European Aviation Safety Agency

DECISION NO 2011/010/R

OF THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY

OF 1ST DECEMBER 2011

amending Decision No. 2003/01/RM of the Executive Director of the Agency of 17 October 2003

on

Acceptable Means of Compliance and Guidance Material for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations ('AMC and GM to Part-21')

'Improvement of GM to 21A.101'

(Establishment of the type-certification basis of Changed Aeronautical Products)

THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY,

Having regard to the Regulation (EC) No 216/2008[1] (hereafter referred to as the 'Basic Regulation'), and in particular Article 38(3)(a) and (e) thereof,

Having regard to the Commission Regulation (EC) No 1702/2003[2] , and in particular 21A.101 of the Annex (Part-21) thereof,

Whereas:

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1 Regulation (EC) No 216/2008 of the European Parliament and the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.03.2008, p. 1). Regulation as last amended by Regulation (EC) No 1108/2009 of 21 October 2009 (OJ L 309, 24.11.2009, p. 51).

2 Commission Regulation (EC) No 1702/2003 of 24 September 2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (Part-21) (OJ L 243, 27.9.2003, p. 6). Regulation as last amended by Regulation (EC) No 1194/2009 of 30 November 2009 (OJ L 321, 8.12.2009, p. 5).

(1) The Agency shall, pursuant to Article 18 of the Basic Regulation, issue Certification Specifications and Acceptable Means of Compliance, as well as Guidance Material for the application of the Basic Regulation and its Implementing Rules.

(2) The Agency is obliged, pursuant to Article 19 of the Basic Regulation, to reflect the state of the art and the best practices in the fields concerned and to update these documents taking into account the worldwide aircraft experience in service, and scientific and technical progress.

(3) The rulemaking task 21.018 of the Agency resulted in a proposal to improve Guidance Material contained in GM 21A.101 'Establishment of the type-certification basis of Changed Aeronautical Products' in order to better support application of the 21A.101 rule of Part-21.

(4) The Agency, pursuant to Article 52(1)(c) of the Basic Regulation and articles 5(3) and 6 of the Rulemaking Procedure[3], has widely consulted interested parties on the matters that are subject of this Decision and has provided thereafter a written response to the comments received[4].

HAS DECIDED:

Article 1

The Annex 'Acceptable Means of Compliance and Guidance Material to be used in the airworthiness certification of products, parts and appliances and the approval of organisations involved in their design or manufacture' to Decision ED/2003/01/RM of the Executive Director of the Agency of 17 October 2003 is hereby amended as provided in Annex 1 to this Decision.

Article 2

This Decision shall enter into force on 8th December 2011. It shall be published in the Official Publication of the Agency.

Done in Cologne, on 1st December 2011.

P. GOUDOU

[3] Management Board Decision concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material (Rulemaking Procedure), EASA MB 08-2007, 13.6.2007.

[4] See Notice of Proposed Amendment (NPA) 2010-02 and Comment Response Document (CRD) 2010-02. Both documents available on Rulemaking Archives page http://www.easa.europa.eu/ws_prod/r/r_archives.php.

EXECUTIVE SUMMARY

GM 21A.101, which is part of 'AMC and GM to Part-21', provides an extensive guidance material (GM) on establishment of the type-certification basis of Changed Aeronautical Products. This guidance supports application in certification projects of major changes to products of the 21A.101 rule of Part-21. The 21A.101, also referred to as 'Changed Product Rule' or 'CPR', deals with designation of applicable certification specifications and environmental protection requirements for the type-certification basis.

Both the CPR rule 21A.101 and the guidance GM 21A.101 are to a large extent harmonised with the corresponding rules and guidance of the Federal Aviation Administration (FAA) and Transport Canada (TCCA). They have not been amended since their adoption in 2003.

Experience gained by all three Authorities since 2003 from application of the above rule and guidance in CPR certification projects of changed products indicated there was a need for improvements of the guidance material to address certain implementation problems identified.

The Agency, the FAA and TCCA agreed to set up a joint team in 2007 under the name 'CPR International Implementation Team' (CPR-IIT). The CPR-IIT was tasked to reflect on the experience gained by the three authorities from overseeing CPR implementation and consider harmonised changes to the existing guidance material and internal policies.

The Agency included into its Rulemaking Programme the rulemaking task 21.018 'Improvement of GM to 21A.101' with the aim to develop and include into GM 21A.101 the improved and harmonised text developed by the CPR-IIT.

The proposal was published as NPA 2010-02 in March 2010 and followed the standard consultation process resulting in publication of the respective CRD in January 2011. The feedback from the NPA consultation did not indicate a major opposition to the amended GM text as a whole but some comments proposed text changes. Quite a number of useful comments were accepted by the Agency which lead to improvement of the the text. The Agency received two reactions on the CRD. One reaction requested withdrawal of the proposal, preparation with STC industry of a new text and another round of NPA/CRD consultation. The Agency's responses to these reactions are contained in the explanatory note.

The new text of GM 21A.101 introduced by this Decision brings an improved guidance for application of the 21A.101 rule.

Annex 1 to ED Decision 2011/010/R

The Annex 'Acceptable Means of Compliance and Guidance Material to be used in the airworthiness certification of products, parts and appliances and the approval of organisations involved in their design or manufacture' to Decision ED/2003/01/RM of the Executive Director of the Agency of 17 October 2003 is hereby amended as follows:

The text of amendments is arranged to show deleted text or new text as shown below:

1. Text to be deleted is shown with a ~~strikethrough.~~
2. New text to be inserted is highlighted with grey shading.
3. … Indicates that remaining text is unchanged in front of or following the reflected amendment.

The existing main body of GM 21A.101 is replaced with the following:

GM 21A.101 Establishing the type-certification basis of Changed Aeronautical Products

Foreword

This guidance material (GM) provides guidance for the application of the Changed Product Rule, 21A.101 and 21A.19, for changes made to type-certificated aeronautical products.

Chapter 1. Introduction

1. Purpose

a. The Agency wrote this GM to provide guidance for establishing the type-certification basis for changed aeronautical products in accordance with 21A.101 and to help identify if it will be necessary to apply for a new type-certificate (TC) under 21A.19. The guidance describes the process for establishing the type-certification basis for changes to type certificates or restricted type-certificates, supplemental type certificates (STC) and amended STCs, detailing evaluations, classifications, and decisions made throughout the process.

b. The content of this GM is divided into 4 Chapters and 5 Appendices:

(1) Chapter 1 explains the purpose of this GM, describes its content, specifies the intended audience, and clarifies which changes are within the scope of applicability of this GM. Chapter 1 also contains definitions and terminology used in this GM for application of 21A.101 and 21A.19.

(2) Chapter 2 provides a general overview of 21A.101 and 21A.19, clarifies the principles and safety objectives and directs applicants to the applicable guidance contained in subsequent chapters of this GM.

(3) Chapter 3 contains guidance for implementation of 21A.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 21A.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.

(4) Chapter 4 contains considerations for design related operating requirements, guidance for establishing type-certification basis for changes on certain small aeroplanes and rotorcraft under specified maximum weight ("excepted products"), guidance for use of special conditions under 21A.101 (d), guidance on the effective period of an application, guidance for establishing the type-certification basis for changes on aircraft designed or modified for a special purpose (to operate under a restricted certificate of airworthiness) and guidance for documentation of revisions to the type-certification basis.

(5) Appendix A contains examples of typical type design changes for small aeroplanes, large aeroplanes, rotorcraft, engines, and propellers which are categorised by the Agency into individual tables according to the classifications to the level of design change - substantial, significant, and not significant.

(6) Appendix B provides detailed guidance with examples for evaluating when compliance would be impractical under the "impracticality" exception in the rule.

(7) 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 certification specifications.

(8) Appendix D contains figures and tables considered useful for understanding of the basic terms used and their mutual relations to assist correct application of this GM.

(9) Appendix E contains cross references to relevant requirements of Part-21 related to application of 21A.19 and 21A.101.

c. This GM describes an acceptable means, but not the only means to comply with 21A.101 and 21A19. However, if an applicant chooses to use the means described in this GM, they must follow it entirely.

2. Audience

This GM is for applicants applying for:

- major changes to type design of products under 21A.97 and to type design of Auxiliary Power Units (APUs) under 21A.604(b)),
- supplemental type-certificates (STCs) under 21A.113, or
- major changes to STCs under 21.117 (b).

3. Applicability

a. *Reserved.*

b. This GM applies to major type design changes under 21A.101 for aeronautical products type-certificated, restricted type-certificated, supplemental type-certificated or ETSO approved (APU) under Part-21 (ref. 21A.21. 21A.23, 21A.115, 21A.604), with application for the type-certification basis of the airworthiness code of the applicable CS (CS-VLA, CS-22, CS-23, CS-25 etc.).

c. Minor type design changes are automatically considered not significant under 21A.101(b) and the existing type-certification basis is considered adequate for their approval under 21A.95.

d. *Reserved.*

e. For the purpose of this GM, the term aeronautical products, or products, means type-certificated or restricted type-certificated aircraft, engines, and propellers or ETSO approved APUs.

f. This GM is not intended to be used to determine the applicable environmental protection requirements (aircraft noise, fuel venting and exhaust emission requirements) for changed products.

4. Definitions and Terminology.

Adequate Type-certification Basis – The type-certification basis for a changed product under 21A.101 is considered adequate when the Agency 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.

Aeronautical product – The terms aeronautical product or product(s) used in this guidance material include type-certificated or restricted type-certificated aircraft, engines, propellers and ETSO approved Auxiliary Power Units (APUs).

Affected area, system, part or appliance – any system, 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.

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.

Earlier certification specifications – The certification specifications of the applicable airworthiness code in effect prior to the date of application for the change, but not prior to the existing type-certification basis.

Existing type-certification basis – The certification specifications of the applicable airworthiness code, special conditions and equivalent level of safety findings incorporated by reference in the type-certificate of the product to be changed.

Latest certification specifications – The certification specifications of the applicable airworthiness code in effect on the date of application for the change.

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 certification specifications were applied.

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, engine, propeller, or APU level of change.

Secondary change – A change is a secondary change if compliance to the latest amendment would not contribute materially to the level of safety UUUUand 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.

Significant change – A change to the type-certificate significant to the extent that it changes at the product level 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 must be considered in the context of all previous relevant design changes and all related revisions to the certification specifications of the applicable airworthiness code. Not all product level changes are significant.

Significant change in an area (for excepted aircraft under 21A.101(c) only) – A change in an area is significant if the general configuration or the principles of construction in that area are not retained, or the assumptions used for certification of that area do not remain valid.

Substantial change – A change which is so extensive that a substantially complete investigation of compliance with the applicable type-certification basis is required, and consequently a new type certificate, in accordance with 21A.19.

Type-certification basis – The certification specifications of the applicable airworthiness code as established in 21A.17 and 21A.101, as appropriate; special conditions; and equivalent level of safety findings applicable to the product to be certificated.

Chapter 2. Overview of 21A.19 and 21A.101

1. 21A.19

a. 21A.19 requires an applicant to obtain a new type-certificate (TC) for a changed product if the change in design, power, thrust, or weight is found by the Agency so extensive that a substantially complete investigation of compliance with the applicable type-certification basis 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 section 3 of Chapter 3. Appendix A to this GM provides examples of type design changes that will require application for a new TC.

c. If the Agency has determined through 21A.19 that the proposed design change does not require a new TC, see 21A.101 for the applicable implementing rules to establish the type-certification basis for the proposed design change. For guidance, see Chapter 3 and the examples in Appendix A of this GM.

2. 21A.101

a. 21A.101(a) requires a change to a TC to comply with the latest certification specifications, unless the change meets the criteria for the exceptions identified in 21A.101(b) and (c). The intent of 21A.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. An applicant can comply with certification specifications of an earlier amendment of the airworthiness code consistent with the requirements of 21A.101(b), when:

- a change is not significant (see 21A.101(b)(1)), or
- an area, system, part or appliance is not affected by the change (see 21A.101 (b)(2)), or
- compliance with the latest amendment for a significant change does not contribute materially to the level of safety (see 21A.101(b)(3)), or
- compliance with the latest amendment would be impractical (see 21A.101(b)(3)).

c. Note that earlier amendments may not precede the corresponding amendment of the airworthiness code incorporated by reference in the type-certificate.

d. 21A.101(b) allows a changed product to comply with an earlier amendment of the applicable airworthiness code, provided one of the criteria in 21A.101(b)(1),(2) or (3) are met and the earlier amendment is considered adequate. However, when a proposed design change involves features or characteristics considered novel or unusual, or the intended use of the changed product is unconventional, or experience from other similar products in service or products having similar design features has shown that unsafe conditions may develop, and the proposed airworthiness standards do not contain adequate or appropriate standards for the changed product, later amendments and/or special conditions will be applied.

e. 21A.101(b)(1)(i) and (ii) describe the automatic criteria establishing that a change is significant.

f. 21A.101(c) provides an exception from the requirements of 21A.101(a) for a change to certain aircraft with less than specified maximum weight. If an applicant applies for a type design change to an aircraft (other than rotorcraft) of 2 722 kg (6 000 pounds) or less maximum weight, or to a non-turbine powered rotorcraft of 1 361 kg (3 000 pounds) or less maximum weight, the applicant can show that the changed product complies with the type-certification basis incorporated by reference in the TC. The applicant can also elect to comply, or may be required to comply, with a later amendment. See chapter 4, section 2 in this GM for specific guidance on this provision.

g. 21A.101(d) provides for the use of special conditions, under 21A.16B, when the proposed amendment of the applicable airworthiness code and any later amendment do not provide adequate standards to the proposed change.

h. 21A.101(e) 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.

Chapter 3. The Process for Establishing the Type-certification Basis for Changed Products 21A.101 (a) and (b)

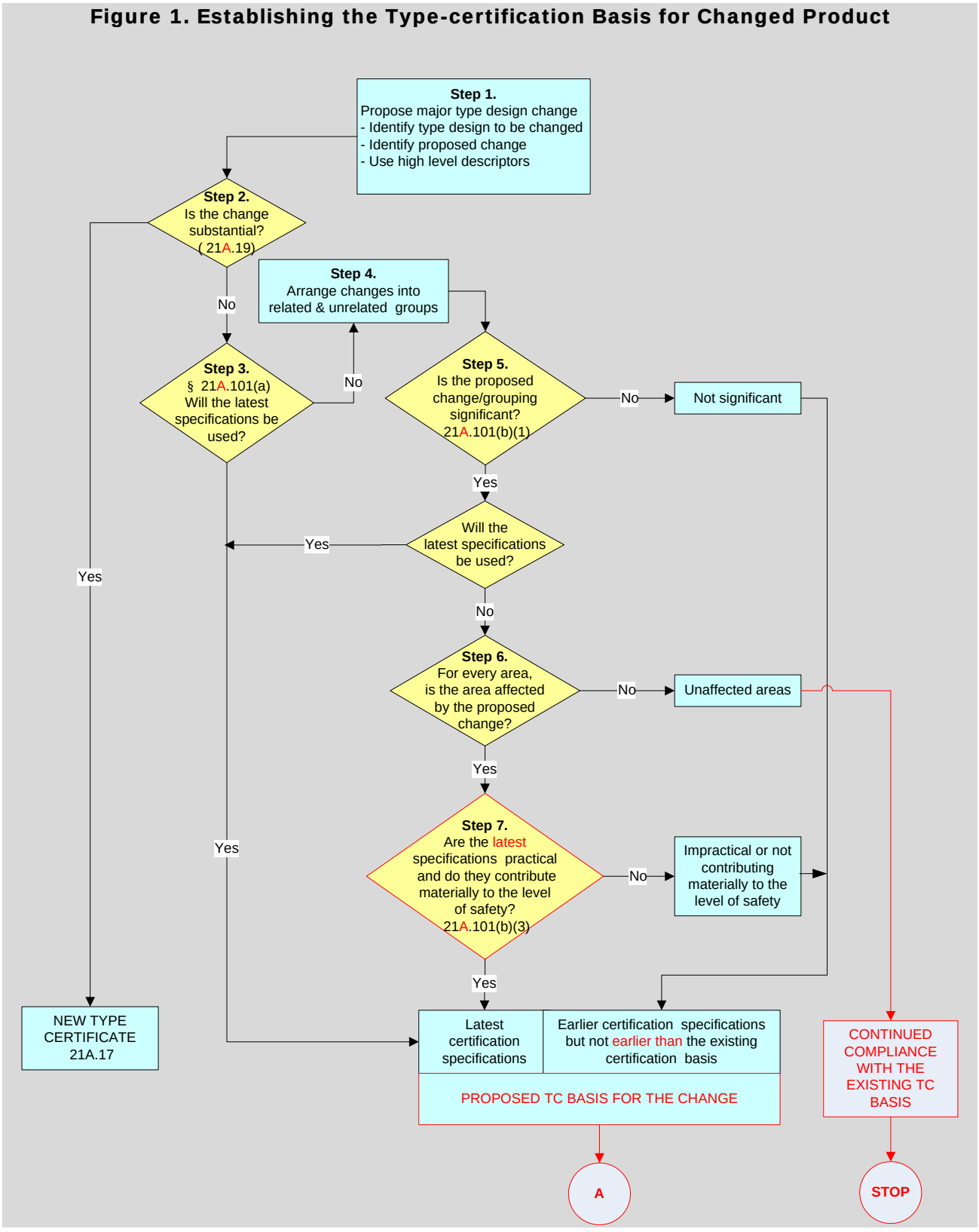
1. Overview

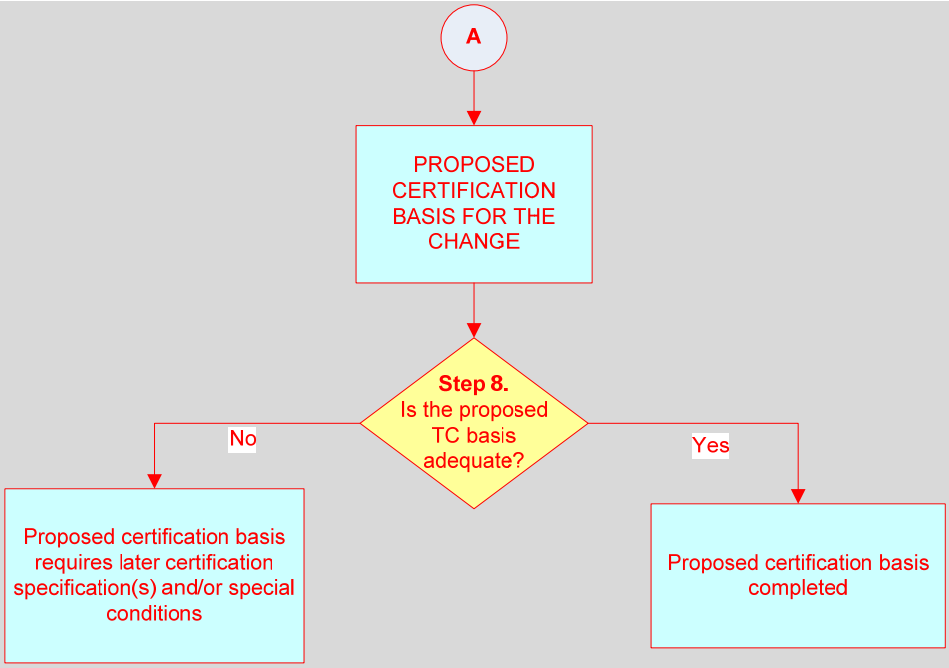
a. Both the applicant and the Agency have responsibility under 21A.101(a) and (b). The applicant must show that the change complies with the latest applicable certification specifications unless use of an exception per 21A.101(b) is justified. If an exception is proposed, the applicant should make a preliminary classification whether the change is significant or not significant, and propose an appropriate type-certification basis. The Agency determines whether the applicant's classification of the change and proposal for the type-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 type-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 type-certification basis, this guidance will help to establish the appropriate amount of coordination required between the applicant and the Agency.

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.

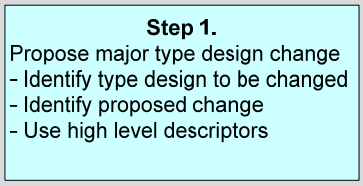
c. In cases where the examples in Appendix A are not applicable for the proposed change, use the following steps in conjunction with Figure 1 on the next page to establish the appropriate type-certification basis for the type design change.

Figure 1. Establishing the Type-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 changes that make it distinct from the other series. The applicant should identify which model or series within that model is 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 an applicant were amending an STC for an external cargo locker and the applicant proposed changing the configuration of the locker, then the starting point would be the existing TC with the existing STC installed. The applicant 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. The applicant for a type design change should consider all previous related design changes and the amendment level of the type-certification basis for these changes.

Note 1: By definition all previously incorporated changes 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: Substantiating data for the proposed type design change can include compliance findings from a previously approved design change, in supporting compliance findings for the proposed change. However, for the purpose of classifying the proposed design change, such previously approved design and compliance data should be now considered in relation to the proposed type design change and should be taken into account as a 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 those design changes are meant 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 type-certification basis should be taken into account in the next design change proposal.

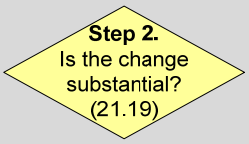
(1) **Example 1:** A 5 % weight increase is currently being proposed, but a previous 10 % and another 15 % weight increase has been incorporated into this aircraft without upgrading the existing type-certification basis. In the current proposal for a 5 % weight increase, the cumulative effects of the two previous weight increases that did not involve upgrade of the type-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 only those incremental increases from the last time the applicable certification specifications in the type-certification basis were upgraded.

(2) **Example 2:** The TC for aeroplane 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 aeroplane. During the review of the X-300 type-certification basis and the certification specifications affected by the proposed change, it was identified that one certification specification, CS-25.571 (damage tolerance), remained at the same amendment level as the X-100 original type-certification basis (derogation from 21A101(a) was allowed). Since the amendment level for this particular certification specification was not changed for the two subsequent aeroplane 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 should 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 characterises 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 complete new interior, an avionics system upgrade, or a passenger-to-cargo conversion are all high-level descriptions that characterise 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 programme may require re-evaluation of the type-certification basis and may result in re-classification of the change. That is, any evolution in the proposed design change after the type-certification basis has been agreed to (or established) will necessitate a revisit of the type-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?



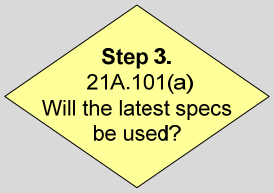
a. 21A.19 requires an applicant to apply for a new TC for a changed product if the proposed change in design, power, thrust, or weight is so extensive that a substantially complete investigation of compliance with the applicable regulations is required. A new TC could be required for either an extensive 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 the certification specifications applicable to a particular category of product. The number of certification specifications to which compliance must be re-established for the changed product may not necessarily be the sole determination criteria as to whether the change is substantial, but rather the extent of effort to establish compliance, or the depth of investigation required to be done. In other words, the 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 the question if a change is substantial at the beginning of the process, the applicant should 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 type-certification basis (as explained in Step 1).

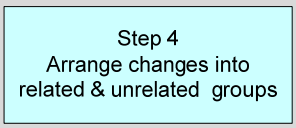
d. If it is not initially clear that a new TC is required, Appendix A provides some examples of substantial changes to aid in this classification. A substantial change requires application for a new TC under 21A.17 and 21A.19. If the change is not substantial, then follow the 21A.101 process.

4. Step 3 of Figure 1. Will the Latest Certification Specifications be Used?



a. The applicant can use the latest certification specifications for their proposed type design change. If the latest certification specifications are used, the applicant will meet the intent of 21A.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 21A.101 for a similar design change proposal, and use the exceptions in accordance with 21A.101(b). If the latest certification specifications are not used, then proceed as follows:

5. Step 4 of Figure 1. Relation of Changes

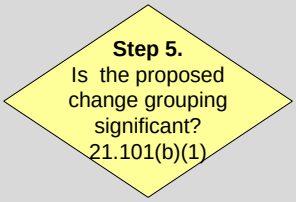


a. Once the proposed changes are identified using high-level descriptions, the next step is to determine if any of these changes are related to each other. Related changes are those that cannot exist without one another, are co-dependent, or a prerequisite of one another. For example, a need to carry 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 modernisation). The proposed avionics upgrade would then be considered an unrelated (or a stand-alone) change. However, the simultaneous introduction of a complete new interior may 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 organised into groupings of those that are related and those that are unrelated (or stand-alone), the applicant is ready for Step 5 of Figure 1. The grouping of related and unrelated changes is particularly relevant to the significant Yes/No decision, (21A.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 groupings and the associated or supporting technical details for each change, the applicant should identify areas, systems, parts or appliances of the product that are affected by the design change and the corresponding certification specifications associated with these areas. For each group, the applicant should assess the physical and/or functional effects of the change on other areas, systems, parts, 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, parts and appliances, 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 Significant? (21A.101(b)(1))



a. In Step 5 it is the applicant's 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 should be considered. 21A.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 number, although this is not required. For examples, see Appendix A to this GM.

(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 and would require extensive reinvestigation to show compliance. For examples, see Appendix A to this GM.

(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 to this GM.

Note: The word "assumptions" in 21A.101 bears a meaning different from CS E-30 and CS-P-30. CS-E and CS-P address the conditions that may be imposed on the engine or propeller when it is eventually installed in the aircraft and are published in the installation manual.

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 the applicant should focus on the design change itself. Consideration of only the regulatory importance or safety benefit of the latest certification specifications 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 large aeroplanes, small aeroplanes, rotorcraft, and engines/propellers that meet the definition of significant. The appendix also includes typical changes that do not achieve the significant level. In these tables, one or more of the three automatic criteria in 21A.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 tables can be used in one of two ways:

(1) To classify a proposed change that is listed in the table, 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 21A.101(b)(1)(i) and (ii) 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 type-certification basis and the final product may be significantly different than would be represented by the existing type-certification basis.

e. Each grouping of related changes and each unrelated (stand-alone) change, identified using high-level descriptions, will be evaluated 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, the type design change can 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 certification specifications in the type-certification basis for the affected area, system, part, or appliance were upgraded.

f. Typically, a change to a single area, system, part or appliance may not result in a product level change. However, there may be distinct cases where the change to a single system or part 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 change is a secondary change if compliance to the latest amendment does 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. Based on this description, a secondary change is not required to comply with the latest certification specifications because it is considered “not contributing materially to the level of safety”, and therefore eligible for an exception under 21A.101(b)(1)(3). Determining whether a change meets the description for secondary change, and thus is eligible for an exception, should be straightforward. Hence the substantiation or justification need only be minimal. If this determination is not straightforward, then the proposed change is very likely not a secondary change.

(1) In some cases 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 21A.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 Agency. To assist the applicant in their assessment, the Agency has predetermined the classification of several typical design changes that can be used for reference, and these examples are listed in Appendix A to this GM.

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 the applicant proposes to comply with an earlier requirement, the procedure outlined in paragraph 7 below should be used.

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, the applicant will comply with certification specifications of the latest amendment of the applicable airworthiness code for certification of the changed product, unless the applicant can justify use of one of the exceptions provided in 21A.101(b)(2) and/or (3) to show compliance with earlier amendment(s). The final type-certification basis may consist of a

combination of certification specifications of the applicable airworthiness code at different amendment levels ranging from the original type-certification basis to the most current amendments.

b. If the classification of the change is significant, all areas, systems, parts or appliances affected by the change must comply with certification specifications of the applicable airworthiness code at the amendment level in effect on the date of application for the change. The applicant will need to show that an area, system, part or appliance is not affected by the change to justify use of the exception in 21A.101(b)(2) (see Section 9 for guidance on whether or not an area is affected by the proposed change).

c. *Reserved.*

d. 21A.101(b)(3) provides two more exceptions applicable to areas, systems, parts or appliances which are affected by the significant change but for which compliance with the latest requirements would either not contribute materially to the level of safety or would be impractical (see Section 10 for more guidance).

e. *Reserved.*

f. The applicant should provide acceptable justification for the application of earlier amendments for areas affected by a significant change. Your justification should show that compliance with later amendment 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, part or appliance affected by the significant change.

g. The final type-certification basis may combine certification specifications at the latest amendment level, earlier (intermediate) amendment levels, and the amendment level of the existing type-certification basis, but cannot contain certification specifications preceding the existing type-certification basis.

h. Note that should an applicant decide to use the latest certification specifications 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 (21A.101(b)(1)) allows the use of the earlier certification specifications, but not dated prior to the existing type-certification basis. Within this limit, the applicant is allowed to propose an amendment level for each certification specification for the affected area. However, the applicant should be aware that their proposal for the type-certification basis will be reviewed by the Agency to ensure that the type-certification basis is adequate for the proposed change (see paragraph 8.d).

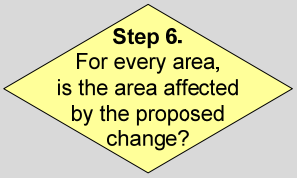
b. *Reserved*

c. When choosing the above option of the existing type-certification basis, an applicant can elect to comply with a specific certification specification or a subset of certification specifications at later amendments. In such a case, the applicant should consult with the Agency to ensure the type-certification basis includes other certification specifications that are directly related. Some later certification specifications may be less restrictive; therefore, the applicant may see advantage in using them on the elect to comply basis. However, the applicant is recommended not to make a final decision until they have learned from the Agency which other certification specifications are considered directly related.

d. For a design change that contains features which are not covered in the proposed type-certification basis, i.e. when the type-certification basis is not considered “adequate” (see the

definition of “adequate type-certification basis” in 1.d of Chapter 1), the Agency will designate the applicable certification specifications at the appropriate amendment level, beginning with the existing type 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 or unusual, for which there is no later applicable certification specification, the Agency will designate special conditions.

9. Step 6 of Figure 1. Is the Area Affected By the Proposed Change? (21A.101(b)(2))



a. A not affected area is any area, system, part, 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, parts, 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 type-certification basis of that area does not need to 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:

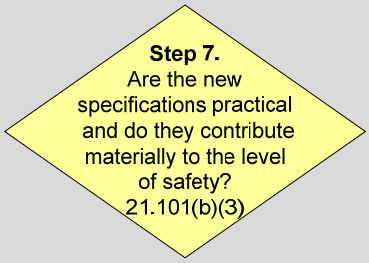
(1) Physical aspects. The physical aspects include direct changes to structures, systems, parts, and appliances (physical aspects may include software/airborne electronic hardware changes and the resulting effect on systems functions).

(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 specifications 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 aeroplane’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 a 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 certification specifications, unless the applicant can show that demonstrating compliance with the latest amendment of a certification specification 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 Latest Certification Specifications Practical and Do They Contribute Materially to the Level of Safety? (21A.101(b)(3))



a. Compliance with the latest certification specifications could be considered ;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 certification specifications. The applicant should provide sufficient justification to allow the Agency to make this determination. This exception could be applicable in the situations described in the paragraphs below:

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

(1) Design features that exceed the existing type-certification basis specifications, but do not meet the latest certification specifications, 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 in the TCDS or STC, where necessary, as an integral part of the type-certification basis. For example[5], an applicant proposes to install winglets on a Part-25 airplane. Part of the design involves adding a small number of new wing fuel tank fasteners. The latest § 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 § 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 certification specifications. Below, an aeroplane 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 GM.

- 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

[5] This example is taken from the FAA experience gained prior to the Agency's start, therefore the references to the FAA sections and amendments are kept.

not materially increase by applying the latest certification specifications.

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

(3) Service experience: Relevant service experience, such as fleet performance or utilisation 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 certification specifications 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 aeroplanes where relevant data may not be sufficient or not available at all because of the reduced utilisation 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 certification specifications, 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 levels 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 Agency.

b. Impractical. Compliance with the latest certification specifications may be considered impractical if the applicant can justify that it would result in additional resource requirements that are not commensurate with the incremental safety benefit (difference between the latest and the proposed type-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) The position that compliance is impractical should be supported with a substantiating data and analyses. While evaluating the applicant's position and their substantiating data regarding impracticality, the Agency may consider other factors (for example, the costs and safety benefits for a comparable new design).

(2) A review of large aeroplane projects showed that in certain cases, where an earlier amendment to applicable certification specifications 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 certification specifications to a changed product rule.

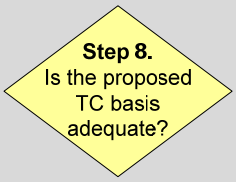
(a) The exception of impracticality is a qualitative and/or quantitative cost/safety benefit assessment for which it is difficult to specify clear criteria. Experience to date with applicants has shown that justification of impracticality is more feasible when both applicant and authority agree at an 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).

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 should 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 certification specification, 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 realised by complying with the later amendment would be minimal, and this would be justified with a demonstrated acceptable service experience in relation to the hazard that the new certification specification addresses.

11. Step 8 of Figure 1. Is the Proposed Type-certification Basis Adequate?



a. Regardless of whether the change is significant or not, the applicant's 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 standards (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 Part-25 aeroplane whose existing type-certification basis did not have lightning protection requirements. In this case, compliance with the certification specification 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 proposed 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 adequacy.

c. In cases where no adequate standard exists in any subsequent amendment of the applicable airworthiness code because of one or more reasons specified in 21A.16B(a), the Agency will prescribe special conditions containing necessary safety standard per 21A.16B(b). 21A.101(d) allows for the application of special conditions, or for changes to the existing special conditions, to address the changed designs where the proposed type-certification basis does not provide adequate standards with respect to the proposed change. Reference section 3 of Chapter 4 for additional information pertaining to special conditions.

d. *Reserved*

e. The final type-certification basis may consist of a combination of the certification specifications of the applicable airworthiness code at different amendment levels ranging from the original type-certification basis to the most current amendments, and special conditions.

Chapter 4. Other Considerations

1. Design Related Operating Requirements. The use of exceptions under 21A.101 is not intended to alleviate or preclude compliance with applicable operating rules or directives that prescribe compliance with the applicable additional airworthiness (design-related) specifications for operations.

2. Excepted Products under 21A.101(c)

a. An applicant for a design change to an excepted product may show that the changed product complies with the existing type-certification basis incorporated by reference in the TC. If the Agency finds that the change is significant "in an area", the Agency will require compliance with a later amendment to the existing type-certification basis that applies to that affected area and any certification specification the Agency finds is directly related. For excepted products, changes that meet one of the following criteria, in the area of change, are automatically considered significant if:

- The general configuration or the principles of construction are not retained, or
- The assumptions used for certification of the product to be changed do not remain valid.

b. However, the Agency may allow the applicant to comply with an earlier amendment to the airworthiness code initially designated or with the existing type-certification basis if the Agency agrees to the applicant's justification.

c. For a design change to an excepted product that contains new features, which are not covered in the existing type-certification basis, the Agency will designate the applicable certification specifications at the appropriate amendment level, beginning with the existing type-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 are no later applicable certification specifications at a later amendment level, the Agency will designate special conditions per 21.101(d).

d. The exception provided for excepted products under 21A.101(c) applies at the aircraft level only. Design changes to type-certificated engines and propellers installed on these excepted aircrafts are assessed as separate products using 21A.101(a) and (b).

3. Special Conditions, 21A.101(d). 21A.101(d) allows for the application of special conditions, or for changes to existing special conditions, to address the changed designs where the proposed type-certification basis does not provide adequate standards for an area, system, part or appliance related to the change and no adequate standard exist in any subsequent amendment of the applicable airworthiness code up to the airworthiness code in effect on the date of the application for the change. The objective is to achieve a level of safety consistent with that provided for other areas, systems, parts or appliances affected by the change by the other certification specifications of the proposed type-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 certification specifications allowed through exceptions, or not significant, the level of safety

intended by the special conditions should be consistent with the agreed type-certification basis. Note that special conditions may also be applied under 21A.16B when the intended use of the changed product is unconventional or experience from other similar products in service or products having similar design features has shown that unsafe conditions may develop.

4. Effective Period for an Application to Change a Type-Certificate (21A.101(e))

Per 21A.101(e), an application for, or a change to, a TC for large aeroplanes and large rotorcraft 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 type-certification basis for the changed product is as current as practical. According to 21A.101(e) (1) and (2), in a case where the change has not been approved, or it is clear that it will not be approved under the time limit established under this subparagraph, the applicant may:

1. File a new application for a change to the type-certificate and comply with all the provisions of paragraph 21A.101 (a) applicable to an original application for a change; or

2. File for an extension of the original application and comply with the provisions of paragraph (a) for an effective date of application, to be selected by the applicant, not earlier than the date which precedes the date of approval of the change by the time period established under this subparagraph for the original application for the change.

This is consistent with the requirements of 21A.17 for a new TC and defines the process of updating the type-certification basis if these time limits are exceeded.

5. Special purpose aircraft

When a change is proposed to aircraft which is designed or modified for a special purpose to operate in restricted airworthiness category (under a restricted certificate of airworthiness), the process of establishing the type-certification basis of the changed product is in principle the same as for aircraft with a standard certificate of airworthiness. 21A.101 is equally applicable to those special purpose aircraft, except that the applicable certification specifications, the proposed change must comply with, can exclude the paragraphs of the applicable airworthiness code that the Agency finds inappropriate for the special purpose for which the aircraft is to be used and may include possible alternative specifications to address that special purpose. Nevertheless, the “top-down” approach under 21A.101(a) and (b) (and the guidance in Chapter 3 of this GM) generally applies also to special purpose aircraft unless the aircraft is meeting the criteria in 21A.101(c) for excepted products, for which “bottom-up” approach applies (see above section 2 in this Chapter). All the exception routes under 21A.101(b)(1), (2) and (3) are still available, in particular the “not materially contributing to the level of safety” and “impractical” exceptions may be found justifiable considering the intended special purpose of the aircraft.

6. *Reserved*

7. Documentation. All changes that result in a revision to the product’s type-certification basis should be reflected on the amended TC or STC. The resulting type-certification basis should be retained as it forms part of the compliance record required by the applicable Agency’s internal working procedures.

The Appendix 1 to GM 21A101 is amended is follows:

Appendix ~~1~~A. to GM 21A.101

Classification of Changes

~~Appendix 1 includes tables of typical changes for small aeroplanes (figure 1), large aeroplanes (figure 2), rotorcraft (figure 3), and engines/propellers (figure 4) that meet the definition of a significant change or substantial change for each product line. The Appendix also includes typical changes that do not achieve the significant level.~~

~~a) The examples in the tables were developed from data collected from regulatory files and included industry review and input. They clearly are changes that we have seen in the past and will likely continue to see in the future. The Agency has made the determination, based on applying the automatic criteria, that these changes are significant or not significant.~~

~~b) The columns "Change to General Configuration", "Change to Principles of Construction" and "Assumptions of Certification" reflect the automatic criteria of 21A.101(b)(1)(i) and (ii). The "Notes" column provides typical rationales that are considered in evaluating the designation of the criteria.~~

~~c) The tables may be used in one of two ways:~~

~~(i) to classify a proposed change that is listed in the table, or~~

~~(ii) in conjunction with the three automatic criteria, to understand the logic used in the table to help classify a proposed change not in the table.~~

~~d) The classification may change due to cumulative effects and/or combinations of individual changes~~.

The following examples of substantial, significant and not significant changes are adopted by the Federal Aviation Administration (FAA), European Aviation Safety Agency (EASA) 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 "N/A" indicated in the substantial example tables indicates "Not Applicable" at the "21A.19 Substantial Evaluation" phase.

~~**Figure 1. Table of c**~~
Table 1.Examples of Changes for Small Aeroplanes (CS-23)

The following examples are for SUBSTANTIAL changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration? 21A.101(b)(1)(i)**	**Is there a change to the principles of construction? 21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated? 21A.101(b)(1)(ii)**	**Notes**
Change in wing location (tandem, forward, canard, high/low).	~~Yes~~ N/A	~~No~~ N/A	~~Yes~~ N/A	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.	~~Yes~~ N/A	~~Yes~~ N/A	~~Yes~~ N/A	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Increase or decrease in the number of engines~~ from one to two~~.	~~Yes~~ N/A	~~Yes~~ N/A	~~Yes~~ N/A	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.	~~Yes~~ N/A	~~Yes~~ N/A	~~Yes~~ N/A	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 SUBSTANTIAL changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration? 21A.101(b)(1)(i)**	**Is there a change to the principles of construction? 21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated? 21A.101(b)(1)(ii)**	**Notes**
Change in engine configuration (tractor/pusher).	~~Yes~~ N/A	~~Yes~~ N/A	~~Yes~~ N/A	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.	~~Yes~~ N/A	~~No~~ N/A	~~Yes~~ N/A	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 aeroplane to all composite primary structure (fuselage, wing, empennage).	~~No~~ N/A	~~Yes~~ N/A	~~Yes~~ N/A	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 Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Conventional tail to T-tail or Y-tail, or vice versa.	Yes	No	Yes	Change in general configuration. Requires extensive structural, flying qualities and performance reinvestigation. Requires a new AFM to address performance and flight characteristics.
Changes in wing configuration such as ~~(addition of tail strakes or~~ change in dihedral, changes in wing span, flap or aileron span, ~~angle of incidence of the tail,~~ addition of winglets, or increase of more than 10 % of the original wing sweep ~~of more than 10%~~ at the quarter chord.	Yes	No	Yes	Change in general configuration. Likely requires extensive changes to wing structure. Requires a new AFM to address performance and flight characteristics. **NOTE:** Small changes to wingtip are not significant changes. See table for not significant changes.
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 AFM to address performance and flight characteristics.

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				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. ~~Likely, at airplane level, general configuration~~ Principles of construction and certification assumptions remain valid.
~~Increase in seating capacity resulting in a different certification category (e.g., from normal to commuter category) where configuration or principles of construction changes or assumptions do not remain valid.~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Change in general configuration. Change in principles of construction. Requires extensive construction re-assessment. Change in certification assumptions. Requires new AFM and pilot type rating.~~
Passenger to freighter configuration conversion which involves the introduction of a cargo door or an increase in floor loading of more than 20%, or provision for carriage of passengers	Yes	No	Yes	Change in general configuration affecting load paths, aeroelastic characteristics, aircraft related systems, etc. Change in design assumptions.

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
and freight together.				
~~A fuselage stretch 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~~	~~Yes~~	~~No~~	~~Yes~~	~~Likely extensive changes to fuselage structure, aerodynamics, aircraft systems performance, and operating envelope. Requires new AFM to address performance and flight characteristics.~~
Replace reciprocating engines with the same number of turbo-propeller engines where the operating envelope is expanded.	No	No	Yes	Invalidates certification assumptions. Requires a new AFM to address performance and flight characteristics.
Addition of a turbo-charger 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 AFM to address performance and flight characteristics.
The replacement of an engine of higher rated	No	Yes	Yes	Invalidates certification assumptions. Requires a new

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
power or increased 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.				AFM to address performance and flight characteristics. Likely changes to primary structure. Requires extensive construction re-investigation.
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 AFM to address performance and flight characteristics.
Short take-off	No	No	Yes	Certification

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
and landing (STOL) kit.				assumptions invalidated. Requires a new AFM to address performance and flight characteristics.
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 re-justified with a majority of specifications.	No	No	Yes	Certification assumptions invalidated. Requires a new 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 aeroplane structure.	No	No	Yes	Changes in design/certification assumptions. Extensive alteration of fuel storage and handling systems.
A design change that alters the aircraft flight characteristics or performance from the type design would normally be	No	No	Yes	Certification assumptions invalidated. Requires a new AFM to address performance and flight characteristics.

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
significant if it appreciably changes the kinematics or dynamics of the ~~airplane~~ aeroplane.				
~~Weight increase which places the aircraft into the commuter category (i.e., above 12500 lbs.)~~	~~No~~	~~No~~	~~Yes~~	~~Certification assumptions invalidated. Requires new AFM.~~
A change in the flight control concept for an aircraft, for example to fly by wire (FBW) and side-stick 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 AFM.
Change to aeroplane'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.

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Addition of cabin pressurisation system.	No	Yes	Yes	Extensive airframe changes affecting load paths, fatigue evaluation, aeroelastic characteristics, etc. ~~Requires extensive construction re-investigation.~~ Invalidates design assumptions.
Changes in types and number of emergency exits or an increase in maximum certificated passenger capacity ~~in excess of maximum passenger capacity demonstrated for the aircraft type~~.	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 re-arrangement, 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 AFM.
~~An appreciable~~ Expansion of an aircraft's operating envelope ~~or operating~~	No	No	Yes	~~Invalidates certification assumptions. Requires new AFM to address performance and~~

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
~~capability would normally be a significant change. e.g., an increase in maximum altitude limitation, approval for flight in known icing conditions, an increase in airspeed limitations~~.				~~flight characteristics.~~ 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.

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Replacement of an aviation gasoline engine with an engine of approximately the same horsepower utilising diesel fuel.	No	No	Yes	A major change to the aeroplane. The general configuration and principles of construction will usually remain valid; however, the assumptions for certification are invalidated.
~~A major~~ Comprehensive flight deck upgrade, such as conversion from entirely federated, independent electro-mechanical flight instruments to highly integrated and combined electronic display systems with extensive use of software and/or complex electronic hardware.	No	No	Yes	~~Extensive changes to avionics and electrical systems design.~~ ~~Invalidates certification assumptions.~~ ~~Extensive re-assessments of systems integration, flight crew workload, human factors evaluation are required.~~ Affects avionics and electrical systems integration and architecture concepts, or philosophies.
Introduction of auto-land.	No	No	Yes	Invalidates original design assumptions.
~~Conventional tail to T-tail or Y-tail, or vice versa~~	~~Yes~~	~~No~~	~~Yes~~	~~Change in general configuration. Requires extensive structural, flying qualities and performance re-investigation.~~ ~~Requires new AFM~~

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				~~to address performance and flight characteristics.~~
Airframe life extension.	No	No	Yes	This modification pertains to fuselage and/or wing limits, and ageing aeroplane concerns. An increase from the original life limit which constitutes a re-evaluation 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 AFM to address performance and flight characteristics.
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

The following examples are for SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				landing, emergency evacuation, etc.), and thus the existing cabin interior becomes an affected area.
Conversion from normal category to commuter category aeroplane.	Yes	No	Yes	In many cases this change could be considered a substantial change to the type design. Therefore, a proposed change of this nature would be subject to Agency determination under 21A.19.

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Addition of wingtip modifications (not winglets).	No	No	No	A major change to the aeroplane. 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 aeroplane, 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 aeroplane certification.
Litter, berth and cargo tie down device installation.	No	No	No	~~Not an airplane level change.~~
Increased tire size, including tundra tires.	No	No	No	~~Not an airplane level change.~~
Replacement of one propeller type with another (irrespective of increase in number of blades).	No	No	No	Although a major change to the ~~airplane~~ aeroplane, likely the original general configuration, principles of construction and

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				certification assumptions remain valid.
Addition of a turbo-charger that does not change the power envelope, operating range, or limitations (e.g. a turbo-normalised engine, where the additional power is used to enhance high altitude or hot day performance).	No	No	No	~~Not an airplane level change.~~
~~Replace a petrol engine with a diesel engine or approximately the same horsepower.~~	~~No~~	~~No~~	~~No~~	~~Although a major change to the airplane, likely the original general configuration, principles of construction and certification assumptions remain valid.~~
Substitution of one method of bonding for another (e.g. change in type of adhesive).	No	No	No	~~Not an airplane level change.~~
Substitution of one type of metal for another.	No	No	No	~~Not an airplane level change.~~
Any change in construction or fastening not involving primary structure.	No	No	No	~~Not an airplane level change.~~
A new fabric type for fabric	No	No	No	~~Not an airplane level change.~~

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
skinned aircraft.				
Increase in flap speed or undercarriage limit speed.	No	No	No	Although a major change to the ~~airplane~~ aeroplane, 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~~ aeroplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Instrument flight rules (IFR) upgrades involving installation of components (where the original certification does not indicate that the aeroplane is not suitable as an IFR platform, e.g. special handling concerns).	No	No	No	~~Not an airplane level change.~~

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Fuel lines, where engine horsepower is increased but fuel flow is not increased beyond the certificated maximum amount.	No	No	No	~~Not an airplane level change.~~
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	~~Not an airplane level change.~~
Limited changes in a pressurisation system, e.g. number of outflow valves, type of controller or size of pressurised compartment, but the system must be re-substantiated if the original test data are invalidated.	No	No	No	Although a major change to the aeroplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Install a quieter exhaust system.	No	No	No	~~Not an airplane level change.~~

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Changes in engine cooling or cowling.	No	No	No	~~Not an airplane level change.~~
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 aeroplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
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 aeroplane, 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%, unless assumptions made in justification of	No	No	No	Although a major change to the aeroplane, likely the original general configuration, principles of

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
the design are thereby invalidated.				construction, and certification assumptions remain valid. (Unless this weight increase would result in a shift to commuter category.)
An additional aileron tab (e.g., on the other wing).	No	No	No	Although a major change to the aeroplane, 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	~~Not an airplane level change.~~
Autopilot installation (for instrument flight rules (IFR) use, where the original certification does not indicate that the aeroplane is not suitable as an IFR platform).	No	No	No	Although a major change to the aeroplane, likely the original general configuration, principles of construction, and certification assumptions remain valid.
Increased battery capacity or relocate battery.	No	No	No	~~Not an airplane level change.~~
Replace generator with alternator.	No	No	No	~~Not an airplane level change.~~
Additional lighting (e.g.	No	No	No	~~Not an airplane level change.~~

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
navigation lights, strobes).				
Higher capacity brake assemblies.	No	No	No	~~Not an airplane level change.~~
Increase in fuel tank capacity.	No	No	No	~~Not an airoplane 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 aeroplane, 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	~~Not an airplane level change.~~
A small increase in cg range.	No	No	No	At a ~~airplane~~ product level, no change in general configuration, principles of construction, and

The following examples are for NOT SIGNIFICANT changes for Small Aeroplanes (CS-23):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				certification assumptions.
APU installation that is not flight essential	No	No	No	Although ~~A~~a major change to the aeroplane level, likely the original general configuration, principles of construction, and certification assumptions remain valid. ~~Requires certification substantiation applicable to APU installation requirements.~~
An alternative auto-pilot.	No	No	No	~~Not an airplane level change.~~
Addition of Class B Terrain Awareness and Warning Systems (TAWS).	No	No	No	~~Not an airplane level change.~~

~~Figure 2.~~ Table 2. Examples of changes for Large Aeroplanes (CS-25)

The following examples are for SUBSTANTIAL changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**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.	~~Yes~~ N/A	~~No~~ N/A	~~Yes~~ N/A	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Change from a high-wing to low-wing configuration.	~~Yes~~ N/A	~~No~~ N/A	~~Yes~~ N/A	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 aeroplane to all composite primary structure (fuselage, wing and empennage).	~~Yes~~ N/A	~~Yes~~ N/A	~~Yes~~ N/A	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable regulations is required.
Change of empennage configuration for larger aeroplanes (cruciform vs. 'T' or 'V' tail).	N/A	N/A	N/A	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.	N/A	N/A	N/A	Proposed change in design is so extensive that a substantially

The following examples are for SUBSTANTIAL changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				complete investigation of compliance with the applicable regulations is required.

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
~~Derivative model, e.g., increased passenger payload, freighter version or complete update of a certified aeroplane.~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Multiple changes packaged into a new model. Increased payload new freighter would change the general configuration and assumptions. Updated aeroplane could change principles of construction.~~
Reduction in the number of flight crew (in conjunction with flight deck update).	Yes	No	No	Extensive changes to avionics and aircraft systems. Impact to crew workload and human factors, pilot type rating.
Modify an aeroplane 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	Yes	No	Yes	Extensive airframe changes affecting load paths, aeroelastic characteristics,

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
structure and 9g net or rigid barrier.				aircraft related systems for fire protection, etc. Design assumptions changed from passenger to freighter.
~~Change to pressurized cabin including the introduction of a pressurization system.~~ Increase in cabin pressurisation system.	No	No	Yes	~~Essentially a re-certification of airframe and systems associated with operating envelope change.~~ 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 ~~aeroplane flight manual~~ AFM to address performance and flight characteristics.

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Fuselage ~~length change – lengthen or shorten fuselage~~ stretch or shortening in the cabin or pressure vessel.	Yes	No	No	~~Requires extensive changes to fuselage structure, affects aircraft level systems, and requires a new aeroplane flight manual to address performance and flight characteristics.~~ 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.

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
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 AFM to address performance and flight characteristics.
Changing the number of axles or number of landing gear done in context with a product change that involves changing the aeroplane gross weight.	Yes	No	No	Requires extensive changes to aircraft structure, affects aircraft systems, and requires AFM 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 ageing aeroplane concerns. An increase from the original life limit which constitutes a re-evaluation of certification design assumptions.

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Typically, an increase in design weight of more than 10%. ~~(Note: Potentially substantial if it is a change from a high wing to a low wing, or a new wing.)~~	No	No	Yes	~~When it r~~Requires extensive re-substantiation of aircraft structure, aircraft performance and flying qualities and associated systems.
Installation of winglets.	Yes	No	Yes	
Wing changes in span, sweep, tip designs or wing chord.	Yes	No	~~No~~ Yes	When it requires extensive changes to wing structure, adds aircraft systems, and requires a new ~~aeroplane flight manual~~ AFM 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 ~~in conjunction with~~ or an increase in the maximum certificated number of passengers.	~~No~~Yes	No	Yes	The new emergency egress requirements exceed those previously substantiated.
Comprehensive	No	No	Yes	Affects avionics

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
flight deck upgrade, such as conversion from entirely federated, independent electro-mechanical flight instruments to highly integrated and combined electronic display systems with extensive use of software and possibly complex hardware.				and electrical systems integration and architecture concepts and philosophies. ~~This drives a re-assessment of flight crew workload and other human factors issues, and requires a re-evaluation of the original design assumptions used for the cockpit.~~
Change in primary flight controls to fly by wire (FBW) system. (Some aeroplanes have some degree of FBW. Achieving full FBW may be a not significant change on some aeroplanes.)	~~Yes~~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 a new ~~aeroplane flight manual~~ AFM to address

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				performance and flight characteristics.
Typically a thrust increase of more than 10 %.	No	No	Yes	~~When it r~~Requires re-substantiation of powerplant installation, and has a marked affect on aircraft performance and flying qualities.
Initial installation of an auto-land system.	No	No	Yes	Baseline aeroplane not designed for auto-land operation, potential crew workload and systems compatibility issues.
Installation of a new fuel tank, (horizontal stabiliser tank or auxiliary fuel tank in the fuselage outside the wing in conjunction with increased maximum take-off weight and takeoff thrust).	No	No	Yes	Requires changes to airframe, systems and AFM. Results in performance changes.
Main deck cargo door installation.	Yes	No	No	Redistribution of internal loads, change in aeroelastic characteristics, system changes.
Expansion of an aircraft's operating envelope.	No	No	Yes	An expansion of operating capability would normally be a significant change (e.g. an increase

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				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.
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 APU essential for aircraft flight	No	No	Yes	Changes emergency electrical power requirements, change in ~~flight~~

The following examples are for SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
operation.				~~manual~~ AFM and operating characteristics.
Conversion from hydraulically actuated brakes to electrically actuated brakes.	No	No	Yes	Assumptions of certification for aeroplane performance are changed.
Change to aeroplane'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 analysis.
Installation of engine thrust reversers.	Yes	No	Yes	

The following examples are for NOT SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **1A.101(b)(1)(ii)**	**Notes**
Alternate engine installation or hush kit at same position.	No	No	No	~~Although an aeroplane level change,~~ Typically, it is not significant any longer as there is not more than a 10% increase in thrust or a change in the principles of propulsion.
A small change in ~~F~~fuselage length ~~change – lengthen or shorten fuselage~~ due to refairing the aft body or radome.	No	No	No	~~A small change in fuselage length due to re-fairing the aft body or radome~~ ~~f~~For cruise performance reasons, where such changes do not require extensive structural, systems, aerodynamic, or AFM changes.
Refairing of wing tip caps (~~e.g.~~ 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.
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.

The following examples are for NOT SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **1A.101(b)(1)(ii)**	**Notes**
~~General avionics changes.~~	~~No~~	~~No~~	~~No~~	~~These modifications are generally adaptive* in nature, and do not change the original certification assumptions, alter basic cockpit design architecture concepts and philosophies, and do not have a major impact on crew workload or man/machine.~~ ~~*Adaptive means the change adapts to the existing airplane buses, power, structure, …~~
Installation of an auto-pilot system.	No	No	~~No~~ See note	It may be possible that the ~~M~~modification is ~~generally~~ adaptive in nature, with no change to original certification assumptions. However, in certain cases the installation of an auto-pilot may include extensive changes and design features which change the assumptions for certification (i.e. installation of the auto-pilot may introduce a number of additional mechanical and electronic failure modes and change the hazard classification of given aircraft level failures).
~~Integrated modular avionics~~	~~No~~	~~No~~	~~No~~	~~The basic functionality of the~~

The following examples are for NOT SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **1A.101(b)(1)(ii)**	**Notes**
				~~systems are unchanged. No change from analog to digital.~~
~~Installation or rearrangement of an interior in an aircraft.~~	~~No~~	~~No~~	~~No~~	~~Special conditions could be used for new and novel features~~
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.
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 ~~level~~ change. It ~~could be a~~ is significant if part of a cargo conversion of a passenger aeroplane.
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

The following examples are for NOT SIGNIFICANT changes for Large Aeroplanes (CS-25):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **1A.101(b)(1)(ii)**	**Notes**
				holder may not be required to comply with these requirements, the operator may be required to comply.
A re-arrangement of an interior (e.g. seats, galleys, lavatories, closets, etc)	No	No	No	Re-arrangement requires the use of the existing floor mounting structure.
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 specifications that adequately address these features.
Initial installation of a non-essential APU.	No	No	No	A stand-alone initial APU installation on an ~~airplane~~ aeroplane originally designed to use ground/airport supplied electricity, and air-conditioning. In this case, the APU would be an option to be independent of airport power.

~~Figure 3. Table of examples of Changes for Rotorcraft~~

~~The following are examples of substantial changes:~~

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

The following examples are for SUBSTANTIAL changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Change from the number and/or configuration of rotors (e.g. main & tail rotor system to two main rotors).	~~Yes~~ N/A	~~No~~ N/A	~~Yes~~ N/A	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.	~~Yes~~ N/A	~~Yes~~ N/A	~~Yes~~ N/A	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 (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Comprehensive flight deck upgrade, such as conversion from entirely federated, independent electro-mechanical flight instruments to highly integrated and combined electronic display systems with extensive use of software and/or complex electronic hardware.	~~Yes~~ No	No	Yes	~~The degree of change is so extensive that it~~ aAffects avionics and electrical systems integration and architecture concepts and philosophies. ~~This drives a complete reassessment of flight crew workload and other human factor issues, and requires a re-evaluation of the original design assumptions used for the cockpit.~~
Certification for flight into known icing conditions.	No	No	Yes	
(Fixed) flying controls from mechanical to fly by wire.	~~Yes~~ No	~~Yes~~ No	Yes	This drives a complete reassessment of the rotorcraft controllability and flight control failure.
Addition of an engine, e.g. from single to twin or reduction of the number of engines, e.g., from twin to single.	Yes	~~No~~ 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	No	Yes	Yes	

The following examples are for SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
increase in horsepower of an engine or changing a piston engine to a turbine engine.				
A fuselage or tail boom modification that changes the primary structure, aerodynamics, ~~or~~ 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 increased performance).	No	Yes	Yes	
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	No	No	Yes	~~Any~~ Many EMS configurations will not be classified as significant. Modifications made

The following examples are for SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
changes sufficient to invalidate the certification assumptions.				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	~~If the rotorcraft is such that the skid or wheel configuration is inherent in the basic certification design, the change may be not significant.~~
Change of the number of rotor blades.	Yes	No	~~No~~ Yes	~~The addition/deletion of rotor blades may not be significant provided the remainder of the basic propulsion system remains essentially unchanged.~~
Change tail anti-torque device (e.g. tail rotor, ducted fan or other technology).	Yes	Yes	No	
Passenger configured helicopter to a fire fighting equipment configured helicopter.	Yes	No	Yes	Depends on the fire fighting configuration.
Passenger configured helicopter to an agricultural configured helicopter.	Yes	No	Yes	Depends on the agricultural configuration.

The following examples are for SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
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	
Human External Cargo (HEC) certification approval.	No	No	Yes	Must comply with the latest HEC Certification specifications in order to obtain operational approval. HEC include fatigue, Quick Release Systems, HIRF, OEI performance and OEI procedures.
Reducing the number of pilots for IFR from 2 to 1.	No	No	Yes	Significant change, if there are extensive equipment and design changes such that the certification assumptions are invalidated.

The following examples are for NOT SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Emergency floats	No	No	No	Must comply with the specific applicable specifications 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.
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.

The following examples are for NOT SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
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.
Expanded limitations with minimal or no design changes, following further tests/justifications or different mix of limitations (CG limits, oil temperatures, altitude, minimum/ maximum weight, minimum/maximum external temperatures, speed, ratings structure).	No	No	No	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.
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.

The following examples are for NOT SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Snow skis, “Bear Paws”	No	No	No	Must comply with specific certification specifications 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.
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

The following examples are for NOT SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				altitude and temperature) and mission profile (such as passenger carrying operations to external load operations, excluding 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.
Instrument flight rules (IFR) upgrades involving installation of upgraded components ~~(where the original certification does not indicate that the rotorcraft is not suitable as an IFR platform, e.g., special handling concerns)~~ to replace existing components.	No	No	No	Not a rotorcraft level change.
~~An upgrade to CAT A certification approval~~	~~No~~	~~No~~	~~No~~	~~Typically these are engine and drive systems rating changes appropriate for CAT A and rotorcraft performance requirements. Rotorcraft modifications, if any necessary, do not typically~~

The following examples are for NOT SIGNIFICANT changes for Rotorcraft (CS-27 and CS-29):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				~~invalidate the certification assumptions, or change the general configuration of principles of construction.~~

~~Figure 4. Engines and Propellers~~

~~The following are examples of significant changes:~~

~~Turbine engines~~

Table 4. Examples for Engines (CS-E)

The following are examples of SUBSTANTIAL changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Turbine Engines				
Traditional turbofan to geared-fan engine.	N/A	N/A	N/A	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 by-pass ratio engine to high by-pass ratio engine with an increased inlet area.	N/A	N/A	N/A	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.

The following are examples of SUBSTANTIAL changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Turbojet to Turbofan.	N/A	N/A	N/A	Change in general configuration. Likely change in model designation. Not inter-changeable. Assumptions for certification may no longer be valid in terms of lifting, ingestion, icing, blade out criteria etc. Note that this change is most likely substantial under 21A.19.
Turbo-shaft to turbo-propeller.	N/A	N/A	N/A	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.
Conventional ducted fan to unducted fan.	N/A	N/A	N/A	Proposed change in design is so extensive that a substantially complete investigation of

The following are examples of SUBSTANTIAL changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				compliance with the applicable regulations is required. **Note:** There may be certain circumstances where this change would be significant.
~~Conventional~~ 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 are examples of SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Turbine Engines				
~~Traditional turbofan to geared-fan engine.~~	~~Yes~~	~~No~~	~~Yes~~	~~This change would affect the engine in terms of foreign object ingestion (FOD), containment etc.~~ ~~Note that this change is most likely substantial under 21A.19.~~
~~Low by-pass ratio engine to high by-pass ratio engine with an increased inlet area.~~	~~Yes~~	~~No~~	~~Yes~~	~~Change in general configuration.~~ ~~Likely change in model designation.~~ ~~Not interchangeable~~ ~~Assumptions for certification may no longer be valid in terms of ingestion, icing etc.~~ ~~Note that this change is most likely substantial under 21A.19.~~

The following are examples of SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
~~Turbojet to Turbofan~~	~~Yes~~	~~No~~	~~Yes~~	~~Change in general configuration.~~ ~~Likely change in model designation.~~ ~~Not interchangeable~~ ~~Assumptions for certification may no longer be valid in terms of lifting, ingestion, icing, blade out criteria etc.~~ ~~Note that this change is most likely substantial under 21A.19.~~
~~Turbo-shaft to turbo-propeller~~	~~Yes~~	~~No~~	~~Yes~~	~~Change in configuration such as an additional gearbox.~~ ~~Change in model designation.~~ ~~Change in mission profile.~~ ~~Assumptions for certification may no longer be valid in terms of flight envelope, ratings etc.~~ ~~Note that this change is most likely substantial under 21A.19.~~

The following are examples of SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
~~Conventional ducted fan to unducted fan.~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Change in configuration.~~ ~~Change in type.~~ ~~Not interchangeable~~ ~~Assumptions for certification may no longer be valid.~~ ~~Note that this change is most likely substantial under 21A.19.~~
~~Conventional engine for subsonic operation to after-burning engine for supersonic operation~~	~~Yes~~	~~Yes~~	~~Yes~~	~~Change in configuration Change in Type~~ ~~Not interchangeable Assumptions for certification may no longer be valid Change in operating envelope~~ ~~Note that this change is l most likely substantial under 21A.19~~
Increase/decrease in the number of compressor/turbine stages with resultant change in approved operational limitations* (*exclude life limits)	~~No~~Yes	No	Yes	Change is associated with other changes to the ratings and operating limitations; engine dynamic behaviour, in terms of backbone bending, torque spike effects on casing, surge

The following are examples of SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				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	~~Likely change in model designation~~ Change is associated with other changes ~~that would affect~~ to the engine thrust, ratings and ~~/power~~ operating limitations ~~and have effect~~ ~~affected the~~ engine dynamic behaviour ~~of the engine~~ in terms of backbone bending, torque spike effects on casing, foreign object ingestion behaviour, burst model protection for the aircraft. If there is a diameter change, installation will be also affected.
Hydro-Mechanical control to FADEC/EEC without hydro mechanical back-up.	Yes	~~Yes~~ No	~~Yes~~No	Change in engine control configuration. ~~Likely change in model designation~~ Not interchangeable Likely fundamental

The following are examples of SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				change to engine operation. ~~Assumptions used for certification are no longer valid or were not~~
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.
Replace gas generator (core, turbine/compressor /combustor) with a different one that is 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 behaviour 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

The following are examples of SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				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 engine configuration~~ Change in operating envelope and performance.
Convert from air cooled 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

The following are examples of SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				operating envelope and engine temperature requirements.
Convert from spark-ignition 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 are examples of NOT SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**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. ~~No likely change in model designation~~ 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. ~~Model designation may or may not change~~ Assumptions are still valid.
New components internal to the FADEC/EEC the introduction of which does not change the function of the system.	No	No	No	No change in configuration. Retrofitable. 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	~~Component Level Change~~
A new combustor that does not change the approved limitations, or dynamic behaviour* *exclude life limits.	No	No	No	~~Component Level Change~~
Bearing changes	No	No	No	~~Component Level Change~~
New blade designs with similar material that can	No	No	No	~~Component Level Change~~

The following are examples of NOT SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
be retrofitted.				
Fan blade redesign that can be retrofitted.	No	No	No	~~Component Level Change~~
Oil tank redesign	No	No	No	~~Component Level Change~~
Change from one hydro-mechanical control to another hydro-mechanical control.	No	No	No	~~Component Level Change~~
Change to limits on life limited components.	No	No	No	~~Component Level Change~~
Changes to limits on exhaust gas temperature.	No	No	No	
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	

The following are examples of NOT SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**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	~~Component Level Change~~
Piston Engine				
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	~~Component Level Change~~
New or redesigned cylinder head, or valves, or pistons.	No	No	No	
Changes in crankshaft.	No	No	No	~~Component Level Change~~
Changes in crankcase.	No	No	No	~~Component Level Change~~
Changes in carburettor	No	No	No	~~Component Level Change~~
Changes in mechanical fuel injection system.	No	No	No	~~No controversy No comments~~
Changes in mechanical fuel injection pump.	No	No	No	

The following are examples of NOT SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Engine model change to accommodate new aeroplane 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	
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	

The following are examples of NOT SIGNIFICANT changes for Engines (CS-E):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**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	Component level change
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	Component level change

Table 5. Examples of Changes for Propellers (CS-P)

The following are examples of SUBSTANTIAL changes for Propellers (CS-P):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Change in the number of blades.	N/A	N/A	N/A	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 (CS-P):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**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	~~Change in propeller configuration Likely change in model designation Propeller's operating characteristics and inherent strength require re-evaluation.~~ 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	Yes	Yes	No	Requires extensive modification of

The following are examples of SIGNIFICANT changes for Propellers (CS-P):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
propeller to the engine such as a spline to a flange mount.				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.
Change in hub material from steel to aluminium.	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.
Change from hydro-mechanical to electronic control.	Yes	Yes	Yes	Electronic manufacturing and design methods required. Assumptions used for

The following are examples of SIGNIFICANT changes for Propellers (CS-P):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
				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 21A.16B.

The following are examples of NOT SIGNIFICANT changes for Propellers (CS-P):				
Description of change	**Is there a change to the general configuration?** **21A.101(b)(1)(i)**	**Is there a change to the principles of construction?** **21A.101(b)(1)(i)**	**Have the assumptions used for certification been invalidated?** **21A.101(b)(1)(ii)**	**Notes**
Change in the material of a blade bearing.	No	No	No	~~Component Level Change~~
Change to a component in the control system.	No	No	No	~~Component Level Change~~
Change to a propeller de-icer boot.	No	No	No	~~Component Level Change~~
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.

The Appendix 2 to GM 21A101 is replaced by Appendix B as follows:

Appendix ~~2~~B to GM 21A.101
PROCEDURE FOR EVALUATING IMPRACTICALITY OF APPLYING LATEST CERTIFICATION SPECIFICATIONS TO A CHANGED PRODUCT

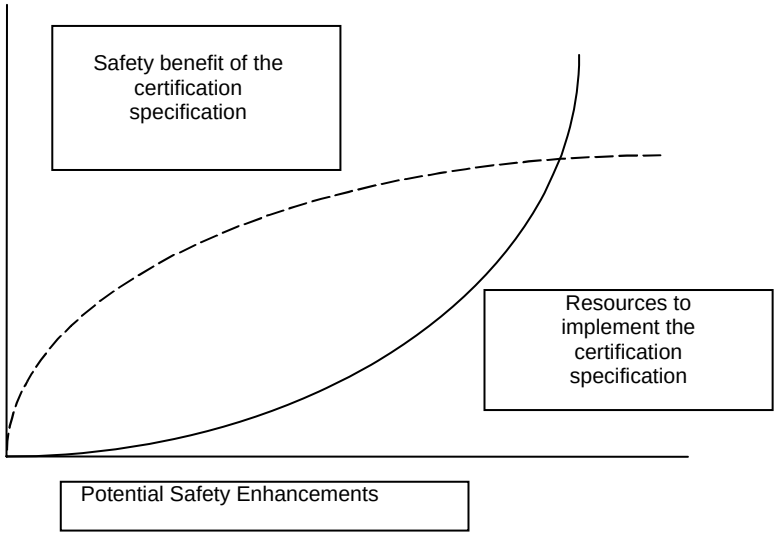
1. Introduction

a. The basic principle of enhancing the level of safety of changed aeronautical products is to apply the latest certification specifications for significant design changes to the greatest extent practical. In certain cases, the cost of complying fully with a later certification specification may not be commensurate with the small safety benefit achieved. It is recognised that the existing fleet and newly produced aeroplanes, 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 certification specification may be considered impractical, thereby allowing compliance with an earlier certification specification. This appendix gives one method of determining if compliance with a later requirement standard is impractical; however, this does not preclude the use of other methods for improving the safety of aeronautical products.

b. This GM recognises 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 should show that a proposed type-certification basis is able to achieve a positive safety benefit for the overall product.

c. In this regard, any method used should 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.

Figure 2. Safety Benefits vs. Resources



d. Typically, one will find that there are proposals that can achieve a positive safety benefit and 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 standards relative to the respective cost to reach this point.

e. This Appendix to GM 21A.101 provides procedural guidance for determining the practicality of applying a certification specification 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 certification specifications in the type-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 certification specifications. It provides a means, but not the only means, for an applicant to present its position in regard to impracticality.

g. The type-certification basis for a change to a product will not be at an amendment level earlier than the existing type-certification basis. Therefore, when determining the impracticality of applying a certification specification at the latest amendment level, only the increase in safety benefits and costs beyond compliance with the existing type-certification basis should be considered.

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

The following are steps to determine the impracticality of applying a certification specification at a particular amendment level. The first step will be to identify the regulatory change being evaluated.

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

In this step, it will be necessary to document:

(1) The specific certification specification (for example, CS 25.365),

(2) The amendment level of the existing type-certification basis for the certification specification, and

(3) The latest amendment level of the certification specification.

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

(1) Each certification specification 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 certification specification 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 available background information from development and adoption of this certification specification (Explanatory Note and Comment/Response Document to the NPA. It may also be helpful to discuss the hazard with the Agency).

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 % of the passengers died;
- Accidents where 10 % or more passengers died; and
- Accidents where a total hull loss occurred.

(2) The background information from development and adoption of the certification specification 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 hazard occurrence can be determined. It is important to recognise that the frequency of occurrence may be higher or lower in the future. Therefore, it is also 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 background information from development and adoption of the certification specification 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 certification specification would be completely effective at addressing the associated hazard. It is expected that the hazard would be eliminated, avoided, or dealt with. 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 type-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 recognised 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, prudence should be exercised 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 avoid completely 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 certification specification may also facilitate certification of a product by the competent authority of a third country.

(2) When determining the impracticality of applying a certification specification at the latest amendment level, only the incremental costs and safety benefits from complying with the existing type-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 certification specifications to the cost to incorporate the same design feature in a new aeroplane. In many cases an estimate for the cost of incorporation in a new aeroplane is provided in the regulatory evaluation by the Agency, which was presented when the corresponding certification specification 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, utilisation, etc. may be different than that experienced for derivative product designs and must be validated.

• Labour: 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 labour requirements, including training, should be considered.

• Capital: Construction of new, modified or temporary facilities for design, 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 minimising 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 certification specification is necessary. The applicant would pursue the change at the latest amendment level.

(2) Compliance with an amendment level between the existing type-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 certification specification.

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

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

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

3. Examples of How to Certify Changed Aircraft. The following examples are for large aeroplanes and illustrate the typical process an applicant follows. The process will be the same for all product types.

a. Example 1: CS 25.963 (e) Fuel Tank Access Covers

(1) This change is part of a significant large aeroplane change that increases passenger payload and gross weight by extending the fuselage by 20 feet. To accommodate the higher design weights and increased braking certification specification, 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 aeroplane 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 recognises 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 aeroplane that is being changed is CS-25 prior to Amendment3.

(b) Amendment 3 to CS-25 added the requirement that fuel tank access covers on large aeroplanes be designed to minimise 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 aeroplane. Amendment 3 ensures that all access covers on all fuel tanks are designed or located to minimise 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 % 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 % 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 3 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 aeroplane, there would be minor increases in labour 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 aeroplanes or derivatives of these aeroplanes. These aeroplanes would average five flights a day. Therefore, statistically there will be accidents in the future if the hazard is not alleviated. Compliance will provide cost benefits related to avoiding lawsuits, accident investigations, and public relation costs.

• There are cost savings associated with meeting a single type-certification basis for the Agency and foreign regulations.

(9) **Conclusion.** It is concluded that compliance with the latest certification specification increases the level of safety at a minimal cost to the applicant. Based on the arguments and information presented by the applicant through the Certification Review Item (CRI) process, the Agency determined that meeting the latest amendment would be practical.

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

NOTE: This example is taken from the FAA certification experience gained before the Agency's start, so references to FAR sections and amendments are kept.

(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 25-40. 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 § 25.365(e)(2) at Amendment 25-54.

(c) Amendment 25-71/72 (Amendments 25-71 and 25-72 are identical) extended the requirement to all pressurised compartments, not just passenger compartments, and to the pressurisation of unpressurised areas. Pressurisation of unpressurised 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 “pressurisation into unpressurised areas” requirement introduced in Amendment 25-71/72. The applicant does not propose to comply with the formula hole size requirement introduced in § 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 % deaths, and more than 10 % 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 % deaths;
- One occurrence with less than 10 % 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 worldwide passenger fleet in service.

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

(a) Costs: There would be savings in both labour 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:

(1) There were four 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 two flights a day. Therefore, statistically there will be accidents in the future if the hazard is not alleviated. Compliance will provide cost benefits related to avoiding lawsuits, accident investigations, and public relation costs.

(2) There are cost savings associated with meeting a single certification basis for FAA and foreign regulations.

(9) **Step 7: Document Conclusion Regarding Practicality.** The design complies with 14 CFR § 25.365 at Amendment 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.

The Appendix 3 to GM 21A101 is amended as follows:

Appendix ~~3~~C to GM 21A.101.
THE USE OF SERVICE EXPERIENCE IN THE CERTIFICATION PROCESS

1. Introduction.
Service experience may support the application of an earlier airworthiness 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 certification specifications. The applicant must provide sufficient substantiation to allow the Agency to make this determination. A statistical approach may be used, subject to the availability and relevance of data, but sound engineering judgment should be used as a minimum. 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 Certification Review Item (CRI) process (either a stand-alone CRI or included in the CRI.A-1) would be used, and the applicant should provide documentation to support the following:

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

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

c. Evidence showing that the proposed type-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 certification specifications.

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

e. Data for the product pertinent to the certification specification.

(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) Reports from Accident Investigation Boards

(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;

(c) 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 certification specification to be addressed.

3. Example:

NOTE: This example is taken from a FAA certification gained prior to the Agency's start, so references to FAR sections and amendments are kept.

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 large aeroplanes 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 tThe differences between the regulation in the existing certification basis and the regulation as amended, and the effect of the change in the requirement.

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) Evidence_that the proposed type-certification basis for the changed product, together with applicable service experience and other compliance measures provide an acceptable level of safety

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) 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) Data for the product pertinent to the requirement

The FAA and applicant record the data in an issue paper (G-1 or a technical issue paper). 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

Conclusion 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.

A new appendix D to GM 21A101 is introduced as *follows:*

Appendix D to GM 21A.101.

TABLES AND FIGURES TO ASSIST CPR UNDERSTANDING

Figure 3: Affected and Not affected area

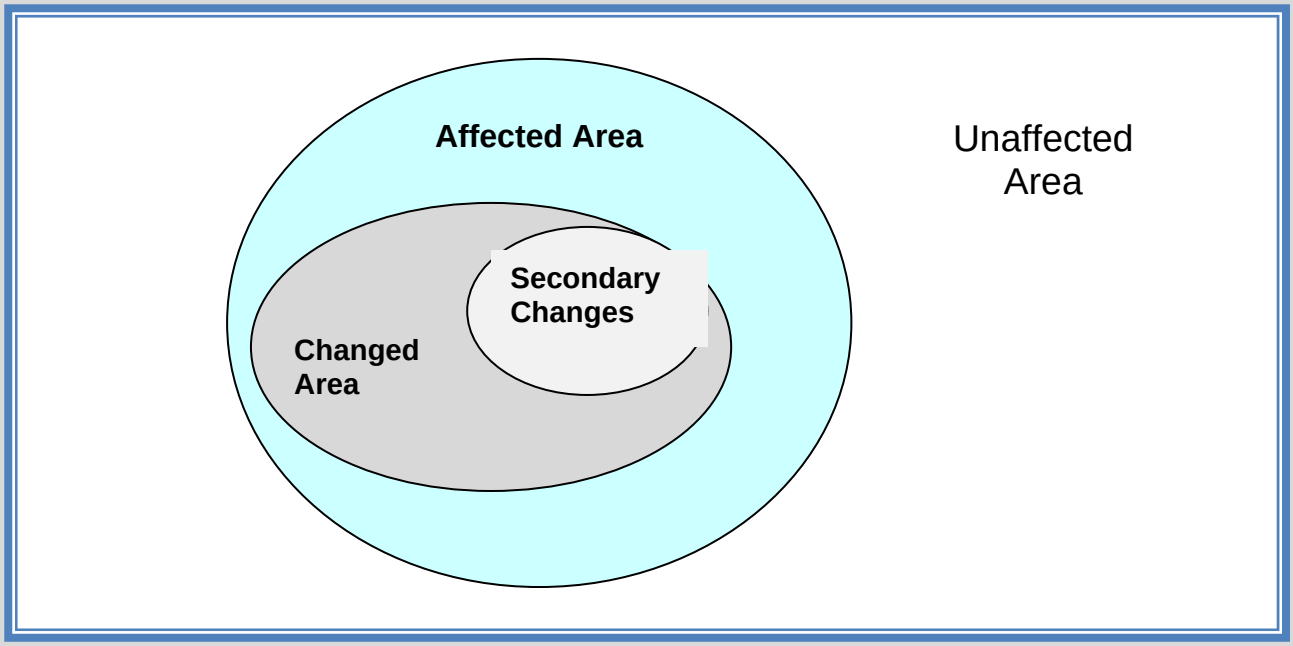


Figure 4: Example of Related and Unrelated changes – Increase in Maximum Number of Passengers

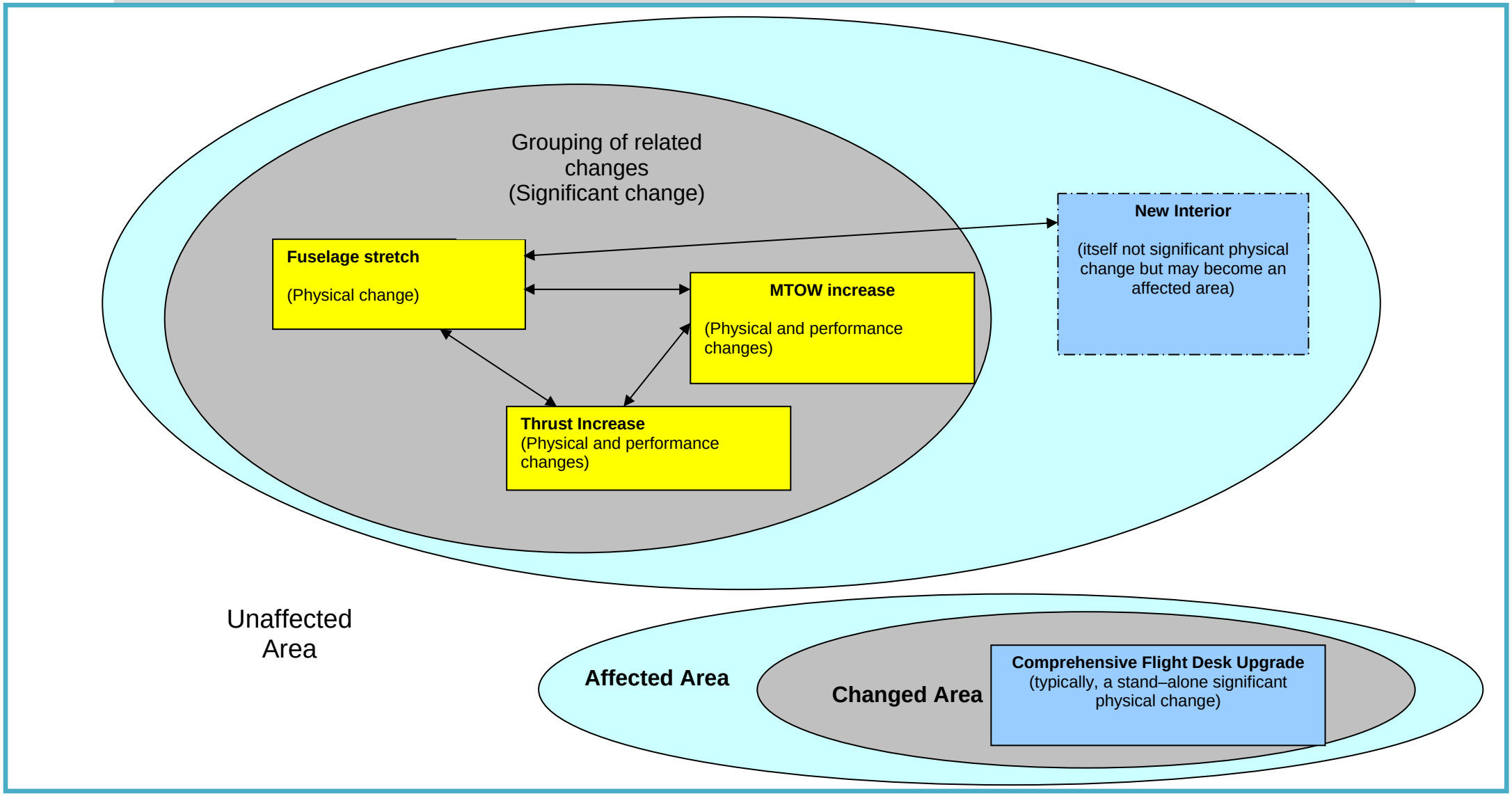


Figure 5: Establishing TC basis for Substantial, Significant and Not significant changes according to 21A.101 (a) and ((b)

<table>
<tr><td>Substantial
(21A.19)</td><td colspan="3">Significant
(21A.101) (a) and (b))</td><td colspan="2">Not significant
(21A.101)(b)(1)</td></tr>
<tr><td rowspan="3">Full product

New showing of compliance for full changed product required.

Previously approved type design and compliance data may be allowed if valid for the changed product.</td><td colspan="2">Affected area
(Changed areas and/or physically unchanged but functionally affected areas)

New showing of compliance is required</td><td rowspan="3">Unaffected area

No new showing of compliance is required.

Unaffected area continues to comply with the existing TC basis.

The applicant may elect to comply with later certification specifications.</td><td rowspan="3">Affected area
(Changed areas and/or physically unchanged but but functionally affected areas).

New showing of compliance is required.

The applicant may propose a certification basis using an earlier amendment but not earlier than the existing TC basis.</td><td rowspan="3">Unaffected area

No new showing of compliance is required.

Unaffected area continues to comply with the existing TC basis.

The applicant may elect to comply with later certification specifications.</td></tr>
<tr><td colspan="2">Compliance with the latest amendment materially contributes to safety</td><td>No material contribution to safety</td></tr>
<tr><td>(Practical)</td><td>Impractical

The applicant may propose a certification basis using an earlier amendment but not earlier than the existing TC basis.</td><td>Secondary (and not secondary)

The applicant may propose a certification basis using an earlier amendment but not earlier than the existing TC basis.</td></tr>
<tr><td colspan="6">TC basis proposed by the Applicant</td></tr>
<tr><td colspan="2">Certification specifications of the latest amendment
+ elects to comply</td><td colspan="2">Certification specifications of an earlier amendment
+ elects to comply</td><td>Elects to comply (later than the existing TC basis</td><td>An earlier amendment
+ elects to comply</td><td>Elects to comply (later than the existing TC basis</td></tr>
<tr><td colspan="6">TC basis recorded by the Agency</td></tr>
<tr><td>Certification specifications of the latest amendment
+ SC
(if the latest amendment is not adequate)

+ elects to comply</td><td>Certification specifications of the proposed amendment
or,
if not adequate, the first appropriate later amendment (if available)
or SC
+ elects to comply</td><td>Certification specifications of the proposed amendment (if adequate)
or,
if not adequate, the first appropriate later amendment (if available)
or SC
+ elects to comply</td><td>Elects to comply as proposed</td><td>The proposed amendment (if adequate)
or
First appropriate later amendment (if available) or SC

+ elects to comply</td><td>Elects to comply as proposed</td></tr>
</table>

Figure 6: Establishing TC basis for a Change on Excepted Products (21A.101(c))

<table>
<tr><td colspan="4">Affected area
(Changed areas and/or physically unchanged but functionally affected areas)

New showing of compliance is required</td><td>Unaffected area

No new showing of compliance is required.

Unaffected area continues to comply with the existing TC basis.

The applicant may elect to comply with later certification specifications.</td></tr>
<tr><td colspan="5">TC basis proposed by the Applicant</td></tr>
<tr><td colspan="4">The existing TC basis + elects to comply</td><td>Elects to comply
(later than the existing TC basis)</td></tr>
<tr><td colspan="3">Found by the Agency ‘significant in an area’</td><td>(Not significant in an area)</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Compliance with a later amendment materially contributes to safety</td><td rowspan="2">No material contribution to safety</td><td rowspan="2"></td></tr>
<tr><td>(Practical)</td><td>Impractical</td></tr>
<tr><td colspan="5">TC basis recorded by the Agency</td></tr>
<tr><td>Certification specifications of a later amendment designated by the Agency
+ SC

+elects to comply</td><td>The existing TC basis
or,
if not adequate, the first appropriate later amendment
(if available)
or (if not)
SC
+elects to comply</td><td>The existing TC basis
or,
if not adequate, the first appropriate later amendment
(if available)
or (if not)
SC

+elects to comply</td><td>The existing TC basis
or,
if not adequate, the first appropriate later amendment
(if available)
or (if not)
SC
+elects to comply</td><td>Elects to comply
(later than the existing TC basis)</td></tr>
</table>

A new a*ppendix* E *to GM 21A101 is* introduced as *follows:*

Appendix E to GM 21A.101. Related Part-21 Requirements

- 21A.16A, Airworthiness codes
- 21A.16B, Special conditions
- 21A.17, Type-certification basis
- 21A.18, Designation of applicable environmental protection requirements and certification specifications
- 21A.19, Changes requiring a new type-certificate
- 21A.21, Issue of type-certificate
- 21A.23, Issue of a restricted type-certificate
- 21A.90, Scope
- 21A.91, Classification of changes in type design
- 21A.93, Application
- 21A.95, Minor changes
- 21A.97, Major changes
- 21A.101, Designation of applicable certification specifications and environmental protection requirements
- 21A.103, Issue of approval
- 21A.111, Scope
- 21A.113, Application for a supplemental type-certificate
- 21A.114, Showing of compliance
- 21A.115, Issue of a supplemental type-certificate
- 21A.117, Changes to that part of a product covered by a supplemental type-certificate
- 21A.604(b), 21A.604 ETSO Authorisation for an auxiliary power unit (APU)