

Development of OSTIV Airworthiness Standards traced in OSTIV-Publications

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Presented at the XXVIII OSTIV Congress, Eskilstuna, Sweden, 8-15 June 2006

Abstract

During the task to extend the applicability of the OSTIV Airworthiness Standards (OSTIVAS) to sailplanes and powered sailplanes operated outside mass limitations covered by OSTIVAS today, it was regarded to be desirable to learn how OSTIVAS developed and which influences and contributions to OSTIVAS can be found in OSTIV-Publications. As early publications are no longer available, the author scanned old documents and collected them in a literature listing and prepared a CD which is available from the author. Summaries of the articles selected from OSTIV-Publications are given in the paper together with the impact they may have had on OSTIVAS.

Nomenclature

A nomenclature of all symbols used in following literature cannot be given. Please see the nomenclature of each individual paper given hereafter.

Introduction

In the author's paper "Basic Criteria for Airworthiness Requirements", published in "Technical Soaring, Volume 26, Number 1, January 2002, he documented the evolution of the basic criteria for airworthiness requirements. The author thinks that this work should be extended. Consequently, in the following text, relevant papers found in OSTIV-Publications are quoted. As OSTIV-Publications I through IV are no longer available, scans of the old papers are provided on a CD available from the author.

Document text

Already in OSTIV-Publication I covering papers given at Örebro, Sweden in 1950, L.L.Th. HULS made "Some remarks on glider design and related subjects", see [Lit. 1]. He is asking for a modern version of the Olympia sailplane built to airworthiness requirements internationally agreed. Huls also asks for c.g.-tow release and flutter requirements.

In OSTIV-Publication II, see [Lit. 2], Miha MAZOVEC from Belgrade gives a paper called "Critical Gust". Using theory available at that time, he determines the critical gust gradient. The wing bending deflections under air loads and the "Wagner Effect" are included. The review of this paper shows, that it had an important impact on gust load requirements.

Dr.-Ing. Svetopolk PIVKO gives a calculation method for wing lift distributions of wings of multiple taper and sweep, see [Lit. 3]. The method is based on early publications of V.M. FALKNER (1943), J. ALLEN (1945) and SCHLICHTING and KAHLERT (1948). Horseshoe type vortices are distributed over the wing area.

L.L.Th. HULS asks in his paper "Airworthiness Requirements for Gliders and Sailplanes", see [Lit. 4], to "form a

small working group to prepare a draft for international airworthiness requirements". This seems to be the start for the OSTIV-SDP in 1952. As a start, he compares structural strength requirements of sailplanes certified in GB, France, Germany, Switzerland and U. S. A. Huls also notes the need for flutter prevention and handling qualities.

In [Lit. 5], W. NICOLE shows that airworthiness requirements are based on - mostly bad - experience. He demonstrates the benefits of accident investigation and gives some examples in showing how violent elevator deflections result in increasingly fast pitch rotations with speed. He makes proposals for reduced control inputs at high speeds, which are 40% of the possible deflections for ailerons and elevator and 60% for the possible rudder deflection.

Miloch ILITCH from Belgrade reports in [Lit. 6] about "Determination de l'Angle de Portance Nulle" (Zero Lift Angle). This paper is based on famous literature provided by I. LOTZ 1931, H.A. PEARSON 1937, H. MULTHOPP 1938, FUCHS, HOPF, SEEWALD 1935 and R.F.ANDERSON 1936. The paper gives simple but efficient procedures to cover the subject. It is important to have these data at design stage in order to judge the slipstream effects of the wing to the fuselage and the horizontal tailplane.

In [Lit. 7], Jaroslav KOSER of Ljubljana gives "Measurements of lateral Control Characteristics" and compares them with calculations according to PERKINS and HAGE 1950. He can see the findings of the test pilots with spiral instability confirmed.

B.S. SHENSTONE gives a major report about "Two-Seat Sailplanes" in [Lit. 8] and asks for "good view for the second pilot and to achieve a low all-up-weight" to enable easy ground handling. He favours wing forward sweep and has perhaps influenced development of a new generation of training two-seaters.

The historic excursion on the subject, as well as the data basis given in the aforementioned papers, is complete and demonstrates the diligence of the first chairman of the OSTIV-SDP. Note, [Lit. 2] through [Lit. 8] are scanned and reprinted

from OSTIV-Publication II, papers read 1952 at Madrid, Spain.

[Lit. 9] is a very important paper written in German with the translated title: "Proposal on how to quantify Flying-Qualities in Numbers" which Hans ZACHER read in Buxton, England in 1954. He shows how most important data can be measured in flight by using little and cheap additional equipment in test flights. Quantified Data are laid down for acceptable stalling characteristics, longitudinal stability, desirable stick forces with air speed variation and aileron effectiveness. Criteria are given to judge lateral stability, side slip behaviour, spinning characteristics and take-off and landing performance; a small list of qualitative tests. Comparing what we see in modern requirements like OSTIVAS or CS-22, we can find most of Hans Zacher's proposal still to be valid today.

Another paper given in German, see [Lit. 10], was given by Heinz KENSCHKE, the father of our OSTIV Vice-president Christoph Kenschke. Heinz Kenschke shows the state of the art in sailplane design in 1954, when new construction methods were tried in order to take full advantage of the NACA-6-Series laminar airfoils together with the demand to achieve high cross country speeds. In a parameter discussion, he proposes to use high aspect ratio wings together with increased wing loading. His paper favours a design trend, which continues still today.

In [Lit. 11], given in German, Hans Zacher offers "Some Notes for internationally co-ordinating Airworthiness Requirements". Hans Zacher proposes three Sailplane Categories, Normal, Acrobatic and Special, minimum values for maximum occupant(s) mass and crashworthy seat belt attachment points. He also proposes standardised control handle shapes and positions including a colour code and operation directions for these control handles. From this proposal, almost all survived until today except for the colour scheme for the control handles.

Boris J. CIJAN from Belgrade gives in [Lit. 12a] "Rational Requirements for Tail Boom Design". Boris Cijan shows that tail down landing conditions can be critical for the tail boom, compared to horizontal tail loads and that energy absorption of the tail skid (or wheel) is vital. His proposal to calculate the tail down landing forces of the fuselages has been adapted by OSTIVAS and many other Airworthiness Requirements.

In [Lit. 12b], Mirco JOSFOVIC of Belgrade adds "A practical tabular Method for calculating Fuselage Frames of the semi-monocoque Type loaded by arbitrary vertical Forces". This paper can be regarded as an acceptable method of compliance of relevant forces and structures.

Note, [Lit. 9] through [Lit. 12] are scanned and reprinted from OSTIV-Publication III, papers read 1954 at Buxton, England.

Our long-time SDP-member, Prof. Frank G. IRVING, reports in [Lit. 13] on flight testing of British prototype gliders according to BCAR, Section E, including how tests were performed. The paper shows how many of the BCAR – E re-

quirements regarding flying qualities went into OSTIVAS and other modern airworthiness requirements.

M. PEYER of Bern compares in [Lit. 14] airworthiness categories of airworthiness requirements in Switzerland, Germany, England and France valid at that time and adds some cases where accident investigation resulted in additional requirements and quotes simple flutter analysis according to British and ICAO – Standards, higher loads due to higher control surface deflections and missing requirements about camber changing flaps. It is important that Mr. Peyer weighs the cost for certification against the economic damage which results from accidents.

[Lit. 15] is a paper given in French language by Svetopolk PIVKO, Belgrade, who calculates the effects of wing bending under load to internal stress of the wing bending structure.

Boris J. CIJAN, Belgrade, gives in [Lit. 16] quantitative structural parameters for metal sailplanes in the design stage especially when the sailplanes get heavier and faster. Torsional stiffness requirements for the wings, in order to avoid flutter, may get dominant over strength requirements and gust loads may override manoeuvre loads.

[Lit. 17a] and [Lit. 17b] are papers given by H. NAE-GELE and Richard EPPLER and Dr. Piero MORELLI about aerodynamic and structural design of the FS 24 PHOENIX and the CVT-2 VELTRO sailplanes which demonstrate the state of the art in sailplane design at that time.

In [Lit. 18] Dr. Alberto MORELLI shows solutions for landing gear design of high performance sailplanes. The advantages of (retractable) wheels over skids are discussed as well as the differences in energy absorption required for wheels or skids.

[Lit. 19] is a paper given by four authors, H.C.N. GODHART, F.G. IRVING, D.H.J. INCE and Paul F. BIKLE on handling characteristics of high performance sailplanes. Stability, manoeuvrability, aileron and rudder effectiveness, stalling and spinning characteristics, airbrake characteristics, cockpit assessment and layout are discussed and desirable qualities are quantified, when possible. A high degree of coincidence in opinions is noted, as well as – in retrospect – a great impact on OSTIVAS and other modern requirements can be stated.

Note, [Lit. 13] through [Lit. 19] are scanned and reprinted from OSTIV-Publication IV, papers read 1956 at St. Yan, France.

Conclusions

The author would like to add valuable literature not available from OSTIV which was published at the same time or only little later than OSTIV-Publications I through IV but show the effort needed to cover the impact of atmospheric turbulence to airplanes. This additional literature shows the theoretical background of the gust load formulae we are using still today to calculate the V-n gust envelope. The literature is as follows:

David J. PEERY: "Aircraft Structures", pages 261 through 264, McGRAW - HILL BOOK COMPANY, INC., New York - Toronto - London, 1950.

Bernard ETKIN: "Dynamics of Flight, Stability and Control", pages 310 through 340, John Wiley & Sons, Inc., summarising literature from 1941 through 1958, New York - London.

Heinrich HERTEL: "LEICHTBAU, Flugzeug und andere Leichtbauwerke, Chapter XVIII. Flugzeugbelastungen, pages 511 through 526, SPRINGER-VERLAG, Berlin/Goettingen/Heidelberg, 1960.

D.O. DOMMASCH, S.S. SHERBY, T.F. CONNOLLY: "Airplane Aerodynamics, Third Edition, 1961; PITMAN PUBLISHING CORPORATION, New York - Toronto - London.

Reading and reviewing all literature given above, we can clearly see the dominant influence of OSTIV in harmonising international airworthiness requirements for sailplanes. The effort of ISTUS in setting criteria to select the OLYMPIA-Sailplane and British BCAR-E requirements were the basis to set requirements for handling qualities of sailplanes. V-n manoeuvring envelopes were agreed together with "Sailplane Categories" and V-n gust envelopes were adapted to measured atmospheric turbulence. Flutter and fatigue were open subjects at that time and were on the agenda of the OSTIV-SDP for many years.

Acknowledgements

The author thinks that the work on development of OSTIVAS must be continued and already has the offer for help to do so from Prof. Dr. Jozef GEDEON, Budapest, and Prof. Dr. Josef MERTENS, Aachen, as well as valuable contributions. Thanks must be given to Mr. Richard W. BUTLER, Manchester, TN, for providing both, time and his private library for the author's investigations. Many thanks also to the Honorary OSTIV-President Prof. Dr. Manfred E. REINHARDT and OSTIV-President Prof. Ir. L.M.M. Boermans for providing the first OSTIV-Publications which have suffered from rough treatment during scanning. I am so sorry for that, but we all may get this information now saved and easily copied from modern media.

References

As [Lit. 1] through [Lit. 19] can no longer be ordered in printed form from OSTIV, the author has prepared a CD of this literature. The contents of the CD are available from the author. [Lit. 1] through [Lit. 19] are scanned and reprinted from OSTIV-Publications I through IV with permission of OSTIV-President Prof. Ir. L.M.M. BOERMANS, TU Delft, The Netherlands.