Notice of Proposed Amendment 2020-13

Regular update of CS-22

RMT.0037

EXECUTIVE SUMMARY

The objective of this Notice of Proposed Amendment (NPA) is to reflect the state of the art of the certification of sailplanes and powered sailplanes. To that end, this NPA proposes amendments to CS-22 following the selection of non-complex, non-controversial, mature subjects, and it also includes editorial corrections. The subjects have been selected in coordination with the Sailplane Development Panel (SDP).

In particular, this NPA proposes amendments for the following items:

Item 1: Addressing a safety recommendation related to the unintended opening of air brakes,

Item 2: Addressing a safety recommendation related to the operation of the cable release mechanism during launch,

Item 3: Removal of the obsolete 45° dive requirement for sailplanes approved for aerobatics,

Item 4: Additional information for winch launch tests, to address recent winch launch accidents,

Item 5: Structure requirements: State-of-the-art aerofoils and materials,

Item 6: Change of gust load factors,

Item 7: Changes to the content of the aircraft flight manual (AFM), and

Item 8: Editorial corrections.

The proposed changes are expected to increase safety and improve cost-effectiveness for sailplane and powered sailplane designers and users.

Action area:	Design and production		
Affected rules:	CS-22		
Affected stakeholders:	Sailplane and powered sailplane manufacturers and other design organisations dealing with type certificates, supplemental type certificates (STCs), repairs or changes to sailplanes or powered sailplanes.		
Driver:	Efficiency/proportionality	**Rulemaking group:**	No
Impact assessment:	None	**Rulemaking Procedure:**	Standard

14.01.2016	14.12.2020	2021/Q3

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1. About this NPA

1.1. How this NPA was developed

The European Union Aviation Safety Agency (EASA) developed this NPA in line with Regulation (EU) 2018/1139[1] ('Basic Regulation') and the Rulemaking Procedure[2]. This rulemaking activity is included in the European Plan for Aviation Safety (EPAS)[3] under Rulemaking Task (RMT).0037. The text of this NPA has been developed by EASA. The subjects have been selected in coordination with the Sailplane Development Panel (SDP), which is one of three panels within the Organisation Scientifique et Technique Internationale du Vol à Voile (OSTIV). OSTIV has the special status of an international affiliated member of the Fédération Aéronautique Internationale (FAI). It is hereby submitted to all interested parties[4] for consultation.

1.2. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[5].

The deadline for submission of comments is **14 March 2021.**

1.3. The next steps

Following the closing of the public commenting period, EASA will review all the comments received.

Based on the comments received, EASA will issue a decision in order to amend the Certification Specifications (CS) and Acceptable Means of Compliance (AMC) for Sailplanes and Powered Sailplanes (CS-22).

A summary of the comments received will be provided in the explanatory note to the decision.

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1 Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (OJ L 212, 22.8.2018, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1535612134845&uri=CELEX:32018R1139).

2 EASA is bound to follow a structured rulemaking process as required by Article 115(1) of Regulation (EU) 2018/1139. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 18-2015 of 15 December 2015 replacing Decision 01/2012 concerning the procedure to be applied by EASA for the issuing of opinions, certification specifications and guidance material (http://www.easa.europa.eu/the-agency/management-board/decisions/easa-mb-decision-18-2015-rulemaking-procedure).

3 https://www.easa.europa.eu/document-library/general-publications?publication_type%5B%5D=2467

4 In accordance with Article 115 of Regulation (EU) 2018/1139 and Articles 6(3) and 7 of the Rulemaking Procedure.

5 In case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

2. In summary — why and what

2.1. Why we need to amend the rules — issue/rationale

The aviation industry is evolving. CSs and AMC need to be updated regularly to ensure that they are fit for purpose, cost-effective, and can be implemented in practice.

Regular updates are issued when relevant data is available following an update of industry standards, feedback is received from certification activities, or minor issues are raised by the stakeholders.

Item 1: Unintended opening of air brakes.

Following an accident report (Schlussbericht Nr. 2155 Schweizerischen Unfalluntersuchungsstelle SUST), the SDP) discussed the issue of the inadvertent deployment of air brakes during take-off. It was concluded that the inadvertent deployment of air brakes during sailplane operations is occurring for several reasons, and that it can create a situation that is unsafe enough to deserve a clarification to CS 22.697(b).

CS 22.697(b) addresses inadvertent extension or movement, but is not specific about the cause of such movement. Inadvertent deployment could be a result of pilot-induced (human factors) or system characteristics and aerodynamic forces during take-off.

Item 2: Operation of the cable release mechanism should not be limited during launch.

Air Accidents investigation Branch report AAIB Bulletin: 7/2013 includes Safety Recommendation 2013-008. This safety recommendation states 'It is recommended that the European Union Aviation Safety Agency amend the certification standard for Sailplanes and Powered Sailplanes (CS-22) to include a requirement that the cable release mechanisms can be operated at any stage of the launch without restricting the range of movement of any flying control.'

Item 3: Removal of the obsolete 45° dive airbrake requirement for sailplanes approved for aerobatics.

CS 22.73, Descent, high speed, includes a specification for aerobatic sailplanes that is no longer found to be appropriate to the design of sailplanes. The use of air brakes is not the correct action for aerobatic manoeuvres which went wrong, or to recover from a dive.

Item 4: Additional information for winch launch tests, to address recent winch launch accidents.

Launch procedures differ in relation to the characteristics of the towing winch. E.g. the ground run takes longer with a less powerful towing winch and may require a change of flap settings to keep the wings level. Some sailplanes require a minimum cable speed that some towing winches are unable to produce. In other circumstances, a high acceleration can result in a pitch-up momentum for which controllability needs to be demonstrated. The type of cable may influence the automatic activation of the release device when the sailplane overflies the towing winch, as per CS 22.713(b). AMC 22.152 currently does not provide information to cover this.

Item 5: Structural requirements: state-of-the-art aerofoils and materials.

AMC 22.441 and AMC 22.443 'Vertical tail surfaces' were last amended during the transition from JAR 22 to CS-22, at which a limitation was introduced for the applicability of the formulas for the induced rolling moment for T-tails. In the face of the existing and well-tried range of designs, the limitation is too restrictive. The wider scope of designs needs to be reflected in this AMC.

Also vertical tail loads have evolved over time. In aerobatics, it is today a common practice in flick manoeuvres to alternately deflect the rudder to superimpose the rudder deflection with sideslip. This can require a specific load case to be taken into account. This needs to be brought to the attention of designers.

In addition, conclusions from research and scientific papers concerning ground loads (hard landings) need to be reflected in the AMC.

An adjustment of towing hook attachment forces is also required. The tow hook attachment loads on the tow hook used for aero-tow must take account of the lower cable loads that have been established during an earlier amendment of JAR 22 without adjustment of the attachment loads. A second change is introduced to use a reserve factor for winch launch loads to take account of an increase of permitted weak links by a clearer specification of weak link strength.

Item 6: Change of gust load factors formula

The motivation for this proposed change was unintentionally ignited by the microlight glider community. (Microlight gliders are sailplanes which fall into Annex I of the Basic Regulation due to their low maximum take off weight (MTOW)). As it is described below, finally this process led to the insight, that also for the typical CS-22 design the gust load formula is not so solidly founded as it could be.

The calculation of the gust load factors is based on an assumed sinusoidal gust and its corresponding ramp length. Statistics of the ramp length were used based on measurements with transport airplanes and have led to a supposed proportionality of the ramp length to the mean wing chord (NACA Report 1206, 1955). For the wide variety of sailplanes from light wooden constructions to modern, heavy Open-Class sailplanes, this dependency of the gust ramp length from the wing chord cannot be correct, since meteorological conditions are not a function of the sailplane geometry.

Uncontested, the current gust load formula has led to safe and reliable sailplanes over decades. Nevertheless, an approach is required that allows inclusion of better gust data from meteorologic research creating margin for further development of designs.

Item 7: Changes to the content of the aircraft flight manual (AFM)

Sailplane pilots are not always aware of certain limits that sailplanes are designed for. This knowledge is covered by the training syllabus; however, the content of the AFM, as provided in CS 22.1585, is not explicit about all applicable operational limitations and procedures and requires additional operational limitations and procedures.

Item 8: Editorial mistakes.

In addition, a number of editorial mistakes are corrected.

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 1 of the Basic Regulation. This proposal will contribute to the achievement of the overall objectives by addressing the issues outlined in Section 2.1.

The specific objective of this proposal is to amend CS-22 based on the above selection of non-complex, non-controversial, and mature subjects, with the ultimate goal being to increase safety.

2.3. How we want to achieve it — overview of the proposals

Item 1: Unintended opening of air brakes.

There is no guidance to CS 22.697(b) addressing the risk that air brakes that are not in a locked position could move during a launch or start and create a substantial performance loss.

EASA therefore proposes a new GM to 22.697(b) to highlight this risk.

Item 2: Operation of the cable release mechanism should not be limited during launch.

CS 22.777(b) states: 'The controls must be located and arranged so that the pilot, when strapped in the seat, has full and unrestricted movement of each control without interference from either clothing (including winter clothing) or from the cockpit structure. The pilot must be able to operate all the controls necessary for the safe operation of the aeroplane from the seat designated to be used for solo flying'.

The objective specification is generic, and it was not specifically clear that it should be possible to operate the cable release mechanisms at any stage of the launch without being restricted by the range of movement of any flight controls.

As there is also no existing AMC to address this, EASA proposes a new AMC to 22.777(b) to address this feature.

Item 3: Removal of the obsolete 45° dive airbrake requirement for sailplanes approved for aerobatics.

The specification was found to be outdated during the SDP meeting in 2016. The use of air brakes during aerobatics is not recommended due to the reduced load factors with air brakes extended. This specification is therefore proposed to be removed.

Item 4: Additional guidance for winch launch tests, to address recent winch launch accidents.

The existing AMC 22.152 does not address scenarios that have been identified as contributing to winch launch accidents.

EASA therefore proposes an amendment to the AMC to address this deficiency without being too prescriptive.

Item 5: Structure requirements: Adjustments to state-of-the-art aerofoils and materials.

Item 5.1 Vertical tail surfaces – Rolling Moments for T-tails.

A limitation on the formulas of induced rolling moment in AMC 22.441 and AMC 22.443 has been introduced during the transition from JAR 22 to CS-22. Since designs outside the limitation have been designed with these formulas and successfully been operated, the limitation is adjusted to those values for which positive experience exists.

Item 5.2 Vertical tail surfaces – Flick Manoeuvres.

CS 22.441 concretely defines the vertical tail manoeuvring load cases. While this is appreciated for the Category U design, it might not suffice for the Category A design. Awareness of the specific aerobatic load cases that could be applicable for a design is brought to the reader's attention in the AMC.

Item 5.3 Ground loads

The OSTIV SDP proposed during its 2019 meeting to readjust the four factors of ground load, descent velocity, energy absorption, and c.g. acceleration. EASA agrees the combination of these changes provides an improved level of safety while taking into account heavier sailplanes and a greater amount of water ballast carried.

Item 5.4 Tow hook attachments and cable loads

In Joint Aviation Authority (JAA) NPA 22C-85, the maximum cable loads for a sailplane in aerotow from JAR 22.581(b) have been reduced from $1.2 \times Q_{nom}$ to $1.0 \times Q_{nom}$, assuming the use of a textile rope. The limit load for the towing hook attachment (JAR 22.585) has not been changed, however. Therefore, a factor for the ratio between cable load and attachment loads has been introduced.

Furthermore, the use of weak links in winch launching has led to the situation where the additional cable load factor of 1.2 is not fully usable in operations. Modern winches with higher acceleration of the sailplane would require slightly higher weak links and therefore it is proposed to use this factor for that purpose with the introduction of a new maximum level for the maximum weak link strength.

Item 6: Change of gust load factors

As mentioned above, the motivation for this proposed change was unintentionally ignited by the microlight glider community. The question was raised, whether CS-22 would also be suitable to be applied for microlight gliders. CS-22 is more adjusted to gliding flight than many popular microlight airworthiness codes. Since the requirements are generally in proportion to the MTOW, there are only a few difficulties:

- Few requirements are expressed in absolute values (e.g. towing speeds, minimum weak link strength)
- Often the calculation of gust load factors results in very high gust load factors.

While choosing appropriate values for towing speeds etc. is straightforward, the question of gust loads needed some more exhaustive analysis. During this analysis, it became evident, that even for the typical CS-22 glider the foundation of the gust load factor formula requires reconsideration.

A new formula was derived based on the numerical calculation of the response of sailplanes to gusts. Different types of sailplanes were assumed (Very light, 18 m, Open-Class), as well as the full range of gust lengths. Stiff as well as flexible structures were considered, as well as different loading configurations. Different software packages were used for comparison. (Boermans, Lasauskas, 2019). A new formula was derived, which conservatively reproduces the gust loads from the simulations as a function of the gust length.

However, for application, the new formula requires the gust length as input, as it is no longer derived from the wing chord. Up to now, no statement about an appropriate gust length covering all relevant meteorological conditions could be made. More investigation is required on this topic. Therefore, for the time being, in this proposed change the gust length is chosen such, that the same level of safety is achieved as with the current formula. This leaves the door open for a more tailored gust load factor, if more meteorological data is available. It also allows adjustments to special environments with different gust conditions.

Item 7: Changes to the content of the aircraft flight manual (AFM).

By amending the content of the AFM in AMC 22.1585, emphasis is placed on the limits that sailplanes are designed for.

Item 8: Editorial corrections.

Various corrections in:

CS 22.331(d)(2),

CS 22.335(f), and

CS 22.375(b)(2).

2.4. What are the expected benefits and drawbacks of the proposals

The proposed amendments reflect the state of the art of sailplane and powered sailplane certification. Overall, this would provide a moderate safety benefit, would have no social or environmental impacts, and would provide some economic benefits by removing obsolete requirements.

3. Proposed amendments and rationale in detail

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

— deleted text is ~~struck through~~;

— new or amended text is highlighted in blue;

— an ellipsis '[…]' indicates that the rest of the text is unchanged.

3.1. Draft Certification Specifications and Acceptable Means of Compliance for Sailplanes and Powered Sailplanes (Draft EASA Decision amending CS-22)

Item 1: Unintended opening of air brakes.

It is proposed to introduce new guidance material to CS 22.697(b) addressing the unintended movement of airbrakes during the take-off phase of sailplanes and powered sailplanes.

GM1 22.697(b) Wing-flap and air-brake controls

The air brakes, when closed but not locked, remain substantially closed during the launch take-off phase of the sailplane

Item 2: Operation of the cable release mechanism should not be limited during launch.

It is proposed to introduce new acceptable means of compliance to CS 22.777(b) stating that cable release mechanisms can be operated at any stage of the launch without restricting the range of movement of any flying control.

AMC 22.777(b) Cockpit controls

Special consideration should be given to ensuring that cable release mechanisms can be operated at any stage of the launch without restricting the range of movement of any flying control, including when the pilot has the hand on the release during the launch.

Item 3: Removal of the obsolete 45° airbrake dive requirement for sailplanes approved for aerobatics.

The requirement was found to be outdated during the SDP meeting in 2016. The use of air brakes during aerobatics is not recommended due to the reduced load factors with air brakes extended. EASA agrees to this. It is proposed to remove the 45° airbrake dive requirement from CS 22.73.

The specification of CS 22.73 has its origin in the early days of gliding. At that time, air brakes were called 'nosedive brakes' and were intended to be used as a last resort to recover from a loss of control. The Lufttüchtigkeitsforderungen für Segelflugzeuge und Motorsegler (LFSM) issued in 1975 still required all sailplanes to comply with the 45° airbrake dive requirement. Only with the initial issue of JAR-22 in 1980 was the specifications limited to sailplanes approved for cloud flying and aerobatics. For all other certifications, a 30° airbrake dive specification was kept and later amended to less than 30° if a rate of descent of more than 30 m/s can be achieved.

However, deploying the air brakes is not the correct action in a dive situation during aerobatics, since in accordance with CS 22.345, the manoeuvring load factor is limited to -1.5 to +3 g compared with the higher allowable loads in a clean configuration. The correct action to recover from a dive is to apply an elevator input without the use of air brakes. Consequently, the specification is found to be obsolete for sailplanes approved for aerobatic manoeuvres.

For sailplanes approved for cloud flying, the 45° airbrake dive specification is still justified. In the case of a loss of control inside the cloud (with no external visual reference), the recommended recovery procedure is to fully extend the air brakes, set the elevator trim slightly forward, and release the controls.

CS 22.73 Descent, high speed

It must be shown that the sailplane with the airbrakes extended, will not exceed V_{NE} in a dive at an angle to the horizon of:

(a) 45° when the sailplane is approved for cloud flying ~~and/or aerobatics when certificated in the Aerobatic or Utility Category;~~

(b) in other cases

(i) 30°

(ii) less than 30° when a rate of descent of more than 30 m/s can be achieved.

Item 4: Additional guidance for winch launch tests, to address recent winch launch accidents.

Launch procedures differ in relation to the characteristics of the towing winch. E.g. the ground run takes longer on a less powerful towing winch and may require a change of flap settings to keep the wings level. Some sailplanes require a minimum cable speed that some towing winches are unable to produce. In other circumstances, high acceleration is in principle good for shorter take-off run and attaining faster minimum speed, but can result in a pitch-up momentum in which controllability has to be demonstrated. The type of cable may have an influence regarding the automatic activation of the release device when the sailplane overflies the towing winch as per CS 22.713(b). It is proposed to give more details on this in AMC 22.152.

AMC 22.152 Winch-launching and auto-tow launching

~~For showing compliance with the winch-launching requirements at least 6 winch-launches should be made, covering the range of speeds up to V_W. During these launches a range of release points should be selected along the flight path to cover the normal operating range and the release in emergency.~~

In demonstrating compliance with this specification, in addition to the specifications of CS 22.21(a) and (b), and CS 22.713 (b), the effects of at least the following should be investigated:

(1) Variations in the speed, up to V_W;
(2) A range of release points along the flight path to cover the normal operating range and the release in an emergency;
(3) Different winch characteristics (e.g. engine power, cable speed, acceleration); and
(4) Different cable types (e.g. steel or textile).

Appropriate limitations may be addressed by the operating limitations of the AFM.

Item 5: Structure requirements: Adjustments to state-of-the-art aerofoils and materials.

Item 5.1 Vertical tail surfaces – Rolling Moment for T-tails.

The last change of AMC 22.441 and AMC 22.443 was discussed for JAR-22 Change 7, which eventually was published as the initial issue of CS-22. For that change, the formulas for the rolling moment induced at the horizontal tail

$$M_r = 0.2\, S_t \frac{\rho_0}{2} \beta\, V^2\, b_h$$

in AMC 22.441 and

$$M_r = 0.2\, S_t \frac{\rho_0}{2} \beta\, VU\, b_h k$$

in AMC 22.443 were multiplied by the factor

$$2\,\frac{b_v}{b_h}$$

which resulted in the proposed formula

$$M_r = 0.4\, S_t \frac{\rho_0}{2} \beta\, V^2\, b_v$$

in AMC 22.441 and

$$M_r = 0.4\, S_t \frac{\rho_0}{2} \beta\, VU\, b_v k$$

in AMC 22.443.

Where:

M_r = induced rolling moment at horizontal tail (Nm)

b_v = span of vertical tail (m), measured from the bottom of the fuselage

b_h = span of the horizontal tail (m)

ß = side-slip angle (radians)

U = gust speed (m/s)

k = gust factor, should be taken as 1.2

At the introduction of the existing formula, a restriction was introduced that this formula was only valid without more detailed rational analysis, for vertical tail aspect rations between 1 and 1.8 and horizontal tails without dihedral and aspect ratios below 6. This restriction was not justified with structural problems with T-tails, it was justified with reports of 3-D vortex-lattice example calculations. (JAR Study Group 22, Paper No. 22C-78, 1999).

In a non-exhaustive list of modern sailplanes, aspect ratios range up to 8 for the horizontal tail and up to 2 for the vertical tail. There are no problems known with these designs in respect of the rolling moment on the T-tail, independent of whether they were designed with the old formula, or with the new formula (where the mentioned restriction has not been applied in agreement with the authorities).

The factor 2 $\frac{b_v}{b_h}$ is in the order of 1, which means that experience of JAR-22 designs is still applicable.

Therefore, it does not seem justified, to set a restriction upon the use of these formulas, which exclude designs, for which positive experience exists. Thus, aspect ratios up to 2 (vertical tail) and up to 8 (horizontal tail) are deemed as acceptable for the application of the above formulas, and proposed in this NPA.

Item 5.2 Vertical tail surfaces – Flick Maneouvres.

CS-22 does not explicitly specify requirements for sailplanes used for unlimited aerobatic manoeuvres. Nevertheless, at SDP meeting 2011 it was proposed to complement AMC 22.441 with the information that higher loads may have to be regarded in case of flick manoeuvres of Category A sailplanes, which are initiated with a yawing manoeuvre with full rudder deflection applied opposite to the sideslip angle. EASA agrees with the SDP proposal to highlight this load case.

The background is a structural failure of a tail due to torsion during flight test of an Open-Class sailplane. Thanks to the flight test gear, it was possible to determine, that the failure happened while the combined loads of sideslip and rudder deflection acted upon the tail. This is outside the envelope of Category U sailplanes, but may become relevant for Category A sailplanes when subjected to flick manoeuvres.

CS 22.441 for the vertical tail describes the exact combinations of loads to be applied, which may not be sufficient for the Category A design. In contrast, CS 22.423, for the horizontal tail, only refers to 'the most severe loads likely to occur in pilot-induced pitching manoeuvres, at all speeds up to V_D'. Therefore, all aerobatic manoeuvres are already included in CS 22.423.

AMC 22.441 Vertical tail surfaces

Manoeuvring load

For sailplanes where the horizontal tail is supported by the vertical tail, the tail surfaces and their supporting structure including the rear portion of the fuselage should be designed to withstand the prescribed loadings on the vertical tail and the rolling moment induced by the horizontal tail acting in the same direction.

For T-tails in the absence of a more rational analysis, the rolling moment induced by side-slip or deflection of the vertical rudder may be computed as follows:

$$M_r = 0.4\, S_t \frac{\rho_o}{2} \beta\, V^2\, b_v$$

where:

M_r = induced rolling moment at horizontal tail (Nm)

b_v = span of vertical tail, measured from the bottom of the fuselage

ß = side-slip angle (radian)

This formula is only valid for vertical tail aspect ratios between 1 and ~~1.8~~ 2 (with span and area measured from the bottom of the fuselage) and horizontal tail with no dihedral and aspect ratio ~~6~~ 8 or less. For configurations in excess of these limits more detailed rational analysis will be required.

Designs in the Aerobatic Category must address all unlimited manoeuvres that are permitted and their ensuing loads upon the whole aircraft. In the course of this, the conditions defined in CS 22.441 (a) and (b) may have to be amended for Category A sailplanes. For example, in aerobatics it is common practice in flick manoeuvres to alternately deflect the rudder to superimpose the rudder deflection with sideslip, and thus increasing rudder authority. For Category A sailplanes, loads arising from such cases should be assessed.

AMC 22.443 Vertical tail surfaces

Gust loads

[…]

This formula is only valid for vertical tail aspect ratios between 1 and ~~1.8~~ 2 (with span and area measured from the bottom of the fuselage) and horizontal tail with no dihedral and aspect ratio ~~6~~ 8 or less. For configurations in excess of these limits more detailed rational analysis will be required.

Item 5.3 Ground loads

The proposal for this change is based on the paper 'REVISED OSTIV GROUND LOADS STANDARDS' by Cedric O. Vernon, published in TECHNICAL SOARING, Vol. XX, No.3.

The author of this paper shows, as described below, that landing gear designed to the OSTIVAS figures requires even less stroke than a design to the CS-22 figures. The energy equation, showing kinetic vertical impact energy equalling the energy absorbed by landing gear, assuming Hooke´s law for the spring, provides a means to calculate the stroke of the landing gear.

Using the same spring characteristics for both cases, the minimum landing gear stroke for a rate of sink of 1.7 m/s and just tolerable n = 4 results in a 7.37 cm stroke, whereas a rate of sink of 1.77 m/s and n = 4.5 results in only a 7.1 cm stroke.

The proposed change to CS 22.723, which asks for a slightly higher energy absorption – the proposed factor is 1.5 against the current factor of 1.44 – is necessary to show a similar amount of energy absorption by a landing gear for the old and the proposed standard.

Today's sailplanes designed for heavy water ballast loads to the allowed maximum of n = 4.5 may exceed n = 6, when landed dry.

It is important to know that flight manuals prescribe the jettison of the water ballast prior to normal landings, and, even more importantly, prior to off-field landings. The design load cases for landing gear according to CS-22 with maximum mass are necessary to cover the take-off run, including aborted take-offs from winch launches or aero tows. These 'normal' operations do not normally happen on the best part of the airfield.

For 50 % water ballast compared with the maximum dry mass, this is one third of the maximum mass for which Cedric O. Vernon calculated an increase in Delta n by a factor of 1.225. For the example given above, n = 4.5 = 3.5 + 1 would result in n = 1 + 3.5 x 1.225 = 5.3, which is slightly below the value of n = 6. According to the proposed change to CS-22, n = 4 = 1 + 3 for landing with the maximum mass would result in n = 1 + 3 x 1.225 = 4.7 for landing at maximum dry weight.

Modern competition sailplanes allow a mass increase of about 50 % due to a water ballast load, and the latest designs allow even more.

The final report of the 'Forschungsvorhaben L-5/84', sponsored by the German Ministry of Transport in order to provide the introduction of improved JAR requirements for sailplane landing gear, recommends a maximum load factor of n = 4 for landings with maximum mass. The report specifically notes that the Delta n resulting from the energy absorption is only 3. One more n has to be added to consider level flight attitudes.

The effects of the elastic response of the structure due to the incitation by the landing shock is regarded to be negligible, as is the small increase in Delta n due to a low landing mass.

The above-mentioned report was delivered in October 1987 when the maximum water ballast loads were typically 25 % of the maximum mass. Therefore, the recommended limit for n = 4 = 3 +1 given in the report has to be strictly maintained.

Human tolerance curves for persons in seated positions show the lowest spine load tolerances for pulse lengths of 0.3 to 3 seconds.

CS 22.473 Ground load conditions and assumptions

(a) The ground load requirements of this Subpart, must be complied with at the design maximum weight.

(b) The selected limit vertical inertia load factor at the c.g. of the sailplane for the ground load conditions prescribed in this Subpart

  (i) may not be less than that which would be obtained when landing with a descent velocity of ~~1.77~~ 1.70 m/s.

  (ii) may not be less than 3.

(c) Wing lift balancing the weight of the sailplane may be assumed to exist throughout the landing impact and to act through the c.g. The ground reaction load factor may be equal to the inertia load factor minus one.

CS 22.723 Shock absorption test

The proof of sufficient shock absorption capacity must be determined by test. The landing gear must be able to absorb ~~1.44~~ 1.50 times the energy described in CS 22.473 without failure although it may yield during the test.

CS 22.725 Level landing

(a) The shock absorbing elements (including tyres) must be capable of absorbing the kinetic energy developed in a landing without being fully depressed.

(b) The value of kinetic energy must be determined under the assumption that the weight of the sailplane corresponds to the design maximum weight with a constant rate of descent equalling the value given in CS 22.473(b) and the wing lift balancing the weight of the sailplane.

(c) Under the assumption of (b) the c.g. acceleration must not exceed ~~4.5~~ 4.0 g.

Item 5.4 Tow hook attachment and cable loads

By the introduction of JAA NPA 22C-85, the maximum cable loads for a sailplane in aerotow were reduced from the JAR 22.581(b) value of $1.2\times Q_{nom}$ to $1.0\times Q_{nom}$, assuming the use of a textile rope. The limit load for the towing hook attachment (JAR 22.585) was not changed, however.

For several reasons, it is useful to design a tow hook attachment to be able to carry slightly higher loads than the loads resulting from the cable loads in flight. The ratios of the tow hook attachment limit load was equal for aerotow launching hooks and winch launching hooks before JAA NPA 22C-85.

Prior to the introduction of the change from JAA NPA 22C-85, there was one ratio of the tow hook attachment load (FTH) and the cable load (FC) for both aerotow launching hooks and winch launching hooks:

$FTH / FC = (1.5\times Q_{nom})/(1.2\times Q_{nom}) = 1.25$

This linkage of FTH and FC worked quite well for all gliders certified according to JAR 22.

When the aerotow cable loads were reduced according to NPA 22C-85, the tow hook attachment loads were not correspondingly corrected. This resulted in limit loads for the aerotow launching hook attachment which exceeded the aerotow cable loads by 50 %. Therefore, CS 22.585(a) proposes the ratio FTH / FC to be 1.25 for both types of tow hooks to re-establish the former ratio as it was before JAA NPA 22C-85.

Furthermore, with the existing wording, all cable loads have been calculated for 1.2 Q_{nom}. The internationally established types of weak links in winch towing prevent increase in the cable loads beyond the weak link strength, therefore this reserve factor is never used in reality. Nevertheless, due to a steady increase of maximum torque of winch engines, incidents have become more regular where the weak link fails during the acceleration part of the winch tow, which created a potential new hazard during operation. Therefore, the proposed introduction of a definition of a maximum value for the weak link specified for winch towing, provides a strength reserve so that weak links can be 20 % stronger than before, which would considerably decrease the unnecessary failure of weak links due to the faster acceleration possible with modern winches.

CS 22.581 Aerotowing

(a) The sailplane must be initially assumed to be in stabilized level flight at speed V_T with a cable load acting at the launching hook in the following directions:

(1) horizontally forwards;

(2) in plane of symmetry forwards and upwards at an angle of 20° with the horizontal;

(3) in plane of symmetry forwards and downwards at an angle of 40° with the horizontal; and

(4) horizontally forwards and sidewards at an angle of 30° with the plane of symmetry.

(b) With the sailplane initially assumed to be subjected to the same conditions as specified in CS 22.581(a), the cable load due to surging suddenly increases to Q_{nom}, assuming the use of a textile rope.

(1) The resulting cable load increment must be balanced by linear and rotational inertia forces. These additional loads must be superimposed on those arising from the conditions of CS 22.581(a).

(2) ~~Q_{nom} is the rated ultimate strength of the towing cable (or weak link if employed).~~ For the purpose of these requirements, Q_{nom} ~~it~~ must be assumed to be not less than 1.3 times the sailplane maximum weight and not less than 500 daN.

(c) The ultimate strength tolerance of the weak link designated for operation must not exceed +/- 10 % centred by the rated ultimate strength.

CS 22.583 Winch-launching

(a) The sailplane must be initially assumed to be in level flight at speed V_W with a cable load acting at the launching hook in a forward and downward direction at an angle ranging from 0° to 75° with the horizontal.

(b) The cable load must be determined as the lesser of the following two values:

(1) 1.2 Q_{nom} as defined in CS 22.581(b), or

(2) the loads at which equilibrium is achieved, with either:

(i) the elevator fully deflected in upward direction, or

(ii) the wing at its maximum lift.

A horizontal inertia force may be assumed to complete the equilibrium of horizontal forces.

(c) In the conditions of CS 22.583(a), a sudden increase of the cable load to the value of 1.2 Q_{nom} as defined in CS 22.581(b), is assumed. The resulting incremental loads must be balanced by linear and rotational inertia forces.

(d) The rated ultimate strength of the weak link for winch tows must not be larger than 1.2 Q_{nom}. The ultimate strength tolerance of the weak link designated for operation shall not exceed +/- 10 % centred by the rated ultimate strength.

CS 22.585 Strength of launching hook attachment

(a) The launching hook attachment must be designed to carry a limit load of ~~1.5 Q_{nom}, as defined in CS 22.581(b),~~ 125 % of the highest associated cable load, calculated according to and acting in the directions specified in CS 22.581 and CS 22.583.

(b) The launching hook attachment must be designed to carry a limit load equal to the maximum weight of the sailplane, acting at an angle of 90° to the plane of symmetry.

Item 6: Change of gust load factors

The Pratt-Walker formula for the gust alleviation factor given in CS 22.341:

$$k = 0.88\,\mu / (5.3 + \mu) \qquad (1)$$

implies a (1-cos) gust, with a length of H = 12.5 * lm.

In ref. 1, the Pratt-Walker formula was updated:

$$k = 0.96\,\mu / (H/lm) / (0.475 + \mu / (H/lm)) \qquad (2)$$

For a range of sailplane configurations ..

— … and for a gust length of H = 12,5 * lm, formula (2) always results in a gust load factor not below the CS 22.341 formula (1);

— … and for gusts of variable length, formula (2) results in load factors which agree very well with numerical simulations of entering a gust – under the assumption of both stiff and flexible wings.

This formula requires reliable information about the applicable gust length H.

Measurements have found a linear gust ramp gradients of up to 1.25 m/s per meter (ref 2). With an additional factor of 1.25 for the non-linear (1-cos)-gust this results in at least H = 1.25 * 15 m/s / 1.25 (m/s)/m) = 15 m for the 15 m/s gust.

It has not yet been demonstrated, however, that this covers the most severe turbulent conditions to be expected in operation of sailplanes (e.g. see description of the meaning of the Rough Air Speed in section 2.2 of the Specimen Flight Manual in AMC 22.1581).

To achieve the same level of safety, the formulas (1) and (2) are set equal:

$$0.96\, \mu / (H/lm) / (0.475 + \mu / (H/lm)) = 0.88\mu / (5.3+\mu) \qquad (3)$$

Solved for H:

$$H = (12.17 + 0.191\, \mu)\, lm \qquad (4)$$

This is the gust length H that would have to be used in combination with formula (2) to achieve the same structural reserves as with formula (1). Unless a more rational analysis on H is available, this formula must be applied for each configuration.

ref 1: L.M.M. Boermans, E. Lasauskas, On the gust loads of sailplanes, OSTIV SDP abstract, 2019.

ref 2: V.V. Chernov, Results of research in the field of structural strength limits for sporting gliders, OSTIV Publication VIII, 1956.

CS 22.341 Gust load factors

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

$$n = 1 \pm \left[\frac{\left(\frac{k}{2}\right)\rho_0 UVa}{\left(\frac{mg}{S}\right)}\right]$$

where:

ρ_0 = density of air at sea-level (kg/m^3)

U = gust velocity (m/s)

V = equivalent air speed (m/s)

a = slope of wing lift curve per radian

m = mass of the sailplane (kg)

~~G~~g= acceleration due to gravity (m/s^2)

S = design wing area (m^2)

k = gust alleviation factor calculated from the following formula:

$$\cancel{k = \frac{0.88\mu}{5.3+\mu}}$$

$$k = \frac{0.96\frac{\mu}{H/l_m}}{0.475 + \frac{\mu}{H/l_m}}$$

where:

$\mu = \frac{2\frac{m}{S}}{\rho l m\, a}$ (non-dimensional sailplane mass ratio)

where:

ρ = density of air (kg/m^3) at the altitude considered

l_m = mean geometric chord of wing (m)

H= length of the (1-cos)-shaped gust;

unless there is justification for a different value, H must be computed as follows:

$$H = (12.17 + 0.191\mu)l_m$$

(b) The value of n calculated from the expression given above need not exceed:

$$n = 1.25\left(\frac{V}{V_{S1}}\right)^2$$

Item 7: Changes to the content of the aircraft flight manual (AFM).

During a joint meeting of the OSTIV Training and Safety Panel and the Sailplane Development Panel in 2017, it was emphasised that not all pilots and flight instructors have full visibility of the operational limitations deriving from CS-22-certified sailplanes.

Sailplane pilots are not always aware of certain limits that sailplanes are designed for. This knowledge should be covered by the training syllabus, however, it is proposed to amend the content of the AFM.

CS 22.349: Full deflection of ailerons can only be combined with 2/3 of the maximum allowable manoeuvre loads.

CS 22.337 & CS 22.341: A combination of full manoeuvre loads and gust loads is not considered.

CS 22.333 & CS 22.335: Rough-airspeed and manoeuvring airspeed limitations. No full deflection of controls above the manoeuvring speed limit.

CS 22.345: Limited loads with airbrakes extended.

See AMC belowXXX for more detailed information about spin characteristics and the allowed configurations and limitations thereof, for use in approvals for intended spin.

AMC 22.1581 Flight manual

General

The flight manual is not intended to teach good airmanship. The flight manual supplies information about the specific characteristics of the sailplane type. The reader of the flight manual is not a professional pilot, therefore information should be presented clearly and condensed. Thus, the properties that stem from the specifications of Subpart C, and therefore are general characteristics of gliders, are not described, except if listed within the paragraphs of the section 'Flight Manual' of Subpart G.

An acceptable format for a flight manual is given on the next pages.

[...]

CS 22.1583 Operating limitations

[...]

(e) *Flight load factors.* Manoeuvring load factors; the following must be furnished:

(1) The factors corresponding to point A and point G of Figure 1 of CS 22.333(b), stated to be applicable at V_A;

(2) The factors corresponding to point D and point E of Figure 1, of CS 22.333(b), stated to be applicable at V_{NE}.

(3) The factor with airbrakes extended as specified in CS 22.345.

(4) The factor with wing-flaps extended as specified in CS 22.345.

(5) Markings in accordance with CS 22.1548.

(6) The reduction of load factors with ailerons deflected as used for demonstration of CS 22.349.

(7) A statement that full manoeuvring loads are considered without gust loads, and full gust loads are only considered without manoeuvring loads.

[…]

CS 22.1585 Operating data and procedures

[…]

(o) In connection with high-speed flight, and, if applicable, the following cautions must be given:

(1) Exceed the rough-air speed only in calm air (yellow arc of airspeed indicator).

(2) Above the manoeuvring speed (the yellow arc of the airspeed indicator), full control deflections must not be applied. At VNE (red radial line), only one third of the full travel is permissible.

(3) In the yellow range, air brakes may only be operated under g-loads between –1.5 g and +3.5 g.

(4) Reference to Section 2.9 'Manoeuvring load factors' (in the case of the specimen flight manual), or whichever Section in the actual manual, conditions of reduced manoeuvring load must be provided.

AMC 22.1585 Operating data and procedures

(1) A statement should be included if the sailplane is not, or is not in all configurations, approved for intentional spins. If applicable, the influence of water ballast should be taken into account.

(2) Spiral dive characteristics, including how to distinguish a spin dive from a spin, and the recommended recovery procedure should be provided.

If the use of air brakes reduces the permissible load factors as specified in CS 22.345, this should be pointed out, and consequently a recommendation should be given to not use the airbrakes on recovery from a spiral dive.

The influence of water ballast should be taken into account

Item 8: Editorial corrections.

The definition of non-scope gliders is not relevant in the certification specifications, and therefore it is proposed to delete the following AMC.

~~AMC 22.1(a) Applicability~~

~~CS-22 is not applicable to aeroplanes classified as hang-gliders and ultralights or microlights. The definitions of these aeroplanes differ from country to country. However, hang-gliders can be broadly defined as sailplanes that can take-off and land by using the pilot's muscular energy and potential energy.~~

~~Ultralights or microlights can be described as very low-energy aeroplanes, as some of their main characteristics are strictly limited. The following criteria are often used (alone or in combination): stalling speed, weight to surface area ratio, maximum take-off weight, maximum empty weight, fuel quantity, number of seats.~~

~~In addition, both hang-gliders and ultralights/microlights are usually not type-certificated, and CS-22 prescribes minimum standards for the issue of type certificates.~~

Mistakes in CS 22.331, CS 22.335, and CS 22.375 need corrections, as proposed below.

CS 22.331 Symmetrical flight conditions

[...]

(d) Aerodynamic data required for the establishment of the loading conditions must be verified by tests, calculations or by conservative estimation.

(1) In the absence of better information the maximum negative lift coefficient in the normal configuration may be taken as –0.8

(2) If the pitching moment coefficient C_{mo} is less than ±0.025, a coefficient of at least ~~–~~ ±0.025 must be used for the wing and horizontal tail.

CS 22.335 Design air speeds

[...]

(f) *Design Maximum Speed V_D.* The design maximum speed may be chosen by the applicant but must not be lower than:

$$V_D = \cancel{18 \sqrt[3]{\left(\frac{W}{S}\right)\left(\frac{1}{Cd_{min}}\right)}}\ 18 \cdot \sqrt[3]{\left(\frac{W}{S}\right) \cdot \left(\frac{1}{C_{D_{min}}}\right)}$$ (km/h) for sailplanes of Category U

$$V_D = 3.5\left(\frac{W}{S}\right) + 200$$ (km/h) for sailplanes of Category A

where:

$\frac{W}{S}$ = Wing loading (daN/m²) at design

Cd_{min} = The lowest possible drag coefficient of the sailplane

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For a powered sailplane, V_D must also not be lower than 1.35 V_H.

CS 22.375 Winglets

[...]

(b) In the absence of more rational analysis the loads must be computed as follows:

(1) The lift at the winglets due to sideslip at V_A –

$$L_{W_m} = 1.25 C_{L_{max}} S_W \frac{\rho o}{2} V_A{}^2$$

where:

$C_{L_{max}}$ = maximum lift coefficient of winglet profile

S_W = area of winglet

(2) The lift at the winglets due to lateral gust at V_B and V_D –

$$L_{W_g} = a_W\, S_W \frac{\rho o}{2} VUk$$

where:

U = lateral gust velocity at the values as described in CS 22.333(c)

a_W = slope of winglet lift curve per radian

k = Gust alleviation factor as defined in CS 22.443(b)

The above-described load L_{W_g} need not exceed the value

$$L_{W_{max}} = \cancel{1.25 C_{L_{max}} S_W \frac{\rho o}{2} V_{max}{}^2}\ 1.25 C_{L_{max}} S_W \frac{\rho_0}{2} V^2$$

[...]

4. Impact assessment (IA)

The proposed amendments are expected to contribute to updating CS-22 to reflect the state of the art of sailplane and powered sailplane certification. Overall, this would provide a moderate safety benefit, would have no social or environmental impacts, and would provide some economic benefits by removing redundant details in the certification process. There is no need to develop a regulatory impact assessment (RIA).

5. Proposed actions to support implementation

N/A

6. References

6.1. Affected/Related regulations

N/A

6.2. Affected/Related decisions

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

6.3. Other reference documents

— Accident report (Schlussbericht Nr. 2155 der Schweizerischen Unfalluntersuchungsstelle SUST)

— AAIB Bulletin: 7/2013 (includes Safety Recommendation 2013-008)

— Joint Aviation Authorities (JAA) - NPA 22C-85 'Aerotowing'

— 'A Revised Gust-Load Formula and a Re-Evaluation of V-G Data Taken on Civil Transport Airplanes From 1933 to 1950', by K.G. Pratt, W.G. Walker, NACA Report 1206, 1955

— 'On the Gust Loads of Sailplanes', by L.M.M. Boermans, E. Lasauskas, OSTIV SDP abstract, 2019

— 'REVISED OSTIV GROUND LOADS STANDARDS' by Cedric O. Vernon, published in TECHNICAL SOARING, Vol. XX, No. 3

— 'Forschungsvorhaben L-5/84' sponsored by the German Ministry of Transport

— 'Rolling Moments on T-Tails', Paper No. 22C-78, JAR 22 Study Group, Issue 2, 29. Nov. 1999

7. Appendix

NPA

8. Quality of the document

If you are not satisfied with the quality of this document, please indicate the areas which you believe could be improved and provide a short justification/explanation:

— technical quality of the draft proposed rules and/or regulations and/or the draft proposed amendments to them
— text clarity and readability
— quality of the impact assessment (IA)
— others (please specify)

Note: Your replies and/or comments to this section shall be considered for internal quality assurance and management purposes only and will not be published in the related CRD.