CS-22 AMENDMENT 1 - CHANGE INFORMATION

Certification Specifications (CS) are used for establishing the certification basis for applications made after the date of entry into force of a CS including any amendments. Since the complete text of a CS, including any amendments to it, is relevant for establishing the certification basis, the Agency has decided to enact and publish all amendments to CS's as consolidated documents instead of enacting and publishing only the amended text.

Consequently, except for a note "[Amdt 22/1]" under the amended paragraph, the consolidated text of CS-22 does not allow readers to see the detailed changes introduced by the new amendment. To allow readers to also see these detailed changes this document has been created. The same format as for publication of Notices of Proposed Amendments has been used to show the changes:

1. text not affected by the new amendment remains the same: unchanged
2. deleted text is shown with a strike through: ~~deleted~~
3. new text is highlighted with grey shading: new
4. ....
   Indicates that remaining text is unchanged in front of or following the reflected amendment.
   ....

CS-22 BOOK 1 – AIRWORTHINESS CODE

SUBPART C - STRUCTURE

1. Amend CS 22.561(b)(1), (2) and (d) as follows:

EMERGENCY LANDING CONDITIONS

CS 22.561 General (See AMC 22.561)

(a) The sailplane although it may be damaged in emergency landing conditions must be designed as prescribed in this paragraph to protect each occupant under those conditions.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a crash landing when proper use is made of belts and harnesses provided for in the design, in the following conditions:

(1) The occupant experiences, separately, ultimate inertia forces corresponding to the accelerations shown in the following:

Upward	~~4·5g~~	7·5 g
Forward	~~9·0g~~	15·0 g
Sideward	~~3·0g~~	6·0 g
Downward	~~4·5g~~	9·0 g

(2) An ultimate load of ~~6~~ 9 times the weight of the sailplane acting rearwards and upwards at an angle of 45° to the longitudinal axis of the sailplane and sideward at an angle of 5° acts on the forward portion of the fuselage at ~~the foremost point(s) suitable for the application of such a load~~ a suitable point not behind the pedals. (See AMC 22.561(b)(2))

(c) Each sailplane with a retractable landing gear must be designed to protect each occupant in a landing with wheel(s) retracted under the following conditions:

(1) a downward ultimate inertia force corresponding to an acceleration of 3 g;

(2) a coefficient of friction of 0·5 at the ground.

(d) Except as provided in CS 22.787, the supporting structure must be designed to restrain, under loads up to those specified in sub-paragraph (b)(1) of this paragraph each item of mass that could injure an occupant if it came loose in a ~~minor~~ crash landing.

….

SUBPART D - DESIGN AND CONSTRUCTION

2. Amend CS 22.785 by revising paragraph (f) as follows:

CS 22.785 Seats and safety harnesses

….

(f) Each seat and safety harness installation must be designed to give each occupant every reasonable chance of escaping serious injury under the conditions of CS 22.561 (b)(1) and (b)(2). (See AMC 22.785 (f)).

3. Amend CS 22.787 by revising paragraph (b) as follows:

CS 22.787 Baggage Compartment

….

(b) Means must be provided to protect occupants from injuries by movement of the contents of baggage compartments under an ultimate forward acceleration of ~~9·0~~ 15·0 g.

CS-22 BOOK 2 - ACCEPTABLE MEANS OF COMPLIANCE (AMC)

AMC TO SUBPART C – STRUCTURE

4. Insert the following new AMC 22.561:

AMC 22.561
Emergency Landing Conditions - General

For maximum protection of the occupants in survivable crash landings, the main part of the cockpit, defined in AMC 22.561(b)(2), should constitute a safety cell strong enough to comply with paragraph CS 22.561 (b)(2).

The forward part should be sufficiently weaker for it to yield before the main part, but stiff enough for it to absorb considerable energy in doing so. (ref. 2, 4, 5, 8, 9, 11)

Energy-absorbing seats, seat cushions or seat mountings constitute another means of improving safety by reducing the load on the occupants head and spine in a crash (ref. 1, 3, 10) and /or landing with retracted wheels (CS 22.561(c)).

The wording „give every reasonable chance" expresses the limited possibility to determine the quantitative probability of injuries in the process, which is affected by many random inputs (e.g.: physical weight and height of the occupant, his age, influencing the spinal load resistance, specific characteristics of the particular accident etc.).

The required load level has been chosen partly on medical grounds and partly in consideration of what is currently practicable. The objective is to design a cockpit structure that does not collapse under survivable emergency landing conditions.

Furthermore the sailplane design should consider:

- Maximum energy absorption, and

- Occupant protection against serious injuries, namely injuries of head and spine.

For maximum protection of the foremost part of legs during the front part deformation, the feet should have adequate space to move slightly backwards together, without twisting or rocking.

The conditions specified in this paragraph are considered to be most representative of the wide envelope of possible crash loads and impact directions (ref. 5, 9). However the design should be such that the strength is not unduly sensitive to load direction in pitch or yaw.
Further information about different aspects of the crashworthiness of small aircraft design has been accumulated for small airplanes (ref. 6). Published data and procedures are also applicable for sailplane designs.
Applicable information on dynamic computer modelling contained in (ref. 7) might be used to assess applicability of such methods for sailplanes crashworthiness tasks.

Note: Compliance with the revised CS 22.561 requirements would also assure the adequate structural characteristics for safe ground impact when Sailplane Parachute Rescue System is applied. (ref. 4,12)

References:

(1) Chandler. R.F.
Injury Criteria Relative to Civil Aircraft Seat and Restraint Human Systems. SAE TP Series No. 851847.(Publication 1985)

(2) Hansman, R.J., Crawley, E.F., Kampf, K.P.
Experimental Investigation of the Crashworthiness of Scaled Composite Sailplane Fuselages.
Technical Soaring Vol. 14 No 4. ISSN #0744-8996 (1990)

(3) Segal, A.M., McKenzie, L., Neil, L., Rees, M.
Dynamic Testing of Highly Damped Foam.

Technical Soaring Vol. 19 No 4. ISSN #0744-8996 (1995)

(4) Rőger, W., Conradi, M., Ohnimus, T
Insassensicherheit bei Luftfahrtgerät. Fachhochschule Aachen. Forschungsbericht im Auftrag des Bundesministerium für Verkehr 1996 (Publication December 1996)

(5) Sperber, M.
Crashworthiness in Glider Cockpits.
OSTIV XXV Congress paper 1997, St Auban
Untersuchung des Insassenschutzes bei Unfällen mit Segelflugzeugen und Motorsegler Forschungsauftrag Nr.L-2/93-50112/92, TÜV Rheinland, Köln/Rh. Germany, 1998

(6) Hurley, T.R., Vandenburg, J.M.
Small Airplane Crashworthiness Design Guide, AGATE-WP3.4-034043-036
Simula Technologies, Phoenix AZ, USA. (Publication April 2002)

(7) FAA ACE 100
FAA Methodology for Dynamic Seats Certification by Analysis. AC 20 -146, FAA, USA (Publication date 5/19/03)

(8) Boermans, L., Nicolossi, F., Kubrynski, K.,
Aerodynamic Design of High Performance Sailplane Wing Fuselage Combination.
ICAS-98-2, 9, 2 Publication. (Publication 1998)

(9) Sperber, M. et al.
Energy absorption on landing accidents with sailplanes and powered sailplanes Rep. No. FE-Nr.L-2/2005-50.0304/2004, TÜV Rheinland, Köln /Rh., Germany, 2007

(10) Segal, A.M.,
Energy Absorbing Seat Cushions for use in Gliders. Technical Soaring Vol. 32, No1/2. ISSN #0744-8996 (2008)

(11) Röger, W.
Safe and Crashworthy Cockpit
Fachhochschule Aachen, Fachbereich Luft-und Raumfahrttechnik,Germany, 2007

(12) Röger, W.
Verbesserung der Insassensicherheit bei Segelflugzeugen und Motorsegler durch integrierte Rettungssysteme, Forschungsauftrag Nr. L-2/90-50091/90, Fachhochschule Aachen, Germany, 1994.

5. Insert the following new AMC 22.561(b)(2):

AMC 22.561(b)(2)

Emergency Landing Conditions

Compliance with CS 22.561(b)(2) can be shown either by static tests or by analysis using methods validated by previous static test evidence from structures of similar design. The analysis should, at minimum, show that ultimate material strength properties and stability limits, such as buckling of the canopy sill, are not exceeded. The weight used when showing compliance to CS 22.561(b)(2) should represent the maximum weight derived from CS 22.25(a)(2) as far as these weights contribute to the loading of the safety cell.

For conventional (semi-reclined) seating configurations it is sufficient to demonstrate, that the main part of the cockpit, extending at least from the front control pedals (adjusted to the intermediate longitudinal position) to the rearmost headrest mounting or the wing attachment section whichever is further aft, including the harness attachments (ref. 1), meets the requirements of CS 22.561(b).

References:

(1) Sperber, M.
Restraint Systems in Gliders under Biomechanical Aspects.
Technical Soaring Vol. 19 No 2. ISSN #0744-8996 (1995)

AMC TO SUBPART D - DESIGN AND CONSTRUCTION

6. Amend AMC 22.785(f) by adding the following sub-paragraph (4) to paragraph (f) as follows:

AMC 22.785(f)
Seats and safety harnesses

….

(4) The design of the shoulder harness supporting structure has to consider the combination of the occupant ultimate inertia forces corresponding to a forward acceleration from CS 22.561(b)(1) combined with fuselage loads and possible side deformation resulting from the ultimate load defined under CS 22.561(b)(2).