NOTICE OF PROPOSED AMENDMENT (NPA) No 2007-12

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY

amending Decision No 2003/13/RM of the Executive Director of the European Aviation Safety Agency of 14 November 2003 on certification specifications including airworthiness codes and acceptable means of compliance for sailplanes and powered sailplanes (« CS-22 »)

Cockpit crashworthiness

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A. EXPLANATORY NOTE

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to envisage amending Decision 2003/13/RM of the Executive Director of the Agency of 14 November 2003[1] on certification specifications, including airworthiness codes and acceptable means of compliance for sailplanes and powered sailplanes. The scope of this rulemaking activity is outlined in ToR 22.004 and is described in more detail below.

2. The Agency is directly involved in the rule-shaping process. It assists the Commission in its executive tasks by preparing draft regulations, and amendments thereof, for the implementation of the Basic Regulation[2] which are adopted as "Opinions" (Article 14(1)). It also adopts Certification Specifications, including Airworthiness Codes and Acceptable Means of Compliance and Guidance Material to be used in the certification process (Article 14(2)).

3. When developing rules, the Agency is bound to following a structured process as required by Article 43(1) of the Basic Regulation. Such process has been adopted by the Agency's Management Board and is referred to as "The Rulemaking Procedure"[3].

4. This rulemaking activity is included in the Agency's rulemaking programme for 2008. It implements the rulemaking task 22.004 "Cockpit crashworthiness" to improve occupant protection and enhance the survivability chances in case of emergency landing conditions.

5. The text of this NPA has been developed by the Agency. It is submitted for consultation of all interested parties in accordance with Article 43 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

II. Consultation

6. To achieve optimal consultation, the Agency is publishing the draft decision of the Executive Director on its internet site. Comments should be provided within 3 months in accordance with Article 6(4) of the EASA Rulemaking procedure. Comments on this proposal should be submitted by one of the following methods:

CRT: Send your comments using the Comment-Response Tool (CRT) available at http://hub.easa.europa.eu/crt/

E-mail: In case the use of CRT is prevented by technical problems these should be reported to the CRT webmaster and comments sent by email to NPA@easa.europa.eu.

[1] Decision No 2003/13/RM of the Executive Director of the European Aviation Safety Agency of 14.11.2003 on certification specifications, including airworthiness codes and acceptable means of compliance for sailplanes and powered sailplanes (CS-22).

[2] Regulation (EC) No 1592/2002 of the European Parliament and of the Council of 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency (*OJ L 240, 7.9.2002, p.1).* Regulation as last amended by Regulation (EC) No 334/2007 *(OJ L 88, 29.3.2007, p. 39).*

[3] Management Board Decision concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material ("Rulemaking Procedure"), EASA MB/08/07, 13.6.2007

Correspondence: If you do not have access to internet or e-mail you can send your comments by mail to:
Process Support
Rulemaking Directorate
EASA
Postfach 10 12 53
D-50452 Cologne
Germany

Comments should be received by the Agency before 01 December 2007. If received after this deadline they might not be taken into account.

III. Comment response document

7. All comments received in time will be responded to and incorporated in a comment response document (CRD). The CRD will be widely available on the Agency's website and in the Comment-Response Tool (CRT).

IV. Content of the draft decision

8. Summary

This NPA introduces revisions to CS 22.561 Emergency Landing Conditions. The existing figures and requirements contained in this paragraph have been reviewed and revised. The revised CS 22.561 reflects the current knowledge for protecting sailplane occupants against serious injury during emergency (outfield) landings and impacts, following recovery from emergency situations close to the ground.

The increased loads in the revised CS 22.561 also take into account the introduction of Sailplane Parachute Rescue Systems (SPRS), which after activation brings the sailplane or its damaged body to the ground at a vertical speed of maximum 8 m/sec and approximately 45° negative pitch.

9. Background

At the end of the 1980s increased numbers of fatalities and serious injuries occurred during emergency landings of sailplanes. Modern composites such as carbon fibre reinforced plastics, used in sailplane structures have greatly increased the static strength. On the other hand, they showed less good performance on dynamic impact. There are examples where nose impact following a low height stall during an interrupted winch-launch or a high flatten-out resulted in the total collapse of the cockpit section.

This problem became an important part of OSTIV-SDP[4] activity after 1989, when at the Wiener Neustadt meeting the problem of fuselage energy absorption capability was discussed and the Crashworthiness Subcommittee was established.

An analysis of the statistics of sailplane accidents in Germany during the period 1987 – 1992, was carried out by TÜV Rheinland (see Ref. 6, page 11), which for the first time included an analysis of damage intensity in different parts of the cockpit. This analysis showed that in nearly 80% of the accidents (including three nose impact configurations), the most seriously damaged part of the cockpit was that between the control stick and the pilot's seat, i.e. the part most important for protecting the occupant.

[4] Sailplane Development Panel of the Organisation Scientifique et Technique du Vol à Voile

During the 1990s the accident statistics showed a significant increase in fatalities caused by difficulties during bail-out after mid-air collisions (this occurred especially during international competitions). This resulted in the development of SPRS. The first example of the application of such a system is the Integral Sailplane Recovery System, which after activation lowers the sailplane (its damaged body) on a parachute to the ground, with occupant(s) remaining in the cockpit. Structural failures in the fuselage and the loading conditions during ground impact of the sailplane body descending on a parachute have been studied.

Last, but not least, stall speeds of modern sailplanes have increased to an upper limit of 95 km/h and also the maximum mass often approaches the upper limits. This increase in kinetic energy is caused mainly by the introduction of powered sailplanes and the updating of sporting competition rules.

At the beginning of the 1990s, the German Federal Ministry of Transportation (BMV), commissioned and encouraged German scientific and research institutions to investigate occupant safety in sailplanes and powered sailplanes, to verify passenger protection as regulated by JAR 22 paragraph 22.561, and to start a detailed research programme covering all aspects of SPRS and structural requirements during ground impact, whether resulting from an emergency landing or the application of SPRS.

The Organisation Scientifique et Technique du Vol à Voile (OSTIV) took an active part in the most important research programmes and conferences. This resulted in the revision of the OSTIV Airworthiness Standards (OSTIV AS) Section 3.75 and Appendix 3.5.

10. Envisaged changes

The envisaged changes in Decision 2003/13/RM CS-22 are:

In Book 1 CS-22 Subpart C - Structure amend the values of accelerations (inertia forces) determined in CS 22.561(b) (1). Change the wording and load forces in subparagraph (b)(2). In Subpart D – Design and construction amend par.22.785(f) Seats and safety harnesses and par.22.787 (b) Baggage compartment.

In Book 2 CS-22 add the new AMC 22.561 Emergency Landing Conditions.

Note: Reference (11) in AMC 22.561 is made available for this NPA on http://www.ostiv.fai.org/, “bookshop, free downloads”; preceding the final publication in early 2008.

V. Regulatory Impact Assessment

11. Purpose and Intended Effect

a) Issue which the NPA is intended to address

Several new sailplane designs of the last decade, incorporated improved cockpit crashworthiness features, taking into account the results of the research, described in the previous chapter. They show significantly better occupant protection in survivable crash cases than older designs.

The objective of this NPA is to introduce into the CS the structural requirements for emergency landing conditions corresponding to the improvements in sailplane design achieved within the last 20 years and to incorporate the results of research programmes related to the crashworthiness of sailplane cockpits. The other intended effect of this NPA is to provide the sailplane designers with Guidance Material, including references to the appropriate reports and documents dealing with this matter.

b) Scale of the issue

This issue has an impact on all newly designed powered or non-powered sailplanes. However, since the international sailplane organisation OSTIV already revised the applicable emergency landing loads in their Airworthiness Standards in 1997 and these Airworthiness Standards are generally acknowledged, it is anticipated that a number of new designs will already meet these new requirements.

c) Brief statement of the objectives of the NPA

The objective is to improve the occupant protection against serious injuries with lasting effects and enhance the survivability chances in case of emergency landing conditions.

12. Options

The options identified:

1. Do nothing.

2. Change structural requirements in relation to the survivability of an emergency landing in CS-22 and provide related AMC material.

13. Sectors concerned

Manufacturers, customers / operators of (powered) sailplanes.

14. All impacts identified

a) Safety

Option 1 would have no effect on safety.

Option 2 would have a beneficial effect on occupant safety. The number and severity of casualties resulting from emergency landings will reduce considerably.

b) Economic

Option 1 would have no economic effect.

Option 2 could have only a moderate negative impact. Costs for achieving increased protection of occupants and showing the compliance with new requirements would moderately rise with the necessary design effort. No further research is necessary, published results of accomplished research programmes are sufficient. The new models of sailplanes with improved cockpit design show, that the extra costs are negligible. The results are achieved with the application of standard materials (composites) but with an intelligent structural design, providing the necessary strength in the main part of the cockpit and energy absorption capability in the front part. The weight penalty remains limited. The costs for showing compliance are not increased, thanks to the development of computerised modelling programmes, considered as acceptable means of compliance.

c) Environmental

No impact expected.

d) Social

No impact expected.

e) Other aviation requirements outside EASA scope

Not applicable.

f) Foreign comparable regulatory requirements

The current applicable OSTIV Airworthiness Standards (OSTIVAS) were changed in July 1997 to reflect the technical status as now proposed by this NPA. This proposed amendment of CS-22 would therefore harmonise with those existing OSTIVAS. Since these OSTIVAS are used as a basis for the development of several national standards outside of Europe (e.g. Australian) this proposed amendment would provide an even more global standard.

15. Equity and Fairness issues

All applicants are equally affected.

16. Summary and Final Assessment

a) Comparison of the positive and negative impacts for each option evaluated:

Option 1 will have no impacts while option 2 will have a prevailing positive effect on safety and may have moderately negative economical consequences.

b) A summary of who would be affected by these impacts and issues of equity and fairness:

Option 2 will equally affect sailplane manufacturers and customers / operators.

c) Final assessment and recommendation of a preferred option:

After due consideration the Agency decided that option 2 is to be preferred in order to improve occupant protection and enhance the survivability chances in case of emergency landing conditions.

B. DRAFT DECISION

The text of the amendment is arranged to show deleted text, new text or new paragraph as shown below:

1. ~~Text to be deleted is shown with a line through it.~~
2. New text to be inserted is highlighted with grey shading.
4. ….

Indicates that remaining text is unchanged in front of or following the reflected amendment.

….

I. Draft Decision to CS-22

Book 1

SUBPART C - STRUCTURE

EMERGENCY LANDING CONDITIONS

CS 22.561 General

(See AMC 22.561)

……

(b)…….

(1)……

Upward	~~4.5~~ g	7.5 g
Forward	~~9.0~~ g	15.0 g
Sideward	~~3.0~~ g	6.0 g
Downward	~~4.5~~ g	9.0 g

(2) An ultimate load of ~~6~~ 9 times the maximum 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.

……

SUBPART D - DESIGN AND CONSTRUCTION

COCKPIT DESIGN

……

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)).

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 g~~ 15 g

……

Book 2

……

SUBPART C - STRUCTURE

AMC 22.561
Emergency Landing Conditions

Showing Compliance.
To show compliance with CS 22.561 (b) no dynamic tests are mandatory. Static tests or calculation methods are Acceptable Means of Compliance. If calculation methods are solely used for the proof of compliance, they shall be verified by re-calculation of static tests data of structures of similar design. Calculation methods should at least consider margins against material properties like tensile or compressive strength and margins against stability limits like e.g. buckling of canopy sill.
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 (Reference (3)), meets the requirements of CS 22.561(b).

Impact energy absorption.
For maximum protection of the occupants in survivable crash landings, the main part of the cockpit, defined in AMC material, should constitute a cage strong enough to comply with paragraph CS 22.561 (b)(2).
The forward part of the appropriate length should be sufficiently weaker for it to yield before the main part, but stiff enough for it to absorb considerable energy in doing so. (Reference (2), (5), (6), (9), (10) and (12))
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 (Reference (1), (4) and (11)) and /or landing with retracted wheels (CS 22.561(c)).
The wording „give every reasonable chance“ should express 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 of this requirement is to design a cockpit structure that in survivable emergency landing conditions shall provide:
- 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 (Reference (6) and (10)). 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 (Reference (7)). Published data and procedures are also applicable for sailplane designs.
Applicable information on dynamic computer modelling contained in (Reference. (8)) 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. (Reference (5) and (13))

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

(4) 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)

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

(6) 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

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

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

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

(10) 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

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

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

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