

Proposed Special Condition on loads requirements for justification of winglets structural strength on a general aviation airplane

Introductory note:

The hereby presented Special Condition has been classified as important and as such shall be subject to public consultation, in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) of which states: "2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

STATEMENT OF ISSUE:

An applicant has applied for EASA certification of a major change relating to installation of winglets on a general aviation airplane type.

According to guidance material of § 21.A.101 of Part 21, installation of winglets on a small airplane constitutes an example of significant change, so needing demonstration of compliance of the changed areas and affected areas with CS 23 in effect at time of application for the change.

However in the particular case of this winglets installation, the proposed design indicates that the change:

- does not constitute a change to the general configuration at product level that distinguishes the resulting product from other product models. There is:
 - o a very small increase in wingspan and in wing surface
 - o no change to wing primary structure
 - o no significant change to secondary structure
 - o no negative impact on approved performances or on flight qualities, which is confirmed by the applicant development flights and first certification flights performed with EASA flight test team.
- is not a change to the principles of construction at the product level. There is no change to materials and/or construction methods that affects all overall products' operating characteristics or inherent strength and would require extensive reinvestigation to show compliance.
- does not invalidate the assumptions used for certification. The original assumptions at the product level associated with the compliance demonstration, the performance and the operating envelope, and the methodologies of demonstrating compliance, are still valid.

Considering the above, the EASA certification team has accepted the applicant's request to classify the change as non significant.

Nevertheless the original airplane certification basis applicable to the changed parts does not provide adequate requirements for winglets installation. Indeed CS 23 amendment 2 (in effect at time of the application) addresses winglets in § 23.441 to 23.445 relating to loads cases to be applied on vertical surfaces, including winglets. Equivalent paragraphs of the original certification basis are applicable only to vertical tail surfaces (main fin or outboard fins).

Consequently, in application of § 21.A.101(d) and § 21.A.16B of Part 21, EASA considers a special condition is necessary to complete the airplane original certification basis in order to adequately address the installation of winglets.

It is proposed that the applicant must demonstrate compliance with the special condition below:

SPECIAL CONDITION
Loads requirements for justification of winglets structural strength

Note: This special condition addresses a winglet extending only above the wing surface.

SC-1 - Manoeuvring loads

(a) At speeds up to V_A the winglet must be designed to withstand the following conditions. In computing the loads, the yawing velocity may be assumed to be zero:

(1) With the airplane in un-accelerated flight at zero yaw, it is assumed that the rudder control is suddenly displaced to the maximum deflection, as limited by the control stops or by limit pilot forces.

(2) With the rudder deflected as specified in paragraph (a)(1), it is assumed that the airplane yaws to the resulting sideslip angle. In lieu of a rational analysis, an overswing angle equal to 1.3 times the static sideslip angle of paragraph (a)(3) may be assumed.

(3) A yaw angle of 15 degrees with the rudder control maintained in the neutral position (except as limited by pilot strength).

(b) The yaw angles specified in paragraph (a)(3) may be reduced if the yaw angle chosen for a particular speed cannot be exceeded in –

(1) Steady slip conditions; or

(2) Uncoordinated rolls from steep banks;

SC-2 - Gust loads

(a) Winglets must be designed to withstand, in un-accelerated flight at speed V_C , lateral gusts of the values prescribed for V_C in (c) “Gust Envelope” of paragraph “Flight Envelope” of the airplane original certification basis.

(b) In the absence of a more rational analysis, the gust load must be computed as follows:

$$L_{vt} = K_{gt} U_{de} V_{avt} S_{vt} / 498$$

where –

L_{vt} = Winglet loads (lbs);

$K_{gt} = 0,88 \mu_{gt} / (5,3 + \mu_{gt})$ = gust alleviation factor;

$\mu_{gt} = 2W / (p C_{tgavt} S_{vt}) * (K / l_{vt})^2$ = lateral mass ratio;

U_{de} = Derived gust velocity (f.p.s.);

ρ = Air density (slugs/cu.ft.);

W = the applicable weight of the airplane in the particular load case (lbs.);

S_{vt} = Area of winglet (ft.²);

C_t = Mean geometric chord of winglet (ft.);

a_{vt} = Lift curve slope of winglet (per radian);

K = Radius of gyration in yaw (ft.);

l_{vt} = Distance from airplane c.g. to lift centre of winglet (ft.);

g = Acceleration due to gravity (ft./sec.²); and

V = Airplane equivalent speed (knots)

SC-3 – Induced loads on wing

(a) The wing must be designed for its maximum load in combination with loads induced by the winglet and moment or forces exerted on wing by the winglet.

(b) When rational methods are used for computing loads, the manoeuvring loads of § SC-1 on the winglet and the one-g wings load, including induced loads on the wing and moments or forces exerted on the wing by the winglet, must be applied simultaneously for the structural loading condition.