement PS-ACE100-2001-006 states, "In the past, the conservative energy cut off applied as an upper level limit to the ultimate load requirement for thick structures was 1,000 inch-pounds. A value of 500 inch-pounds is a more realistic energy cutoff; however, lower impact energy levels have been justified using service data and probabilistic analyses. In most composite shell structures that are characteristic of small airplanes and business jets, the cut-off level is not applied because damage visibility is typically achieved at impact energies of 300 inch-pounds or less."

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Types of OEM Design Philosophy

4. (continued) Actual impact energies is likely buried in the OEM threat assessment document. The 1200 in-lb impact will occur in a very localized region of the aircraft and there is little chance of the modifier knowing the location of this impact region (or know the impact energy requirements in any region. Therefore, the modifier will create a threat assessment document and it will not be the same as the OEM, unless the modifier possesses the OEM data.
- BVID/CVID is an example of a good reason to follow the OEM design philosophy but it is unlikely the modifier would have access to this info. However, the modifier can create a credible threat assessment document and do necessary tests to determine the effects of impactor size/ energy or the modifier can simply use a conservative criteria.

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Working Without OEM Data

The approach to working without OEM data varies with the application and how much OEM data is available. It is rare to accomplish a modification with no OEM data. Typically the modifier has access to maintenance manuals, flight manuals, SRMs, sometimes drawings, service bulletins, etc. In addition, there is a lot of info available through technical papers, written by the OEM staff, OEM information provided to owners through "owners conferences," etc.

Appendix C - Reverse Engineering and Using OEM Design Philosophies

Working Without OEM Data

- Some of this data cannot be directly used for certification data, but it can provide corroborating evidence of other information. For example, if you remove a piece of a stringer and a metallurgical lab identifies the material as 2024-T3 and the OEM service support group states the stringer is fabricated from 2024-T3, you have confidence in the metallurgical lab analysis.
- Conversely, if the stringer is on the upper wing skin of a highly stressed wing (Biz Jet, Transport, etc.), you would be expecting the stringer to be a 7000 series aluminum, If the metallurgical lab says 2024-T3 and the OEM support says 7075-T6, you should probably get a second opinion from another lab.

Appendix C - Reverse Engineering and Using OEM Design Philosophies

- **Effects of Incorrect Design Philosophy**
 - OEMs to provide information for this section?

Appendix C

- **Is there value to the information in this appendix?**
- **Should the information be elsewhere?**
 - Industry documentation?
- **Is the content complete? How can it be filled in further?**