

Minefield Avoidance for Mechanics Performing Alterations

Presented to: Ohio Aviation Maintenance
Symposium

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Date: March 19 – 20, 2008



Federal Aviation
Administration

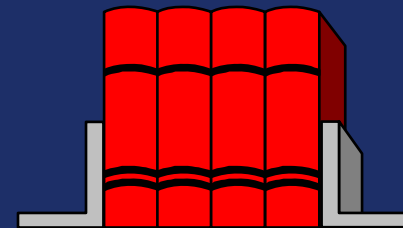


Overall Objectives of Presentation

- To identify...
- To explain...
- To clarify...
- To recognize requirements and shortfalls
- To obtain compliance and increase safety



Regulations
and policies
pertaining to
alterations



Definitions and Detailed Objectives

Certification: *the guaranteeing of the truth or validity of; attestation...*

– *versus*

Approval: *official consent; sanction*

Detailed objectives of this presentation:

- to examine differences and their implications
- to improve your understanding of requirements of the regulations and policies
- to assist you applying best alteration practices

Minefield Recognition and Escape...

- To recognize “minefields” with the Federal Aviation Regulations (FAR) pertaining to performance of alterations
- A explanation on how to obtain interpretations with FARs applicable to alterations and how to apply them
- Explore and escape alteration minefields...



Minefield Avoidance in Alterations

- Problem: Sometimes we find ourselves lost in regulatory minefields because most of the time we think we know the regulations to which we are working and applying to the work performed
- Solution: Practice as if every alteration is performed to sustain airworthiness to ensure...
 - ...at least equal to its original or properly altered condition
 - ...conforms to its [original] type design and is in a condition for safe operation



Know the Regulatory Differences

- §21.93 - A minor change is one that has no appreciable effect on the weight, balance, structural strength, reliability, operational characteristics, or other characteristics affecting the airworthiness of the product
 - All other changes are major changes
- §1.1 - A major alteration is one that might appreciably affect weight, balance, structural strength, performance, powerplant operation, flight characteristics, or other qualities affecting airworthiness

Comparing 14 CFR §21.93(a) with §1.1

§ 21.93(a)	§ 1.1
MAJOR DESIGN CHANGES	MAJOR ALTERATIONS
1. Weight	1. Weight
2. Balance	2. Balance
3. Structural Strength	3. Structural Strength
4. Reliability	4. Not Applicable
5. Operational Characteristics	5. Flight Characteristics
6. Characteristics Affecting Airworthiness	6. Qualities Affecting Airworthiness
	7. Performance
	8. Powerplant Operations
	9. Not Using Accepted Practices
	10. Not An Elementary Operation



Examination of 14 CFR §21.95 & §21.97

- §21.95 - Approval of Minor Changes in Type Design
 - Minor changes in a type design may be approved under a method acceptable to the Administrator before submitting to the Administrator any substantiating or descriptive data
- §21.97 - Approval of Major Changes in Type Design
 - Under a major change in type design, the applicant must submit substantiating data and necessary descriptive data for inclusion in the type design
 - **Note inclusion of the word inclusion! Major Alterations are not legally recorded in a form or manner for inclusion within the type design!**

Major Alteration vs. Major Change

- When taken literally a major alteration that is accomplished under the Field Approval process is considered a minor change to the type design
- Otherwise, an alteration which is “significant” enough to qualify as a major change to the type design requires that the approval process be undertaken by applying for and being awarded an Supplemental Type Certification (or amended TC)
- In other words, in order for a Field Approval to be considered, the type design change MUST be minor, whereas if major, an STC must be obtained

Description of Alterations

- For practical purposes, 14 CFR part 43, appendix A, provides a listing of product alterations classified as major alterations
 - This listing is not and cannot be all inclusive
 - Anyone proposing to alter or approve an alteration to a type certificated product must determine whether the alteration is major or minor
- This listing does not consider the effects pertaining to a major design change, only a major alteration!
- The definitions in §1.1 serve as the foundation to make the determination of whether a change to the certificated properties of the product rise to the level of a major alteration

Appreciable - What Does It Mean?

- The difficulty in applying these definitions is determining the meaning of “appreciable” and “other qualities affecting airworthiness”
- “Appreciable effect” and “other qualities affecting airworthiness” must be considered for the proposed alteration...
 - **Webster's 9th New Collegiate Dictionary definition of “appreciable” is “capable of being valued or estimated”**
- Thus any effect that could be valued or estimated would be appreciable
- Appreciable is the value of such measurable effect

Negligible - What Does It Mean?

- “Negligible” which is often referred to with respect to such effects is defined as “that [which] can be disregarded; inconsiderable; trifling; of little importance or size”
- Any claim to “negligible” which cannot be established should not be referred to or used
- The net effect to a weight change, for example, is totally dependent upon the location (flight station, water line, etc.) not the actual weight of the article
- Therefore, a one pound weight change at station 186 on a Piper Cherokee 140, for example, may result in a major alteration, (or major change) as opposed to...

Negligible, As In Weight That Is...

...a one pound weight change at station 72, which may result in a minor alteration...

- 14 CFR part 43, appendix A(a)(xi) is sufficiently definitive
- If an alteration results in an increase in the maximum certificated weight or the center of gravity limits of the aircraft the effect is appreciable and the alteration is major
- If the alteration does not result in the weight or the center of gravity limitations being exceeded, or the mass distribution being changed, then it is a minor alteration with regard to weight and balance

Airworthiness - Useful Definition

- Airworthiness means that an aircraft, aircraft engine, propeller, or appliance is considered airworthy when it conforms to its original type design, and to subsequent changes to its type design, and is in a condition for safe operation
 - **The definition has never been adopted by FAA legal nor by the various FAA divisions**
- The airworthiness language however, does appear on the airworthiness certificate for the aircraft
- Airworthiness is used both as a verb and a noun

Other Properties – Explained (1/5)

- Structural strength. Generally, structural strength is determined by engineering analysis or tests. If analysis or tests are required to determine the effect of an alteration, then it is major
- If the structural alteration involved is performed according to standard practices (acceptable data that serves as the basis for an approval) and the structural strength of the product has not been lessened or impaired by the alteration, then that alteration is minor with regard to structural strength
- Penetration of pressure vessels are normally considered to have a lessening effect on structural strength! Thus, an analysis should be performed to determine the safety margin if it is not known

Other Properties – Explained (2/5)

- Flight characteristics. Are similar to and closely related to aircraft performance. Any measurable change to thrust or drag that affects performance is also likely to affect flight characteristics and requires engineering flight test for evaluation
- Thus, any alteration that may produce such an effect (such as a change in the external aircraft surfaces or change in power or thrust) is a major alteration
- All other changes are minor with respect to flight characteristics



Other Properties – Explained (3/5)

- Other qualities affecting airworthiness. This is an area where the definitions for major and minor could definitely apply
- Could the alteration as a result of malfunction or improper accomplishment “preclude continued safe flight and landing” or “adversely affect the safety of crew or passengers”?
- This could encompass areas such as fire protection, landing gear, personnel accommodations (pilot's view ventilation, emergency egress, etc.) and functioning of installed equipment (navigation, communications, flight instruments, autopilots, etc.)

Other Properties – Explained (4/5)

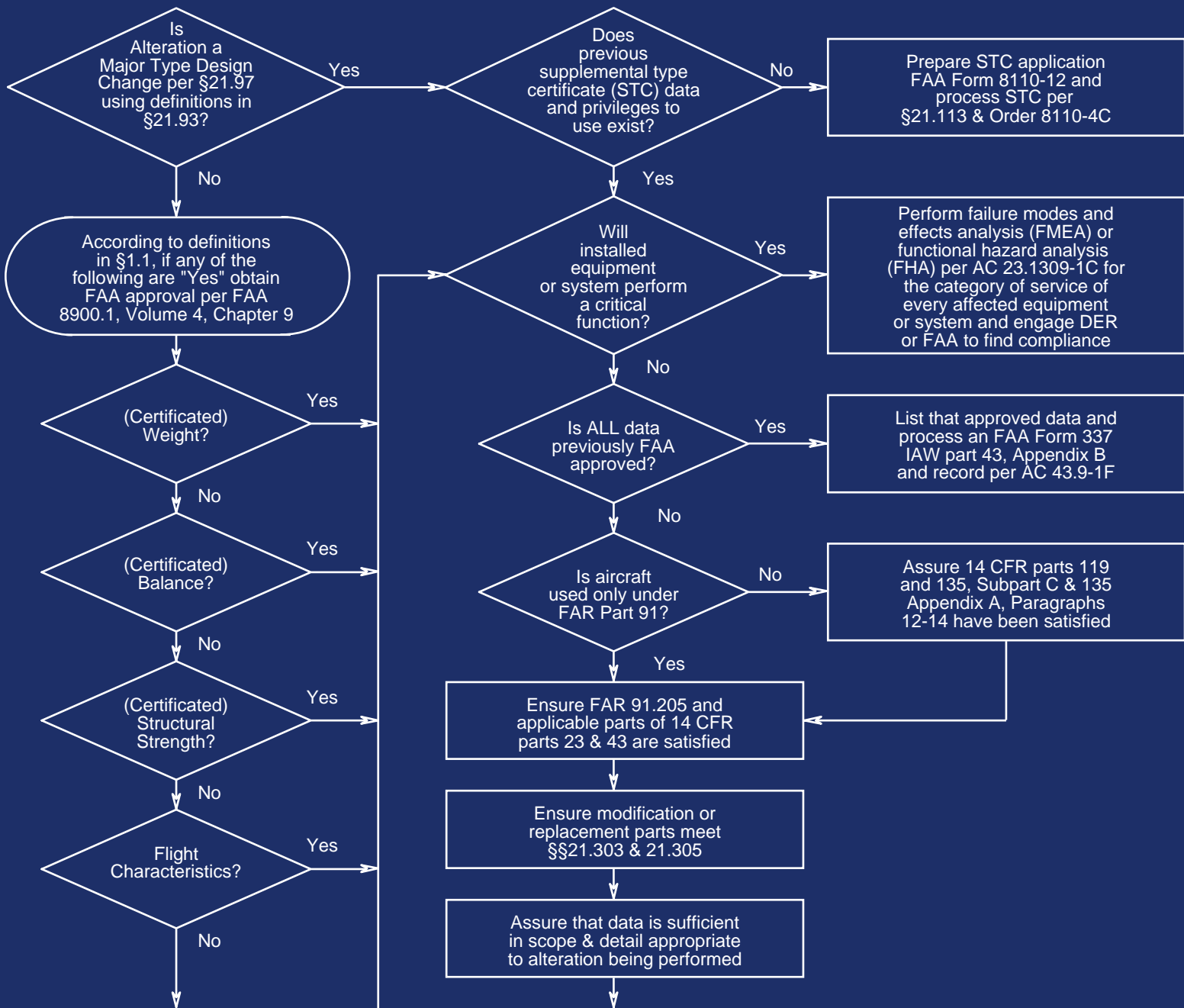
- Performance. Aircraft performance is determined primarily by the difference in available thrust and the aircraft aerodynamic drag in a given flight condition
- Any alteration to the aircraft that may affect thrust, drag, or other changes that may affect the airflow over the aircraft, is likely to affect performance
- If engineering analysis or flight test is necessary to substantiate the changes, the alteration is major. If experience or accepted guidelines have demonstrated that an alteration (such as a small antenna installation) does not produce a measurable effect on performance, then the alteration is minor with regard to performance

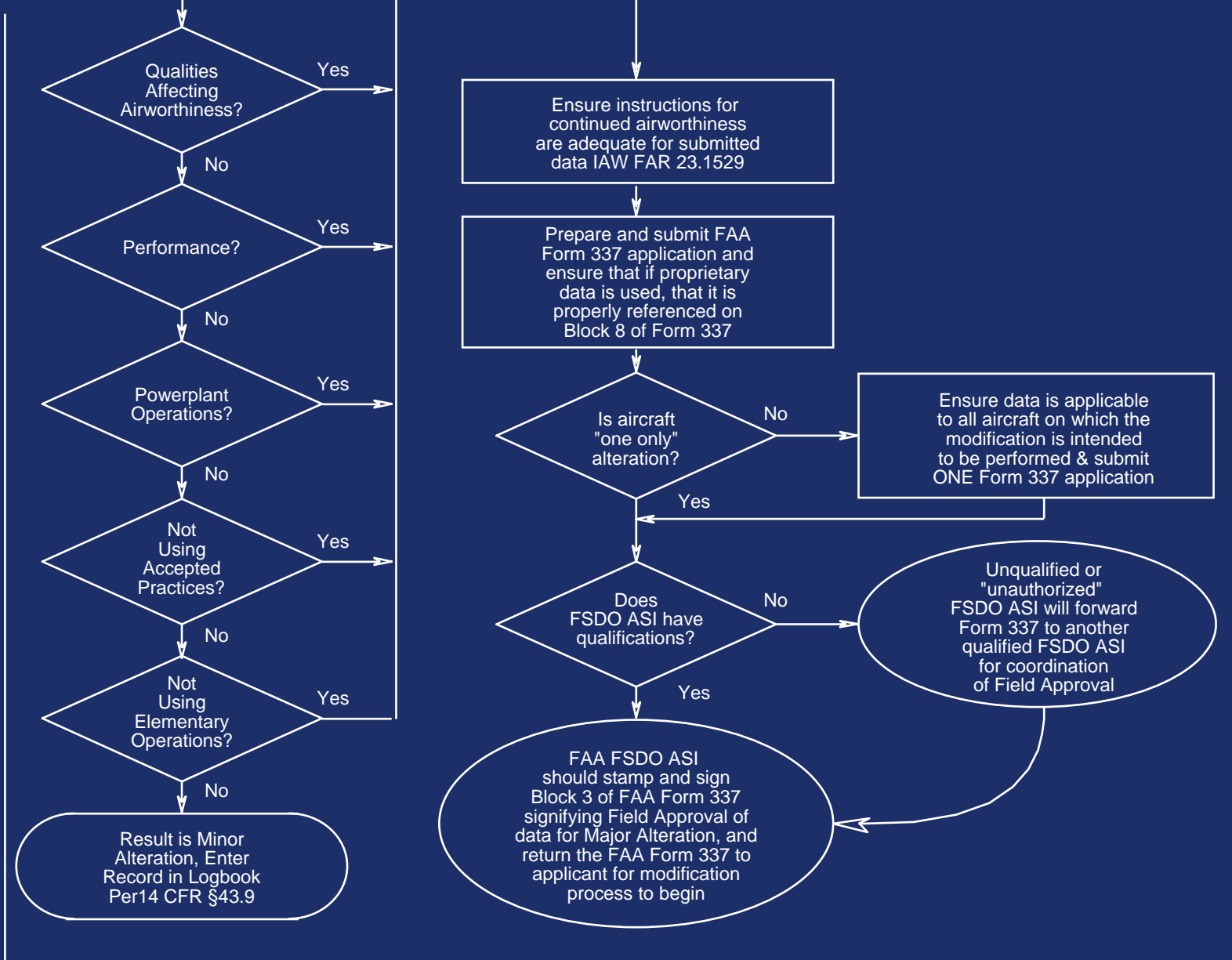
Other Properties – Explained (5/5)

- Manufacturer's approved alterations. An exception to the above discussion concerning the determination of major versus minor are those alterations approved during the type certification process and listed on the product specifications or type certificate data sheet (TCDS)
- Regardless of the nature of the alteration (e.g. optional engine or propeller), if it is listed on the specifications or TCDS, installation of the alteration using the aircraft, engine or propeller manufacturer's instructions is considered a minor alteration

Major Type Design Change/Major Alteration Decision Tree (Applicable to 14 CFR part 23 Airplanes)

- The decision tree on the following two pages...
 - Will assist in making determinations as to whether a type design change is major therefore, requiring application for amended type certification or STC; or,
 - Whether the intended alteration is a minor change to the type design therefore, permitting a major (or minor) alteration to be accomplished





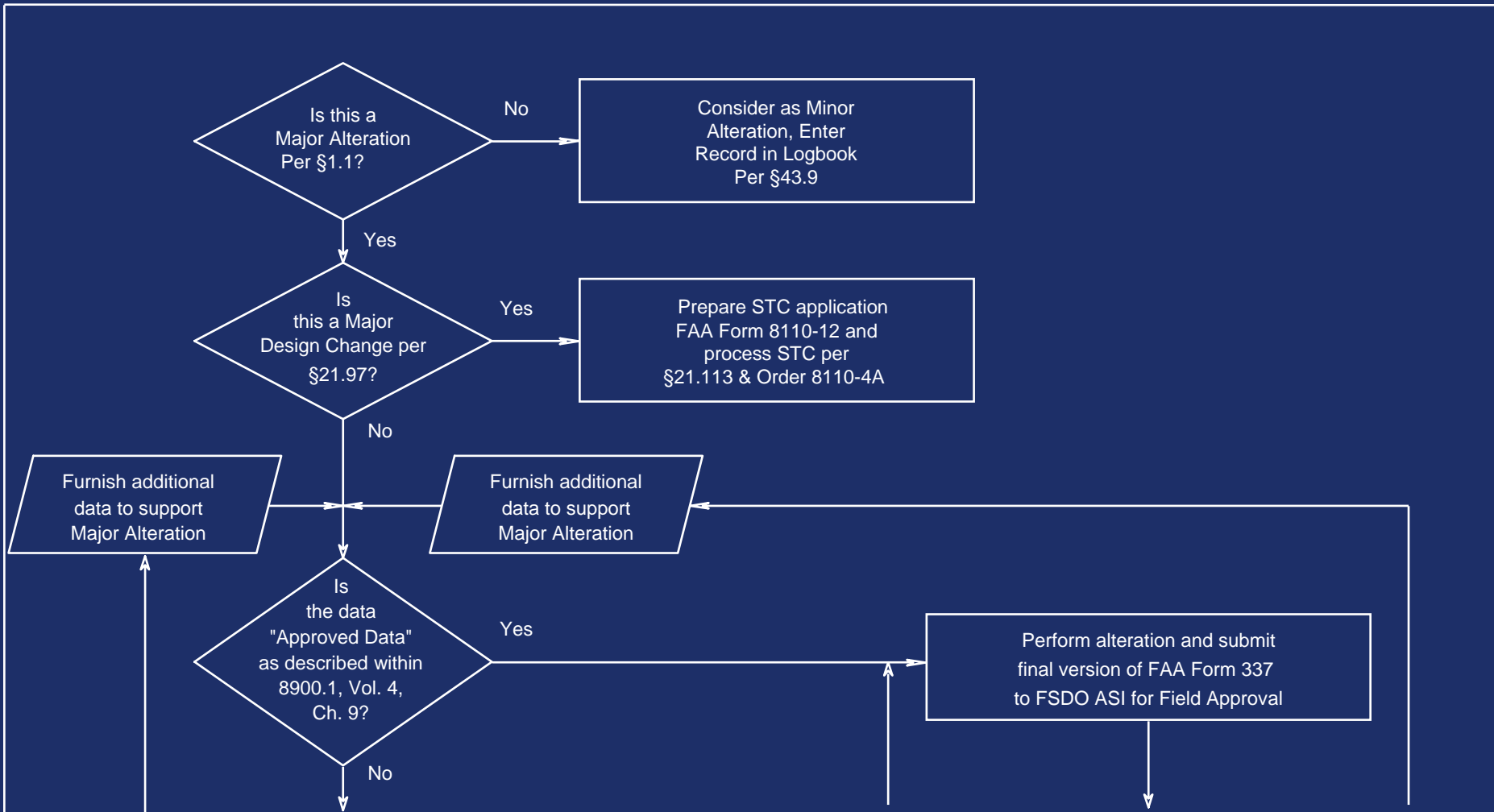
Is a Field Approval Necessary and Can it Be Obtained?

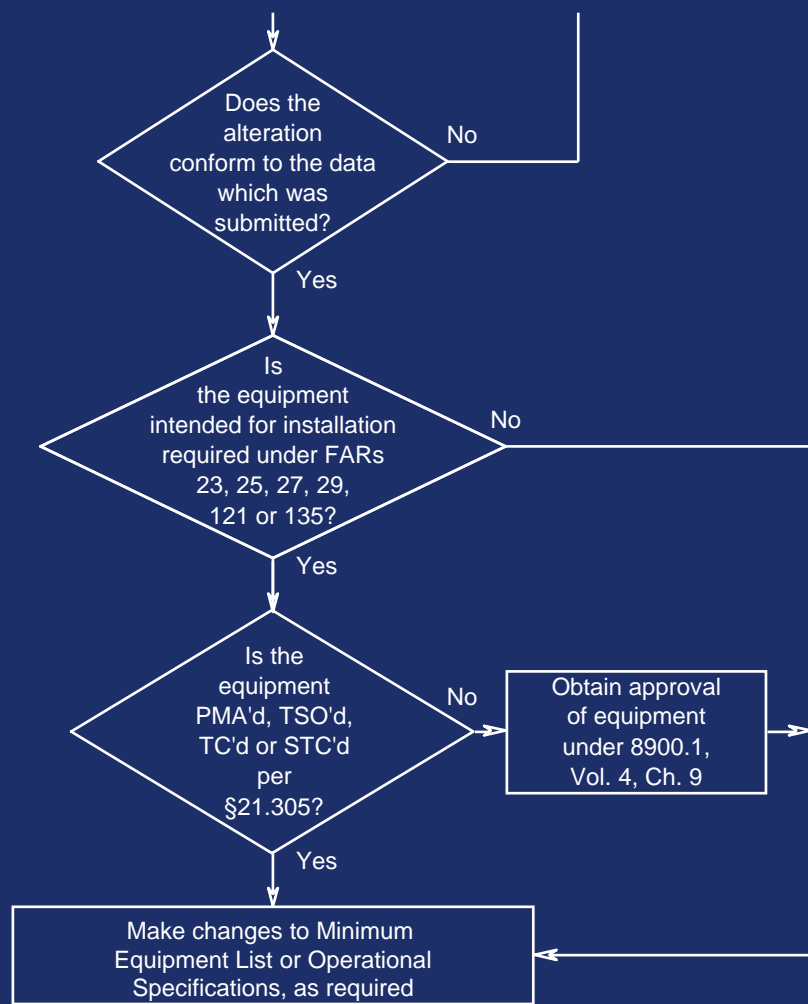
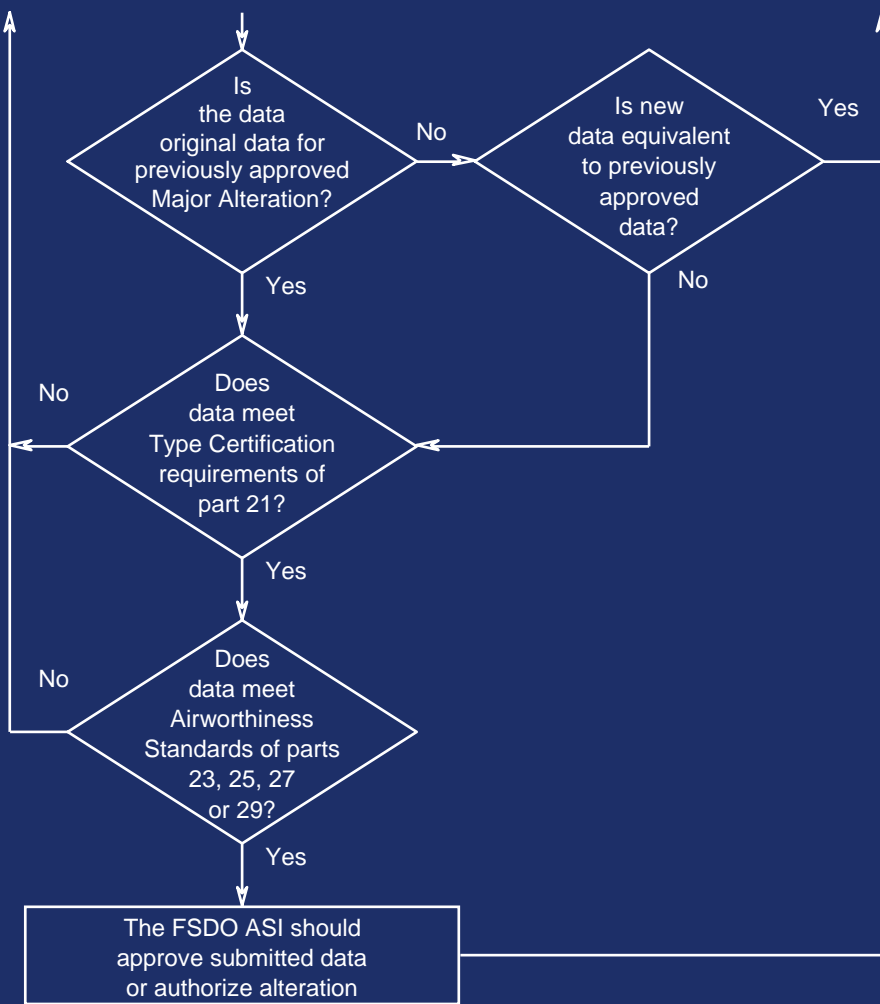
- Is modification likely to change the type design or certification basis? If so, has that portion of the modification been identified as requiring an STC?
- Is the level of the modification for Field Approval likely to affect aircraft records and continued airworthiness or other maintenance requirements?
- Is previous STC (certificate and supporting data) available as a basis for validating a Field Approval?
- Can a Field Approval be accomplished without engineering coordination or assistance?
- Can multiple disciplined DERs perform compliance findings thus eliminating need for Field Approval?
- Or, can equipment be installed as a minor alteration?

Major Type Design Change/Field Approval Decision Tree Discussion

- The decision tree on the following two pages...
 - Will question whether the alteration, if determined to be a minor change to the type design, can be considered eligible for Field Approval, and
 - Will assist in determining whether the data developed for an alteration is adequate and substantial to permit a Field Approval to be performed; or,
 - Whether an STC will need to be applied for under the basis of definitions found in §21.93 as described in §21.97

Major Type Design Change/Field Approval Decision Tree (truncated)





Differences Between Some Regulations

Title	FAR 23	FAR 25	FAR 27	FAR 29
Static Pressure Systems	.1325	.1325	.1325	---
Static Pressure & Pressure Altimeter Systems	---	---	---	.1325
Pitot Heat Indication Systems	---	.1326	---	---
Instruments Using a Power Supply	.1331	.1331	---	.1331
Instrument Systems	---	.1333	---	.1333
Storage Battery Design & Installation	.1353	---	.1353	---
Electrical Equipment & Installation	---	.1353	---	.1353
Distribution System	---	.1355	---	.1355
Fire & Smoke Protection	.1359	---	---	.1359
Master Switch	.1361	---	.1361	---
Electrical Systems Test	---	.1363	---	.1363
Electrical Cables	.1365	---	.1365	---
Electrical Cables & Equipment	.1365	---	---	---
Switches	.1367	---	.1367	---
Wing Icing Detection Lights	---	.1403	---	---
Safety Belts & Harnesses	.1413	---	---	---
Safety Belts	---	---	.1413	---
Safety Belts: Passenger Warning Device	---	---	---	.1413
Pneumatic De-Icer Boot System	.1416	---	---	---
Megaphones	---	.1421	---	---
Public Address System	---	.1423	---	---
Electronic Equipment	.1431	.1431	---	.1431

Compliance Checklist – Its Use is Strongly Encouraged! (See AC 23-21)

Legend: Analysis = A, Test = T, Document = D, Mockup = MU, Demonstration = DM							
FAR Section and Title	Paragraph	Means of Compliance					Document/Drawing No.
		A	T	D	MU	DM	
23.1301 - Function and Installation	(a) thru (d)		X				Ground Test Procedure/ Report No. 20080913
23.1303 - Flight and Navigation Instruments	(a) thru (c)			X			Equipment and Systems Description 20080909
23.1307 - Miscellaneous Equipment	(b)(1) thru (3)			X			Equipment and Systems Description 20080909
23.1309 - Equipment, Systems, and Installation	(a)(1)(i)		X				Ground Test Procedure/ Report No. 20080913
23.1309 - Equipment, Systems, and Installation	(a)(3)	X					Failure Modes & Effects Analysis, No. 20080911
23.1309 - Equipment, Systems, and Installation	(b)(1) thru (4)	X					Failure Modes & Effects Analysis, No. 20080911
23.1309 - Equipment, Systems, and Installation	(c)(1), (2)(i) and (3)		X				Ground Test Procedure/ Report No. 20080913
	(a) thru (d)						

Is Equipment Complex? And Is Additional Determination Required?

- Is an aircraft flight manual supplement required?
- Is or are operational limitation placards required?
- Is the aircraft intended to be or operated in part 135 service? How about part 121? If so, has additional required equipment been taken into consideration?
- Is the aircraft single engine and operated in part 135 service? If so, has additional required equipment been taken into consideration?
- If multiple, different equipment is installed, are more and different types of approvals required?

Is Aircraft a Transport Category Aircraft, e.g. 14 CFR part 25 or 29?

- If multiple, redundant systems are required, has consideration been given to separation of busing and wire routing?
- Can the equipment, as installed, fulfill multiple flightcrew positions/stations?
- Has the equipment been installed in a such a manner to minimize effects from interference from other equipment and systems?
- Are you prepared to perform a functional hazard assessment or failure modes and effects analysis?

Equipment & Systems Installation Planning

- Is equipment intended for IFR operational use?
- If equipment is not furnished with optional annunciators, switches, etc., has installation cost been budgeted?
- Are drawings and other technical data planned to be prepared to engineering standard quality?
- Have you contacted a DER to determine the effects of the alteration which is planned?
- Have you examined all other approvals and ADs?
- Has the FAA or other authority been advised?

Compatibility Tests, e.g. FADEC, HIRF, Lightning, etc.

- If test plan or procedure is needed, is FSDO ASI prepared to approve it, if you create it?
- Is a test plan available from others such as the airframe or engine manufacturer?
- Is FAA engineering or aircraft or engine manufacturer participation needed?
- Will a special flightcrew be needed for ground and/or flight testing?
- Does aircraft need to be placed into experimental category for purpose of showing compliance?

Substantiating and Descriptive Data, and Other Paperwork

- Assuming that a Field Approval is possible, are separate FAA Form 337s needed for different types of equipment installation?
- If equipment is different and requires “different” approval review by the FAA, is separate substantiation needed?
- Can portions of the modification be accomplished as a minor alteration? If so, make certain that the logbook entry and the FAA Form 337 conform to weight and balance entry, and the equipment list

Other Considerations and How a DER Can Assist You...

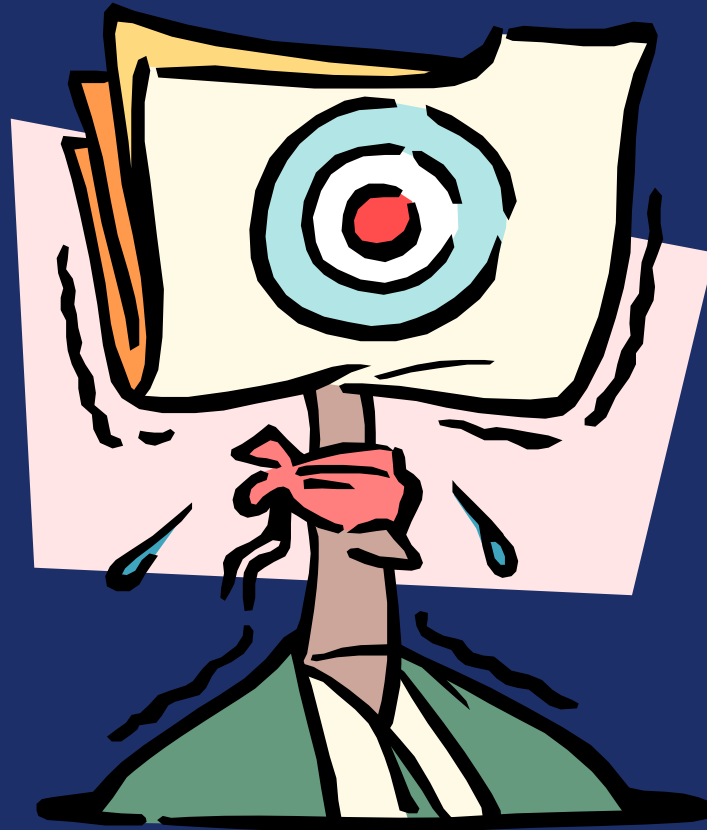
- Does the alteration appreciably affect structural strength, flight characteristics, or performance?
- If structural strength is affected, is the area affected primary structural element, e.g. pressure bulkhead, fuselage, wing, tail, etc.? If uncertain, a DER may be required to make a determination
- Is the alteration documented in the aircraft records and in a form and manner acceptable to the FAA or other regulatory agency?
- Can a DER or multiple DERs perform compliance findings to alleviate Field Approving changes?

How to Apply for and Obtain a Supplemental Type Certificate

- Documentation requirements and how to create and manage them
 - Apply for an STC on FAA Form 8110-12 and follow guidelines of Advisory Circular 21-40
 - Prepare test plans, drawings, proposed flight manual supplements, proposed TIA, etc.
- Determine what kind of assistance or coordination is needed with Aircraft Certification Office
- If one or more DERs will be used, appoint one as an acting “agent” on your behalf



Questions?????



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