



# Staff Instruction (SI)

## Wing Tip Extensions and Cut-Out Modifications to Fuselages

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## 1.0 INTRODUCTION

### 1.1 Purpose

The purpose of this Staff Instruction (SI) is to provide guidance concerning the substantiation of:

- (a) modifications that incorporate short extensions to the wing tips of small aeroplanes; and
- (b) structural modifications that incorporate large or small cut-outs in the fuselage of small aeroplane.

### 1.2 Guidance Applicability

This document is applicable to Headquarters (HQ) and Regional Aircraft Certification personnel, including Design Approval Representatives, Design Approval Organizations, and Airworthiness Engineering Organizations hereafter referred to as Delegates.

### 1.3 Description of Changes

This document merges two similar documents and has been revised in accordance with SI GEN-002. It is updated to reflect current Airworthiness Manual (AWM) references, and contemporary terminology and practices.

### 1.4 Termination

This document does not have a terminating action. It will however, be reviewed periodically for suitability of content.

## 2.0 REFERENCES

### 2.1 Reference Documents

It is intended that the following reference materials be used in conjunction with this document:

- (a) Part V, Subpart 13 of the *Canadian Aviation Regulations (CAR)- Approval of Modification and Repair Design*
- (b) Chapter 505 of the AWM – *Delegation of Authority*;
- (c) Chapter 523 of the AWM – *Normal, Utility, Acrobatic and Commuter Category Aeroplanes*;
- (d) Staff Instruction (SI) GEN-002 – *Introduction to Aircraft Certification Guidance Material*;
- (e) Staff Instruction (SI) 513-001 – *Approval Procedures for Modifications and Repairs to Damage Tolerant Aircraft Structures*; and
- (f) Aircraft Certification Staff Instruction (ACSI) No. 43 – *Regional Flight Test Procedures*.

### 2.2 Cancelled Documents

As of the effective date, the following documents are cancelled:

- (a) ACSI 41; and
- (b) ACSI 58.

## 3.0 BACKGROUND

### 3.1 Wing Tip Extensions

The incorporation of wing tip extensions should be viewed as a major modification. Any such alteration will result in changes to the magnitude and distribution of external loads, which in some cases may be critical. Generally, manoeuvre loads will be redistributed further outboard, resulting in increased wing bending moments; gust loads will escalate as a result of the increased lift-curve

slope. Consequently, a full review of applicable load cases will be required. In addition, potential flutter problems may occur due to changes to the aero-elastic characteristics of the wing.

### 3.2 Cut-Out Modifications

The incorporation of cut-outs in a fuselage is one of the most significant structural modifications made to an aeroplane. Such modifications include cut-outs to install large cargo or baggage doors, to enlarge existing doors, or to install oversize windows. Small cut-outs in a fuselage generally cause lesser structural impact. These modifications include cut-outs for installations such as a camera window, auxiliary power unit intake and exhaust, and antenna.

### 4.0 GENERAL

It is the responsibility of the Regional Aircraft Certification Engineer to ensure that when a modification or a design change is proposed, the aeroplane basis of certification meets the requirements of section 513.07 of the CAR (Changed Product Rule) before a Supplemental Type Certificate or Limited Supplemental Type Certificate is issued.

The limitations of a Delegate's scope of authority should be considered when establishing a Compliance Program that outlines approval of Engineering or Flight Test Reports and the associated Transport Canada Level of Involvement. These limitations are stated in Chapter 505 of the AWM and the Delegate's Letter of Authorization. If a modification requires substantiation in areas that are outside a Delegate's scope of authority, the Regional Aircraft Certification Engineer may request the involvement of the HQ Flight Test division, Engineering division, or both. For additional guidance on flight test procedures, refer to ACSI No. 43.

However, HQ should be consulted for the following:

- (a) **Loads.** A load report is required for all modifications involving wing-tip extensions or cut-out modifications. This report must cover all load cases that are affected by the modification and must clearly indicate the extent to which the original design loads are increased or redistributed. Approval of this report may require the HQ Engineering division involvement.  
  
A Delegate would normally approve internal load analyses, but any finite element analysis done by computer requires the Regional Aircraft Certification Engineer or the HQ Engineering division to verify that the model is representative of the actual structure.
- (b) **Flutter.** Flutter analysis or flight demonstration of freedom from flutter, or a ground vibration test, or both, before and after the modifications are accomplished, may be required. This is to ascertain the effect of the modification on the flutter or vibration characteristics, or both, of the aeroplane.
- (c) **Performance and Flight Characteristics.** The possible impact of these modifications on the flying qualities and performance of the aeroplane must be considered. The HQ Flight Test division should be contacted as early as possible during an approval program requiring flight test support.

The Aircraft Flight and Maintenance Manuals may be affected and pertinent changes should be captured in their supplements. Substantiation of changes to life limits for structural parts are generally outside the approval authority of a Delegate and would normally require HQ involvement.

### 5.0 ADDITIONAL GUIDELINES

#### 5.1 Wing Tip Modifications

The following information applies specifically to wing-tip extensions:

- (a) Sections 523.21, 523.45, 523.141, 523.301, 523.305, 523.307, 523.572 to 523.575, 523.629, 523.641, 523.1529, and 523.1581 of the AWM.

- (b) **Fatigue and Damage Tolerance.** A fatigue or damage tolerance evaluation may be necessary if, as a result of increased static loads, analysis shows reduced (but still positive) margins of safety on significant structural parts. Likewise, similar evaluation may be required if stress levels are increased due to local geometry change. SI 513-001 contains additional information. Approval of a fatigue report requires the involvement of the HQ Engineering division.

## 5.2 Cut-Out Modifications

The following information applies specifically to cut-out modifications to a fuselage:

- (a) Sections 523.301, 523.305, 523.307, 523.365, 523.571, 523.573, 523.574, 523.575, 523.629, 523.1529 and 523.1591 of the AWM.
- (b) **Fatigue and Damage Tolerance.** In the case of large cut-outs in a pressurized fuselage, analysis or tests, or both, will require the involvement of the HQ Engineering division. Small cut-outs such as those required for antenna installations, should not normally require their assistance. SI 513-001 contains additional information.
- (c) **Performance and Flight Characteristics.** Changing the contour or finish of the exterior surfaces could alter the flight characteristics. Pressure errors in particular must be addressed if the modification could affect the airflow over the static ports. As a minimum, the vibration, buffet and flutter characteristics will require flight test to confirm  $V_{NE}/V_{MO}$  limitations, or to establish new limits.

## 6.0 ACCEPTABLE METHODS OF SUBSTANTIATION

### 6.1 Wing Tip Extensions

The structural integrity of a small aeroplane modified by the addition of extended wing tips may be substantiated as follows:

- (a) Determine loads on modified wing for all required design cases using original manoeuvre and gust envelopes or other original design conditions. The extent to which tail loads are affected should also be determined.
- (b) Analyze internal loads in the wing, tail or other affected structures to determine whether or not negative margins of safety would exist under application of new, increased or redistributed loads.
- (c) Conduct any testing required by the aeroplane basis of certification for proof of structure. In most cases this basis will apply to the structure of the wing-tip extension and its attachment but may also apply to the original wing structure.

If negative margins of safety are found, or if new margins cannot be established by available documentation, a load factor versus speed (V-n) diagram should be developed. The V-n diagram for the original design may have exceeded the minimum requirements of the basis of certification; it may be possible to demonstrate a reduction in external loads with a revised V-n diagram. The stresses on the structure may not exceed the original levels for the same design cases. In any case, there must not be negative margins of safety, and the requirement for proof of structure by testing is not waived.

In substantiating static strength, it will be necessary to ensure that the aeroplane operating limitations, flutter and related phenomena continue to comply with the original certification basis.

### 6.2 Cut-Out Modifications

The structural integrity of the fuselage of a small aeroplane modified by incorporation of large or small cut-outs may be substantiated as follows:

- (a) Identify the critical pressure, flight, landing, and ground loads; identify also any combination of these loads. These loads may be obtained from existing Type Certificate

data, made available by the Type Certificate holder, or derived by the applicant using conservative assumptions and reliable methods.

- (b) After the loads have been identified or derived, complete substantiation of the modified structure should be performed. This may be accomplished by an analysis showing that the strength of the modified structure is equal to or exceeds the strength of the unmodified structure, or by a detailed stress analysis. Substantiation may also be made by a combination of static test to limit load, and analysis to ultimate load, as limited by applicable sections of the original certification basis.

The redistribution of axial, shear, and pressure loads, and changes in stiffness must be addressed in the design. In the case of a pressurized fuselage, fatigue strength must be substantiated.

For pressurized cabins, pressurization tests should be accomplished after the modification is complete, in accordance with the requirements of the original basis of certification, unless instructed otherwise by the HQ Engineering division.

## **7.0 HEADQUARTERS CONTACT**

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