Aircraft Airworthiness Certification Department
of Civil Aviation Administration of China
(CAAC-AAD)

Advisory Circular

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Establishing the Certification Basis of Changed Aeronautical Products

Contents

Chapter 1. Introduction

1. Purpose.

This advisory circular (AC) is to provide guidance for establishing the certification basis for changed aeronautical products in accordance with Chinese Civil Aviation Regulations Part 21 (CCAR-21) § 21.101 and to help identify if it will be necessary to apply for a new type certificate (TC) under CCAR-21 § 21.19. The guidance describes the process for establishing the certification basis for amended TCs, supplemental type certificates (STC) or amended STCs, modification design approval (MDA) or amended MDAs, detailing evaluations, classifications, and decisions made throughout the process. This AC is also applicable to establish the certification basis for validation type certificate (VTC) and (VSTC), unless otherwise specified by airworthiness bilateral documents between CAAC and export authority.

2. Authority.

This AC is formulated on the basis of Civil Aviation Products and Parts (CCAR-21).

3. Content.

The content of this AC is divided into 4 chapters and 5 appendices:

a. Chapter 1 explains the purpose of this AC, describes its content, and clarifies which changes are within the scope of applicability of this AC.

b. Chapter 2 provides a general overview of CCAR-21 §§ 21.101 and 21.19, clarifies the principals and safety objectives.

c. Chapter 3 contains guidance for implementation of § 21.101(b) to establish the type-certification basis for changed aeronautical products. Chapter 3 describes in detail the various steps of the “top-down” certification basis development approach. Chapter 3 also addresses § 21.19 considerations to identify conditions under which an applicant for a type design change is required to submit application for a new TC and provides guidance at which stage of the process this assessment is to be performed.

d. Chapter 4 contains considerations for design related operating

requirements, use of special conditions under § 21A.101 (c), the effective period of an application, CCAR part 26 requirements, documentation of revisions to the type certification basis and approach to “other category aircraft” under § 21.101 (e).

e. Appendix A contains examples of typical type design changes for small airplanes, transport category airplanes, rotorcraft, engines, and propellers which are categorized into individual tables according to the classifications to the level of design change - substantial, significant, and not significant.

f. Appendix B provides detailed guidance with examples for evaluating when compliance to the rule would be impractical under the “impracticality” exception in the rule.

g. Appendix C provides guidance with examples on use of relevant service experience in the certification process as one way to show that a later amendment may not contribute materially to the level of safety, allowing the use of earlier requirements.

h. Appendix D lists the applicable definitions, and terminology for application of the rule.

i. Appendix E contains cross references to the requirements of §§ 21.19 and 21.101.

Note: In order to describe how to establish the type-certification basis for changed aeronautical products better, the examples in this AC use FAR amendments

4. Applicability.

a. This AC applies to major type design changes under CCAR-21 § 21.101 for aeronautical products certificated under CCAR §§ 21, 23, 25, 27, 29, 31, 33, and 35.

b. Minor type design changes are automatically considered not significant under § 21.101(b) and the type certification basis is approved in accordance with procedures prescribed by authority under § 21.95.

c. This AC also applies to aircraft certificated under CCAR-21 §§ 21.17(b), 21.19, 21.24, and 21.25.

d. This AC is not intended to be used to determine the applicable aircraft noise, fuel venting, and exhaust emission requirements for changed products.

5. References.

FAA AC 21.101-1A， Establishing the Certification Basis of Changed Aeronautical Products.

Chapter 2. Overview of CCAR-21 §§ 21.19 and 21.101

1. CCAR-21 § 21.19.

a. CCAR-21 § 21.19 requires that the applicant shall apply for a new TC for a changed product if the change in design, power, thrust, or weight is found to be so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

b. Changes that require a substantial re-evaluation of the product's compliance findings are referred to as "substantial changes". For guidance see paragraph 3 of chapter 3. Appendix A in this AC provides examples of type design changes that will require application for a new TC.

c. If the proposed design change does not require a new TC under § 21.19, see § 21.101 for the applicable requirements to develop the certification basis for the proposed design change. For guidance, see chapter 3 and the examples in appendix A in this AC.

2. CCAR-21 § 21.101.

a. CCAR-21 § 21.101(a) requires a change to a TC to comply with the latest requirements, unless the change meets the criteria for the exceptions identified in §§ 21.101(b) and (c). The intent of § 21.101 is to enhance safety through the incorporation of the latest regulatory standards in the type certification basis for changed products to the greatest extent practicable.

b. You can comply with the earlier requirements consistent with the requirements of § 21.101(b), when:

(1) A change is not significant (see § 21.101 (b) 1), or

(2) An area, system, component, equipment or appliance are not affected by the change (see § 21.101 (b) 2), or

(3) Compliance with a later amendment for a significant change does not contribute materially to the level of safety (see § 21.101 (b) 3) , or

(4) Compliance with a latest amendment would be impractical (see § 21.101(b) 3).

c. Note that earlier amendments may not precede either the corresponding amendment of the regulation incorporated by reference in the type certification

basis and any requirement found in CCAR §§ 23.2, 25.2, 27.2, and 29.2. For transport category airplanes only, the provisions of part 26 that is related to the change is also required.

d. § 21.101(b) allows a changed product to comply with an earlier amendment of a regulation, provided the earlier amendment is considered adequate and meets the criteria in §§ 21.101(b) 1, 2 or 3. However, when a proposed design change involves features or characteristics considered novel and unusual and the proposed airworthiness standards do not contain adequate or appropriate safety standards for this feature, later amendments and/or special conditions will be applied.

e. §§ 21.101(b) 1.(1) and (2) describe the automatic criteria establishing that a change is significant.

f. § 21.101(c) provides for the use of special conditions, under § 21.16, when the proposed certification basis and any later regulations do not provide adequate standards to the proposed change because of a novel or unusual design feature.

g. § 21.101(d) prescribes the effective period an application will remain valid for a change. This section is consistent with the requirements of § 21.17 for a new TC.

h. § 21.101(e) pertains to aircraft certificated in certain categories and special classes (e.g. gliders, airships, and other nonconventional aircraft), including the engines and propellers installed on them, under the requirements of §§ 21.17(b), 21.24, and 21.25 airworthiness requirements.

i. For transport category airplanes, you must comply with each applicable provision of CCAR-26 for the change, unless you have elected or are required to comply with a corresponding amendment to CCAR-25 that was issued on or after the date of the applicable CCAR-26 provisions.

Chapter 3. The Process for Establishing the Certification Basis for Changed Products

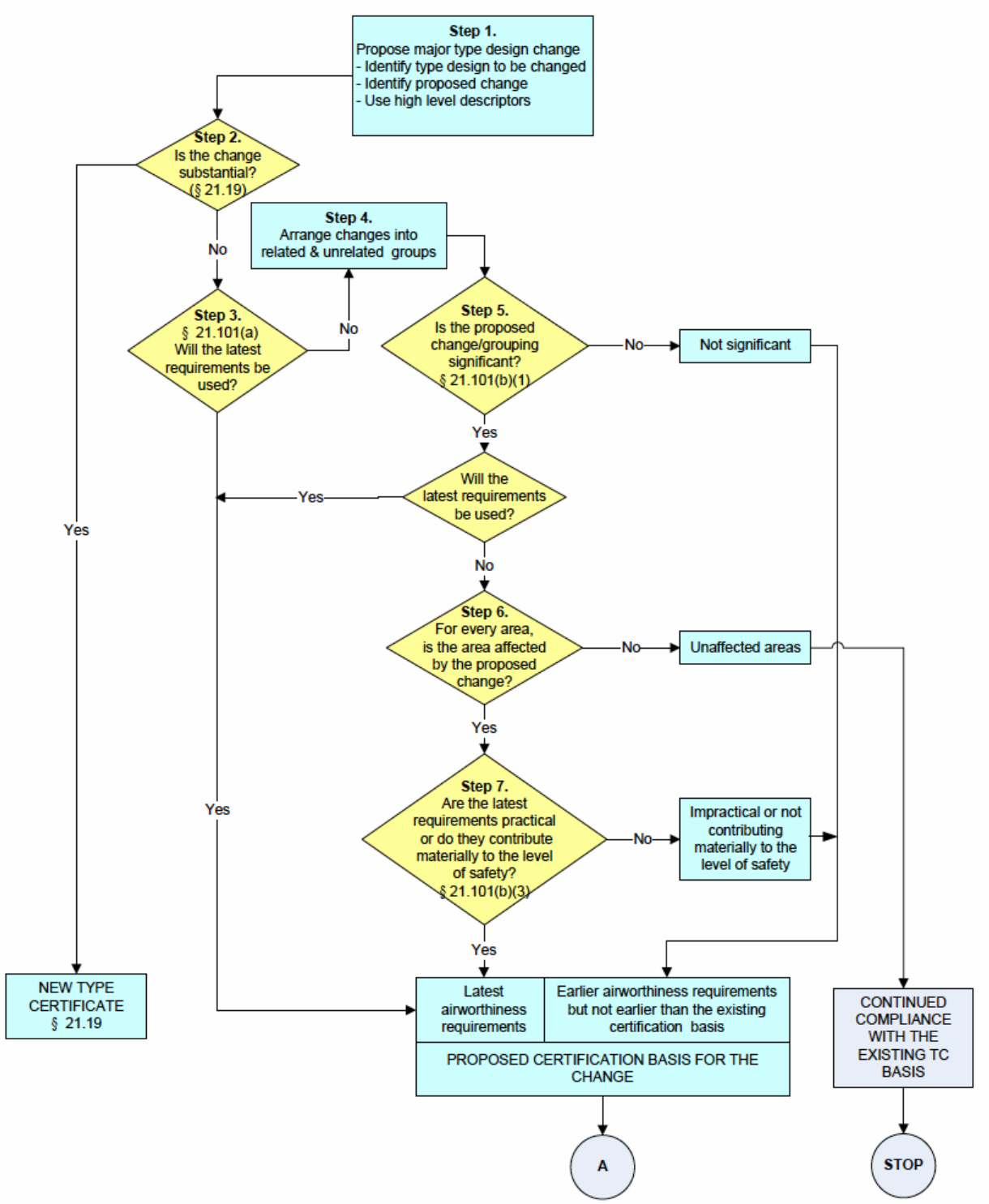
1. Overview.

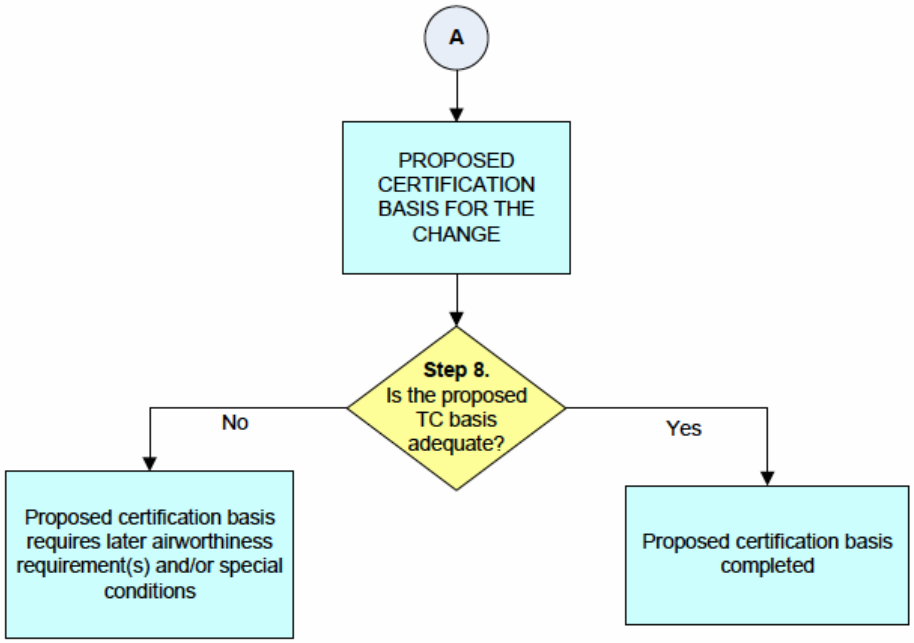
a. The applicant and the CAAC each have a responsibility under CCAR § 21.101(a) and (b). As an applicant for the certification of a type design change, you must show that the change complies with the latest applicable airworthiness requirements unless you propose an exception per § 21.101(b). If you are proposing exception, you should make a preliminary classification whether the change is significant or not significant, and propose an appropriate certification basis. The CAAC determines whether your classification of the change and proposal for the certification basis are consistent with the applicable rules and their interpretation, but should not be dependent on whether the TC holder or applicant for a STC is originating the change. The certification basis can vary depending on the magnitude and scope of the change. The steps below present a streamlined approach for making this determination. In addition to assisting in the determination of significance and establishing the certification basis, this guidance will help to establish the appropriate amount of coordination required between the applicant and the CAAC.

b. Classifications of typical type design changes are in appendix A, Classification of Changes. See paragraph 6 (c) of this chapter for instructions on how to use appendix A.

c. In cases where the examples in appendix A are not applicable for the proposed change, use the following steps in conjunction with figure 1, on the next page, to develop the appropriate certification basis for the type design change.

Figure 1. Establishing the Certification Basis for Changed Product





2. Step 1 of Figure 1. Identify The Proposed Type Design Change To An Aeronautical Product.

a. Prior to describing the proposed change(s), it is important to clearly identify the type design configuration to be changed. A series of derivative aircraft, engines, or propellers (for example, x -100, x-200, x-300) may evolve based on predecessor type designs, each with its own design change that make it distinct from the other series. You should identify which model or series within that model the specific configuration that will be modified.

Note: An STC is not a product; it is a change to a product. When changing or amending an STC, the starting point is the existing modified product (TC with existing STC installed). For example, if you were amending an STC for an external cargo locker and you proposed changing the configuration of the locker, then your starting point would be the existing TC with the existing cargo locker installed by STC. You would then compare that configuration (TC with existing STC installed) to the changed product (TC with proposed amended STC installed).

b. Changes to a product can include physical design changes, changes to an operating envelope, and/or performance changes. The change can be a single change or a collection of changes. The purpose of this process step is to identify and describe the change to the aeronautical product. As an applicant for a type design change you must consider all previous related design changes and the amendment level of the certification basis used for these changes.

Note 1: By definition all previously incorporated changes will have been approved. The purpose of step 1 is to consider the net cumulative effect of the changes since the last time the certification basis for the changed/affected area was upgraded from that of the original type design.

Note 2: For the purpose of classifying the proposed design change, previously approved design data are still considered part of the proposed design and must be considered part of the proposed design change classification.

c. When identifying the changes being proposed as part of a modification, consider previous relevant changes that create a cumulative effect, as these may influence the decisions regarding substantial and significant changes later in the process. By previous relevant changes we mean design changes whose effects accumulate, such as successive thrust increases, incremental weight increases, or sectional increases in fuselage length. Any previous relevant design changes in the area affected by the current change that did not involve an upgrade of the existing certification basis must be taken into account in the next design change proposal.

(1) **Example 1:** A 5% weight increase is currently being proposed, but a previous 10% and another 15% weight increase has been incorporated into this aircraft without upgrading the existing certification basis. In the current proposal for a 5% weight increase, the cumulative effects of the two previous weight increases that did not involve upgrade of the certification basis will now be accounted for as an approximately 30% increase in weight, for the purpose of making the substantial and/or significant decisions. Note that the cumulative effects to be considered are those incremental increases since the last time the airworthiness requirements, in the type certification basis applicable to the area affected by the current change, were upgraded.

(2) **Example 2:** The TC for airplane model X lists three series, namely X-300, X-200, and X-100. The X-300 is a derivative of the X-200 which is a derivative of the original X-100 series. An applicant proposes a design change to the X-300 series airplane. During the review of the X-300 certification basis and the regulations affected by the proposed change, it was identified that one regulation, § 25.571 (damage tolerance requirements), remained at the same amendment level as the X-100 original certification basis (exception was granted). Since the amendment level for this particular regulation was not changed for the two subsequent airplane series (X-200 and X-300), the cumulative effects of these two previous design changes that are related to the proposed change and the damage tolerance requirements must now be

addressed.

d. To identify and describe the proposed changes to any aeronautical product, use a high level description of the design change that characterizes the intent of, or the reason for, the change. No complex technical details are necessary at this stage. For example, a proposal to increase maximum passenger-carrying capacity may require an addition of a fuselage plug, and as such, a "fuselage plug" becomes one possible high level description of this design change. Similarly, a thrust increase, a new or complete interior, an avionics system upgrade, or a passenger-to-cargo conversion are all high level descriptions that characterize typical changes to the aircraft, each driven by a specific goal, objective or purpose.

e. Evolutionary Changes. Evolutionary changes that occur during the course of a certification program may require re-evaluation of the certification basis and may result in reclassification of the change. That is, any evolution in the proposed design change after the certification basis has been agreed to (or established) will necessitate a revisit of the certification basis to ensure that "evolved" aspects of the design change are still covered by the agreed upon certification basis.

3. Step 2 of Figure 1. Is the Change Substantial? (CCAR § 21.19)

a. § 21.19 requires that you apply for a new TC for a changed product if the proposed change in design, power, thrust, or weight is so extensive that a substantially complete investigation of compliance with the applicable regulations is required. A new TC could be required for either a single extensive change to a previously type certificated product or for a changed design derived through the cumulative effect of a series of design changes from a previously type certificated product.

b. A "substantially complete investigation" of compliance is required when most of the existing substantiation is not applicable to the changed product. A substantial change proposal will require the need to comply with all requirements applicable to a particular category of product. The number of requirements to which compliance must be re-established for the changed product may not necessarily be the sole determination as to whether the change is substantial, but rather it is the extent of effort to establish compliance, or the depth of investigation required to be done. In other words, the proposed design change may be considered substantial if it is so extensive (making the product

sufficiently different from its predecessor) that the design models, methodologies, and approaches used to demonstrate a previous compliance finding could not be used.

c. To address if a change is substantial at the beginning of the process, you must evaluate the total or combined effect of all the proposed changes identified in step 1, including the cumulative effects of previous relevant design changes since the last update of the certification basis (as explained in step 1).

d. If it is not initially clear if a new TC is required, appendix A provides some examples of substantial changes to aid in this classification. A substantial change requires application for a new TC under §§ 21.17 and 21.19. If the change is not substantial, then follow the § 21.101 process.

4. Step 3 of Figure 1. Will the Latest Requirements be Used? (14 CFR § 21.101(a))

You can use the latest requirements for your proposed type design change. If you use the latest requirements you will meet the intent of § 21.101 and no further classification (significant or not-significant) and justification is needed. However, the decision to voluntarily comply with the latest certification standards for a design change sets a new regulatory baseline for all future related changes in the same affected area. Even though one applicant elects to use the latest certification requirements, another applicant could apply § 21.101 for a similar design change proposal, and use the exceptions in accordance with § 21.101(b). If you are not using the latest requirements then proceed as follows.

5. Step 4 of Figure 1. Relation of Changes.

a. Once the proposed changes are identified using high level descriptions, the next step is to determine if any of these changes are related to each other. Related changes are those that cannot exist without another, are co-dependent, or a pre-requisite of another. For example, a need to carry more passengers could require the addition of a fuselage plug, which will result in a weight increase, and may necessitate a thrust increase. Thus the fuselage plug, weight increase and thrust increase are all related high level changes that will be needed to achieve the goal of carrying more passengers. A decision to upgrade the cockpit to more modern avionics at the same time as these other design changes may be considered unrelated, as the avionics upgrade is not necessarily needed to carry more passengers (it has a separate purpose, likely just modernization).

The proposed avionics upgrade could then be considered an unrelated (or a stand alone) change. However, the simultaneous introduction of a new cabin interior would be considered related since a cabin length change will have an impact on occupant safety considerations. Even if a new cabin interior is not included in the product level change, the functional effect of the fuselage plug has implications on occupant safety (e.g., the dynamic environment in an emergency landing, emergency evacuation, etc.), and thus the cabin interior becomes an affected area.

b. Once the change(s) are organized into groupings of those that are related and those that are unrelated (or stand alone), you are ready for step 5 of figure 1. The grouping of related and unrelated changes is particularly relevant to the significant Yes/No decision, (§ 21.101(b) 1), described in step 5 of figure 1. Each group of related changes and each unrelated (stand alone) change is evaluated on its own merit for significance.

c. After describing the design change groupings and the associated or supporting technical details for each change, you must identify areas, systems, components, equipment, or appliances of the product that are affected by the design change and the corresponding regulatory standards associated with these areas. For each group, you must assess the physical and/or functional effects of the change on other areas, systems, components, equipment, or appliances of the product. The characteristics affected by the change are not only physical changes, but also functional changes brought about by the physical changes. Examples of physical aspects are: structures, systems, equipment, component and appliances, and software in combination with the affected hardware. Examples of functional characteristics are performance, handling qualities, aeroelastic characteristics, and emergency egress. The intent is to encompass all aspects where there is a need for re-evaluation, that is, where the substantiation presented for the product being changed should be updated or rewritten.

6. Step 5 of Figure 1. Is the Proposed Change/Grouping Significant? (§ 21.101(b) 1)

a. In step 5 it is your responsibility to justify that a grouping of related changes or an unrelated change does not qualify as a significant change. Significant changes are product level changes which are distinct from the vast majority of major changes. In general, these changes are either the result of an accumulation of changes or occur through an isolated extensive change that makes the changed product distinct from its predecessors. Step 1 explains the

accumulation of changes that must be considered. § 21.101(b) 1 defines a significant change as existing when one or more of three automatic criteria apply:

(1) Changes where the general configuration is not retained (significant change to general configuration). A change to the general configuration at the product level that distinguishes the resulting product from other product models, for example, performance or interchangeability of major components. Typically, for these changes, an applicant will designate a new aircraft model or series number, although this is not required. For examples see appendix A in this AC.

(2) Changes where the principles of construction are not retained (significant change to principles of construction). A change at the product level to the materials and/or construction methods that affect the overall products' operating characteristics or inherent strength would require extensive reinvestigation to show compliance. For examples see appendix A in this AC.

(3) Changes that invalidate the assumptions used for certification (significant change to the assumptions used for certification). A change to the assumptions at the product level associated with the compliance demonstration, performance, or operating envelope that by itself is so different that the original assumptions or methodologies of demonstrating compliance are invalidated. For examples see appendix A in this AC.

b. The above criteria are used to determine if each change grouping and each stand-alone change is significant. These three criteria are assessed at the product level. In applying the automatic criteria you should focus on the design change itself. Consideration of only the regulatory importance or safety benefit of the latest certification requirements is not a justification by itself to cause a design change to be classified or re-classified as a significant change.

c. Appendix A includes tables of typical changes for transport airplanes, small airplanes, rotorcraft, engines, and propellers that meet the definition of significant. In these tables, one or more of the three automatic criteria in § 21.101(b) 1 apply for each case where the changes are identified as significant. Experience has shown the concept of having only the three automatic criteria seems to fit most projects. The examples also include typical changes that do not achieve the significant level. The tables can be used in one of two ways:

(1) To classify a proposed change that is listed in the tables of the appendix, or

(2) In conjunction with the three automatic criteria, to help classify a proposed change not listed in the tables of the appendix by comparing the proposed change to changes which are similar in type and/or magnitude.

d. Design changes can trigger one or more of the automatic criteria listed in §§ 21.101(b) 1.(1) and (2) for the proposed design change. When assessing the design change grouping, consider the cumulative effect of previous relevant design changes. Design changes may have been incorporated over time with no change in the certification basis and the final product may be significantly different than would be represented by the existing certification basis.

e. Each grouping of related changes and each unrelated (stand alone) change, identified using high level descriptions, will be evaluated on its own merit to determine if it is a significant or not significant change. Use the tables in appendix A as guidance to make the classification of significant, or not significant. Only when one or more of the three criteria is met can the type design change be considered significant for that grouping or unrelated change. The starting point for assessing the cumulative effects of previous relevant design changes is from the last time the applicable requirements in the certification basis for the affected area, system, component, equipment, or appliance was upgraded.

f. Typically, a change to a single area, system, component, or appliance may not result in a product level change. However, there may be distinct cases where the change to a single system or component may, in fact, result in a significant change due to its effect on the product overall. Examples may include addition of winglets, leading edge slats or change in primary flight controls to fly-by-wire system.

g. A secondary change is a physical change (which may include physical aspects as referenced in paragraph 9 in this chapter) that is part of and consequential to an overall significant change. A secondary change is a physical change that does not change the system, structural capacity, or functionality, but is necessary to support a significant change. Based on this description, a secondary change is not required to comply with the latest requirements because it is considered “not contributing materially to the level of safety”, and therefore eligible for an exception under § 21.101. Determining whether a change meets the description for a secondary change, and thus eligible for an exception, should be straightforward. Hence the substantiation or justification need only be minimal. If this determination is not straightforward, then your proposed change is very likely not a secondary change.

(1) In some cases, however, the change which restores functionality may in fact contribute materially to the level of safety by meeting a later amendment. If this is the case it would not be considered a secondary change.

(2) An example of secondary change is lengthening existing control cables passing through the new fuselage plug, to restore existing functions to systems that could be situated within or beyond the new plug. The lengthening of these cables can be accepted as not adding system capacity or capability, so these changes can be identified as secondary changes and not be required to meet the latest amendment.

h. A new model number designation to a changed product is not necessarily indicative that the design change is significant under § 21.101. Conversely, retaining the existing model designation does not mean that the design change is not significant. All changes are considered in light of the magnitude of the type design change.

i. Making the determination. The final determination of whether a design change is significant or not significant is retained by the CAAC. To assist you in your assessment, the CAAC has predetermined the classification of several typical design changes that can be used for reference. These examples are listed in appendix A in this AC.

j. At this point, the determination of significant or not significant for each of the groupings of related changes and each stand alone change has been made. For significant changes, if you propose to comply with an earlier requirement, use the procedure outlined in paragraph 7 below.

7. Proposing an Amendment Level for a Significant Change.

a. If an unrelated (stand alone) change or a grouping of related changes is classified as significant (§ 21.101(a)), you will comply with the latest regulatory requirements for certification of the changed product, unless you justify use of one of the exceptions provided in §§ 21.101(b) 2 and/or 3 to show compliance with earlier amendment(s). The final certification basis may consist of a combination of the regulatory requirements ranging from the original aircraft certification basis to the most current regulatory amendments.

b. If the classification of the change is significant, all areas, systems, components, parts or appliances affected by the change must comply with the regulatory requirements at the amendment level in effect on the date of

application for the change. You can justify use of one of the exceptions in §§ 21.101(b) 2 and 3 to comply with an earlier amendment, but no earlier than the existing certification basis. You must comply with any retroactive requirement found in CCAR §§ 23.2, 25.2, 27.2, and 29.2 applicable on the date of the application for the change.

c. For transport category airplanes only, you must also comply with any applicable provision of CCAR-26 (related to the change) which is applicable on the date of the application for the change, unless you elected or were required to comply with later corresponding CCAR-25 requirements.

d. § 21.101(b) 3 provides two more exceptions applicable to areas, systems, parts or appliances which are affected by the significant change. For a group of related design changes or an unrelated design change that has been determined to be significant, §§ 21.101(b) 2 and 3 provide exceptions from the requirement of § 21.101(a). You can comply with an earlier amendment level or with the existing certification basis for areas not affected by the change, and any areas affected by the change for which compliance with the latest requirements would not contribute materially to the level of safety or would be impractical.

e. The earlier amendments may not precede the corresponding requirements in the existing certification basis or any requirement found in CCAR §§ 23.2, 25.2, 27.2, 29.2, or for transport category airplanes only, CCAR-26, that is related to the change. It is important when seeking to use earlier amendments that you demonstrate that compliance with the latest requirements does not contribute materially to the level of safety, or is impractical.

f. You must provide acceptable justification for the application of earlier amendments for areas affected by a significant change. Your justification must show that compliance with later requirements in these areas would not contribute materially to the level of safety or would be impractical. Such justification should address all the aspects of the area, system, component, equipment, or appliance affected by the significant change.

g. The final certification basis may combine latest, earlier (intermediate), and existing regulations, but cannot contain regulations preceding the existing certification basis.

h. Note that should you decide to use the latest airworthiness standards without any exceptions, no further evaluations and justifications are needed. In such a case, proceed to step 8 (section 11).

8. Proposing an Amendment Level for a Not Significant Change.

a. When a change is classified not significant, the rule (§ 21.101(b) 1) allows the use of the earlier regulatory requirements, but not dated prior to the existing certification basis. Within this limit, you are allowed to propose an amendment level for each certification standard for the affected area. However, you should be aware that your proposal for the type certification basis will be reviewed by the FAA to ensure that the certification basis is adequate for the proposed change (see paragraph 8.d). You must also comply with the retroactive requirements found in CCAR §§ 23.2, 25.2, 27.2, 29.2 applicable on the date of the application for the change.

b. For transport category airplanes only, you must comply with any CCAR-26 requirements related to the change applicable on the date of the application for the change, unless you elected, or were required, to comply with later corresponding CCAR-25 requirements.

c. When choosing the above option of the existing type certification basis, you can elect to comply with a specific airworthiness requirement or a subset of airworthiness requirements at later amendments. In such a case, you should consult with the CAAC to ensure the certification basis includes other airworthiness requirements that are directly related. Some later regulatory requirements may be less restrictive; therefore, you may see advantage in using them on the elect to comply basis. However, it is recommended you do not make a final decision until you learn from the CAAC which other airworthiness requirements are found directly related.

d. For a design change that contains features which are not covered in the existing certification basis, the FAA will designate the applicable airworthiness standard at the appropriate amendment level, beginning with the existing certification basis and progressing to the most appropriate later amendment level for the change. For a change that contains new design features that are novel and unusual, for which there is no later applicable airworthiness requirement, the FAA will designate special conditions. For new design features or characteristics which may pose a potential unsafe condition for which there are not later applicable airworthiness requirements, new requirements may be imposed per § 21.21(d).

e. Adequacy of Certification Basis: The certification basis for a changed product under § 21.101 is considered adequate when the CAAC determines that the prescribed airworthiness requirements (existing, later, or latest amendments,

including special conditions, or new requirements per § 21.21(d)) provide an appropriate level of safety for the changed product and do not result in any unsafe design features or characteristics for the intended use of the product.

9. Step 6 of Figure 1. Is the Area Affected By the Proposed Change? (14 CFR § 21.101(b) 2)

a. A not affected area is any area, system, component, equipment, or appliance that is not affected by the proposed type design change. For a type design change, it is important that the effects of such change on other areas, systems, components, equipment, or appliances of the product are properly assessed because areas that have not been physically changed may still be considered part of the affected area. If a new compliance finding is required, regardless of its amendment level, it is an affected area. If the significant change does not affect the area, then the certification basis of that area need not be revisited, in other words, the unaffected area continues to comply with the existing amendment level without further substantiation.

b. To determine whether an area is affected or not, consider the following aspects of a type design change:

(1) Physical aspects. The physical aspects include direct changes to structures, systems, equipment, components, and appliances (physical aspects may include software/airborne electronic hardware changes and the resulting effect on systems functions).

(2) Performance/functional characteristics. The less obvious aspect of the word “areas” covers general characteristics of the type certificated product, such as performance features, handling qualities, emergency egress, structural integrity, aeroelastic characteristics, or crashworthiness. These characteristics may be affected by a product level change. For example, adding a fuselage plug could affect performance and handling qualities, and thus regulations associated with these aspects would be considered part of the affected area. Another example is the addition of a fuel tank and new fuel conditioning unit. This change affects the fuel transfer and fuel quantity indication system resulting in the airplane’s unchanged fuel tanks being affected. Thus, the entire fuel system (changed and unchanged areas) becomes part of the affected area due to the change in functional characteristics.

Note: Substantiating data for the affected area for your proposed type design change can include compliance findings from a previously approved

design change, in supporting compliance findings for your proposal. However, your proposal to use previously approved compliance data must be considered part of the entire proposed type design change and should be approved as part of your proposed design change.

c. All areas affected by the proposed design change must comply with the latest requirements, unless you show that demonstrating compliance with the latest amendment of a requirement would not contribute to the level of safety or would be impractical. Step 7 provides further explanation.

10. Step 7 of Figure 1. Are the New Requirements Practical and Do They Contribute Materially to the Level of Safety? (14 CFR § 21.101(b) 3)

a. Compliance with the latest requirements could be considered to "not to contribute materially to the level of safety" if the existing type design and/or relevant experience demonstrates a level of safety comparable to that provided by the latest requirements. You must provide sufficient justification to allow us to make this determination. This exception could be applicable in the situations described in the paragraphs below:

Note: Compliance with later requirements would not be required where the amendment is of an administrative nature and has been made only to correct inconsequential errors or omissions, consolidate text, or clarify an existing requirement.

(1) Design features that exceed the existing certification basis requirements, but do not meet the latest requirements, can be used as a basis for granting an exception under the "does not contribute materially" exception. These design features, if accepted as a justification for an exception, must be incorporated in the amended type design configuration and recorded, where necessary, in the certification basis. The description of the design feature would be provided in the type certificate data sheet (TCDS) or STC at a level that allows the design feature to be maintained, but does not contain proprietary information. For example, an applicant proposes to install winglets on a CCAR-25 airplane. Part of the design involves adding a small number of new wing fuel tank fasteners. The latest 14 CFR § 25.981 at amendment 25-102 requires structural lightning protection. The applicant proposes an exception from these latest structural lightning protection requirements because the design change uses new wing fuel tank fasteners with cap seals installed. The cap seal is a design feature that exceeds the requirement of 14 CFR § 25.981 at a

previous amendment level, but does not meet the latest amendment 25-102. If the applicant can successfully substantiate that compliance with amendment 25-102 would not materially increase the level of safety of the changed product, then this design feature can be accepted as an exception to compliance with the latest amendment.

(2) Consistency of design should be considered when applying the latest requirements. Below, an airplane example is provided for describing how this provision may be used; however, the rationale in this example may be applied to any product covered by this AC.

For example, when a small fuselage plug is added, additional seats and overhead bins are likely to be installed, and the lower cargo hold extended. These components may be identical to the existing components. The level of safety may not materially increase by applying the latest requirements.

However, if a fuselage plug is large enough relative to the original certificated aircraft structure, seats, bins, doors, and cargo compartment, the change may require compliance with the latest requirements, comparable with what will be required for a new airplane. In these circumstances, the proposed certification basis should encompass the requirements in effect on the date of application for the change.

(3) Service experience: Relevant service experience, such as fleet performance or utilization over time (relevant flight hours or cycles), is one way of showing that a later amendment may not contribute materially to the level of safety, so the use of earlier requirements could be appropriate. Appendix C provides additional guidance on the use of service experience, along with examples.

There may be cases for rotorcraft and small airplanes where relevant data may not be sufficient or not available at all because of the reduced utilization and the different amount and type of data available. In such cases, other service history information may provide sufficient data to justify the use of earlier requirements, such as: warranty, repair, and parts usage data; accident, incident, and service difficulty reports; service bulletins; airworthiness directives; or other pertinent and sufficient data collected by the manufacturers, authorities, or other entities.

The service experience necessary to demonstrate the appropriate level of safety as they relate to the proposed design change would have to be reviewed and agreed to by the CAAC.

b. Impractical.

Compliance with the latest requirements may be considered impractical if you can justify that it would result in additional resource requirements that are not commensurate with the incremental safety benefit (difference between the latest and proposed certification basis). The additional resource requirements could include those arising from design changes required for compliance and the effort required to demonstrate compliance, but excludes resource expenditures for prior product changes.

(1) Support your position that compliance is impractical with substantiating data and analyses. While evaluating your position and your substantiating data regarding impracticality, CAAC may consider other factors (for example, the costs and safety benefits for a comparable new design).

(2) A review of transport category projects showed that in certain cases, where an earlier amendment to applicable requirements was allowed, design changes were made to nearly comply with the latest amendments. In these cases, the applicants were able to successfully demonstrate that full compliance would require a substantial increase in the outlay or expenditure of resources with a very small increase in the level of safety. These design features can be used as a basis for granting an exception under the “impracticality” exception.

(3) Appendix B provides additional guidance and examples for determining procedures for evaluating impracticality of applying latest requirements to a changed product rule.

(a) The exception of impracticality is a qualitative and/or quantitative cost/safety benefit assessment for which it is difficult to specify clear criteria. Experience to date with applicants has shown that justification of impracticality is more feasible when both applicant and CAAC agree at an earlier discussion that the effort (in terms of cost, changes in manufacturing, etc.), required to comply would not be commensurate with a small incremental safety gain. This would be clear even without the need to perform any detailed cost/safety benefit analysis (although cost analysis could always be used to support an appropriate amendment level). However, there should be enough detail in the applicant’s rationale to justify the exception.

Note: The impractical exception should not be based on the size of the applicant’s company or their financial resources. Costs to comply with a later amendment must be evaluated against the safety benefit of complying with the later amendment. Applicants that may not be able to afford the cost because of

reasons such as fewer resources, will not be granted the impractical exception when the cost is comparable to the safety benefit achieved by complying with a later amendment.

(b) For example, a complex redesign of an area of the baseline aircraft may be required to comply with a new requirement, and that redesign may make the changed product uncommon with respect to design and manufacturing processes from the existing family of derivatives. Relevant service experience of the existing fleet of the baseline aircraft family would be required to show that there has not been a history of problems associated with the hazard that the new amendment in question was meant to address. In this way, the incremental cost/impact to the applicant is onerous and the incremental safety benefit that would be realized by complying with the later amendment would be minimal. This would be justified with a demonstrated acceptable service experience in relation to the hazard that the new rule addresses.

11. Step 8 of Figure 1. Is the Proposed Type Certification Adequate?

a. Regardless of whether the change is significant or not, your proposed type certification basis may be deemed inadequate – that is, the change includes features or characteristics that were not foreseen during the initial (or previously approved) type certification. These features or characteristics, if not adequately addressed, may make the product unsafe for the uses for which certification is requested. This would obstruct issuance of the requested approval for the change. The change must comply with later regulations (such as, a later amendment or a special condition). An example is adding a flight critical system such as an electronic air data display on a CCAR-25 airplane whose existing certification basis did not have lightning protection requirements. In this case, compliance with the regulations for lightning protection will be required, even though this is not a significant change.

b. In cases where inadequate or no airworthiness standards exist for the change in the existing type certification basis, but adequate standards exist in a subsequent amendment of the applicable airworthiness code, the subsequent amendment will be made part of the type certification basis to assure its certification basis is adequate.

c. In cases where no adequate standard exist in any subsequent amendment of the applicable airworthiness code because of novel or unusual design features, the FAA will prescribe special conditions under § 21.16. § 21.101(c) allows for

the application of special conditions, or for changes to existing special conditions, to address the changed designs where the proposed certification basis does not provide adequate standards for an area, system, component, equipment or appliance related to the change. Reference section 2 of chapter 4 for additional information pertaining to special conditions.

d. For new design features or characteristics which may pose a potential unsafe condition for which there are not later applicable airworthiness requirements, new requirements may be imposed per § 21.21(d).

e. The final type certification basis may consist of a combination of the certification standards, ranging from the original aircraft type certification basis to the most current regulatory amendments, and special conditions.

Chapter 4. Other Considerations

1. Design Related Operating Requirements.

The use of exceptions under § 21.101 is not intended to alleviate or preclude compliance with operating regulations (such as CCAR-121) that prescribes compliance with a specific or later amendment of the airworthiness (design-related) requirements.

2. Special Conditions, § 21.101(c).

§ 21.101(c) allows for the application of special conditions to address the changed designs where the proposed certification basis does not provide adequate standards for an area, system, component, equipment, or appliance related to the change. The objective is to achieve a level of safety consistent with that provided for other areas, systems, components, equipment, or appliances affected by the change by the other requirements of the proposed certification basis. The application of special conditions to a design change is not, in itself, a reason for it to be classified as either a substantial change or a significant change. When the change is significant with earlier requirements allowed through exceptions, or not significant, the level of safety intended by the special conditions must be consistent with the agreed certification basis.

3. Effective Period for an Application to Change a TC. (§ 21.101(d))

Per 14 CFR § 21.101(e), an application for, or a change to, a TC for transport category aircraft is effective for 5 years, and an application for a change to any other TC is effective for 3 years. This is intended to ensure that the certification basis for the changed product is as current as practical. This is consistent with the requirements of § 21.17 for a new TC and defines the process of updating the certification basis if these time limits are exceeded.

a. If a design change has not been approved, or if it is clear that the change will not be approved, within the time limit, you may do either of the following:

(1) File for a new application, or

(2) File for an extension to the original application.

b. If you request an extension to the application date, and the product change is significant, a new certification basis is required. The new certification

basis requires the additional latest regulations effective through the new application extension date. However, you may use earlier regulations by documenting justification that the latest regulations for the change would not contribute materially to the level of safety or would be impractical.

c. If the product change is not significant, the existing certification basis can continue to be used as the basis for product certification. However, if additional design changes are made to the product, and the existing certification basis for the change is found to be inadequate, the new certification basis will require later appropriate standards.

4. Other Category Aircraft (§ 21.101(e)).

For aircraft type certificated under §§ 21.17(b), 21.24, and 21.25, the certification basis for the changed product will consist of the amendment levels of the applicable regulations that we find appropriate for the change in effect on the date of application for the change. When selecting a certification basis for a change, you can propose compliance to an earlier amendment using the provisions of § 21.101(b).

a. Special Classes Aircraft.

For special classes of aircraft (for example, gliders, airships, etc.) including any installed engines and propellers certificated in accordance with § 21.17(b), the applicable requirements will be portions of those other airworthiness requirements in CCAR-23, 25, 27, 29, 31, 33, and 35 we find appropriate for the aircraft and applicable to the specific type design, or such airworthiness criteria that provide an equivalent level of safety to those parts.

b. Primary Category Aircraft.

For primary category aircraft certificated under § 21.24, the applicable airworthiness requirements are in CCAR-23, 27, 31, 33, and 35, or such other requirements as we may find appropriate. These requirements must be applicable to the specific design and intended use of the aircraft and provide a level of safety acceptable to us.

c. Restricted Category Aircraft – Civil Derived.

For aircraft certificated in the restricted category under § 21.25, the application of the latest regulations typically would be considered not to contribute materially to the level of safety or be practical for its intended use. However, if the regulations incorporated by reference in the TC do not provide

an adequate level of safety for its intended use, the application of a later regulation will be required.

(1) Features of the changed product that are “novel” or “unusual” to the original certificated restricted category product may be assessed against a later requirement that addresses the feature. In this case, the requirements in effect at the time of the existing restricted category TC may be viewed as a starting point, with subsequent amendments being examined, if necessary, to arrive at a requirement that provides an appropriate level of safety.

(2) For the installation of turbo propeller engines instead of reciprocating engines, either in a restricted category aircraft that was originally certificated based on satisfactory military service experience or in a restricted category aircraft for which the original certification basis did not contain regulations for turbine engine installations, later amendments will be used to provide an appropriate level of safety for its intended operation.

5. CCAR-26 Requirements

CCAR-26 establishes requirements for support of continued airworthiness of and safety for transport category airplanes. If you are an applicant, you must comply with each applicable provision of CCAR-26, unless you have elected or were required to comply with a corresponding amendment to CCAR-25 that was issued on or after the date of the applicable CCAR-26 provision.

6. Documentation.

All changes that result in a revision to the product’s certification basis must be reflected on the amended TCDS or STC. The resulting certification basis must be retained as it forms part of the compliance record required by AP-21-03, Type Certification Procedure.

Appendix A. Classification of Changes

The following examples of substantial, significant and not significant changes are adopted by the FAA, European Aviation Safety Agency (EASA) and Transport Canada Civil Aviation (TCCA) through an international collaboration. The classification may change due to cumulative effects and/or combinations of individual changes. The "NA" in the substantial example tables indicates that the automatic classification criteria in the heading are "Not Applicable" at the "21.19 Substantial Evaluation" phase.

Table 1. Examples of Changes for Small Airplanes (CCAR-23)

The following examples are for **SUBSTANTIAL** changes for **Small Airplanes (CCAR-23)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change in wing location (tandem, forward, canard, high/low)	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Fixed wing to tilt wing	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Increase or decrease in the number of engines	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Replacement of piston or turbo-prop engines with turbojet or turbofan engines	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Change in engine configuration (tractor/pusher)	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Increase from subsonic to supersonic flight regime	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Change from an all metal airplane to all composite primary structure (fuselage, wing, empennage)	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

The following examples are for **SIGNIFICANT** changes for **Small Airplanes CCAR-23):**

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Conventional tail to T-tail or V-tail, or vice versa	Yes	No	Yes	Change in general configuration. Requires extensive structural, flying qualities and performance reinvestigation. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics.
Changes in wing configuration such as change in dihedral, changes in wing span, flap or aileron span, addition of winglets, or increase of more than 10 percent of the original wing sweep at the quarter chord	Yes	No	Yes	Change in general configuration. Likely requires extensive changes to wing structure. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics. **Note:** Small changes to wingtip are not significant changes. See table for not significant changes.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Changes to tail configuration such as the addition of tail strakes or angle of incidence of the tail	Yes	No	Yes	Change in general configuration. Likely requires extensive changes to tail structure. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics. **Note:** Small changes to tail are not significant changes.
Tricycle/tail wheel undercarriage change or addition of floats	Yes	No	No	Change in general configuration at product level. Principles of construction and certification assumptions remain valid.
Passenger to freighter configuration conversion which involves the introduction of a cargo door or an increase in floor loading of more than 20 percent, or provision for carriage of passengers and freight together.	Yes	No	Yes	Change in general configuration affecting load paths, aeroelastic characteristics, aircraft related systems, etc. Change in design assumptions.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Replace reciprocating engines with the same number of turbo-propeller engines where the operating envelope is expanded.	No	Yes	Yes	Invalidates certification assumptions. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics.
Addition of a turbocharger that changes the power envelope, operating range, or limitations.	No	No	Yes	Invalidates certification assumptions due to changes in operating envelope and limitations. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
The replacement of an engine of higher rated power or increase thrust would be considered significant if it would invalidate the existing substantiation, or would change the primary structure, aerodynamics, or operating envelope sufficiently to invalidate the assumptions of certification.	No	Yes	Yes	Invalidates certification assumptions. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics. Likely changes to primary structure. Requires extensive construction reinvestigation.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
A change in the type of material, such as composites in place of metal, or one composite fiber material system with another (e.g., carbon for fiberglass), for primary structure would normally be assessed as a significant change.	No	Yes	Yes	Change in principles of construction and design from conventional practices. Likely change in design/certification assumptions.
Change involving appreciable increase in design speeds Vd, Vmo, Vc, or Va	No	No	Yes	Certification assumptions invalidated. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics.
Short take off and landing (STOL) kit.	No	No	Yes	Certification assumptions invalidated. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
A change in the rated power or thrust is likely to be regarded as significant if the design speeds are thereby changed so that compliance needs to be rejustified with a majority of requirements.	No	No	Yes	Certification assumptions invalidated. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics.
Fuel state: such as compressed gaseous fuels, or fuel cells. This could completely alter the fuel storage and handling systems and possibly affect the airplane structure.	No	No	Yes	Changes in design/certification assumptions. Extensive alteration of fuel storage and handling systems.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
A design change that alters the aircraft flight characteristics or performance from the type design would normally be significant if it appreciably changes the kinematics or dynamics of the airplane.	No	No	Yes	Certification assumptions invalidated. Requires a new aircraft flight manual (AFM) to address performance and flight characteristics.
A change in the flight control concept for an aircraft, for example, to fly by wire (FBW) and sidestick control, or a change from hydraulic to electronically actuated flight controls, would in isolation normally be regarded as a significant change.	No	No	Yes	Changes in design and certification assumptions. Requires extensive systems architecture and integration reinvestigation. Requires a new aircraft flight manual (AFM).

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Change to airplane's cabin operating altitude, or operating pressure.	No	No	Yes	An increase greater than 10% in maximum cabin pressure differential invalidates certification assumptions and the fundamental approach used in decompression, structural strength, and fatigue.
Increase in cabin pressurization.	No	No	Yes	Typically, a change greater than 10% in operational cabin pressure differential. May require extensive airframe changes affecting load paths, fatigue evaluation, aeroelastic characteristics, etc. Invalidates design assumptions.
Addition of cabin pressurization system.	No	Yes	Yes	Extensive airframe changes affecting load paths, fatigue evaluation, aeroelastic characteristics, etc. Invalidates design assumptions.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Changes in types and number of emergency exits or an increase in maximum certificated passenger capacity.	Yes	No	Yes	Emergency egress requirements exceed those previously substantiated. Invalidates assumptions of certification.
A change in the required number of flight crew, which necessitates a complete cockpit rearrangement, and/or an increase in pilot workload would be a significant change.	No	No	Yes	Extensive changes to avionics and aircraft systems. Invalidates certification assumptions. Requires a new aircraft flight manual (AFM).

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Expansion of an aircraft's operating envelope.	No	No	Yes	An appreciable expansion of operating capability would normally be a significant change (e.g., an increase in maximum altitude limitation, approval for flight in known icing conditions, or an increase in airspeed limitations). Merely operating a product to an expanded envelope for which it was originally designed is generally not a significant change. In this case, the assumptions used for certification of the basic product remain valid and the results can be applied to cover the changed product with predictable effects or can be demonstrated without significant.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Replacement of an aviation gasoline with an engine of approximately the same horsepower utilizing diesel fuel.	No	No	Yes	A major change to the airplane. The general configuration and principles of constructions will usually remain valid; however, the assumptions for certification are invalidated.
Comprehensive flight deck upgrade, such as conversion from entirely federated, independent electromechanical flight instruments to highly integrated and combined electronic display systems with extensive use of software and/or complex electronic hardware.	No	No	Yes	Affects avionics and electrical systems integration and architecture concepts and philosophies.
Introduction of autoland	No	No	Yes	Invalidates original design assumptions

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Airframe life extension	No	No	Yes	This modification pertains to fuselage and/or wing limits, and aging airplane concerns. An increase from the original life limit which constitutes a reevaluation of certification design assumptions.
Extensive structural airframe modification, such as a large opening in fuselage	Yes	No	No	Requires extensive changes to fuselage structure, affects aircraft systems, and requires a new airplane flight manual to address performance and flight characteristics.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Fuselage stretch or shortening in the cabin or pressure vessel	Yes	No	Yes	Cabin interior changes are related changes since occupant safety considerations are impacted by a cabin length change. Even if a new cabin interior is not included in the product level change, the functional effect of the fuselage plug has implications on occupant safety (e.g., the dynamic environment in an emergency landing, emergency evacuation, etc.), and thus the existing cabin interior becomes an affected area.
Conversion from normal category to commuter category airplane	Yes	No	Yes	In many cases this change could be considered to be a substantial change to the type design. Therefore, a proposed change of this nature would be subject to a CAAC determination under § 21.19.

The following examples are for **NOT SIGNIFICANT** changes for **Small Airplanes (CCAR-23):**

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Addition of wingtip modifications (not winglets)	No	No	No	A major change to the airplane. Likely the original general configuration, principles of construction, and certification assumptions remain valid.
Installation of skis or wheel skis	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
FLIR or surveillance camera installation	No	No	No	Additional flight or structural evaluation may be necessary, but the change does not alter basic airplane certification.
Litter, berth and cargo tie down device installation	No	No	No	
Increased tire size, including tundra tires	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Replacement of one propeller type with another (irrespective of increase in number of blades)	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Addition of a turbocharger that does not change the power envelope, operating range, or limitations (e.g., a turbo-normalized engine, where the additional power is used to enhance high altitude or hot day performance)	No	No	No	
Substitution of one method of bonding for another (e.g., change in type of adhesive)	No	No	No	
Substitution of one type of metal for another	No	No	No	

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Any change in construction or fastening not involving primary structure	No	No	No	
A new fabric type for fabric skinned aircraft	No	No	No	
Increase in flap speed or undercarriage limit speed	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Structural strength increases	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Instrument flight rules (IFR) upgrades involving installation of components (where the original certification does not indicate that the airplane is not suitable as an IFR platform, e.g., special handling concerns)	No	No	No	
Fuel lines, where engine horsepower is increased but fuel flow is not increased beyond the certificated maximum amount	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Fuel tanks, where fuel is changed from gasoline to diesel fuel and tank support loads are small enough that an extrapolation from the previous analysis would be valid. Chemical compatibility would have to be substantiated.	No	No	No	
Limited changes in a pressurization system, e.g., number of outflow valves, type of controller, or size of pressurized compartment, but the system must be resubstantiated if the original test data are invalidated.	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Install a quieter exhaust system	No	No	No	

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Changes in engine cooling or cowling	No	No	No	
Changing fuels of substantially the same type: such as AvGas to AutoGas, AvGas (80/87) to AvGas (100LL), ethanol to isopropyl alcohol, Jet B to Jet A (although Jet A to Jet B may be considered significant due to the fact that Jet B is considered potentially more explosive).	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Fuels that specify different levels of "conventional" fuel additives that do not change the primary fuel type. Different additives (MTBE, ETBE, ethanol, amines, etc.) in AvGas would not be considered a significant change.	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
A change to the maximum take-off weight of less than 5 percent unless assumptions made in justification of the design are thereby invalidated.	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid. (Unless this weight increase would result in a shift to commuter category.)

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
An additional aileron tab (e.g., on the other wing)	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Larger diameter flight control cables with no change in routing, or other system design	No	No	No	
Autopilot installation (for instrument flight rules (IFR) use, unless the original certification indicates that the airplane is not suitable as an IFR platform)	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Increased battery capacity or relocate battery	No	No	No	
Replace generator with alternator	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Additional lighting (e.g., navigation lights, strobes)	No	No	No	
Higher capacity brake assemblies	No	No	No	
Increase in fuel tank capacity	No	No	No	Not a product level change, unless it is tied with an increase in gross weight.
Addition of an oxygen system	No	No	No	
Relocation of a galley	No	No	No	
Passenger to freight (only) conversion with no change to basic fuselage structure	No	No	No	Although a major change to the airplane, likely the original general configuration, principles of construction, and certification assumptions remain valid. Requires certification substantiation applicable to freighter requirements.
New cabin interior with no fuselage length change	No	No	No	
Installation of new seat belt or shoulder harness	No	No	No	

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
A small increase in c.g. range	No	No	No	At a product level, no change in general configuration, principles of construction, and certification assumptions.
APU installation that is not flight essential	No	No	No	Although a major change to the airplane level, likely the original general configuration, principles of construction, and certification assumptions remain valid.
An alternative autopilot	No	No	No	
Addition of Class B terrain awareness and warning systems (TAWS)	No	No	No	

Table 2. Examples of Changes for Transport Airplanes (CCAR-25)

The following examples are for **SUBSTANTIAL** changes for **Transport Airplanes (CCAR-25)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change in the number or location of engines, e.g., four to two wing-mounted engines or two wing-mounted to two body-mounted engines	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Change from a highwing to low-wing configuration	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Change from an all metal airplane to all composite primary structure (fuselage, wing, empennage)	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change of empennage configuration for larger airplanes (cruciform vs. 'T' or 'V' tail)	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Increase from subsonic to supersonic flight regime	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

The following examples are for **SIGNIFICANT** changes for **Transport Airplanes (CCAR-25):**

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Reduction in the number of flight crew (In conjunction with flight deck update)	No	No	Yes	Extensive changes to avionics and aircraft systems. Impact to crew workload and human factors, pilot type rating.
Modify an airplane for flight in known icing conditions by adding systems for ice detection and elimination	Yes	No	Yes	New aircraft operating envelope. Requires major new systems installation and aircraft evaluation. Operating envelope changed.
Conversion – passenger or combination freighter/passenger to all freighter, including cargo door, redesign floor structure and 9g net or rigid barrier	Yes	No	Yes	Extensive airframe changes affecting load paths, aeroelastic characteristics, aircraft related systems for fire protection, etc. Design assumptions changed from passenger to freighter.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Increase in cabin pressurization	No	No	Yes	Typically, a change greater than 10% in operational cabin pressure differential. May require extensive airframe changes affecting load paths, fatigue evaluation, aeroelastic characteristics, etc. Invalidates design assumptions.
Addition of leading edge slats	Yes	No	No	Requires extensive changes to wing structure, adds aircraft systems, and requires a new airplane flight manual to address performance and flight characteristics.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Fuselage stretch or shortening in the cabin or pressure vessel	Yes	No	Yes	Cabin interior changes are related changes since occupant safety considerations are impacted by a cabin length change. Even if a new cabin interior is not included in the product level change, the functional effect of the fuselage plug has implications on occupant safety (e.g., the dynamic environment in an emergency landing, emergency evacuation, etc.), and thus the cabin interior becomes an affected area.
Extensive structural airframe modification, such as installation of a large telescope with large opening in fuselage	Yes	No	No	Requires extensive changes to fuselage structure, affects aircraft systems, and requires a new airplane flight manual to address performance and flight characteristics.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Changing the number of axles or number of landing gear done in context with a product change that involves changing the airplane gross weight	Yes	No	No	Requires extensive changes to aircraft structure, affects aircraft systems, and requires new aircraft flight manual changes.
Primary structure changes from metallic material to composite material	No	Yes	No	Change in principles of construction and design from conventional practices.
Airframe life extension	No	No	Yes	This modification pertains to fuselage and/or wing limits, and aging airplane concerns. It results in an increase from the original life limit which constitutes a reevaluation of certification design assumptions.
Typically, an increase in design weight of more than 10 percent	No	No	Yes	Requires extensive resubstantiation of aircraft structure, aircraft performance and flying qualities and associated systems.
Installation of winglets	Yes	No	Yes	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Wing changes in span, sweep, tip designs or wing chord	Yes	No	Yes	When it requires extensive changes to wing structure, adds aircraft systems, and requires a new airplane flight manual to address performance and flight characteristics. (Note: Potentially substantial if it is a change from a high wing to a low wing, or a new wing.)
Change in type or number of emergency exits or an increase in the maximum certificated number of passengers	Yes	No	Yes	The new emergency egress requirements exceed those previously substantiated.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Comprehensive flight deck upgrade, such as conversion from entirely federated, independent electromechanical flight instruments to highly integrated and combined electronic display systems with extensive use of software and/or complex electronic hardware.	No	No	Yes	Affects avionics and electrical systems integration and architecture concepts and philosophies.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change in primary flight controls to fly by wire (FBW) system. (Some airplanes have some degree of FBW. Achieving full FBW may be a not significant change on some airplanes.)	No	No	Yes	When the degree of change is so extensive that it affects basic aircraft systems integration and architecture concepts and philosophies. This drives a complete reassessment of flight crew workload, handling qualities, and performance evaluation, which are different from the original design assumptions.
Replace reciprocating with turbo-propeller engines	Yes	No	No	Requires extensive changes to airframe structure, addition of aircraft systems, and new airplane flight manual to address performance and flight characteristics.
Typically a thrust increase of more than 10 percent	No	No	Yes	Requires resubstantiation of powerplant installation, and has a marked affect on aircraft performance and flying qualities.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Initial installation of an autoland system	No	No	Yes	Baseline airplane not designed for autoland operation, potential crew workload and systems compatibility issues.
Installation of a new fuel tank, (horizontal stabilizer tank or auxiliary fuel tank in the fuselage outside the wing in conjunction with increased maximum takeoff weight and takeoff thrust)	No	No	Yes	Requires changes to airframe, systems and Requires a new aircraft flight manual (AFM). Results in performance changes.
Main deck cargo door installation	Yes	No	No	Redistribution of internal loads, change in aeroelastic characteristics, system changes.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Expansion of an aircraft's operating envelope	No	No	Yes	An appreciable expansion of operating capability would normally be a significant change (e.g., an increase in maximum altitude limitation, approval for flight in known icing conditions, or an increase in airspeed limitations). Merely operating a product to an expanded envelope for which it was originally designed is generally not a significant change. In this case, the assumptions used for certification of the basic product remain valid and the results can be applied to cover the changed product with predictable effects or can be demonstrated without significant physical changes to the product.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Conversion from a passenger floor to a cargo floor and installation of a cargo handling system	No	No	Yes	Completely new floor loading and design. Redistribution of internal loads, change in cabin safety requirements, system changes.
Initial installation of an auxiliary power unit (APU) essential for aircraft flight operation	No	No	Yes	Changes emergency electrical power requirements, change in flight manual and operating characteristics.
Conversion from hydraulically actuated brakes to electrically actuated brakes	No	No	Yes	Assumptions of certification for airplane performance are changed.
Change to airplane's cabin operating altitude, or operating pressure	No	No	Yes	An increase greater than 10% in maximum cabin pressure differential invalidates certification assumptions and the fundamental approach used in decompression, structural strength, and fatigue.
Installation of engine thrust reversers	Yes	No	Yes	

The following examples are for **NOT SIGNIFICANT** changes for **Transport Airplanes (CCAR-25):**

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Alternate engine installation or hush kit at same position	No	No	No	Typically it is not significant so long as there is not more than a 10 percent increase in thrust or a change in the principles of propulsion.
A small change in fuselage length due to refairing the aft body or radome	No	No	No	For cruise performance reasons, where such changes do not require extensive structural, systems, aerodynamic, or aircraft flight manual (AFM) changes.
Refairing of wing tip caps (for lights, fuel dump pipes) and addition of splitter plates to the trailing edge thickness of the cruise airfoil	No	No	No	Does not require extensive structural, AFM, or systems changes.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Additional power used to enhance high altitude or hot day performance	No	No	No	Usually no change in basic operating envelope. Existing certification data can be extrapolated. Could be significant product change if the additional power is provided by installation of a rocket motor or additional, on demand engine due to changes in certification assumptions.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Installation of an autopilot system	No	No	See note	It may be possible that the modification is adaptive in nature, with no change to original certification assumptions. However, in certain cases the installation of an autopilot may include extensive changes and design features which change both the general configuration and the assumptions for certification (i.e., installation of the autopilot may introduce a number of additional mechanical and electronic failure modes and change the hazard classification of given aircraft level failures).
Change from assembled primary structure to monolithic or integrally machined structure	No	No	No	Method of construction must be well understood.
Modification to ice protection systems	No	No	No	Recertification required, but certification basis is adequate.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Brakes: design or material change, e.g., steel to carbon	No	No	No	Recertification required, but certification basis is adequate.
Redesign floor structure	No	No	No	By itself, not a significant product change. It is significant if part of a cargo conversion of a passenger airplane.
New cabin interior with no fuselage length change	No	No	No	A new cabin interior includes new ceiling and sidewall panels, stowage, galleys, lavatories, and seats. New and novel features in the cabin interior may require special conditions. Many interior related requirements are incorporated in operational rules. Even though the design approval holder may not be required to comply with these requirements, the operator may be required to comply.
A rearrangement of an interior (e.g. seats, galleys, lavatories, closets, etc)	No	No	No	Rearrangement requires the use of the existing floor structure.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Novel or unusual method of construction of a component	No	No	No	The component change does not rise to the product level. Special conditions could be required if there are no existing regulations that adequately address these features.
Initial installation of a non-essential auxiliary power unit (APU)	No	No	No	A stand-alone initial APU installation on an airplane originally designed to use ground/airport supplied electricity, and airconditioning. In this case, the APU would be an option to be independent of airport power.

Table 3. Examples of Changes for Rotorcraft (CCAR-27 and 29)

The following examples are for **SUBSTANTIAL** changes for **Rotorcraft (CCAR-27 and 29)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change from the number and or configuration of rotors (e.g., main & tail rotor system to two main rotors)	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Change from an all metal rotorcraft to all composite rotorcraft	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

The following examples are for **SIGNIFICANT** changes for **Rotorcraft (CCAR-27 and 29)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Comprehensive flight deck upgrade, such as conversion from entirely federated, independent electromechanical flight instruments to highly integrated and combined electronic display systems with extensive use of software and/or complex electronic hardware.	No	No	Yes	Affects avionics and electrical systems integration and architecture concepts and philosophies.
Certification for flight into known icing conditions	No	No	Yes	
(Fixed) flying controls from mechanical to fly by wire	No	No	Yes	This drives a complete reassessment of the rotorcraft controllability and flight control failure.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Addition of an engine; e.g., from single to twin or reduction of the number of engines; e.g., from twin to single	Yes	Yes	Yes	May be a substantial change depending upon project details.
A change of rotor drive system primary gearbox splash type lubrication system to a pressure lubricated system due to an increase in horsepower of an engine or changing a piston engine to a turbine engine	No	Yes	Yes	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
A fuselage or tail boom modification that changes the primary structure, aerodynamics, and operating envelope sufficiently to invalidate the certification assumptions	Yes	No	Yes	
Application of an approved primary structure to a different approved model (e.g., installation on a former model of the main rotor approved on a new model that results in increase performance)	No	Yes	Yes	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Extensive primary structure changes from metallic material to composite material	No	Yes	Yes	Change in principles of construction and assumptions used for certification for the product level change. Changes of a few individual elements from metal to composite are not typically considered a significant change.
Emergency medical service (EMS) configuration with primary structural changes sufficient to invalidate the certification assumptions.	No	No	Yes	Many EMS configurations will not be classified as significant. Modifications made for EMS are typically internal, and the general external configuration is normally not affected. These changes should not automatically be classified as significant.
Skid landing gear to wheel landing gear or wheel landing to skid	Yes	No	Yes	
Change of the number of rotor blades	Yes	No	Yes	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Change tail anti-torque device (e.g., tail rotor, ducted fan or other technology)	Yes	Yes	No	
Passenger configured helicopter to a Firefighting equipment configured helicopter	Yes	No	Yes	Depends on the firefighting configuration.
Passenger configured helicopter to a agricultural configured helicopter	Yes	No	Yes	Passenger configured helicopter to a agricultural configured helicopter
A new Category A certification approval to an existing configuration	No	No	Yes	
Instrument flight rules (IFR) upgrades involving installation of upgraded components for new IFR configuration	No	No	Yes	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Human external cargo (HEC) certification approval	No	No	Yes	Must comply with the latest HEC certification requirements in order to obtain operational approval. HEC include fatigue, quick release systems, high intensity radio frequency (HIRF), one engine inoperative (OEI) performance and OEI procedures.
Reducing the number of pilots for instrument flight rules (IFR) from 2 to 1	No	No	Yes	

The following examples are for **NOT SIGNIFICANT** changes for **Rotorcraft (CCAR-27 and 29)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Emergency floats	No	No	No	Must comply with the specific applicable requirements for emergency floats. This installation, in itself, does not change the rotorcraft configuration, overall performance, or operational capability. Expanding an operating envelope (such as operating altitude and temperature) and mission profile (such as passenger carrying operations to external load operations, or flight over water, or operations in snow conditions) are not by themselves so different that the original certification assumptions are no longer valid at the type certificated product level

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
FLIR or surveillance camera installation	No	No	No	Additional flight or structural evaluation may be necessary but the change does not alter the basic rotorcraft certification.
Helicopter terrain awareness warning system (HTAWS) for operational credit	No	No	No	Certificated per rotorcraft HTAWS AC guidance material and FAA TSO-C194.
Health usage monitoring system (HUMS) for maintenance credit.	No	No	No	Certificated per rotorcraft HUMS AC guidance material.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Expanded limitations with minimal or no design changes, following further tests/justifications or different mix of limitations (center of gravity (CG) limits, oil temperatures, altitude, minimum/maximum weight, minimum/max external temperatures, speed, ratings structure).	No	No	No	Expanding an operating envelope (such as operatingaltitude and temperature) and mission profile (such as passenger carrying operations to external load operations, or flight over water, or operations in snow conditions) are not by themselves so different that the original certification assumptions are no longer valid at the type certificated product level.
Installation of a new engine type, equivalent to the former one; leaving aircraft installation and limitations substantially unchanged	No	No	No	Refer to AC 27-1 or AC 29-2 for guidance
Windscreen installation	No	No	No	Does not change the rotorcraft overall product configuration.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Snow skis, “Bear Paws”	No	No	No	Must comply with specific requirements associated with the change. Expanding an operating envelope (such as operating altitude and temperature) and mission profile (such as passenger carrying operations to external load operations, or flight over water, or operations in snow conditions) are not by themselves so different that the original certification assumptions are no longer valid at the type certificated product level.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
External cargo hoist	No	No	No	Must comply with the specific applicable requirements for external loads. This installation, in itself, does not change the rotorcraft configuration, overall performance, or operational capability. Expanding an operating envelope (such as operating altitude and temperature) and mission profile (such as passenger carrying operations to external load operations, excluding human external cargo (HEC), or flight over water, or operations in snow conditions) are not by themselves so different that the original certification assumptions are no longer valid at the type certificated product level.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Instrument flight rules (IFR) upgrades involving installation of upgraded components to replace existing components	No	No	No	Not a rotorcraft level change.

Table 4. Examples of Changes for Engines (CCAR-33)

The following examples are for **SUBSTANTIAL** changes for **Engines (CCAR-33)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Turbine Engines				
Traditional turbofan to geared-fan engine	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required. **Note:** There may be certain circumstances where this change would be significant.
Low bypass ratio engine to high bypass ratio engine with an increased inlet area	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required. **Note:** There may be certain circumstances where this change would be significant.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Turbojet to Turbofan	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required. **Note:** There may be certain circumstances where this change would be significant.
Turbo-shaft to turbo-propeller	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required. **Note:** There may be certain circumstances where this change would be significant.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Conventional ducted fan to unducted fan	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Turbine engine for subsonic operation to afterburning engine for supersonic operation	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

The following examples are for **SIGNIFICANT** changes for **Engines (CCAR-33)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Turbine Engines				
Increase/decrease in the number of compressor/turbine stages with resultant change in approved operational limitations* (* exclude life limits)	Yes	No	Yes	Change is associated with other changes to the ratings and operating limitations; engine dynamic behavior, in terms of backbone bending, torque spike effects on casing, surge and stall characteristics, etc.
New design fan blade and fan hub, or a bladed fan disk to a blisk, or a fan diameter change, that could not be retrofitted	Yes	No	Yes	Change is associated with other changes to the engine thrust, ratings, and operating limitations; engine dynamic behavior in terms of backbone bending; torque spike effects on casing; foreign object ingestion behavior; blade-out test and containment; burst model protection for the aircraft. If there is a diameter change, installation will be also affected.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Hydro-mechanical control to electronic engine controls (FADEC/EEC) without hydro mechanical backup	Yes	No	No	Change in engine control configuration. Not interchangeable. Likely fundamental change to engine operation.
A change in the containment case from hard-wall to composite construction or vice versa, that could not be retrofitted without additional major changes to the engine or restricting the initial limitations or restrictions in the initial installation manual.	No	Yes	No	Change in methods of construction that have affected inherent strength, backbone bending, blade to case clearance retention, containment wave effect on installation, effect on burst model, torque spike effects.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Replace gas generator (core, turbine/ compressor/co mbustor) with a different one associated with changes in approved operational limitations (exclude life limits)	No	No	Yes	Change is associated with other changes that would affect engine thrust/power and have affected the dynamic behavior of the engine. Assumptions used for certification may no longer be valid.
Piston Engines				
Convert from mechanical to electronic control system	Yes	Yes	No	Change in engine configuration: Installation interface of engine changed. Changes to principles of construction: Digital controllers and sensors require new construction techniques and environmental testing.
Add turbocharger that increases performance and changes in overall product	Yes	No	Yes	Change in general configuration: Installation interface of engine changed (exhaust system). Certification assumptions invalidated: Change in operating envelope and performance.

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Convert from aircooled cylinders to liquid cooled cylinders	Yes	No	Yes	Change to general configuration: Installation interface of engine changed (cooling lines from radiator, change to cooling baffles). Certification assumptions invalidated: Change in operating envelope and engine temperature requirements.
Convert from sparkignition to compression-ignition	Yes	No	Yes	Change in general configuration: Installation interface of engine changed (no mixture lever). Certification assumptions invalidated: Change in operating envelope and performance.

The following examples are for **NOT SIGNIFICANT** changes for **Engines (CCAR-33)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Turbine Engines				
Change in the material from one type of metal to another type of metal of a compressor drum	No	No	No	No change in performance. Assumptions are still valid.
Increase/decrease in the number of compressor/turbine stages without resultant change in operational performance envelope	No	No	No	No change in performance. Assumptions are still valid.
New components internal to the electronic engine controls (FADEC/EEC) the introduction of which does not change the function of the system	No	No	No	No change in configuration. Assumptions used for certification are still valid. Possible changes in principles of construction are insignificant.
Software changes	No	No	No	
Rub-strip design changes	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
A new combustor that does not change the approved limitations, or dynamic behavior (exclude life limits)	No	No	No	
Bearing changes	No	No	No	
New blade designs with similar material that can be retrofitted	No	No	No	
Fan blade redesign that can be retrofitted	No	No	No	
Oil tank redesign	No	No	No	
Change from one hydro-mechanical control to another hydro-mechanical control	No	No	No	
Change to limits on life limited components	No	No	No	
Changes to limits on exhaust gas temperature	No	No	No	

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Changes in certification maintenance requirements (CMR) with no configuration changes	No	No	No	
Bump ratings within the product's physical capabilities that may be enhanced with gas path changes such as blade restaggered, cooling hole patterns, blade coating changes, etc	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
A change in principal physical properties and mechanics of load transfer of a material of primary structure or highly loaded components. For example, change from traditional metal to either an exotic alloy or a composite material on a highly loaded component.	No	No	No	
Piston Engine				
New or redesigned cylinder head, or valves, or pistons	No	No	No	
Changes in crankshaft	No	No	No	
Changes in crankcase	No	No	No	
Changes in carburetor	No	No	No	
Changes in mechanical fuel injection system	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Changes in mechanical fuel injection pump	No	No	No	
Engine model change to accommodate new airplane installation. No change in principles of operation of major subsystems; no significant expansion in power or operating envelopes or in limitations.	No	No	No	
No change in basic principles of operation, or a simple mechanical change. For example, change from dual magneto to two single magnetos on a model.	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Subsystem change produces no changes in base engine input parameters, and previous analysis can be reliably extended. For example, a change in turbocharger where induction system inlet conditions remain unchanged, or if changed, the effects can be reliably extrapolated.	No	No	No	

Description of change	Is there a change to the general configuration? §21.101(b)1.(1)	Is there a change to the principles of construction? §21.101(b)1.(1)	Have the assumptions used for certification been invalidated? §21.101(b)1.(2)	Notes
Change in material of secondary structure or not highly loaded component. For example, a change from metal to composite material in a non-highly loaded component, such as an oil pan that is not used as a mount pad.	No	No	No	
Change in material that retains the physical properties and mechanics of load transfer. For example, a change in trace elements in a metal casting for ease of pouring or to update to a newer or more readily available alloy with similar mechanical properties.	No	No	No	

Table 5. Examples of Changes for Propellers (CCAR-35)

The following are examples of **SUBSTANTIAL** changes for **Propellers (CCAR-35)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change in the number of blades	NA	NA	NA	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.

The following are examples of **SIGNIFICANT** changes for **Propellers (CCAR-35)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Principle of pitch change such as a change from single acting to dual acting	Yes	Yes	Yes	Requires extensive modification of the pitch change system with the introduction of back-up systems. The inherent control system requires re-evaluation.
Introduction of a different principle of blade retention such as a single row to a dual row bearing	Yes	Yes	No	Requires extensive modification of the propeller hub and blade structure. The inherent strength requires re-evaluation.
A hub configuration change such as a split hub to a one piece hub	Yes	Yes	No	Requires extensive modification of the propeller hub structure. The inherent strength requires re-evaluation.
Changing the method of mounting the propeller to the engine such as a spline to a flange mount	Yes	Yes	No	Requires extensive modification of the propeller hub structure. Note: Such a change could be considered not-significant if implemented without a change in general configuration or principals of construction.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change in hub material from steel to aluminum	Yes	Yes	No	Requires extensive modification of the propeller hub structure and change to method of blade retention. The inherent strength requires re-evaluation.
Change in blade material from metal to composite	Yes	Yes	Yes	Requires extensive modification of the propeller blade structure and change to method of blade retention. Composite construction methods required. The inherent strength requires re-evaluation.

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change from hydromechanical to electronic control	Yes	Yes	Yes	Electronic manufacturing and design methods required. Assumptions used for certification are no longer valid or were not addressed in the original certification, i.e., high intensity radio frequency (HIRF) and lightning protection, fault tolerance, software certification and other aspects. The propeller will require special conditions under § 21.16.

The following are examples of **NOT SIGNIFICANT** changes for **Propellers (CCAR-35)**:

Description of change	**Is there a change to the general configuration? §21.101(b)1.(1)**	**Is there a change to the principles of construction? §21.101(b)1.(1)**	**Have the assumptions used for certification been invalidated? §21.101(b)1.(2)**	**Notes**
Change in the material of a blade bearing	No	No	No	
Change to a component in the control system	No	No	No	
Change to a propeller de-icer boot	No	No	No	
Changes to the operational design envelope such as an increase in power	No	No	No	Propeller's operating characteristics and inherent strength require re-evaluation.
Change to the intended usage such as normal to acrobatic category	No	No	No	Propeller's operating characteristics and inherent strength require re-evaluation.

Appendix B. Procedure for Evaluating Impracticality of Applying Latest Requirements to a Changed Product

1. Introduction.

a. The basic principal of enhancing the level of safety of changed aeronautical products is to apply the latest regulations for significant design changes, to the greatest extent practical. In certain cases, the cost of complying fully with a later regulation may not be commensurate with the small safety benefit achieved. It is recognized that the existing fleet and newly produced airplanes, engines and propellers are safe, and any unsafe condition is immediately addressed through the airworthiness directive process. These factors form the basis where compliance with the latest standard may be considered impractical, thereby allowing compliance with an earlier regulation. This appendix gives one method of determining if compliance with a later regulation is impractical, however, this does not preclude the use of other methods for improving the safety of aeronautical products.

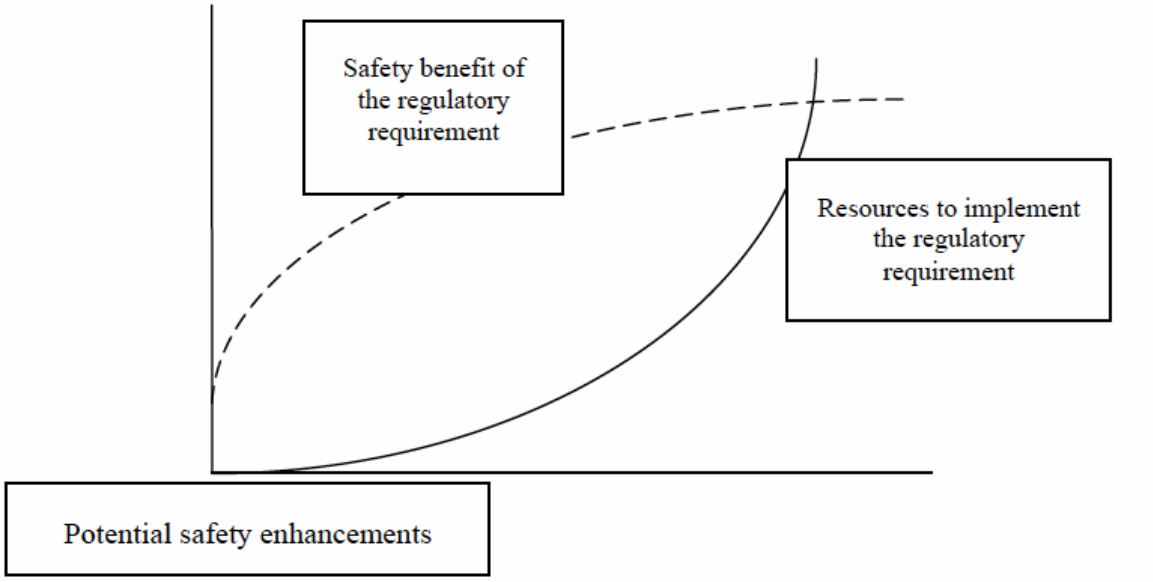
b. This AC recognizes that other procedures can be used and have historically been accepted on a case-by-case basis. The acceptance of results through the use of these procedures may vary from state to state. Consequently, they may not be accepted through all bilateral certification processes. Regardless of which method is used, the process must show that a proposed certification basis is able to achieve a positive safety benefit for the overall product.

c. In this regard, any method used must encourage incorporating safety enhancements that will have the most dramatic impact on the level of safety of the aircraft while considering effective use of resources. This important point is illustrated graphically in the accompanying figure. This figure notionally shows the interrelation between the total resources required for incorporating each potential safety enhancement with the corresponding net increase in safety benefit.

d. Typically, one will find that there are proposals that can achieve a positive safety benefit that are resource effective. Conversely, there are proposals that may achieve a small safety benefit at the expense of a large amount of resources to implement. Clearly, there will be a point where a large percentage of the potential safety benefit can be achieved with a reasonable expenditure of resources. The focus of the methods used should be to determine

the most appropriate regulatory standards relative to the respective cost to reach this point.

Figure 2. Safety Benefits vs. Resources



e. This appendix provides procedural guidance for determining the practicality of applying a requirement at a particular amendment level to a changed product. This guidance can be used to evaluate the safety benefit and resource impact of implementing the latest airworthiness requirements in the certification basis of a changed product. The procedure is generic in nature and describes the steps and necessary inputs that any applicant can use on any project to develop a position.

f. The procedure is intended to be used, along with good engineering judgment, to evaluate the relative merits of a changed product complying with the latest regulations. It provides a means, but not the only means, for an applicant to present its position in regard to impracticality.

g. The certification basis for a change to a product will not be at an amendment level earlier than the existing certification basis or any requirement found in CCAR §§ 23.2, 25.2, 27.2, 29.2 or CCAR-26 that is related to the change. Therefore, when determining the impracticality of applying a requirement at the latest amendment level, only the increase in safety benefits and costs beyond compliance with the existing certification basis should be considered.

2. Procedure for Evaluating Impracticality of Applying Latest Requirements to a Changed Product.

The following are steps to determine the impracticality of applying a requirement at a particular amendment level.

a. Step 1: Identify the Regulatory Change Being Evaluated.

In this step, document:

(1) The specific requirement (for example, § 25.365);

(2) The amendment level of the existing certification basis for the requirement; and

(3) The latest amendment level of the requirement.

b. Step 2: Identify the Specific Hazard that the Requirement Addresses.

(1) Each requirement and subsequent amendments are intended to address a hazard or hazards. In this step, the specific hazard(s) is/are identified. This identification will allow for a comparison of the effectiveness of amendment levels of the regulation at addressing the hazard.

(2) In many cases, the hazard and the cause of the hazard will be obvious. When the hazard and its related cause are not immediately obvious, it may be necessary to review the preamble of the regulation. It may also be helpful to discuss the hazard with the responsible FAA office.

c. Step 3: Review the Consequences of the Hazard(s).

(1) Once the hazard has been identified, it is possible to identify the types of consequences that may occur because of the presence of the hazard. More than one consequence can be attributed for the same hazard. Typical examples of consequences would include, but are not be limited to:

- Incidents where only injuries occurred;
- Accidents where less than 10 percent of the passengers died;
- Accidents where 10 percent or more passengers died; and
- Accidents where a total hull loss occurred.

(2) The preamble to the regulation may provide useful information regarding the consequences of the hazard the requirement is intended to address.

d. Step 4: Identify the Historical and Predicted Frequency of Each Consequence.

(1) Another source for determining impracticality is the historical record of the consequences of the hazard that led to a requirement or an amendment to a requirement. From these data, a frequency of occurrence for the hazard can be determined. It is important to recognize that the frequency of occurrence may be higher or lower in the future. Therefore, it also is necessary to predict the frequency of future occurrences.

(2) More than one consequence can be attributed for the same hazard. Therefore, when applicable, the combination of consequences and frequencies of those consequences should be considered together.

(3) The preamble of the regulation may provide useful information regarding the frequency of occurrence.

e. Step 5: Determine How Effective Full Compliance with the Latest Amendment of the Requirement Would Be at Addressing the Hazard.

(1) When each amendment is promulgated, it is usually expected that compliance with the requirement would be completely effective at addressing the associated hazard. It is expected that the hazard would be eliminated, avoided, or mitigated. However, in a limited number of situations, this may not be the case. It is also possible that earlier amendment levels may have addressed the hazard, but were not completely effective. Therefore, in comparing the benefits of compliance with the existing certification basis to the latest amendment level, it is useful to estimate the effectiveness of both amendment levels in dealing with the hazard.

(2) It is recognized that the determination of levels of effectiveness is normally of a subjective nature. These are relative assessments of a qualitative nature that should not be treated as absolute determinations. Therefore, exercise good judgment when making these determinations. In all cases, it is necessary to document the assumptions and data that support the determination.

(3) The following five levels of effectiveness are provided as a guideline:

(a) Fully effective in all cases. Compliance with the requirement eliminates the hazard or provides a means to avoid the hazard completely.

(b) Considerable potential for eliminating or avoiding the hazard. Compliance with the requirement eliminates the hazard or provides a means to completely avoid the hazard for all probable or likely cases, but it does not cover all situations or scenarios.

(c) Adequately deals with the hazard. Compliance with the requirement eliminates the hazard or provides a means to avoid the hazard completely in many cases. However, the hazard is not eliminated or avoided in all probable or likely cases. Usually this action only addresses a significant part of a larger or broader hazard.

(d) Hazard only partly addressed. In some cases compliance with the requirement partly eliminates the hazard or does not completely avoid the hazard. The hazard is not eliminated or avoided in all probable or likely cases. Usually this action only addresses part of a hazard.

(e) Hazard only partly addressed, but action has negative side effect. Compliance with the requirement does not eliminate or avoid the hazard or may have negative safety side effects. The action is of questionable benefit.

f. Step 6: Determine Resource Costs and Cost Avoidance.

(1) There is always cost associated with complying with a requirement. This cost may range from minimal administrative efforts to the resource expenditures that support full scale testing or the redesign of a large portion of an aircraft. However, there are also potential cost savings from compliance with a requirement. For example, compliance with a requirement may avoid aircraft damage or accidents and the associated costs to the manufacturer for investigating accidents. Compliance with the latest amendment of a requirement may also help a foreign authority certificate a product.

(2) When determining the impracticality of applying a requirement at the latest amendment level, only the incremental costs and safety benefits from complying with the existing certification basis should be considered.

(3) When evaluating the incremental cost, it may be beneficial for the applicant to compare the increase in cost to comply with the latest requirements to the cost to incorporate the same design feature in a new airplane. In many cases an estimate for the cost of incorporation in a new airplane is provided in the regulatory evaluation by the FAA, which was presented when the corresponding regulation was first promulgated. Incremental costs of retrofit/incorporation on existing designs may be higher than that for production. Examples of costs may include, but are not limited to:

(a) Costs: The accuracies of fleet size projections, utilization, etc. may be different than that experienced for derivative product designs and must be validated.

- Labor: Work carried out in the design, fabrication, inspection, operation or maintenance of a product for the purpose of incorporating or demonstrating compliance with a proposed action. Non-recurring labor requirements, including training, should be considered.
- Capital: Construction of new, modified or temporary facilities fordesign, production, tooling, training, or maintenance.
- Material: Cost associated with product materials, product components, inventory, kits, and spares.
- Operating Costs: Costs associated with fuel, oil, fees, and expendables.
- Revenue/Utility Loss: Costs resulting from earning/usage capability reductions from departure delays, product downtime, capability reductions of performance loss due to seats, cargo, range, or airport restrictions.

(b) Cost Avoidance:

- Avoiding cost of accidents, including investigation of accidents, lawsuits, public relations activities, insurance, and lost revenue.
- Foreign Certification: Achieve a singular effort that would demonstrate compliance to the requirements of most certifying agencies, thus

minimizing certification costs.

g. Step 7: Document Conclusion.

Once the information from previous steps has been documented and reviewed, the applicant's position and rationale regarding practicality can be documented. Examples of possible positions would include but are not limited to:

(1) Compliance with the latest requirement is necessary. The applicant would pursue the change at the latest amendment level.

(2) Compliance with an amendment level between the existing certification basis and the latest amendment would adequately address the hazard at an acceptable cost, while meeting the latest amendment level would be

impractical. The applicant would then propose the intermediate amendment level of the requirement.

(3) The increased level of safety is not commensurate with the increased costs associated with meeting the latest amendment instead of the existing certification basis. Therefore, the applicant would propose the existing certification basis.

(4) The results of this analysis were inconclusive. Further discussions with the CAAC are warranted.

Note: This process may result in a required certification basis that renders the proposed modification economically not viable.

3. Examples of How to Certify Changed Aircraft.

The following examples are for transport airplanes and illustrate the typical process an applicant follows. The process will be the same for all product types.

a. Example 1: § 25.963, Fuel Tank Access Covers.

(1) This change is part of a significant transport airplane change that increases passenger payload and gross weight by extending the fuselage 20 feet. To accommodate the higher design weights and increased braking requirements, and to reduce runway loading, the applicant will change the landing gear from a two-wheel to four-wheel configuration; this changes the debris scatter on the wing from the landing gear. The new model airplane will be required to comply with the latest applicable regulations based on the date of application.

(2) The wing will be strengthened locally at the side of the body and at the attachment of engines and landing gear, but the applicant would not like to alter wing access panels and the fuel tank access covers. Although the applicant recognizes that the scatter pattern and impact loading on the wing from debris being thrown from the landing gear will change, he proposes that it would be impractical to redesign the fuel tank access covers.

(3) Step 1: Identify the Regulatory Change Being Evaluated.

(a) The existing certification basis of the airplane that is being changed is part 25 prior to amendment 25-69 (25-40).

(b) Amendment 25-69 added the requirement that fuel tank access covers on transport category airplanes be designed to minimize penetration by

likely foreign objects, and be fire resistant.

(4) Step 2: Identify the Specific Hazard that the Regulation Addresses.

Fuel tank access covers have failed in service due to impact with high-energy objects such as failed tire tread material and engine debris following engine failures. In one accident, debris from the runway impacted a fuel tank access cover, causing its failure and subsequent fire, which resulted in fatalities and loss of the airplane. Amendment 25-69 will ensure that all access covers on all fuel tanks are designed or located to minimize penetration by likely foreign objects, and are fire resistant.

(5) Step 3: Review the History of the Consequences of the Hazard(s).

Occurrences with injuries and with more than 10 percent deaths.

(6) Step 4: Identify the Historical and Predicted Frequency of Each Consequence.

(a) In 200 million departures of large jets:

- One occurrence with more than 10 percent deaths; and
- One occurrence with injuries.

(b) There is no reason to believe that the future rate of accidents will be significantly different than the historical record.

(7) Step 5: Determine How Effective Full Compliance with the Latest Amendment of the Regulation Would Be at Addressing the Hazard.

(a) Considerable potential for eliminating or avoiding the hazard.

(b) Compliance with amendment 25-69 eliminates the hazard or provides a means to avoid the hazard completely for all probable or likely cases. However, it does not cover all situations or scenarios.

(8) Step 6: Determine Resource Costs and Cost Avoidance.

(a) Costs:

- For a newly developed airplane, there would be minor increases in labor resulting from design and fabrication.
- There would be a negligible increase in costs related to materials, operating costs, and revenue utility loss.

(b) Cost Avoidance:

- There were two accidents in 200 million departures. The applicant believes that it will manufacture more than 2,000 of these airplanes or derivatives of these airplanes. These airplanes would average five flights a day.Therefore, statistically there will be accidents in the future if the hazard isnot alleviated. Compliance will provide cost benefits related to avoidinglawsuits, accident investigations, and public relation costs.
- There are cost savings associated with meeting a single certification basis for FAA and foreign regulations.

(9) Conclusion.

It is concluded that compliance with the latest regulation increases the level of safety at a minimal cost to the applicant. Based on the arguments and information presented by the applicant through the issue paper process, the FAA determined that meeting the latest amendment would be practical.

b. Example 2: 14 CFR § 25.365 Pressurized Compartment Loads.

(1) This example is a passenger to freighter conversion STC.

(2) This change affects the floor loads on the airplane as well as the decompression venting.

(3) Step 1: Identify the Regulatory Change Being Evaluated.

(a) The existing certification basis of the airplane that is being changed includes 14 CFR § 25.365 at amendment 25-00. The initial release of 14 CFR § 25.365 required that the interior structure of passenger compartments be designed to withstand the effects of a sudden release of pressure through an opening resulting from the failure or penetration of an external door, window, or windshield panel, or from structural fatigue or penetration of the fuselage, unless shown to be extremely remote.

(b) Amendment 25-54 revised 14 CFR § 25.365 to require that the interior structure be designed for an opening resulting from penetration by a portion of an engine, an opening in any compartment of a size defined by 14 CFR § 25.365(e)(2), or the maximum opening caused by a failure not shown to be extremely improbable. The most significant change is the “formula hole size” requirement introduced into 14 CFR § 25.365(e)(2) at amendment 25- 54.

(c) Amendment 25-71/72 (amendments 25-71 and 25-72 are identical) extended the regulation to all pressurized compartments, not just passenger compartments, and to the pressurization of unpressurized areas. Pressurization of unpressurized areas had previously been identified as an unsafe feature under 14 CFR § 21.21(b)(2).

(d) Amendment 25-87 redefined the pressure differential load factor that applies above an altitude of 45,000 feet. Compliance with amendment 25-87 is not affected since the airplane does not operate above an altitude of 45,000 feet. The applicant proposes to meet the "pressurization into unpressurized areas" requirement introduced in amendment 25-71/72. The applicant does not propose to comply with the formula hole size requirement introduced in 14 CFR § 25.365(e)(2) at amendment 25-54.

(4) Step 2: Identify the Specific Hazard that the Regulation Addresses.

The hazard is a catastrophic structure and/or system failure produced by a sudden release of pressure through an opening in any compartment in flight. This opening could be caused by an uncontained engine failure, an opening of a prescribed size due to the inadvertent opening of an external door in flight, or an opening caused by a failure not shown to be extremely improbable. The opening could be produced by an event that has yet to be identified.

(5) Step 3: Review the History of the Consequences of the Hazard(s).

Occurrences with injuries, less than 10 percent deaths, and more than 10 percent deaths.

(6) Step 4: Identify the Historical and Predicted Frequency of Each Consequence.

(a) In 200 million departures of large jets:

- Two occurrences with more than 10 percent deaths;
- One occurrence with less than 10 percent deaths; and
- One occurrence with injuries.

(b) There is no reason to believe that the future rate of accidents will be significantly different than the historical record.

(7) Step 5: Determine How Effective Full Compliance with the Latest Amendment of the Regulation Would Be at Addressing the Hazard.

(a) Compliance with the latest amendment eliminates the hazard or

provides a means to avoid the hazard completely.

(b) Design changes made to the proposed derivative airplane bring it closer to full compliance with 14 CFR § 25.365 at amendment 25-54. The original airplane was shown to meet the requirements for a hole size of 1.1 square feet. Amendment 25-54 would require a hole size of 5.74 square feet, and the current reinforcements for the converted airplane can sustain a hole size of 3.65 square feet in the forward area and 2.65 at the aft area. This is 3.1 and 2.4 times, respectively, better than the original design condition of amendment 25-0 and is a significant improvement over the world wide passenger fleet in service.

(8) Step 6: Determine Resource Costs and Cost Avoidance.

(a) Costs: There would be savings in both labor and capital costs if compliance were shown to amendment 25-0 instead of amendment 25-54. Major modifications to the floor beams would be necessary to meet the formula hole size requirement in amendment 25-54.

(b) Cost Avoidance:

- There were four accidents in 200 million departures. The applicant believes that it will manufacture more than 2,000 of these airplanes orderivatives of these airplanes. These airplanes would average two flights aday. Therefore, statistically there will be accidents in the future if thehazard is not alleviated. Compliance will provide cost benefits related toavoiding lawsuits, accident investigations, and public relation costs.

- There are cost savings associated with meeting a single certification basisfor FAA and foreign regulations.

(9) Step 7: Document Conclusion Regarding Practicality. The design complies with 14 CFR § 25.365 at amendments 25-0, 25-71/72, and 25-87, and is nearly in full compliance with amendment 25-54 (and certain aspects of amendments 25-71/72 and 25-87). The design would adequately address the hazard at an acceptable cost. Therefore, based on arguments of impracticality discussed in an issue paper, the FAA accepts the applicant’s proposal to comply with 14 CFR § 25.365 at amendment 25-0.

Appendix C. The Use of Service Experience in the Certification Process

1. Introduction.

Service experience may support the application of an earlier regulatory standard if, in conjunction with the applicable service experience and other compliance measures, the earlier standard provides a level of safety comparable to that provided by the latest requirements. The applicant must provide sufficient substantiation to allow the FAA to make this determination. A statistical approach may be used, subject to the availability and relevance of data, but sound engineering judgment must be used. For service history to be acceptable, the data must be both sufficient and pertinent. The essentials of the process involve:

a. A clear understanding of the requirement change and the purpose for the change and hazard addressed;

b. A determination based on detailed knowledge of the proposed design feature;

c. The availability of pertinent and sufficient service experience data; and

d. A comprehensive review of that service experience data.

2. Guidelines.

The issue paper process (either a standalone issue paper or included in the G-1 issue paper) would be used, and the applicant should provide documentation to support the following:

a. The identification of the differences between the requirement in the existing certification basis and the requirement as amended, and the effect of the change in the requirement.

b. A description as to what aspect(s) of the latest requirements the proposed changed product would not meet.

c. Evidence showing that the proposed certification basis for the changed product, together with applicable service experience, relative to the hazard, provides a level of safety consistent with complying with the latest

requirements.

d. A description of the design feature and its intended function.

e. Data for the product pertinent to the requirement.

(1) Service experience from such data sources as the following:

(a) Accident reports;

(b) Incident reports;

(c) Service bulletins;

(d) Airworthiness directives;

(e) Repairs;

(f) Modifications;

(g) Flight hours/cycles for fleet leader and total fleet;

(h) World airline accident summary data;

(i) Service difficulty reports;

(j) National Transportation Safety Board reports; and

(k) Warranty, repair and parts usage data.

(2) Show that the data presented represent all relevant service experience for the product, including the results of any operator surveys, and is comprehensive enough to be representative.

(3) Show that the service experience is relevant to the hazard.

(4) Identification and evaluation of each of the main areas of concern with regard to:

(a) Recurring and/or common failure modes;

(b) Cause;

(c) Probability, by qualitative reasoning; and

(d) Measures already taken and their effects.

(5) Relevant data pertaining to aircraft of similar design and construction may be included.

(6) Evaluation of failure modes and consequences through analytical

processes. The analytical processes should be supported by:

(a) A review of previous test results;

(b) Additional detailed testing as required, or

(c) A review aircraft functional hazard assessments (FHA) and any applicable system safety assessments (SSA) as required.

f. A conclusion that draws together the data and the rationale.

g. These guidelines are not intended to be limiting, either in setting required minimum elements or in precluding alternative forms of submission. Each case may be different, based on the particulars of the system being examined and the requirement to be addressed.

3. Example: 14 CFR § 25.1141(f) Powerplant Controls for Transport Airplanes.

a. The following example, for transport airplanes (14 CFR § 25.1141(f) Auxiliary Power Unit (APU) Fuel Valve Position Indication System), illustrates the typical process an applicant follows. The process will be the same for all product types.

b. This example comes from a derivative model transport airplane where significant changes were made to the main airframe components, engines and systems, and APU. The baseline airplane has an extensive service history. The example shows how the use of service experience supports a finding that compliance with the latest regulation would not contribute materially to the level of safety and that application of the existing certification basis (or earlier amendment) would be appropriate. The example is for significant derivatives of transport airplanes with extensive service history, and illustrates the process, following the guidelines in this appendix, but does not include the level of detail normally required.

(1) Determine the differences between the regulation in the existing certification basis and the regulation as amended, and the effect of the change in the regulation. The existing certification basis of the airplane that is being changed is the initial release of part 25. Amendment 25-40 added requirement 14 CFR § 25.1141(f), which mandates that power-assisted valves must have a means to indicate to the flight crew when the valve is in the fully open or closed position, or is moving between these positions. The addressed hazard would be risk of APU fire due to fuel accumulation caused by excessive unsuccessful

APU start attempts.

(2) What aspect of the proposed changed product would not meet the latest regulations? The proposed APU fuel valve position indication system does not provide the flight crew with fuel valve position or transition indication and, therefore, does not comply with the requirements of 14 CFR § 25.1141(f).

(3) The applicant provides evidence that the proposed certification basis for the changed product, together with applicable service experience of the existing design, provide a level of safety comparable to that intended by the latest regulation. The APU fuel shut-off valve and actuator are unchanged from those used on the current family of airplanes, and have been found to comply with the earlier amendment 25-11 of 14 CFR § 25.1141(f). The existing fleet has achieved approximately (#) flights during which service experience of the existing design has been found to be acceptable. If one assumes a complete APU cycle, i.e., start-up and shutdown for each flight, the number of APU fuel shut-off valve operations would be over 10^8 cycles, which demonstrates that the valve successfully meets its intended function and complies with the intent of the regulation. In addition, the system design for the changed product incorporates features that increase the level of functionality and safety.

(4) The applicant provides a description of the design feature and its intended function. The fuel shut-off valve, actuator design, and operation is essentially unchanged; with the system design ensuring that the valve is monitored for proper cycling from closed to open at start. If the valve is not in the appropriate position (i.e., closed), then the APU start is terminated, an indication is displayed on the flight deck, and any further APU starts are prevented. Design improvements using the capability of the APU electronic control unit (ECU) have been incorporated in this proposed product change. These design changes ensure that the fuel valve indication system will indicate failure of proper valve operation to the flight crew, but the system does not indicate valve position as required by 14 CFR § 25.1141(f).

(5) The FAA and applicant record this in an issue paper. We can use the G-1 or a technical issue paper for this purpose. An issue paper was coordinated, included data, or referenced reports, documenting relevant service experience that has been compiled from incident reports, fleet flight hour/cycle data, and maintenance records. The issue paper also discussed existing and proposed design details, failure modes and analyses showing to what extent the proposed airplane complies with the latest amendment of 14 CFR § 25.1141. Information is presented to support the applicant’s argument that compliance with the latest

amendment would not materially increase the level of safety. Comparative data pertaining to aircraft of similar design and construction are also presented.

(6) The conclusion, drawing together the data and rationale, is documented in the G-1 issue paper. The additional features incorporated in the APU fuel shut-off valve will provide a significant increase in safety to an existing design with satisfactory service experience. The applicant proposes that compliance with the latest amendment would not materially increase the level of safety and that compliance with 14 CFR § 25.1141 at amendment 25-11 would provide an acceptable level of safety for the proposed product change.

Appendix D. Definitions and Terminology

1. Adequate Certification Basis – The type certification basis for a changed product under 14 CFR § 21.101 is considered adequate when the FAA determines that it provides adequate standards for the design change, i.e. when the certification specifications of the applicable airworthiness code and prescribed special conditions provide an appropriate level of safety for the changed product and do not result in any unsafe design features.

2. Aeronautical product – The terms aeronautical product or product(s) used in this guidance material includes type certificated aircraft, engines, and propellers.

3. Affected area, system, component, part or appliance – any system, component, part, or appliance which is either physically altered by a proposed design change or, even if not altered physically, its functional characteristics are altered due to the effects of the physical change.

4. Certification basis – The applicable airworthiness requirements as established in CCAR-21 §§ 21.17 and 21.101, as appropriate; special conditions; equivalent level of safety findings; requirements per CCAR-21 § 21.21(b)(2); and exemptions applicable to the product to be certificated.

5. Design Change – A change in the type design of an aeronautical product. In the context of this document the terms “change”, “design change” and “type design change” are synonymous.

6. Earlier requirements – The requirements in effect prior to the date of application for the change, but not prior to the existing certification basis.

7. Existing certification basis – The requirements incorporated by reference in the type certificate of the product to be changed.

8. Latest requirements – The requirements in effect on the date of application for the change.

9. Previous relevant design changes – Previous design changes, the cumulative effect of which could result in a product significantly or substantially different from the original product or model, when considered from the last time the latest regulations were applied.

10. Product level change – A change or combination of changes that makes the product distinct from other models of the product (for example, range, payload,

speed, design philosophy). Product level change is defined at the aircraft, aircraft engine, or propeller level of change.

11. Secondary change – A change is a secondary change if compliance to the latest amendment would not contribute materially to the level of safety and where it is part of and consequential to an overall significant change. A secondary change is a physical change that restores without changing the system, structural capacity, or functionality, but is necessary to support a significant change.

12. Significant change – A change to the type certificate significant to the extent that it changes one or more of the following: general configuration, principles of construction, or the assumptions used for certification, but not to the extent to be considered a substantial change. The significance of the change is considered in the context of all previous relevant design changes and all related revisions to the applicable regulations. Not all product level changes are significant.

13. Substantial change – 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, in accordance with CCAR-21 § 21.19.

Appendix E. Related Code of Federal Regulations Sections

§ 21.16, Special conditions.

§ 21.17, Designation of applicable regulations.

§ 21.19, Changes requiring a new type certificate.

§ 21.21, Issue of type certificate: normal, utility, acrobatic, commuter, and transport category aircraft; manned free balloons; special classes of aircraft; aircraft engines; propellers.

§ 21.93, Classification of changes in type design.

§ 21.101, Designation of applicable regulations.