



Research on Airworthiness Management of Changes to the Type Design with DAS

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Abstract. Civil aviation certification is a rigorous process that ensures the safety and reliability of aircraft. However, even if an aircraft has been certified, design changes may still be required. Airworthiness management of changes to the type design is applicable to the entire process of change proposal, verification, and approval to ensure that the modified aircraft still remains airworthy. To applicant, the establishment of design assurance system (DAS) is not only a satisfaction to regulations, but also an embodiment of its design and airworthiness ability. This paper introduces the airworthiness management of changes to the type design with DAS and the role of DAS in related work.

Keywords: airworthiness management · Major Change · Minor Change · DAS

1 Introduction

After obtaining the Type Certificate (TC), civil aircraft will continue to optimize and improve for safety, economy, operation, maintenance and other factors. In order to ensure the safety level of civil aircraft, all changes to the certified type design must be approved (certified). In general, the design change adopts the same certification procedure as the initial issuance of the TC [1]. Of course, according to the CCAR21.95 and CCAR21.97 [2], the airworthiness approval paths for Major and Minor Changes are different.

Article 21.487 of CCAR-21-R4 stipulates the rights of design institution that has established a design assurance system (DAS) accepted by CAAC: The approved or recognized DAS has the right to confirm that the design change is classified as a Major Change or a Minor Change, and to approve Minor Changes and maintenance programs [3].

In combination with regulatory requirements, this paper introduces airworthiness management of changes to the type design of civil aircraft main manufacturer with DAS, especially describes different airworthiness management requirements of Major and Minor changes and the role of DAS in design change airworthiness management work. It can provide a certain reference for TC or similar certificate holders to carry out airworthiness management of design changes after certification.

Table 1. Classification of design changes.

Classification of changes in type design					
CCAR21.93					
Major Changes			Minor Changes		
CCAR21.97			CCAR21.95		
Substantial Changes	Significant Changes	Other Major Changes		Minor Changes requiring supplementary verification	Minor Changes without supplementary verification
CCAR21.19	CCAR21.101(b)(1)	-		-	-

2 Classification of Design Changes

Changes to the type design can be divided into Major changes including Substantial Changes, Significant Changes, and other Major Changes and Minor Changes including Minor Changes requiring supplementary verification and Minor Changes without supplementary verification based on the degree of change, affected scope, impact on assumptions used for certification, and depth of review [4]. For Substantial Changes, a substantially complete certification of compliance with the applicable regulations is required, and the applicant shall apply for a new TC; For Significant Changes, such as 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, that have not yet reached the level of Significant Changes, the airworthiness requirements valid on the date of application must be met in accordance with CCAR21.101. The classification of design changes and related regulatory requirements are shown in Table 1.

The classification of design changes in type design shall be confirmed by the authorized personnel of the DAS - Designated Airworthiness Engineer (DAE).

3 The Major Change Airworthiness Management

The airworthiness management and approval of Major Changes shall be carried out in accordance with CCAR21.97 and Section 9.4 of AP-21-AA-2022-11. The approval of Major Changes shall be implemented by the authority. Usually, the airworthiness management work of Major Changes mainly includes the following contents (as shown in Fig. 1).

3.1 The Major Change Application

According to AP-21-AA-2022-11, Substantial Changes need to apply for a new TC, resulting in changes in the TC or Type Certificate Data Sheet (TCDS) needs to apply for changes in the TC, and other Major Changes need to apply in writing for changes

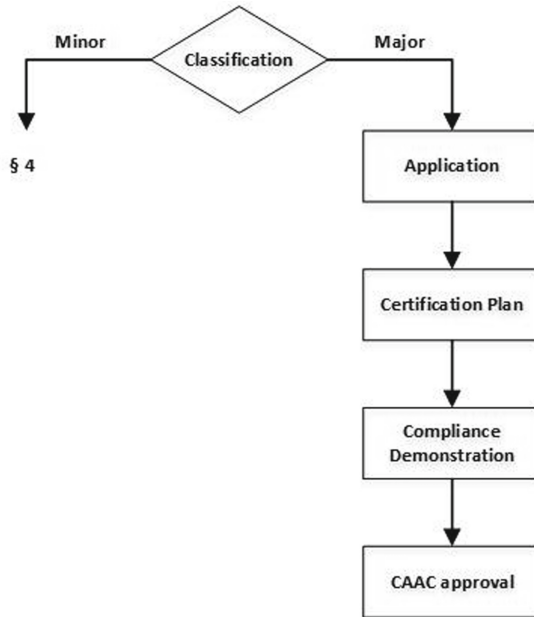


Fig. 1. The airworthiness management work of Major Changes.

in the TC and submit explanatory and supporting materials. Usually, when submitting an application, the applicant should provide a design change plan including all relevant content related to the design change and its association with other design change projects, explain the compliance verification ideas, and analyze the cumulative effects.

Before submitting the application materials for the Major Change to the authority, the Compliance Verification Engineer (CVE) of DAS should verify the technical maturity and completeness of the plan.

3.2 The Major Change Certification Plan

After the application for the Major Change is accepted, a consensus on the certification plan (CP) should be reached with the authority as soon as possible. Usually, a CP includes the certification basis for the Major Change, the compliance methods used for subsequent compliance verification activities, the planned compliance documents, the review activity plan, and specifies the level of involvement of the authority in certification. The determination of certification basis should fully consider the scope of the impact of change and relevant applicable regulations in accordance with CCAR21.101 and AC-21-AA-2014-36 [5].

Before submitting the CP to the authority for approval, it should undergo airworthiness verification by CVE.

3.3 Compliance Demonstration

Compliance verification activities shall be carried out according to the approved CP, and during the process, the applicant shall coordinate the inspection and witnessing with the authority.

The compliance documents should undergo compliance verification by CVE before submission for approval.

3.4 CAAC Approval

After all compliance verification activities are completed and all compliance documents are approved, the type design data of the Major Change should be submitted to CAAC and approved by CAAC. According to CCAR21.97, before submitting a Major Change to the authority for approval, a statement should be submitted stating that the applicant has met the applicable requirements.

4 The Minor Change Airworthiness Management

A Minor Change is the one that has no appreciable effect on the weight, balance, structural strength, reliability, operational characteristics, or other characteristics affecting the airworthiness of the product. According to AP-21-AA-2022-11, there are three ways to approve Minor Changes in type design: (1) approved by Designated Engineering Representative (DER); (2) approved by authorized personnel for approval of Minor Changes listed in the approved design assurance manual; (3) approved by Project Engineer (PE). For TC holders with a DAS, according to method (2), Minor Changes will be approved by the DAE in DAS.

Some Minor Changes in type design that do not have a appreciable effect on airworthiness but do not reach a negligible level require supplementary compliance verification work. However, for some Minor Changes that have significant recognition and negligible effect on airworthiness, such as correcting page numbers, typos, projected views, annotations, etc., resolving interference issues, and adjusting gaps between non critical and non important equipment that do not meet the requirements, additional verification and analysis can be omitted and the type design data can be directly approved.

Usually, the airworthiness management work of Minor Changes mainly includes the following contents (as shown in Fig. 2).

4.1 The Minor Change Certification Plan

For the Minor Change that requires supplementary compliance verification work, a certification plan (CP) needs to be developed to plan for subsequent compliance verification work. The content is roughly consistent with the Major Change CP. However, due to different certification subjects, the CP for the Minor Change is mainly used to plan and arrange the review activities of authorized personnel in the DAS.

The CP for the Minor Change needs to be verified by CVE and approved by DAE.

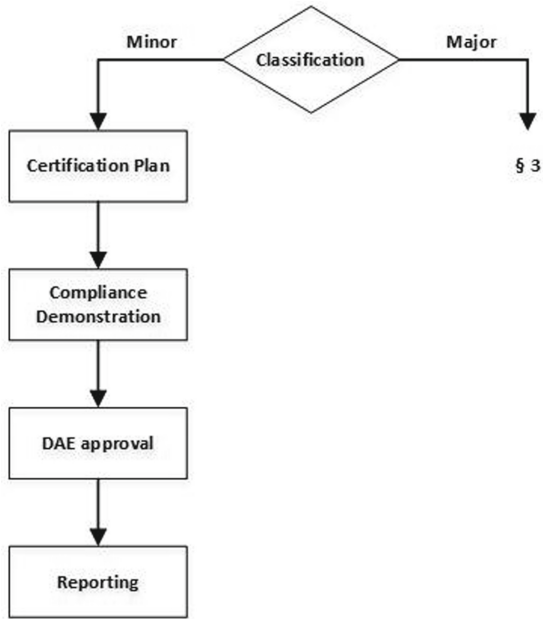


Fig. 2. The airworthiness management work of Minor Changes.

4.2 Compliance Demonstration

For Minor Changes that require supplementary compliance verification work, compliance verification activities shall be carried out according to the approved CP. The manufacturing compliance inspection, test witnessing, and compliance documents shall be executed by the DAS.

The generated compliance documents need to be verified by CVE and approved by DAE.

4.3 DAE Approval

For Minor Changes that require supplementary compliance verification work, after all compliance verification activities are completed, the type design data of the Minor Change will be approved by the DAE in the DAS.

For Minor Changes that do not require additional compliance verification work, the type design data of the Minor Change will be directly approved by the DAE.

4.4 Reporting

According to AP-21-AA-2022-11, Minor Changes approved by the TC holder’s DAS should be reported to the Project Engineer (PE) of the authority for filing, and if necessary, supporting and explanatory materials should be submitted.

5 The Role of DAS

The main roles of authorized personnel in the DAS in various airworthiness management work of changes to the type design after certification are shown in Table 2.

From Table 2, it can be seen that the airworthiness management work for Major and Minor Changes is slightly different, such as submitting an application to the authority for Major Changes and reporting to the authority after Minor Changes approval, which is related to the different approval subjects for Major and Minor Changes. Major Changes are approved by the authority, while Minor Changes are approved by authorized personnel of the DAS. Therefore, in addition to confirming the classification of changes, the authorized personnel of the DAS mainly play a role in various tasks of Minor Changes, including the compliance demonstration and the approval of final type design data. Of course, in order to ensure the quality of the submitted documents to the authority, all compliance documents need to be subject to internal verification by CVE. Therefore, the CVE of the DAS will also bear the responsibility of verification in the Major Changes.

Figure 3 shows the percentage distribution of the number of approved design changes for a certain type over a period of time. It can be seen from the figure that, compared to Major Changes, the proportion of Minor Changes, especially those that do not require supplementary verification work, is relatively large. Of course, a Major Change may include a large amount of verification work, and a Minor Change may only include a small number of drawing changes. The above figure only shows the number of changed projects, but still has some reference value for the total amount of work. In the post certification design change activity, the DAS fully plays a role and undertakes a large number of review tasks. On the one hand, this greatly improves the efficiency of reviewing relevant materials for design changes after certification. A large number of changes with a small degree of change and a small effect on airworthiness are no longer approved by the authority, and there is no need for multiple communication and coordination between the two parties. The airworthiness authorities only conduct spot checks on the

Table 2. The role of DAS in airworthiness management work after certification.

Changes to the type design after certification			
Classification		Confirmed by DAE	
Major Changes		Minor Changes	
Application	verified by CVE	-	-
CP	verified by CVE	CP	verified by CVE, approved by DAE
Test	-	test	witnessed by CVE/DAE
compliance documents	verified by CVE	compliance documents	verified by CVE, approved by DAE
Approval	-	approval	approved by DAE
-	-	reporting	-

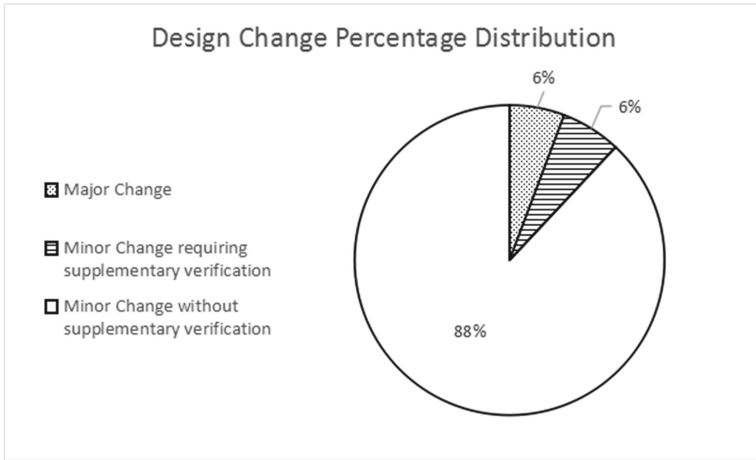


Fig. 3. Design change percentage distribution.

reported information. On the other hand, this greatly reduces the review burden of the authority, and at the same time, it is also a manifestation of the TC holder's improved self airworthiness ability.

6 Conclusion

Design changes are an inevitable part of the civil aviation industry. While the process of making these changes can be challenging, it is essential to ensure that aircraft remains safe and reliable throughout its lifespan. Both airworthiness management and the good operation of the DAS are crucial to ensure that design changes comply with airworthiness regulations, meet safety and reliability requirements, and that changes undergo sufficient testing and analysis. This article introduces the airworthiness management related to post certification design changes, as well as the role played by the DAS, which can provide certain reference value for the civil aviation industry.

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