Discussion on Certification issues

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Landing gear strength requirements in CS LSA

- Requirements are contained in requirement 5.8.1 (of ASTM F245 12d) and sub-paragraph;
- Requirements are similar to CS VLA/23 but
- During recent CS LSA projects some differences were identified in the ASTM F2245 12d,
- The identified differences are under clarification with the ASTM group. As interim, acceptable approaches have been agreed and are here described.

Landing gear strength requirements in CS LSA

Typically, according to ASTM F2245 12d:

- (5.8.1.1) The load factor n_j on wheels may be calculated using the formula:

$$n_j = \frac{h + \frac{d}{3}}{ef \times d}$$

- (5.8.1) The basic load conditions should be then calculated using table 2 (as in CS VLA/23)

TABLE 2 Basic Landing Conditions

NOTE 1—$K = 0.25$
$L = 2/3$ = ratio of the assumed wing lift to the airplane weight
$n = n_j + 2/3$ = load factor
n_j = load factor on wheels in accordance with 5.8.1
NOTE 2—See Fig. 2 for the airplane landing conditions.

Condition	Tail Wheel Type		Nose Wheel Type		
	Level Landing	Tail-down Landing	Level Landing with Inclined Reactions	Level Landing with Nose Wheel Just Clear of Ground	Tail-Down Landing
Vertical component at CG	nW	nW	nW	nW	nW
Fore and aft component at CG	KnW	0	KnW	KnW	0
Lateral component in either direction at CG	0	0	0	0	0
Shock absorber deflection (rubber or spring shock absorber), %	100 %	100 %	100 %	100 %	100 %
Tire deflection	Static	Static	Static	Static	Static
Main wheel loads (V_r)	(n-L)W	(n-L)Wb/d	(n–L)Wa'/d'	(n-L)W	(n-L)W
(both wheels) (D_r)	KnW	0	KnWa'/d'	KnW	0
Tail (nose) wheels (V_f)	0	(n-L)Wa/d	(n-L)Wb'/d'	0	0
Loads (D_f)	0	0	KnWb'/d'	0	0

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- Plus, the additional load conditions (Side, braked roll, etc.) shall be addressed;

Landing gear strength requirements in CS LSA

Main differences between CS LSA and CS VLA/23:

- **A drop test is not strictly required** to evaluate n_j (5.8.1.1) in CS LSA;
- 5.8.1.3 of CS LSA seems to allow **a UL factor lower than 1.5,** if justified through a Reserve Energy drop test from 1.44hLL (5.1.8.3). This items is being discussed with ASTM, but as interim measure it was found acceptable as long as a minimum factor (≈1.3) could be shown;
- **Such** Reserve Energy drop **test can be** also used as **Proof of strength** of the **Ultimate Load** capacity (similarly to CS VLA/23.726), for the basic landing conditions.

Dynamic tests in CS VLA/23

- **CS VLA/23.723** – prescribes that the **limit** ground load **factor** of 23.473 shall be **determined via drop tests** (or analysis if a certain similarity exists);
- **CS VLA/23.725** – provides testing condition for the determination of the **limit** ground **load factor**;
- **CS VLA/23.727** – provides testing condition for the determination of the **Reserve energy** of the landing gear;
- **CS VLA/23.726** – provides testing condition for the **Ultimate proof of strength** of the landing gear (only for load conditions of 23.479 to 23.483);

Dynamic tests in CS VLA/23

CS VLA/23.726 Ground load dynamic tests

(a) If compliance with the ground load requirements of CS-VLA 479 to 483 is shown dynamically by drop test, one drop test must be conducted that meets CS-VLA 725 except that the drop height must be

1. *(1) 2·25 times the drop height prescribed in CS VLA 725 (a); or*
2. *(2) Sufficient to develop 1·5 times the limit load factor.*

Question:

- When CS VLA/23.726 is applied, such drop test can be used to verify the ultimate strength capability of the Landing gear, but
- On the other hand, local Failures at UL are normally acceptable as long as the structure is able to withstand the UL for 3s. How is this criteria applied to the dynamic test of the 726? What type of failures are acceptable?

Answer

- On a CS LSA project it was accepted to have local failures as long as the LL residual strength could be shown;
- Similar approach can be agreed/discussed with EASA.

Landing Gears made of composite (CS LSA)

QUESTION

- Do the special safety factors for 1) production variability and 2) temperature have to be considered for the static tests of the LG?
- What about the fuselage attachment?

ANSWER

- On a CS LSA project it was accepted that **no** special safety **factors** for the temperature or production variability **need to be used**, provided that **a well-established manufacturing and quality control procedure** is in place. For fuselage attachment the safety factors used for Structural verification of the fuselage shall be used.
- **Similar approach can be agreed**/discussed with EASA (on similar categories of aeroplanes, eg LSA, VLA, ELA1)

Landing Gears (in a nutshell)

For CS –LSA

- **a drop test is not** strictly **required** to evaluate n_j;
- **a UL factor lower than 1.5 can be used** (under certain conditions);

For CS-23/VLA/LSA

- When a **dynamic test** is performed (as per CS VLA/23.726) for the Ultimate proof of strength of the landing gear (only for load conditions of 23.479 to 23.483), **local failures are acceptable as long as residual strength capability is demonstrated** (approach to be agreed with EASA)
- For **composite Landing gear** (for the **lower end** of GA), additional **safety factors** for the **temperature** or **production variability need not to be established**, providing that a well-established manufacturing and quality control procedure is in place (approach to be agreed with EASA)

Fire test of engine mount attachment (CS VLA/23)

- The material of the **firewall** and the **engine mount** shall be **fireproof** (ref. CS 23/VLA.865, CS 23/VLA.1191);
- For **composite fuselages**, the potential **temperature degradation** of the material properties **should be investigated**;
- This has been historically addressed via a CRI (AMC) defining combined **fire/static testing conditions;**
- The **CRI** has been recently **revised**. In particular,
  - in case a test is performed to address the effect of material degradation due to temperature, **two options are given**:
  - The **most critical engine mount** attachment is **subject to a flame**, simultaneous to static application of “return home” loads, on the engine mount, or
  - A **fail safe approach** is followed with loss of one engine mount attachment (the most critical) under the same “return home” loads conditions (no flame in this case).

Towing loads on the attachment point of the towing aeroplane (CS LSA)

ASTM F2245-12d – annex A1

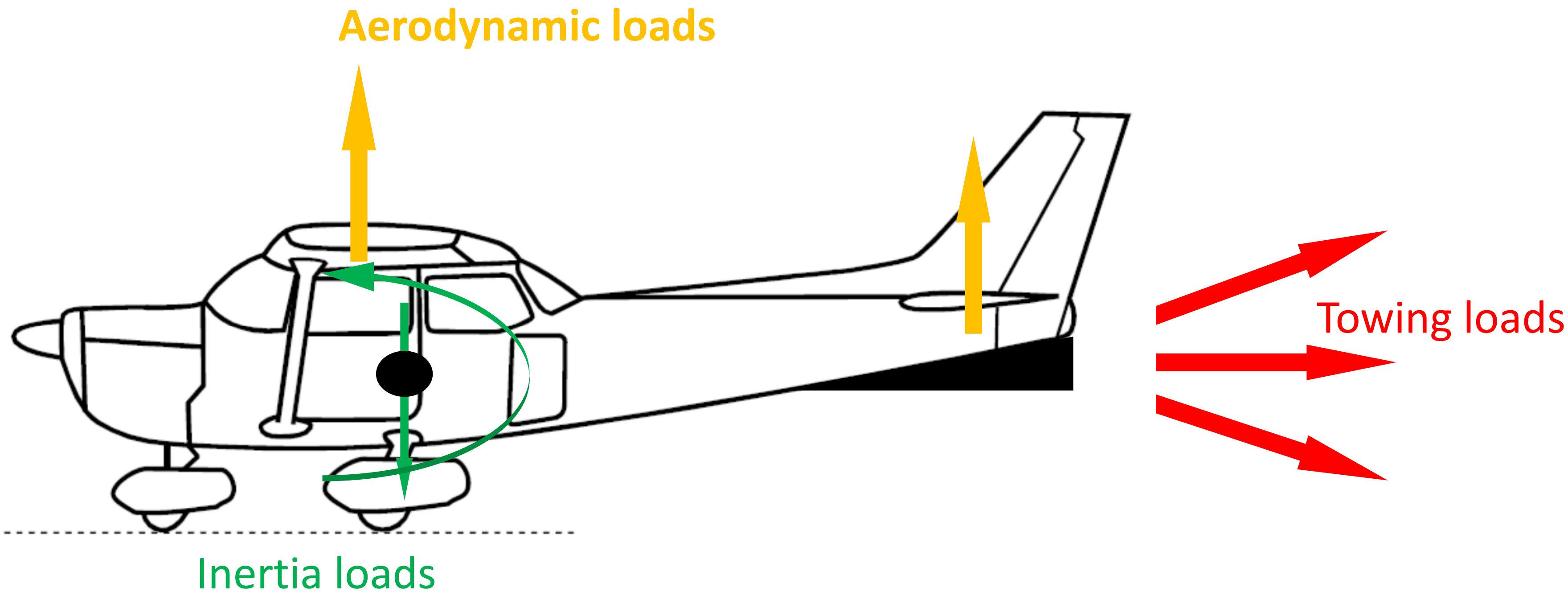
- *A1.6.1.3 Tow equipment attach points on the airframe shall have limit and ultimate factors of safety of not less than 1.0 and respectively, when* ***loads equal to 1.2 of the nominal strength of the weak link*** *(see A1.6.1.5) are applied through the towing hook installation for the following conditions,* ***simultaneously with the loads arising from the most critical normal accelerations*** *(as defined in the normally applicable requirements for structure and strength) at the speed* V_T*.*

QUESTION

- Is the intent to apply the **tow loads simultaneously** to the **gust** (positive or negative whatever is critical) Loads on the fuselage (aerodynamic in the Tail – vertical inertia of the tail masses)?

Towing loads on the attachment point of the towing aeroplane (CS LSA)

Schematic



Towing loads

Answer

- The intent (Combined TOW+GUST?) of the requirements should be clarified by ASTM.
- Meanwhile, alternative loading conditions may be accepted.
- For example:
  - Tow loads may *be balanced by linear and rotational inertia force (ref. Special condition SC_O23-div-02-i1 for Glider-Tow in CS-23/VLA);*
  - Any other combination of tow loads with operating loads conditions (aerodynamic/inertial supported by rationale);

CS LSA - Effects of altitude on gust loads

ASTM F2245-12d – 5.2.1.2

- Loads should be calculated at *"..each practicable combination of weight and disposable load within the operating limitations specified in the POH."*

- Altitude is not explicitly mentioned (As opposed to CS VLA/23.321).

- In fact, the formula in appendix X3 is only valid at sea level. The ρ in the formula should read as ρ_0.

$$n = 1 + \frac{\frac{1}{2}.\rho.V.K_g.a.U_{de}}{\left(\frac{W}{S}\right)}$$

- ASTM should clarify, but it seems that the intent is to calculate the load factor only at sea level.

Definition of VD

ASTM F2245-12d – 5.2.4.4

- *Vd is set as 1.4×Vc_min.*

QUESTION

- Why is Vd set as equal *1.4×Vc_min*? Should it be "higher than *Vc_min*"?

QUESTION

Yes. Proposal has been sent to ASTM

EASA
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End slide

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