Chapter 7

Pilot Safety

Introduction

277. Pilot error was often quoted as the major cause of accidents in ultralights. Witnesses overwhelmingly supported the introduction of pilot training and certification for all ultralight pilots. Pilot error occurs where a pilot, when confronted by a situation requiring certain action to maintain, regain or optimise control, fails to act or acts inappropriately.[1] Pilot error will then be one of the factors contributing to the outcome of the situation. It is generally accepted that adequate training can prevent a significant proportion of ultralight accidents.

278. Evidence in the area of pilot safety and pilot training, generally concentrated on: pilot error and the stall/spin syndrome; the unique flying characteristics of ultralights; and the unavailability of approved 2-seat training aircraft. Very little evidence was received on: the adequacy of existing pilot training under the AUF Operations Manual; the basic training facilities necessary for instructors; and club training facilities. The Committee believed that this information was vital in assessing pilot safety and commissioned an adviser to report on these areas. Much of the information in this chapter is taken from the advisers report.

[1] Exhibit 13, p. 2.

Pilot Training

279. No pilot training whatsoever is required for pilots of 95.10 aircraft under current regulations. Witnesses agreed that this was a lamentable shortcoming and supported the introduction of adequate ultralight pilot training for all pilots. Despite continual reference in the early AUF evidence about total freedom to pursue a chosen sport,[2] the AUF identified the most important area of concern in relation to ultralights as pilot training.[3] Later evidence given by the AUF emphasised the desire for compulsory pilot certification for both the 95.10 and the 95.25 category.[4]

280. Pilots of 95.25 aircraft are required under the legislation to be certificated to the standard specified in the AUF Operations Manual. Section 25 specifies that prior to the issue of a pilot certificate, an applicant must pass an examination by the Chief Flying Instructor (CFI) on Basic Aeronautical Knowledge. It lists 10 topics which must be included in the examination and recommended study references.

281. Considerable evidence exists that untrained pilots cannot adequately appreciate the risks involved in ultralight flight, despite assertions that ultralight enthusiasts acknowledge and accept the risks involved.[5] The AUF Manual quotes that "of 61 serious ultralight accidents up to June 1985, over 65% were 'Stall', 'Stall/spin' or 'Loss of control accidents' ".[6]This indicates the lack of even a basic understanding, by pilots, of the aerodynamic characteristics of the aircraft concerned. Advice was received by the Committee that any stalled condition of flight or any loss of control situation is simple to avoid with knowledge and training. It is almost always a function of maintaining airspeed.[7]

282. All witnesses agreed that the safe flying of ultralights and avoiding danger is a matter of training. The Committee can see no reason for a

[2]Evidence, p. 424.
[3]Evidence, p. 431.
[4]Evidence, p. 1140.
[5]Evidence, p. 429.
[6]Exhibit 13, p. 15.
[7]Exhibit 13, p. 15.

category of ultralight operations for which pilot certification is not required and therefore recommends that:

> **all ultralight pilots be required to be certified to the standards specified in the AUF Operations Manual.**

283. The Committee would encourage manufacturers to also be responsible in this area, by informing purchasers of ultralight aircraft of the pilot licensing requirements.

284. Flight training and theory requirements in the AUF's Flying Training Syllabus appear comprehensive and adequate in the interests of safety. Evidence indicates that the flight training syllabus and facilities offered by the AUF are proving to be effective. According to AUF Secretary, Mr John McAuley, the Pilot Training Program is operating smoothly and the AUF is pleased with the volume of student pilot applications.[8] The publication of an AUF instructor manual is imminent.

285. During the Inquiry, the Committee became aware of a proposed new category of pilot licence derived from the American-style recreational pilots licence[9], called the "Recreational Private Pilots Licence". The Department of Aviation has considered the general principle of simplifying certain aspects of the Private Pilot Licence Syllabus and creating a new class of licence covering aircraft from ultralights up to a light four-seater such as the Cessna 172. Operations would be restricted to uncontrolled airspace and possibly below 5,000 feet altitude.[10] Although this proposal is still in the evaluation stage, it may provide opportunities for lifting of some of the current operational restrictions for ultralights in relation to airports and controlled airspace. The Committee will be closely following the development of the "recreational licence".

[8] Australian Ultralight Federation, *Newsletter No. 12*. October 1986, p. 1.
[9] Evidence, p. 287.
[10] Exhibit 13, p. 3.

2-Seat Training

286. The slowly increasing availability of certified 2-place training aircraft, essential for ultralight training, is proving to be the major factor in educating existing and aspiring aircraft operators. It has been mentioned elsewhere that it took one year for the first 2-seat training aircraft to receive approval and until October 1986 for the second approval. There are currently only 37 2-seat aircraft which have been approved. The Committee can only re-emphasise the urgent need for adequate numbers of training aircraft. One of the Committee's major concerns throughout the Inquiry has been the lack of legal 2-seat trainers.

287. Some training is still occurring in single seat aircraft, but this practice is declining as 2-seaters become available and as the AUF's training program is implemented.[11] In June 1984, an AUF survey indicated that two thirds of pilots were self-taught.[12] The Committee was deeply concerned throughout the Inquiry that ultralight pilots were learning to fly by making short hops in a paddock, followed by a solo maiden flight. The Committee believes that training in single-seat aircraft is inherently dangerous and discourages the continuation of the practice. The Committee urges the DoA to make approval of 2-seat aircraft a priority, so that the training situation continues to improve.

288. The superior training received in a 2-seat aircraft, with an experienced instructor, over single-seat teach-yourself training, was widely acknowledged. However, the Committee heard that due to the lack of approved 2-seat aircraft, illegal, unapproved 2-seat aircraft were being used for training.[13]. Whilst training in uncertified aircraft is potentially unsafe, the Committee was told that there had been no accidents resulting from such training.[14] The Committee was unable to verify this claim from the evidence presented. Suggestions were made that ultralight pilots train in general aviation aircraft,[15] however the witnesses generally agreed that there were inherent performance differences between GA aircraft and ultralights

[11] Exhibit 13, p. 35.
[12] *Aircraft*, June 1984, p. 50.
[13] Evidence, p. 602
[14] Evidence, p. 602.
[15] Evidence, p. 111.

and that ultralight training should take place in ultralight aircraft. The Committee's adviser confirmed this, as did the numbers of licensed pilots involved in ultralight accidents.

289. The Committee heard that imported 2-seat training aircraft, shown to be safe overseas, were not being accepted by the DoA for training in Australia.[16] The benefits of accepting overseas aircraft without proof of airworthiness, may be offset by the safety risk they present. Although the Committee sees an urgent need for 2-seat training aircraft, it cannot sanction the importation of overseas aircraft

Training of Pilots Holding Existing Licences

290. Many ultralight accidents have involved ultralights flown by licensed private pilots. According to the DoA "some pilots - particularly those with experience in General Aviation Aircraft - believe that flying an ultralight is relatively easy. This is a mistaken and dangerous notion."[17] Due to the unique handling requirements of ultralights, their light weight, susceptibility to wind gusts, low power and low speed; general aviation experience is not necessarily completely transferable to ultralights. The Department of Aviation, Queensland Region, told the Committee that over a period of approximately 2 years, it examined seven fatal accidents, and found that in all of those accidents the pilots involved were licensed.[18] One accident involved a Chief Flying Instructor who had 5,000 hours of flying experience. The Queensland Region attributed the majority of accidents to the combination of the light weight, low speed and low power of ultralights, but believes training will overcome most of the problems.

291. A US safety study[19] found a similar problem. Statistics indicated that "42 per cent of the ultralight operators involved in the fatal accidents held pilot certificates issued by the FAA [Federal Aviation Administration]" and "of the certificated pilots killed in ultralights, 96% had more than 50 hours of total flying experience." The US evidence also indicated a possible

[16] Evidence, p. 200.
[17] Department of Aviation, *Aviation Safety Digest* 124, p. 6.
[18] Evidence, p. 1016.
[19] NTSB, p. 7.

relationship between the amount of flying experience in a specific make and model ultralight and the ability to operate it safely.

292. The statistics indicate that an appreciation of the flying characteristics of ultralights requires knowledge beyond the admittedly extensive training appropriate to the Private Pilot's Licence (PPL). Some conversion training is definitely required, especially in emergency procedures where ultralight performance is dramatically different to regular light aircraft. Such areas would include stall/spin training, familiarisation with the flying characteristics of an ultralight, flight in unfavourable conditions (wind and turbulence) and some theory training of ultralight regulations. The Committee therefore recommends that:

> **the AUF, in consultation with the Department of Aviation, compile a short training program appropriate to pilots who hold existing licences, emphasising the different flying characteristics of ultralights and appropriate emergency procedures.**

Instructor Training

293. As this area was not adequately addressed by witnesses, the Committee referred the matter to its adviser, who holds a Grade 2 Instructor Rating and who has been involved in design evaluation flying and test flying for ultralight aircraft.

294. The Committee was informed that instructor qualifications are currently granted, under Section 21 of the AUF Manual, on the basis of a flight test assessed by an examiner who remains on the ground. In general aviation, candidates for Flight Instructor Rating (Aeroplanes) are required to demonstrate not only competent technique in aircraft handling, but more importantly a command of sound instructional ability. The Committee accepts that it is difficult to see how these qualities can be adequately assessed by an examiner who observes from the ground.[20] In the NSW Region, at least, examiners are requiring appropriate dialogue and demonstration of sound instructional techniques before certifying instructor candidates.

[20] Exhibit 13, p. 19.

295. *Instructors do not receive any formal training before beginning to teach student pilots.* The Committee agrees with the adviser that the unfavourable learning environment a flying ultralight provides and the technical nature of much of the theory, makes it essential that instructors receive some formal training. Other sports aviation activities require some training for instructors. For example, to become a parachute instructor with the Australian Parachute Federation, the candidate must possess certain licence qualifications, be recommended by two senior instructors, undergo a course of instruction and pass written, oral and practical examinations.[21] The Committee believes that formalised instructor training for ultralights is essential.

296. The Committee was advised that an ultralight training syllabus should include:

- effective instructional techniques, both ground-borne and airborne;
- development of appropriate dialogue or "patter" for all basic training sequences, and coordinating this with polished demonstrations;
- analysis and correction of common student faults;
- practising pre-flight briefings and post-flight de-briefings; and
- establishing the appropriate high standard of theoretical knowledge, not only of the basic aeronautical knowledge subjects, but also all relevant operational, emergency and procedural matters.

297. At the very least, there should be compulsory seminars for instructor candidates incorporating discussion of the abovementioned items, with certification subject to attendance at the seminars. Preferably, instructors should be formally trained. A two week full-time training program conducted at an ultralight flying school, run either by the AUF or by a flying school or schools approved by the AUF under the auspices of a Chief Flying Instructor, would offer a basic cover of essential items.[22]

[21] Evidence, p. 354.
[22] Exhibit 13, p. 35.

298. The Committee believes that formal training should be introduced so that the abilities of an instructor candidate can be assessed. The Committee believes that the existing requirements for certification of pilot instructors are insufficient to ensure a high standard of instruction. Increasing the safety standards of ultralights depends greatly on the quality of instruction received by its pilots. The Committee recommends that:

> **Section 21 of the AUF Operations Manual be amended to require the pilot instructor candidate to demonstrate competency in aircraft handling and a command of sound instructional ability before certification as Pilot Instructor.**

299. Additionally, the Committee believes that high safety standards will only be maintained if instructors are formally trained and accordingly recommends that:

> **the AUF prepare and implement a syllabus, in consultation with the Department of Aviation, for a formal instructor certification training course of a least 2 weeks duration which incorporates effective airborne instructional techniques and an appropriate level of operational, emergency and procedural spin/stall training.**

300. There was disagreement amongst witnesses about the value of spin training. The Department recommends against spin training but apparently, according to an AUF Newsletter, gave its approval because the AUF National Flying Coach was so insistent.[23] Ultralights are forbidden by regulation to spin. The AUF, along with most of the ultralight community, believes that spin training "should be part of the pilot training for ultralights,"[24] because spinning is part of the inherent behaviour of the aircraft.

301. In general aviation, spin training has been removed but "aeroplanes still spin in".[25] Spin training is part of the training course for gliders.[26]

[23] *AUF Newsletter No. 12*, p. 11.
[24] Evidence, p. 578.
[25] Evidence, p. 431.
[26] Evidence, p. 432.

Committee Members observed gliders in spin training at an inspection at the Adelaide Soaring Club, Gawler, South Australia. Gliding instructors told the Committee they were convinced of the benefits of spin training experience.

Figure 7.1: *Mr Geoff Wood, Chief Flying Instructor, Geelong Ultralights, explaining training features to the Chairperson, Mrs Elaine Darling, MP.*

302. Similarly, training can teach a pilot to recognise the onset of a stall and take appropriate action. Advice provided to the Committee maintains that no aircraft, except one with the narrowest imaginable performance envelope, will encounter an aerodynamic stall as an immediate result of a loss of power. Provided sufficient elevator control is present the pilot can, with or without power, set and maintain a flight altitude which will keep the aircraft's speed safely above the stall speed. Inadequate response or response rate may lead to a stall. Even after a stall occurs, if the pilot takes the appropriate control action he can regain flying speed and make a successful forced landing. If the onset of a stall is not recognised, or the response is incorrect, the stall may rapidly develop into a spin. The Committee believes that avoiding or recovering from the stall/spin is a matter of training.

303. One proposal was that spin training be made optional, to be recommended by the National Flying Coach if he wished, but not mandatory.[27] On the basis of the evidence before the Committee and the opinion of the adviser, the Committee believes that spin/stall training in 2-seat training aircraft will increase the safety standard of ultralight aircraft. It is therefore recommended that:

> **current legislation be changed to legalise spin/stall training for ultralights and that spin/stall training in 2-seat aircraft be incorporated into the flight training syllabus of student pilots.**

Pilot Error

304. Pilot error occurs where a pilot is confronted by a situation, normal or emergency, and either fails to act or acts inappropriately. Much of the evidence suggested that training would eliminate pilot error and hence the majority of ultralight accidents.

305. The Hang Gliding Federation of Australia told the Committee that accidents were basically caused by pilot error and equipment failure and that by far the greatest number of hang-gliding accidents occur due to misjudgements by the particular pilot.[28] The Gliding Federation of Australia estimated the ratio of pilot related accidents to airworthiness accidents at about 45:1.[29] According to most witnesses, the major safety risk in relation to ultralights was the pilot, not the aircraft. The AUF claims that all the statistics the Department has put out in relation to ultralight accidents indicate the existence of pilot error. They claim that, apart from one exception, every aircraft failure accident can be attributed in some way to the pilot overstressing the aircraft.[30]

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[27] AUF Newsletter No. 12. p. 11.
[28] Evidence, p. 529.
[29] Evidence, p. 340.
[30] Evidence, p. 423.

306. One witness disagreed saying there was no such a thing as pilot error — aircraft design error was the thing that killed people.[31] The Committee believes that pilot error exists and is still the most common single factor in aircraft accidents.[32] The Bureau of Air Safety Investigation's accident summaries attribute many accidents to pilot misjudgement, improper operation of controls, poorly planned approach, loss of control of aircraft by pilot, aircraft stalls etc.[33]

307. The Committee concludes that pilot error has contributed to a considerable number of ultralight accidents and that the solution is adequate and comprehensive training. The Committee is confident that the increasing availability of approved 2-place training aircraft and the AUF's pilot training program are increasing the competence of ultralight pilots and the general safety standard.

Club Facilities

308. The evidence presented to the Committee contains very little current information, partly because ultralight clubs are new, small and widespread; and partly due to state differences. There are many types of ultralight clubs and their size, nature and facilities vary markedly.

309. Information provided to the Committee by the AUF Operations Manager, Mr Bill Dinsmore,[34] indicated that, until recently, clubs have largely been a "loose collection of individuals" who owned a single-seat ultralight but had no formal club structure. Some clubs are formed by a group of people who have come together with the express purpose of buying one or more aircraft and sharing the cost.

310. Generally there are no facilities for non-members or people who do not own their own aircraft. Members are responsible for maintenance of

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[31] Evidence, p. 779.

[32] Exhibit 13, p. 2.

[33] Bureau of Air Safety, Accident and Incidents Data Recording System — Condensed Report, 6 November 1986.

[34] AUF, Supplementary Information, 10 November 1986.

their own aircraft.

311. The AUF is now experiencing a steady growth in membership and the Committee believes the club situation is improving. Ideally, clubs should have rules and facilities and should be well equipped for training, maintenance and advice. Establishment of the pilot training scheme and the fact that the AUF can now offer benefits such as comprehensive insurance,[35] is likely to strengthen the club situation and encourage some of those older pilots, who have so far been reluctant to become AUF members, to join.

312. At a meeting between the Committee and ultralight representatives in Melbourne on October 6, 1986, the Committee was pleased to hear that 48 clubs were now affiliated with the AUF and a further 50 or so are likely to become affiliated.

313. Whilst the club situation to date has been poor, the Committee is encouraged by the progress being made by the AUF in this area and is confident that with further approvals of 2-seat training aircraft, many more clubs could offer more adequate facilities. Each club should possess at least one approved 2-seat aircraft, a qualified training instructor, a safety education program, maintenance facilities and advice, in order to ensure the continued improvement in ultralight safety.

Conclusion

314. The Committee concluded that whilst the current overall level of pilot safety is inadequate, adequate standards and procedures are now in place to ensure a continuing increase in the safety level. The pilot training syllabus is adequate for pilots engaging in recreational flying, but a higher standard of training would be necessary for non-recreational uses of ultralights. The Committee believes it is essential that ultralight instructors undergo a formal testing process and formal instruction before qualification, to ensure that long term training requirements are met. With a few exceptions, club facilities will need substantial organisational and administrative improvement. However, the Committee feels that improvements are

[35] Evidence, p. 1145.

currently being made and suggests that the AUF examine the club structure and facilities offered by the Gliding Federation of Australia and the Hang Gliding Federation of Australia.

Chapter 8

Safety of Other Classes of Sports Aviation

Introduction

315. With the exception of ultralights, the various classes of sports aviation activity showed no significant safety problems which the Committee felt warranted detailed examination. The Department of Aviation and the relevant national sporting bodies agreed that safety levels were generally high. Whilst some safety problems were identified, the relevant organisations were taking appropriate steps to overcome the problems. Frequently during the Inquiry, the regulatory, administrative and operational, arrangements of the Gliding Federation of Australia and the Hang Gliding Federation of Australia were used as models for the struggling ultralight movement.

Ballooning

316. The national body is the Australian Ballooning Federation (ABF) with approximately 300 members. It is estimated that there are 90 thermal balloons and one gas balloon in Australia, but the actual level or frequency of ballooning activity is unknown.

317. Sports ballooning activity must be in accordance with ANO 95.54 and ANO 100.54, which restrict activity to below 10,000 feet in visual meteorological conditions and outside controlled airspace. The operation of balloons on a commercial basis is governed by a separate ANO, ANO 95.53.

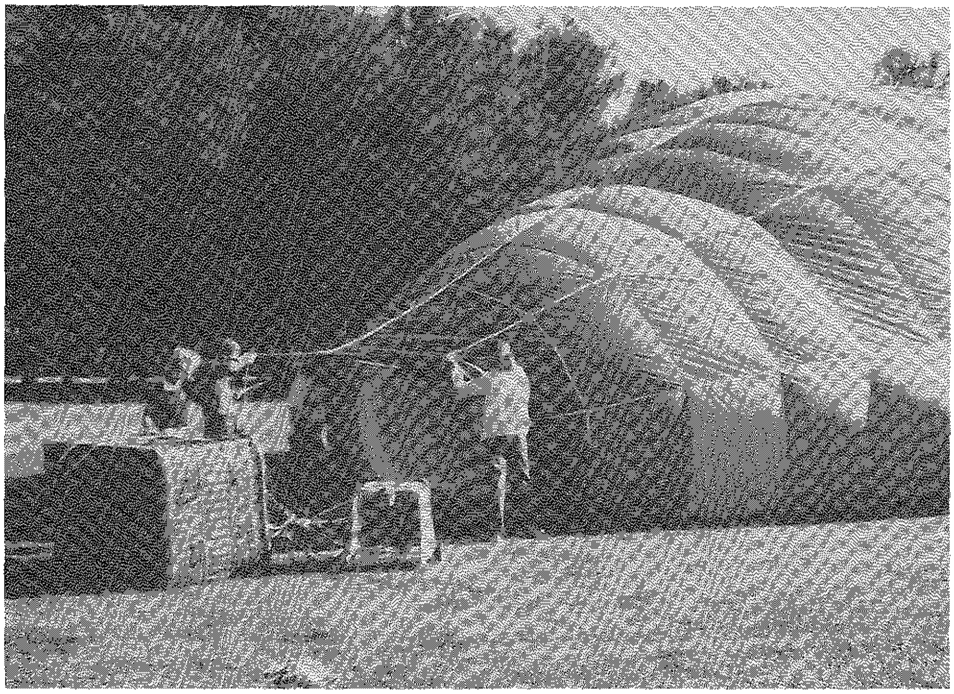

Figure 8.1: *The Committee inspecting hot-air ballooning at Seppeltsfield, SA.*

318. Training and operational standards have been devised by the ABF in consultation with the Department of Aviation. The ABF has responsibility for pilot training and certification, through power delegated to it by the DoA. Self-regulation for this sport experienced some minor problems, but is now in place. [1]

319. Ballooning has an excellent safety record with only 3 accidents recorded, none of which involved fatalities, in the past 5 years.[2]

[1]Evidence, p. 867.
[2]Evidence, p. 18.

320. The ABF enjoys an excellent relationship with the Department of Aviation and is satisfied that its input into the regulations has been given every consideration.[3]

Gliding

321. The national body of gliders in Australia is the Gliding Federation of Australia (GFA) with a membership of 4,437. GFA members operate 1,005 registered gliders, with 600 to 700 active at any one time. Gliders may be registered as aircraft.[4]

322. The regulations governing gliding are contained in ANO 95.4, which require gliders to be operated and maintained in accordance with the rules, orders, directions, standards and operational procedures of the GFA, as set down in their Manual of Standard Procedures. There are also Flying Operations Instructions which contain the Department of Aviation's policy on glider operations. GFA reports generally good relations with the DoA, having a DoA officer permanently seconded to GFA as a Technical Liaison Officer, who contributes to safety promotion.

323. The GFA has a complex organisational structure which has proven itself effective in terms of cost, administration and safety. The DoA often uses the Gliding Federation as a shining example of self-regulation and safety promotion. The GFA has produced a number of working documents which are used by gliding clubs all over Australia. [5] These include:

- Manual of Standard Procedures. Part 1 — Administration (Admin);
- Manual of Standard Procedures. Part 3 — Airworthiness (Air);
- Rules of the Air for Glider Pilots;
- Gliding Instructor's Hand Book; and
- Sporting Code — Gliders. (Section 3 Class D of FAI code).

[3]Evidence, p. 865.
[4]Evidence, p. 27.
[5]Evidence, p. 332.

324. The Department has delegated significant powers to the GFA, for example, the administration of first of type procedure for kit-built or plan-built aircraft,[6] and an airworthiness system which functions in a delegated capacity.[7]

325. Safety standards have been reasonably high, despite the fact that the Department estimates the fatality rate to be about double that for general aviation.[8] The GFA is taking steps to improve training of instructors through a series of flight safety seminars in all states.[9] The Committee was impressed with the professional manner in which the Gliding Federation operates.

Hang Gliding

326. The national body is the Hang Gliding Federation of Australia (HGFA) with 1382 members. The actual number of hang gliders in Australia is unknown. Hang-gliding activity is governed by ANO 95.8 which, among other things, generally restricts hang gliders to operate below 300 feet above ground level, with some concessions allowing operations up to 9,500 feet above sea level in certain areas.[10]

327. A recent development is the introduction of powered hang gliders, which are the result of the combination of the latest hang-gliding design with a suspended trike, containing the pilot, the propulsion unit and the wheeled landing gear. Powered hang-gliders have many similarities to ultralights.

328. The safety record is difficult to determine because not all accidents are reported and the extent of hang gliding is not accurately known. In the 5 year period from 1980 to 1985 there were 45 reported accidents involving 12 fatalities. There is some agreement that hang gliding in its early days had severe safety problems similar to those currently being experienced by

[6] Evidence, p. 349.
[7] Evidence, p. 346.
[8] Evidence, p. 28.
[9] Evidence, p. 331.
[10] Evidence, p. 32.

ultralights. For example, the majority of hang gliding accidents occur due to pilot misjudgements.[11] Safety improved substantially with the establishment of HGFA in 1978, a design change in hang gliders which makes them safer in pitch and structure,[12] the HGFA's recognition by DoA and the development of training and operations procedures. It was claimed that similar steps would overcome the current ultralight safety problems.

329. The Department of Aviation is satisfied that arrangements made by HGFA for training and operations are satisfactory, and is considering delegating significant powers to the Federation, along the same lines as for the GFA.

Parachuting

330. There were 5,833 registered members of the Australian Parachuting Federation (APF) in 1984. It is estimated that 120,000 jumps were performed in 1984. Parachuting is governed by ANO 29.1 and Flying Operations Instructions 24.1 and 24.2. Parachutes are manufactured to standards laid down in ANO 103.18 and must be maintained in accordance with the regulations. The APF controls and conducts all parachute training in accordance with its DoA approved manuals.[13]

331. Powers have already been delegated to the APF, for example, responsibility for the certification of all parachutists.[14] The APF is increasingly being asked to act in disciplinary matters normally handled by the Department.

332. The safety record of parachuting has improved since 1974 with an overall decrease in the number of fatalities in spite of the dramatic increase in the number of jumps each year. Within the APF there is a National Director of Safety who co-ordinates and supervises 10 Area Safety Officers and 46 Drop Zone Safety Officers. There is random surveillance by DoA

[11] Evidence, p. 529.
[12] Evidence, p. 542.
[13] Evidence, p. 37.
[14] Evidence, p. 364.

officers of the APF's activities to ensure safety procedures and promotion is satisfactory. The APF enjoys a very good working relationship with the Department.[15]

Gyroplanes

333. There are approximately 150 gyroplanes in Australia. The national body is the Australian Sport Rotorcraft Association (ASRA) with a current membership of 350. Gyroplane activity is controlled by ANO 95.12 which restricts such activity to private property only. All gyroplane operations are required to comply with the ASRA Operations Manual. As with ultralights in the 95.10 category, gyroplanes are not required to meet formal airworthiness or maintenance standards, although a Manual of Operations has now been approved by the Department.

334. ASRA is responsible for all aspects of safety promotion. In the period 1980 to 1985 there have been 13 reported gyroplane accidents including 6 fatalities. In three of those fatalities, ASRA told the Committee that the student *"completely and utterly abandoned any advice . . . and proceeded to do something which has led him into that situation"*[16] The accident rate is reducing dramatically, mainly due to increased education. Two-seat training should further improve the safety record. ASRA was at the time of its hearing, awaiting delivery of a two-seat trainer.[17]

335. The lack of an airworthiness standard for gyroplanes disturbs the Committee. For similar reasons as apply to ultralights, the Committee cannot see any reason for the existence of this aircraft category without any airworthiness requirements. This applies particularly to a category which does not have an enviable safety record. A basic airworthiness standard, developed by the DoA and ASRA, would satisfy the Committee that safety of this form of sports aviation is assured.

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[15] Evidence, p. 364.
[16] Evidence, p. 562.
[17] Evidence, p. 570.

Model Aircraft

336. The Model Aeronautical Association of Australia (MAAA) has 6,000 members flying a variety of small free flight gliders and remote-controlled powered model aircraft. Flying must be in accordance with ANO 95.21 and the MAAA Manual of Procedures, which has received DoA approval.[18]

337. Safety promotion is done entirely by MAAA and to date no accidents involving injury to the public have been reported. Safety is promoted at club level, state level and national level There is a very strong emphasis on safety and safety promotion at all levels.[19] Each club has a safety officer, pilots must demonstrate full control of their aircraft before being able fly solo and aircraft are checked for airworthiness. The standard of controls and instruction ensures a high level of safety.

338. The MAAA enjoys a very good relationship with the Department and believes it had considerable input into the regulations.[20]

Aerobatics

339. The national body is the Australian Aerobatic Club. Current membership is not known precisely. To perform aerobatics, pilots must be licensed, suitably qualified and competent and undergo and examination by a DoA Examiner of Airmen. Most pilots are only certified to do aerobatics above 3,000 feet, but some skilled pilots may obtain approval to do aerobatics below that height. Passengers are prohibited on all aerobatic flights below 3,000 feet.

340. In the five years to June 1985 there have been 3 accidents resulting in 4 fatalities. All of these accidents occurred during unauthorised aerobatics or when the pilot was flying below the minimum height for which he had approval. However, the Department polices unauthorised aerobatics and accidents occurring in authorised aerobatics is very low.

[18] Evidence, p. 35.
[19] Evidence, p. 810.
[20] Evidence, p. 810.

Conclusion

341. The general safety levels for the various classes of sports aviation activity mentioned in this chapter are adequate. Whilst some problem areas were identified by the Committee, the relevant organisations were taking appropriate measures to raise the safety standards.

342. No real dispute was raised in relation to regulatory arrangements and funding and most of these sports aviation bodies enjoyed a good working relationship with the Department of Aviation. The Committee sees no reason to recommend changes to either regulatory or administrative arrangements. Neither the DoA nor any of the national sports aviation organisations identified any significant safety or administrative problems.

Chapter 9

Conclusions

343. The Committee finds the overall level of sports aviation safety to be adequate. The exception is the safety of ultralight aircraft. Whilst the level of ultralight safety could not be quantified, due to the lack of complete statistical data, serious deficiencies were found in aircraft safety and pilot safety.

344. The Committee considers the current ultralight regulations inadequate to promote safety. The Committee cannot sanction the continuation of an aircraft category which has no airworthiness or design requirements. To ensure aircraft safety, all aircraft will need to meet basic airworthiness and safety standards. These standards should also address the safety of the pilot, whose safety is presently ignored by the regulations. There should be a greater consistency between sports aviation ANOs, rather than the current proliferation on an ad hoc basis.

345. The current level of ultralight pilot safety and instructor training is inadequate. Until recently, 2-seat training for ultralight pilots was virtually non-existent. The Committee believes that adequate training standards and procedures are now in place to ensure a continuing increase in the safety level. Instructors, who currently receive no formal training, should undergo a formal testing and training process before beginning to teach students.

This will ensure that long term training and safety requirements are met. There is also much room for improvement in AUF club facilities and services. The continued injection of funding and encouragement from the Department of Aviation is required to bring facilities to the level of other sports aviation bodies.

346. Significant problems were found to exist in relation to ultralight accident investigation and the release of accident information to the ultralight community. Ultralight accident investigation receives a very low priority in relation to other aircraft. Release and dissemination of the results of accident investigations, which are designed to prevent similar future accidents, has been poor. The Committee finds many of the problems stem from the central office of the Department of Aviation rather than from regional offices. A re-allocation of priorities within the DoA and the implementation of an efficient accident notification scheme is essential.

347. Many difficulties were evident in the self-regulation of the ultralight movement, which eventually resulted in a serious communication breakdown. A regulatory impasse had developed between the Department and the AUF, due to a combination of: a naive and unstable ultralight movement; unreasonable departmental expectations; and a lack of consultation between the DoA and AUF. Conflicting perceptions of ultimate responsibility resulted in almost no enforcement of the regulations in relation to illegal and unsafe aircraft. Compulsory aircraft registration, clearly delineated responsibilities and widespread consultation should overcome the major problems and ensure regulatory and safety standards are acceptable to both parties.

348. The Committee finds that whilst the Department has apparently co-operated with other sectors of sports aviation, it has demonstrated a lack of responsibility in ensuring the safety of ultralight aircraft. It has taken virtually no action against aircraft which were drawn to its attention as unsafe and which were involved in a number of accidents, under the guise of being unsure of its legal powers.

E.E. DARLING
Chairperson

28 January 1987

Appendix A

Conduct of the Inquiry

On 1 April 1985 the Minister for Aviation asked the Committee to inquire into and report on the safety of sports aviation activities, particularly ultralights.

The Inquiry was advertised nationally on 3 and 4 May 1985. The Committee also wrote to all state governments, relevant Commonwealth departments and industry bodies. A total of 64 submissions were received.

Commencing on 6 November 1985, 10 public hearings were held in all capital cities except Hobart, over 1100 pages of evidence were taken and 51 witnesses appeared before the Committee. A list of witnesses who appeared before the Committee is given at Appendix B.

Evidence given at the public hearings is available for inspection at the Committee Office of the House of Representatives and the National Library of Australia.

The Committee wishes to thank Mr Kirrell Bolonkin from the Department of Aviation, who although not appearing as a witness provided much additional information at short notice and who was helpful at all times.

Many of the photographs appearing throughout the report are by courtesy of Mr Greg Adkins. The Committee thanks him for his time and patience.

The Committee also wishes to thank Ms Monica Telesny who prepared this report and thanks the Secretary Mr Allan Kelly.

Appendix B

List of Witnesses

AUBURY, M.B.	Principal Structures Engineer, Airworthiness Branch, Flight Standards Division, Department of Aviation, Canberra, Australian Capital Territory, (19 March 1986) pp. 681-729, (22 October 1986) pp. 1004-1110.
BAMFORD, G.R.	President, Lightweight Aircraft Association, PO Box 382, Abbotsford, Victoria, (5 February 1986) pp.193-201.
BIRRELL, R.P.	President, Australian Ultralight Federation, PO Box 105, Young, New South Wales, (22 October 1986) pp. 1111-1153.
BRANDON, C.	Chief Instructor, Airborne Windsports Pty Ltd, 280 Charlestown Road, Charlestown, New South Wales, (6 February 1986) pp. 575-598.
BURNS, M.P.	Chief Technical Officer, Airworthiness, Gliding Federation of Australia, 130 Wirraway Road, Essendon Airport, Victoria, (5 February 1986)pp. 318-350.
BURNS, T.M.	Senior Inspector, Sport Aviation, Flight Standards Division, Department of Avi-

	ation, Canberra, Australian Capital Territory, (22 October 1986) pp. 1004-1110.
CAMPBELL, R.	Secretary, Ultralight Aircraft Division, Sport Aircraft Association of Australia, 265 Queens Parade, Clifton Hill, Victoria, (5 February 1986)pp. 202-245, (22 October 1986) pp. 1111-1153.
CANT, L.R.	Secretary, Aeromodellers WA Inc., 15 Lincoln Street, Highgate, Western Australia, (24 March 1986) pp. 807-817.
CAVELL, P.E.	Secretary, Amateurbuilt Aircraft Division, Sport Aircraft Association of Australia, 265 Queens Parade, Clifton Hill, Victoria, (28 April 1986) pp. 947-963.
CHANDLER, R.A.	Technical Director, Amateurbuilt Aircraft Division, Sport Aircraft Association of Australia, 265 Queens Parade, Clifton Hill, Victoria, (28 April 1986) pp. 947-963.
CHOQUENOT, P.	Director, Bureau of Air Safety Investigation, Canberra, Australian Capital Territory, (22 October 1986) p. 1044-1110.
CLARKE, M.A.	Managing Director, Elite Aircraft, 2 Yardley Drive, Mulgrave, Victoria, (5 February 1986) pp. 295-317.
COLLINS, R.K.	National Examiner, Australian Parachute Federation Ltd, 14 Balcombe Road, Mentone, Victoria, (5 February 1986) pp. 351-376.
CREER, B.P.	Training Co-ordinator, Training Committee, Queensland Flyers Association,

	12 Dinsmore Street, Moorooka, Queensland, (6 November 1985) pp. 103-122.
D'ARCY, N.T.L.	Member, Pastoral Committee, Pastoralists and Graziers Association of Western Australia Inc., 789 Wellington Street, Perth, Western Australia, (24 March 1986) pp. 744-806.
de LISSA, J.	Chairman, Basic Flying Machines Pty Ltd, "Clifton", Manildra Road, Molong, New South Wales, (6 February 1986) pp. 599-618.
DICKSON, I.L.	Federal President, Sport Aircraft Association of Australia, 265 Queens Parade, Clifton Hill, Victoria, (28 April 1986) pp. 947-963, (22 October 1986) pp. 1111-1153.
DINSMORE, W.M.	Operations Officer, Australian Ultralight Federation, Young, New South Wales, (6 February 1986)pp. 395-524, (22 October 1986) pp. 1111-1153.
DROWLEY, E.G.	Technical Secretary, Model Aeronautical Association of Australia, 6 Coppelius Close, Sunbury, Victoria, (28 April 1986) pp. 964-1003.
DUNCAN, R.	Manager, Airborne Windsports Pty Ltd, 280 Charlestown Road, Charlestown, New South Wales, (6 February 1986) pp. 575-598.
DUNN, M.D.	Assistant Secretary, Airworthiness Branch, Flight Standards Division, Department of Aviation, Canberra, Australian Capital Territory, (19 March 1986) pp.681-729, (22 October 1986) pp. 1004-1110.

FARQUHARSON, P. — *Assistant Regional Director, Flight Standards*, Department of Aviation, Brisbane, Queensland, (8 October 1986) pp. 1006-1041.

GILES, R.O. — 125 RAAFA Estate, Bull Creek Drive, Bull Creek, Western Australia, (24 March 1986) pp. 818-840.

GRAHAM, A.D.B. — Chairman, Composite Industries Ltd, 44 St Georges Terrace, Perth, Western Australia, (24 March 1986) pp. 744-806.

GRAHAM, N.D.B. — Managing Director, Composite Industries Ltd, 44 St Georges Terrace, Perth, Western Australia, (24 March 1986) pp. 744-806.

HANSON, P.L. — National Director, Australian Ballooning Federation Ltd, PO Box 95, Glen Osmond, South Australia, (25 March 1986) pp. 864-881.

HEFFERNAN, P.J. — President, Amateurbuilt Aircraft Division, Sport Aircraft Association of Australia, 265 Queens Parade, Clifton Hill, Victoria, (28 April 1986) pp. 947-963.

HUGHES, B.F. — 92 Worendo Street, Southport, Queensland, (6 November 1985) pp. 142-189.

KAY, A.G. — National President, Australian Sport Rotorcraft Association, 7 Cabena Street, Donvale, Victoria (6 February 1986) pp. 554-574.

KILLMIER, R.E. — Deputy Commissioner, South Australian Police Department, 1 Angas Street, Adelaide, South Australia, (25 March 1986) pp. 843-863.

KREMKE, M.	Managing Director, West Australian Aircraft Company, 15 Lynwood Avenue, Ringwood, Victoria, (5 February 1986) pp. 377-396.
LEACH, J.G.	Treasurer, Ultralight Aircraft Division, Sport Aircraft Association of Australia, 265 Queens Parade, Clifton Hill, Victoria, (5 February 1986) pp. 202-245.
	(also appeared as Vice-President, Australian Ultralight Federation, PO Box 105, Young, New South Wales, (22 October 1986) pp. 1111-1153.)
LLEWELLYN, D.J.	ex-Airworthiness Officer, Australian Ultralight Federation, Young, New South Wales, (6 February 1986) pp. 395-524.
McAULEY, J.	Secretary, Australian Ultralight Federation, Young, New South Wales, (6 February 1986) pp. 395-524.
McGREGOR, R.J.	Inspector, Air Safety, Brisbane Field Office, Bureau of Air Safety Investigation, Department of Aviation, Brisbane, Queensland, (8 October 1986) pp. 1006-1041.
MARKEY, G.F.	President, Australian Ultralight Federation, Young, New South Wales, (6 February 1986) pp. 395-524.
MATTHEWSON, E.P.	Secretary, Hang Gliding Federation of Australia, Suite 508, Sports House, 157-161 Gloucester Street, Sydney, New South Wales, (6 February 1986) pp. 525-553.
MATTSSON, B.A.	Co-ordinator of Recreation Development, South Australian Department of Recreation and Sport, Adelaide, South Australia, (25 March 1986) pp. 843-863.

MOHRING, C.	Secretary, Lightweight Aircraft Association, PO Box 382, Abbotsford, Victoria, (5 February 1986) pp. 193-201.
NEUMANN, T.F.	Chairman, Technical Committee, Gliding Federation of Australia, 130 Wirraway Road, Essendon Airport, Victoria, (5 February 1986) pp. 318-350.
NOLAN, R.S.	Building 26, Essendon Airport, Victoria, (28 April 1986) pp. 906-946.
O'DAY, R.C.	First Assistant Secretary, Flight Standards Division, Department of Aviation, Canberra, Australian Capital Territory, (6 November 1985) pp. 3-102, (22 October 1986) pp. 1004-1110.
PETERS, A.W.	Managing Director, Ultralight Aircraft Industries Australia Pty Ltd, PO Box 104, Goolwa, South Australia, (25 March 1986) pp. 882-903.
TOVELL, E.J.	Superintendent, Brisbane Field Office, Bureau of Air Safety Investigation, Department of Aviation, Brisbane, Queensland, (8 October 1986) pp. 1006-1041.
VALENTINE, M.	National Coach and Chief Technical Officer, Operations, Gliding Federation of Australia, 130 Wirraway Road, Essendon Airport, Victoria, (5 February 1986) pp. 318-350.
VON MUENCHHAUSEN, H.	Director, Special Operations Section, Flight Standards Division, Department of Aviation, Canberra, Australian Capital Territory, (6 November 1985) pp. 3 - 102, (12 March 1986) pp. 681-729.
WANSBROUGH, K.E.	President, Aeromodellers WA Inc., 15 Lincoln Street, Highgate, Western Australia, (24 March 1986) pp. 807-817.

WARREN, P.D.	Assistant Secretary, Lightweight Aircraft Association, PO Box 382, Abbotsford, New South Wales, (5 February 1986) pp. 246-252
WATKINS, W.J.	39 Grandview Road, Box Hill South, Victoria, (5 February 1986) pp. 253-294.
WHITNEY, C.W.	Director, C.W. Whitney Pty Ltd, 307 Verney Road East, Graceville, Queensland, (6 November 1986) pp. 123-141.
WINTON, C.F.	23 Foxwell Road, Coomera, Queensland, (12 March 1986) pp. 621-677.
YEOMANS, M.J.	President, Hang Gliding Federation of Australia, Suite 508, Sports House, 157-161 Gloucester Street, Sydney, New South Wales, (6 February 1986) pp.525-553.

Appendix C

AUF Technical Bulletins Nos. 1-4

AUSTRALIAN ULTRALIGHT FEDERATION

TECHNICAL BULLETIN No. 1: Safety harness anchorage tests.

BACKGROUND: Proof of satisfactory safety harness installation (four-point harness) is a pre-requisite for approval of all australian Light Sports Aircraft (i.e. ultralight aircraft to be operated under ANOs 95.25 or 95.55.)

PROCEDURE: The safety harness anchorage points must be tested as described in the attached information sheets (tests one and two); these tests are to be witnessed by an independent party, who must sign the witness form attached.

The test report, witness report, and the harness type, must be acceptable, before an application for approval will be processed.

....

SAFETY HARNESS TEST REPORT : AUF TECH. BULLETIN No 1

AIRCRAFT TYPE...................... MANUFACTURER.........................

DATE OF MANUFACTURE.....................

OWNER'S NAME & ADDRESS...

....

DETAILS OF SAFETY HARNESS: TYPE...

MANUFACTURER...

DESCRIPTION..

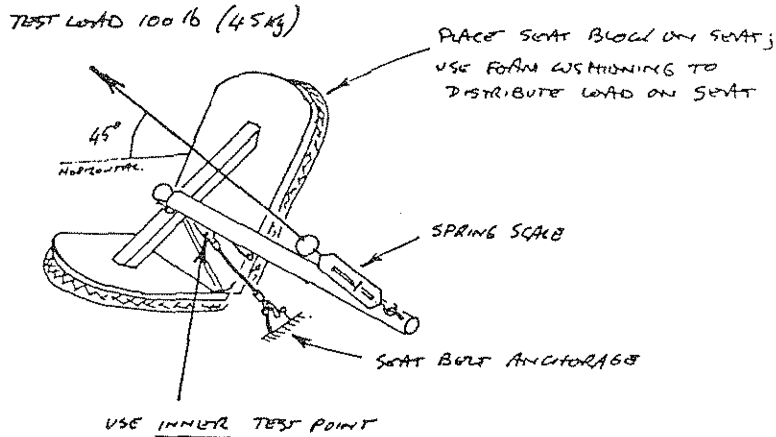


FIG. 1 : SEAT BELT ANCHORAGE TEST

(REPEAT FOR OTHER SIDE)

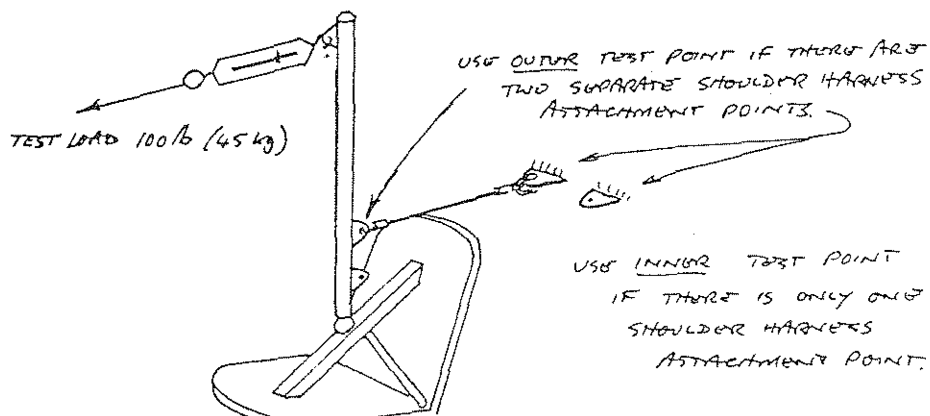
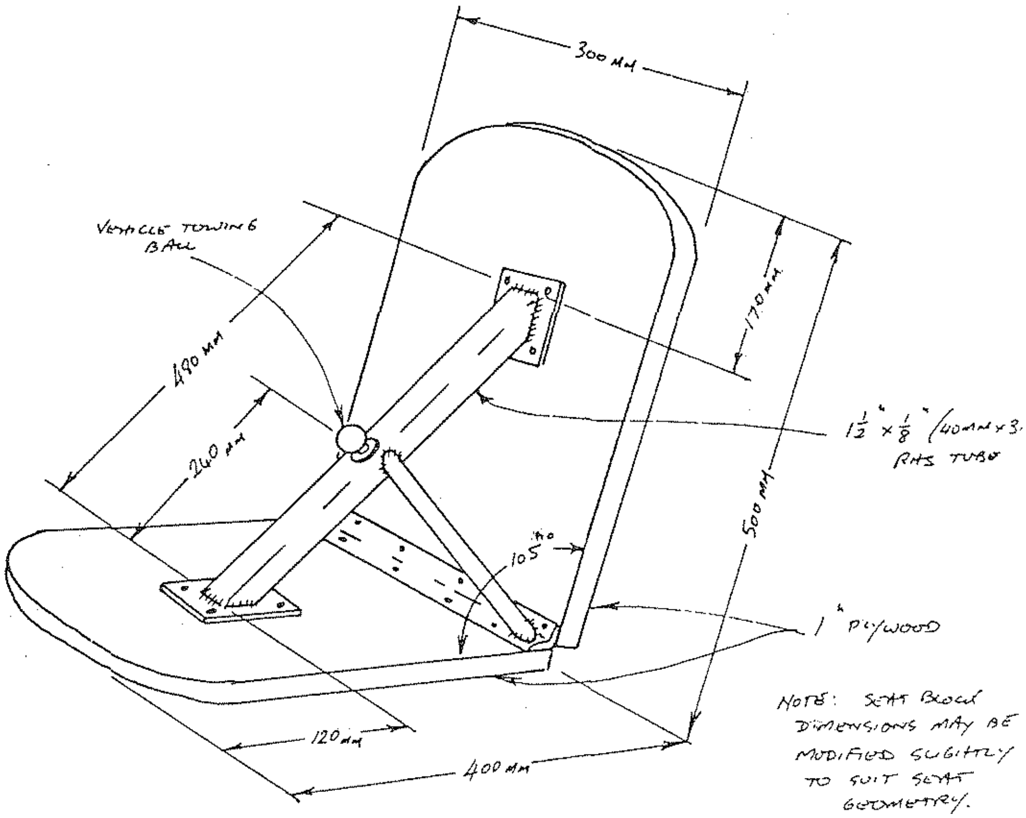
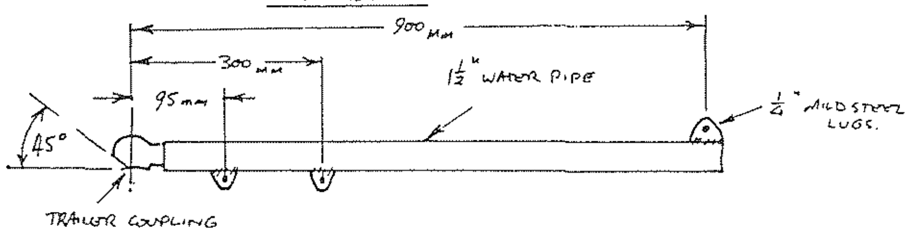


FIG. 2 : SHOULDER HARNESS ANCHORAGE TEST



SEAT BLOCK



TEST LEVER

Weighing procedure

1. Set and record the zero reading of each scale, after the scales have been placed in position for the weighing, but before the aircraft is placed upon them. (Include in the zero setting, any slings, supports or other apparatus whose weight would affect the scale readings during the weighing of the aircraft.)
2. Place the aircraft on the scales and record the scale readings.
3. Subtract from the scale readings obtained in step 2, the zero readings obtained in step 1. Record the net readings thus obtained.
4. Add together the net readings to obtain a total net reading.
5. Remove the aircraft from the scales, and again determine the zero readings (as in step 1), without re-adjusting the scales.
6. Replace the aircraft on the scales and record the scale readings for the second weighing.
7. Subtract from the scale readings obtained in step 6, the zero readings obtained in step 5. Record the second set of net readings thus obtained.
8. Add together the second set of net readings to obtain a second total net reading.
9. Remove the aircraft from the scales, and again determine the zero readings (as in steps 1 and 5), again without re-adjusting the scales.
10. If the difference between the zero readings (greatest difference between any two zero readings for any scale set) exceeds two percent of the total net reading, or five kilograms, whichever is the greater, repeat the weighings until two consecutive results are obtained which fall within this tolerance.
11. If the difference between the total net readings exceeds two percent of the total net reading or five kilograms, whichever is the greater, repeat the weighings until two consecutive results are obtained which fall within this tolerance.
12. The aircraft empty weight shall be taken as the average of two total net readings as determined by two consecutive weighings which comply with the above tolerance requirements.
13. As the above steps are performed, the details are to be recorded in the Aircraft Weighing Summary, a sample copy of which is given in appendix 1 of this bulletin.

DETERMINATION OF AIRCRAFT EMPTY CENTRE OF GRAVITY POSITION.

Condition of the aircraft

-as for determination of aircraft empty weight.

Levelling of the aircraft

The aircraft must be longitudinally level whilst its centre of gravity is being determined; this is to be achieved by levelling the aircraft in its suspension (by adjustment of the slinging point) until the reference levelling datum is level by reference to a spirit level.

Aircraft reference levelling datum.

The datum used to determine aircraft longitudinal level shall be:
(a) The levelling datum as specified by the manufacturer, or failing that
(b) With the fuselage reference axis horizontal, or failing that
(c) Where the wing aerofoil is either flat-bottomed or has a concave undersurface, with the flat bottom of the wing aerofoil at the wing root horizontal, or a straightedge touching the undersurface of the root aerofoil at two points

WEIGHT AND CENTRE OF GRAVITY DETERMINATION FOR AIRCRAFT TO BE CERTIFICATED UNDER AIR NAVIGATION ORDERS 95.25 and 95.55

The empty weight and centre of gravity position of each aircraft which is intended to be operated under A.N.O. 95.25 and 95.55 must be determined and must comply with the category limitations for the aircraft type as defined in these A.N.O.s.

Acceptable procedures for the determination of aircraft weight and centre of gravity position shall be either those set out in A.N.O. Part 100.7; alternatively, the procedure specified in this bulletin may be used.

NOTE: Determination of aircraft empty centre of gravity position by methods which involve the calculation of moments derived from weight readings at wheels or jacking points, will be acceptable only where the scales used meet the calibration standard specified in A.N.O. 100.7.

The alternative method of centre of gravity determination specified in this bulletin does not require calibrated scales.

Determination of aircraft empty weight may be made using scales whose calibration is verified only to the standard described in this bulletin; however the aircraft empty weight thus determined, may not exceed 95 percent of the category limitation for the aircraft type as defined in A.N.O.s 95.25 or 95.55, as applicable. If the aircraft empty weight is closer to the category limit than this, the scales used must meet the calibration standard specified in A.N.O. 100.7.

CALIBRATION OF SCALES

Scales used to determine the empty weight of an aircraft, to not closer than 95% of the category weight limit, may be calibrated in the following manner:

1. Weigh the same test object on each of the scales and on a set of railway parcels office scales. The test object should be 70 Kg ± 20 Kg in weight. Record the weight as measured on each of the scales, together with the identific -ation of the set of scales on which each reading was obtained.
2. The difference between the greatest scale reading and the least scale reading, must not exceed five percent of the greatest reading.
3. The difference between the average of the readings of all the scales to be used for weighing the aircraft, and the reading of the railway parcels office scales, must not exceed five percent of the greatest reading.
4. The above calibration standard must be complied-with within one month of the date of weighing of the aircraft. Calibration details are to be entered into the pro-forma of which a sample is given in appendix 2 of this bulletin, and must be attached to the weighing details.

DETERMINATION OF AIRCRAFT EMPTY WEIGHT

Condition of the aircraft at weighing

The aircraft must be complete including all items of fixed equipment and other equipment which is mandatory for all operations, fixed ballast, unusable fuel, undrainable oil, total quantity of engine coolant and total quantity of hydraulic fluid, but excluding all other items of disposable load.

Number of scales required

A separate set of scales must be provided for each point at which the aircraft is supported whilst being weighed. (This implies a minimum of three sets if the aircraft is supported from below, or a single set if the aircraft is suspended solely from the set of scales. The practice of moving scales from one support point to another is not permissible; scales must not be moved during the weighing process.)

Weighing procedure

1. Set and record the zero reading of each scale, after the scales have been placed in position for the weighing, but before the aircraft is placed upon them. (Include in the zero setting, any slings, supports or other apparatus whose weight would affect the scale readings during the weighing of the aircraft.)
2. Place the aircraft on the scales and record the scale readings.
3. Subtract from the scale readings obtained in step 2, the zero readings obtained in step 1. Record the net readings thus obtained.
4. Add together the net readings to obtain a total net reading.
5. Remove the aircraft from the scales, and again determine the zero readings (as in step 1), without re-adjusting the scales.
6. Replace the aircraft on the scales and record the scale readings for the second weighing.
7. Subtract from the scale readings obtained in step 6, the zero readings obtained in step 5. Record the second set of net readings thus obtained.
8. Add together the second set of net readings to obtain a second total net reading.
9. Remove the aircraft from the scales, and again determine the zero readings (as in steps 1 and 5), again without re-adjusting the scales.
10. If the difference between the zero readings (greatest difference between any two zero readings for any scale set) exceeds two percent of the total net reading, or five kilograms, whichever is the greater, repeat the weighings until two consecutive results are obtained which fall within this tolerance.
11. If the difference between the total net readings exceeds two percent of the total net reading or five kilograms, whichever is the greater, repeat the weighings until two consecutive results are obtained which fall within this tolerance.
12. The aircraft empty weight shall be taken as the average of two total net readings as determined by two consecutive weighings which comply with the above tolerance requirements.
13. As the above steps are performed, the details are to be recorded in the Aircraft Weighing Summary, a sample copy of which is given in appendix 1 of this bulletin.

DETERMINATION OF AIRCRAFT EMPTY CENTRE OF GRAVITY POSITION.

Condition of the aircraft

-as for determination of aircraft empty weight.

Levelling of the aircraft

The aircraft must be longitudinally level whilst its centre of gravity is being determined; this is to be achieved by levelling the aircraft in its suspension (by adjustment of the slinging point) until the reference levelling datum is level by reference to a spirit level.

Aircraft reference levelling datum.

The datum used to determine aircraft longitudinal level shall be:

(a) The levelling datum as specified by the manufacturer, or failing that
(b) With the fuselage reference axis horizontal, or failing that
(c) Where the wing aerofoil is either flat-bottomed or has a concave undersurface, with the flat bottom of the wing aerofoil at the wing root horizontal, or a straightedge touching the undersurface of the root aerofoil at two points

one at the trailing edge, and one towards the front of the aerofoil (See diagram 1)

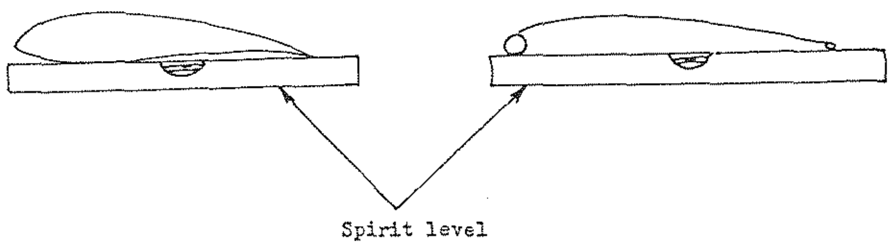


Diagram 1: Method of levelling aircraft by reference to undersurface of wing root aerofoil section.

Centre of Gravity determination procedure

Suspend the aircraft from a sling, so arranged as to pivot from a single point. (Note: The method depends for its accuracy, on the weight of the sling assembly being very light by comparison with the aircraft itself. It is suggested that a suitable sling would be made of aircraft control cable or light synthetic rope, with no spreader beams. The total weight of the sling assembly should not exceed one percent of the aircraft empty weight.)

Level the aircraft by adjustment of the relative lengths of the front and rear legs of the sling (or by movement of the slinging point with respect to the aircraft).

When the aircraft is longitudinally level, lower a plumb bob from the sling point, and measure the fore-and-aft distance between the point at which the plumb bob touches the wing, and the root leading edge of the wing (See diagram 2).

Record this distance, using the pro-forma given in appendix 3 of this bulletin.

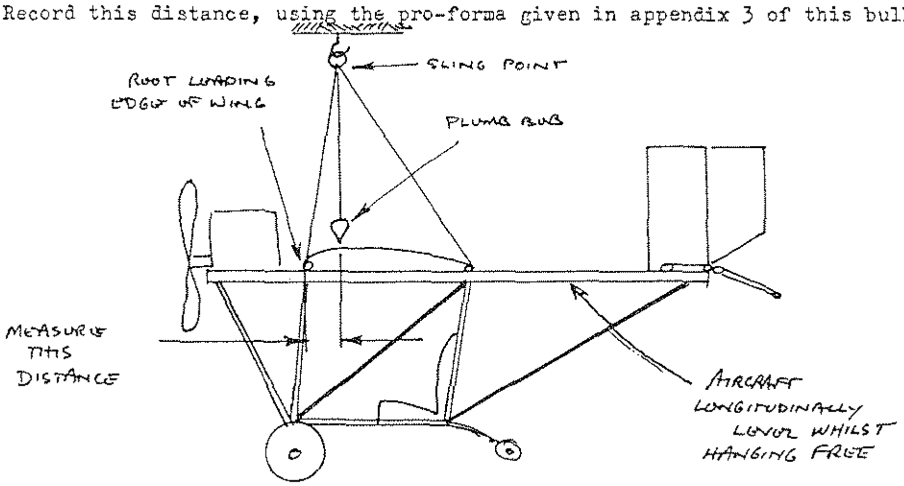


Diagram 2: Use of plumb-bob to determine empty aircraft centre of gravity position.

AUSTRALIAN ULTRALIGHT FEDERATION TECHNICAL BULLETIN No. 2 APPENDIX 1:

AIRCRAFT WEIGHING SUMMARY

Aircraft Type: . . . .

Serial Number: . . . .

Identification & Markings: . . . .

Date of weighing: . . . .

1. Place scales in position	SCALE A	SCALE B	SCALE C	
2. Record initial scale zero readings with all slings, chocks, etc. in place				
3. Position aircraft gently onto scales				
4. Record first weighing scale readings				1st Total net reading
5. Subtract line 2 from line 4 (Gives 1st set of net readings)				
6. Remove aircraft from scales - do not re-zero the scales				
7. Record second scale zero readings with all weighing apparatus in place				
8. Place aircraft gently back onto scales				
9. Record second weighing scale readings				2nd Total net reading
10. Subtract line 7 from line 9 (Gives 2nd set of net readings)				
11. Remove aircraft from scales - do not re-zero the scales				
12. Record third scale zero readings with all weighing apparatus in place				

Average total net reading: . . . . of which two percent equals: . . . .

Difference between 1st & 2nd Total net readings: . . . . (Must not exceed 2% of average total net reading)

Greatest difference between zero reading for any single scale: . . . . . . (Must nut exceed 2% of average total net reading)

Weighing procedures conducted by: . . . .

Address: . . . .

Weighing procedures witnessed by: . . . .

Address: . . . .

AUSTRALIAN ULTRALIGHT FEDERATION TECHNICAL BULLETIN No. 2 APPENDIX 2:

AIRCRAFT WEIGHING SCALE CALIBRATION VERIFICATION

	SCALE A	SCALE B	SCALE C
Scale description, type, serial No., or identification			
Scale zero reading prior to calibration check			
Scale reading with test weight.			
Net scale reading (Reading with test weight less zero reading)			
Scale zero reading after calibration check			

Greatest net scale reading with test weight: . . . . Five percent thereof: . . . . .

Reading of railway parcel office scales at: . . . . railway station with test weight: . . . .

Least net scale reading with test weight: . . . .

Difference between average net scale reading & railway scale reading: . . . .

(Must not exceed five percent of greatest net scale reading)

Difference between greatest and least net scale reading: . . . .

(Must not exceed five percent of greatest net scale reading)

Calibration check conducted by: . . . .

Address: . . . .

Calibration check wirnessed by: . . . .

Address: . . . .

Date of calibration check: . . . .

AUSTRALIAN ULTRALIGHT FEDERATION TECHNICAL BULLETIN No. 2 APPENDIX 3:

AIRCRAFT EMPTY CENTRE OF GRAVITY DETERMINATION

Aircraft Type: . . . .

Serial Number: . . . .

Identification & Markings: . . . .

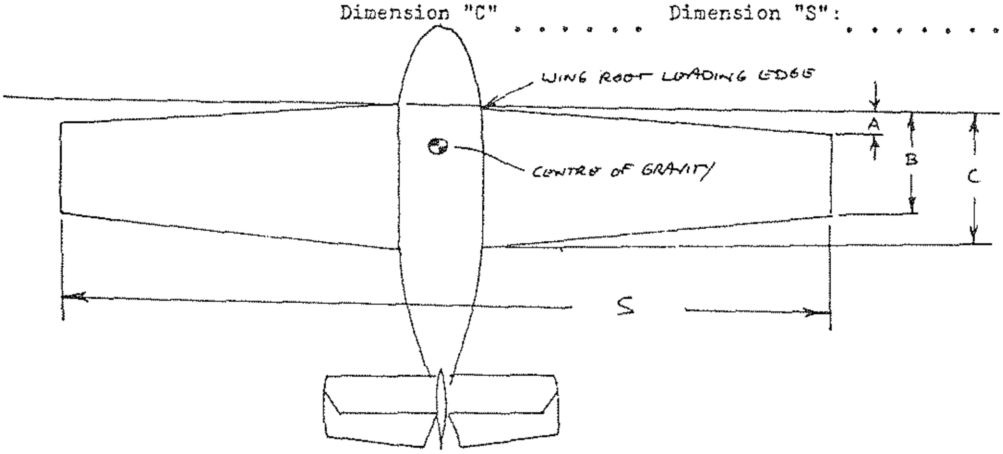
Date of C of G determination: . . . .

Aircraft levelling datum: . . . .

Distance of C of G aft of wing root leading edge: . . . .

Wing planform geometry: Dimension "A": . . . . . . Dimension "B": . . . .

Dimension "C" . . . . . . Dimension "S": . . . .



AIRCRAFT CONFIGURATION AT TIME OF C. OF G. DETERMINATION OR WEIGHING:

No. of seats installed: . . . . . No. of occupant safety harnesses: . . . . . .

Total fuel tank capacity: . . . .

List instruments, radios, etc, installed: . . . .

. . . .

. . . .

Any other equipment included in empty weight: . . . .

. . . .

. . . .

C. of G. determination conducted by: . . . .

Address: . . . .

Witnessed by: . . . .

Address: . . . .

STRUCTURAL SUBSTANTIATION OF AIRCRAFT FOR CERTIFICATION UNDER ANO 95.25 INCLUDING STANDARD METHOD FOR PROOF-TESTING

1. DEFINITIONS:

"Primary structure" means any part of the structure of an aircraft, the failure of which would seriously endanger the aircraft.

"FAR" means the Federal Airworthiness Requirements of the United States of America.

"BCAR" means British Civil Airworthiness Requirements.

"JAR" means the Joint Airworthiness Requirements, agreed in common by the civil airworthiness authorities of several European countries.

"Empty weight" means the empty weight of the aircraft determined in accordance with Australian Ultralight Fedération Technical Bulletin No. 2.

"Load factor" means the ratio of the total lift on all lifting surfaces to the weight of the aircraft.

"Limit load factor" means the maximum load factor anticipated in normal conditions of operation.

"Limit load" means the maximum load anticipated in normal conditions of operation.

"Ultimate load" means the product of the limit load and the ultimate factor of safety

2. REQUIREMENT:

Each aircraft which is to be certificated under A.N.O. 95.25 must be shown to have adequate structural strength to meet the basic flight load cases of an airworthiness design standard acceptable to the Australian Ultralight Federation, with appropriate factors of safety. Controls must move freely at limit load.

3. DESIGN STANDARDS:

Airworthiness design standards which are acceptable to the Australian Ultralight Federation for the purpose of structural strength include FAR 23, BCAR Section K, JAR 22, BCAR Section S. Other design standards may be considered; applicants should apply to The Secretary, Australian Ultralight Federation, for information concerning the acceptability of other design standards.

4. PROOF OF COMPLIANCE:

Acceptable proof of compliance with the requirements of this Bulletin shall be:

(a) A Certificate of Type Approval for the basic aircraft type, issued by the responsible authority in the country of origin pursuant to an acceptable airworthiness design standard; together with a Certificate of Manufacture or Export Certificate of Airworthiness for each individual aircraft; or

(b) Suitable evidence from the aircraft manufacturer, showing that the structural requirements of an acceptable airworthiness design standard are met by the basic aircraft design, together with suitable evidence that each individual aircraft conforms with the basic design and that the quality control of materials and manufacture processes used in all primary structure are of an acceptable standard; or

(c) A successful structural test of the prototype aircraft, conducted in accord-ance with the procedures set out below, together with suitable evidence from the aircraft manufacturer that each individual aircraft of the type conforms with the basic design and that the quality control of materials and manufacture processes used in all primary structure are of an acceptable standard.

4. Note: Where the structure of the aircraft is of a type for which normal methods of structural analysis are reliable, and of materials whose minimum mechanical properties are reliably known, a conservative structural analysis based on minimum probable material mechanical properties will be acceptable as suitable evidence of compliance for the basic aircraft design, provided the applicant furnishes suitable evidence that the calculations have been performed or checked in detail by a person appropriately qualified to do so.

5. FACTOR OF SAFETY AND TEST LOAD FACTOR

The ultimate factor of safety which must be shown to exist, by test or structural analysis, shall be not less than 1.5.

In the case of aircraft whose design is proven by test, the following test load factors must also be applied:

(a) For aircraft whose primary structure is made entirely from recognised aeronautical materials supplied under accepted aeronautical quality-control procedures; and which are manufactured and assembled in accordance with sound aeronautical engineering practice, the test load factor shall be not less than 1.10

Note: Reference should be made to A.N.O. 100.4 for details of accepted quality-control procedures for the supply of aeronautical materials.

(b) For aircraft whose primary structure incorporates components manufactured from commercial-quality materials other than wood, fibre-reinforced plastics, or metal-to-metal bonded structure; or for which the manufacture and assembly processes do not conform with accepted sound aeronautical practices, the test load factor shall be not less than 1.25

Note: Structural welding in any primary structure must be performed only by the holder of a valid, appropriate aircraft welding authority. Applicants must produce evidence that any such welding was performed by an authorised welder.

(c) For aircraft whose primary structure incorporates components manufactured from commercial-quality materials including wood, fibre-reinforced plastics or metal-to-metal bonding, the test load factor shall be not less than 1.33

6. RE-USE OF TEST AIRCRAFT STRUCTURES FOR FLIGHT PURPOSES

The following rules apply to the use of aircraft structural items which have been subjected to the test loads specified in this Bulletin, for subsequent flight purposes: (Note - such re-use is not common practice throughout the aircraft industry; however, in the case of one-off aircraft there are certain circumstances in which it can be tolerated.)

(a) Mechanically-fastened (not welded) metal structural components which show no visible damage or deformation as a result of the test loads, may be used for subsequent flight purposes.
Note: Particular attention must be given to post-loading inspection for local damage in the vicinity of fasteners.

(b) Welded metallic structure for which acceptable evidence can be produced that the welding was entirely performed by the holder of an appropriate aircraft welding authority, and which show no visible damage or deformation as a result of the test loading, including a dye-penetrant inspection of all weld zones, may be used for subsequent flight purposes.

6. (c) Wood structures having solid plank or routed spars will be considered on their individual merits for use for subsequent flight purposes. Such structures may be required to pass a second series of test loads equal to 90% of the test loads specified in this bulletin, to demonstrate that no incipient compression failures or other damage exists as a consequence of the original test loading.

No other forms of structure are acceptable for flight use subsequent to structural test.

7. CONDITION OF AIRCRAFT FOR STRUCTURAL TESTING

The aircraft structure must be complete so far as the wing and its associated bracing; and stabilising surfaces and their associated bracing, the structure connecting the wing and stabilising surfaces, and all control surfaces and linkages. Non-structural covering may be omitted.

8. AIRCRAFT MAXIMUM WEIGHT.

The aircraft weight used in determining design loads for structural compliance shall be not less than:

The aircraft empty weight as determined in accordance with AUF Technical Bulletin No. 2, plus 90 Kg for each occupant, plus full fuel (at 0.72 Kg per litre), plus the maximum weight of baggage or other disposable load which the aircraft is to be permitted to carry;
and may not be more than 290 Kg for single place aircraft, or 400 Kg for two place aircraft.

9. AIRCRAFT STALL SPEED

The stall speed used in calculating structural test loads shall be the stall speed with wing flaps (if fitted) in the cruise position, at maximum weight.
Stall speed may be determined by flight tests, using a calibrated airspeed indicating system (See note below); or by the use of the formulae and chart given in appendix 1 of this bulletin.

Note: A calibrated airspeed indicating system may be either a proven flight-test system (e.g. trailing pitot-static with calibrated indicator) which can be deployed so that its readings are not affected by the disturbed airflow in the vicinity of the aircraft; or the aircraft airspeed indicating system may be calibrated by suitable flight test. Airspeed system calibration method, results obtained and calibration curve must be supplied if this method is adopted.

The stall speed may not exceed forty knots calibrated airspeed.

10. AIRCRAFT WING LOADING

The wing loading used for calculating structural test loads and airspeeds shall be taken as the aircraft maximum weight divided by the total planform area of the wing, including ailerons and flaps. The area of tailplanes and elevators may not be included; however the area of foreplane surfaces on aircraft of canard layout may be included in the wing area. Flaps are to be in retracted position.

STANDARD METHOD FOR PROOF TESTING

FLIGHT ENVELOPE : FLIGHT LOAD FACTORS AND SPEEDS

The flight envelope used for the determination of flight load factors and speeds will be defined by the airworthiness design standard selected by the applicant. The example given is from BCAR Section S; any applicant using other airworthiness design standard must calculate the equivalent load factors and speeds in accordance with the procedures specified in that airworthiness design standard.

STEP ONE:

Determine the aircraft maximum weight:

Aircraft empty weight (Refer AUF Tech. Bulletin No. 2)	....	Kg.
Weight of ... occupants @ 90 Kg each	....	Kg.
Maximum fuel contents ... litres @ 0.72 Kg/litre	....	Kg.
Baggage or other disposable load (maximum)	....	Kg.
TOTAL	....	Kg.

STEP TWO:

Determine the wing area in square metres. ....

STEP THREE:

Divide the aircraft maximum weight by the wing area to obtain the wing loading.

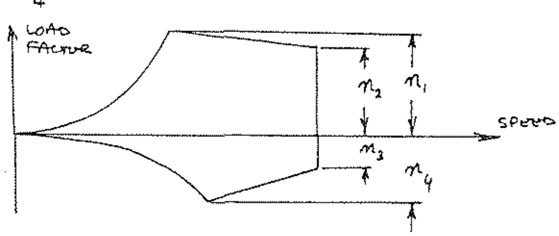
Example: $\frac{\text{Weight}}{\text{Wing area}} = \frac{290 \text{ Kg}}{10.5 \text{ sq. metres}} = 27.62$ Kg/sq metre

Your value: .... Kg/sq metre

STEP FOUR:

Look up the airworthiness design standard you have chosen to use, and find the flight envelope. Obtain the required values of n_1 , n_2 , n_3 , and n_4 from the desing standard.

(Note: The values from BCAR section S are: $n_1 = 4.0$; $n_2 = 4.0$; $n_3 = -1.5$; $n_4 = -2.0$)

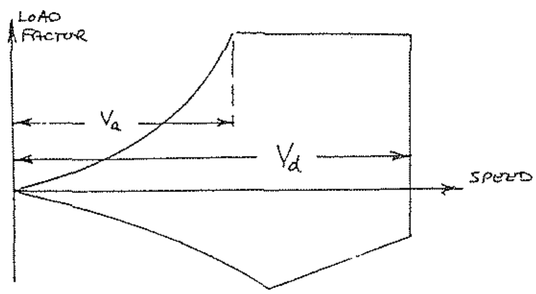


Your values: n_1 = ... ; n_2 = ...; n_3 = ...; n_4 = ...

STANDARD METHOD FOR PROOF TESTING - continued.

STEP FIVE:

From the airworthiness design standard, find the flight envelope speeds V_a (Manoeuvre speed) and V_d (Design diving speed)



Note: $V_a = V_{s1}\sqrt{n_1}$,

where V_{s1} is the aircraft stall speed as defined in paragraph 9.

In the case of BCAR S, $n_1 = 4$ so $V_a = 2 \times V_{s1}$

Hence, if the aircraft stall speed were 36 knots CAS, V_a would be 72 knots CAS.

Your value: V_a = ... Knots CAS

Each airworthiness design standard will give a different formula for finding V_d; (it is usually some ratio of the maximum cruise speed). To find it, you would need to know the maximum cruise speed of your aircraft in calibrated airspeed terms.

Failing this, for the purpose of this Bulletin, it will be acceptable to use the following formula:

V_d = (1.85 x wing loading (Kg/M^2) + 50)knots CAS. (See table below)

Wing loading Kg/sq.metre	V_d Knots CAS	Wing loading Kg/sq. metre	V_d Knots CAS	Wing loading Kg/sq. metre	V_d Knots CAS
15	78	24	94	33	111
16	80	25	96	34	113
17	82	26	98	35	115
18	83	27	100	36	117
19	85	28	102	37	118
20	87	29	104	38	120
21	89	30	106	39	122
22	91	31	107	40	124
23	93	32	109	41	126

Your value: V_d= . . . . . Knots CAS

TEST LOADS ON WING

The test load is given by the formula $L = 1.5 \times F \times n \times (W - w_w) - w_w$

where L = total load to be applied to wing in test case;
F = Test load factor as defined in paragraph 5 of this Bulletin;
n = flight load factor in the test case being considered;
W = Aircraft maximum weight as defined in paragraph 8 of this Bulletin;
w_w = Weight of the aircraft's wings, in flying condition.

There are five test cases for the wings, as tabulated below. Fill out the table with your values.

Case No.	Speed (Knots)	Flight load factor	Centre of pressure	W (Kg)	w_w (Kg)	F	$(W - w_w)$	L (Kg)	$P = \frac{L}{\text{wing area}}$
1	V_a = ...	n_1 = ...	25% chord*						
2	V_a = ...	n_1 = ...	33% chord*						
3	V_d = ...	n_2 = ...	50% chord*						
4	V_d = ...	n_3 = ...	-50% chord*						
5	V_a = ...	n_4 = ...	0% chord*						

NOTE: If n_1 and n_2 are the same, leave out case 2.

* These centre of pressure positions must be used unless more precise values are calculated using actual wing aerofoil properties. See over for details.

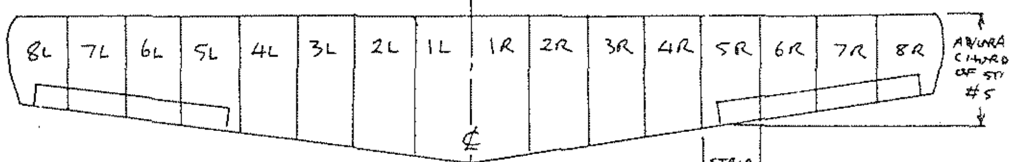
P is test load to be applied to wing, in Kg per square metre.

STANDARD METHOD FOR PROOF TESTING - continued.

DISTRIBUTION OF TEST LOAD ON WING

STEP ONE:

Divide the wing into sixteen chordwise strips: (Eight each side of the aircraft centreline)



STEP TWO:

Calculate the area of each strip. Multiply the area of each strip by the value of P for the test case under consideration; this gives the total load to be applied to each strip.

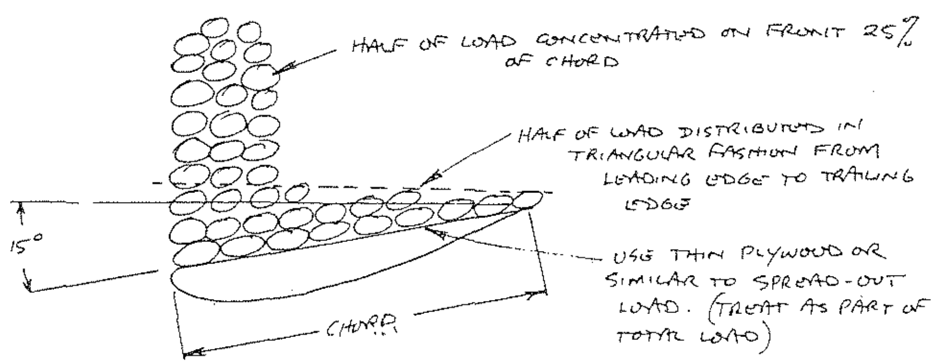
Strip No.	1L, 1R	2L, 2R	3L, 3R	4L, 4R	5L, 5R	6L, 6R	7L, 7R	8L, 8R
Width								
Average chord								
Area (sq. metres)								
P (Kg/sq. metre)								
Load on strip (Kg)								

(You will require one table for each wing test load case)

STEP THREE:

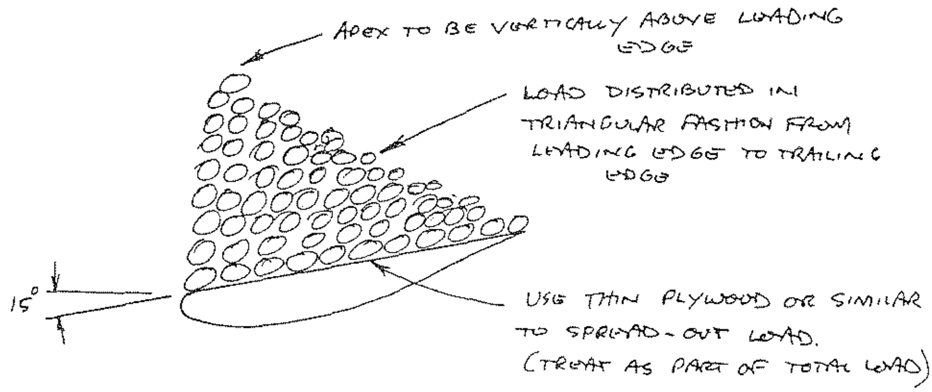
Calculate the chordwise distribution of load for each strip. The chordwise distribution depends upon the centre of pressure position in the test case being considered; the following chordwise distributions will give the required centre of pressure loadings:

1. Centre of pressure at 25% chord: (Load case 1)

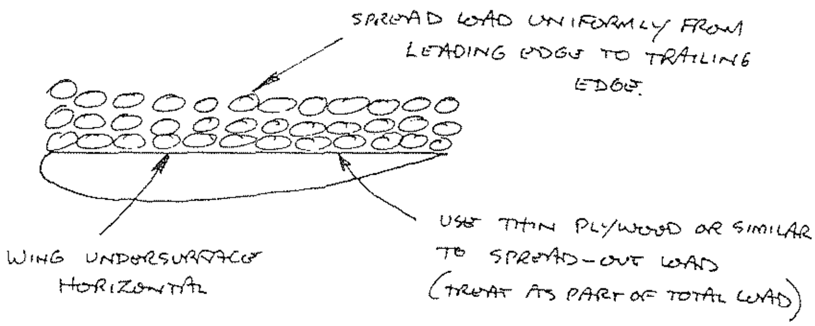


STANDARD METHOD FOR PROOF TESTING - continued

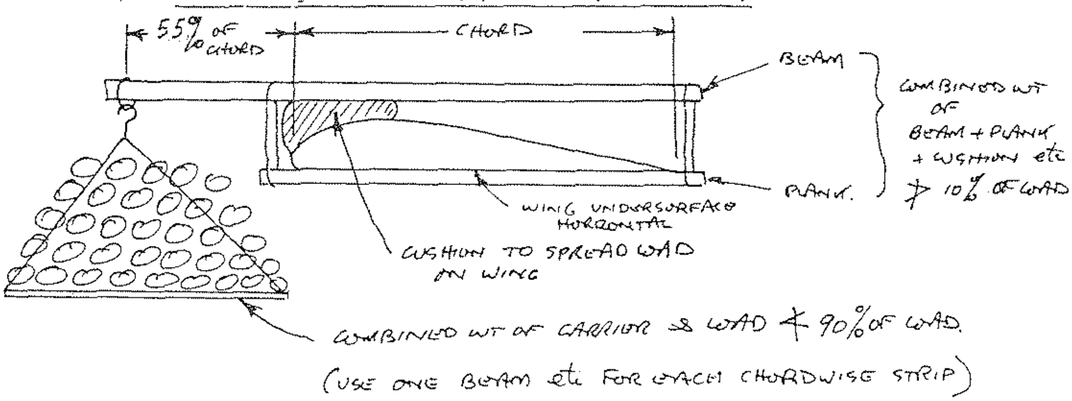
2. Centre of pressure at 33% chord: (Load case 2)



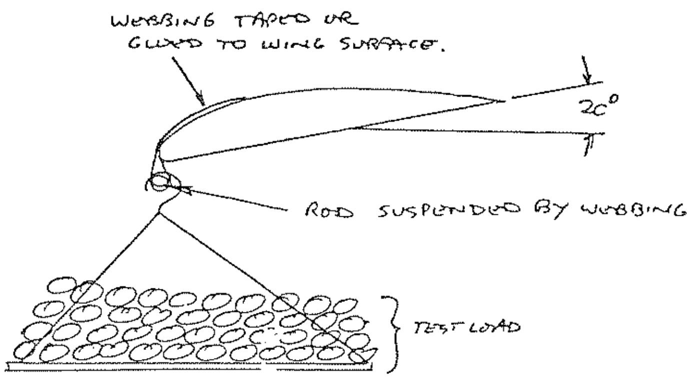
3. Centre of pressure at 50% chord: (Load case 3)



4. Centre of pressure at -50% chord: (Load case 4)



5. Centre of pressure at 0% chord: (Load case 5)



SUPPORT OF AIRCRAFT FOR STRUCTURAL TESTING OF WINGS

The aircraft is to be trestled or otherwise supported at the pilot's seat or other points, excluding the wing root attachments, on the fuselage adjacent to the wing, and at which the concentrated loading will not damage the aircraft structure. A secondary support will be needed at the tailplane (or foreplane, in the case of an aircraft of canard layout); this should be at the point of tailplane/foreplane attachment to the fuselage. Padding should be used as required to prevent localised concentration of loading at the support points.

(Note: The supports will have to bear the test load plus the weight of the aircraft. Ensure that they will have adequate strength to carry these loads without damage to the aircraft.)

It is permissible to support the wings whilst the test loads are being placed in position; if the supports are removed progressively until the wing is carrying the full test load without support, it may be possible to detect any areas which need structural reinforcement without causing major damage to the test specimen in the process.

WING TEST PROCEDURE

Trestle the aircraft (upside-down for cases 1, 2, & 3; right-way-up for cases 4 & 5). Note the wing angle for each test.
Secure the controls in the cockpit in the central position.

LOADING: Support the wings and place two-thirds of the test load in position, distributed as for the full-load case. Release the cockpit controls and remove the supports from under the wings. Verify that the controls are free to move over their full travel.
Re-secure the controls and replace the supports under the wings. Increase the load to the full test value.
Remove the supports from under the wings and verify that the wings can carry the full test load for at least three seconds.

STANDARD METHOD OF PROOF TESTING - continued

LOADS ON EMPENNAGE

The tailplane and elevators (or in the case of an aircraft of canard layout, the foreplane), together with the fin and rudder, must be able to carry, with the prescribed factor of safety and (in the case of aircraft substantiated by structural test) test load factors, the loads arising from manoeuvres and gusts as specified in the airworthiness design standard.
The consequent tailplane/foreplane loads may be calculated by rational or conservative analysis and test loads deduced accordingly; or alternatively, the following simplified approach may be used:

TAILPLANES & ELEVATORS OR FOREPLANES:

The tailplane & elevators or foreplane must be able to carry, with the prescribed factor of safety and test load factors, the maximum aerodynamic force which it would be capable of generating in free air at V_a; to which load must be added the incremental load arising as a result of wing pitching moment at V_d. The maximum lift coefficient for a tailplane & elevator shall be taken as not less than 1.5; for a foreplane, the maximum lift coefficient shall be taken as not less than 2.5.

The limit load per unit area for horizontal stabilising surfaces is thus not less than:

For tailplanes:

$$1.5\, q_a + \frac{C_{mo} q_d}{\overline{V}} \quad \text{downwards}$$

$$1.5\, q_a - \frac{C_{mo} q_d}{\overline{V}} \quad \text{upwards}$$

For foreplanes:

$$2.5 q_a - \frac{C_{mo} q_d}{\overline{V}} \quad \text{downwards}$$

$$2.5 q_a + \frac{C_{mo} q_d}{\overline{V}} \quad \text{upwards}$$

Where q_a is the dynamic pressure at V_a

q_d is the dynamic pressure at V_d

S' is the area of the tailplane + elevators, or of the foreplane.

C_{mo} is the wing pitching-moment coefficient (Nose-down +ve)

$\overline{V}$ is the tail volume coefficient, $\frac{S'\, l_t}{S\, \overline{c}}$

l_t is the distance between the wing mean aerodynamic quarter-chord point and the tail (or foreplane) quarter-chord point.

S is the wing area

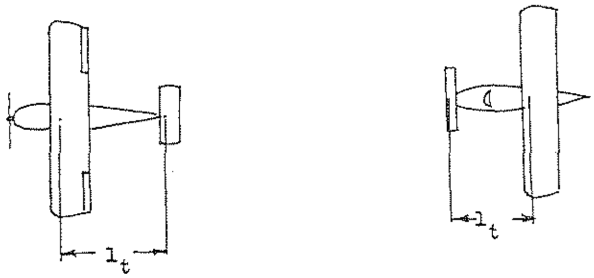
$\overline{c}$ is the geometric mean chord of the wing; take as $\frac{\text{wing area}}{\text{wing span}}$

STEP ONE: Calculate the distance between the wing mean aerodynamic quarter-chord point and the tail (or foreplane) quarter chord point. (Note: For wings whose quarter-chord line is unswept, the quarter-chord point will be 25% of the root chord, aft of the root leading edge of the wing. For swept wings, an appropriate calculation will be required to locate the wing mean aerodynamic quarter-chord point.)

See next page for example:

STANDARD METHOD FOR PROOF TESTING - continued

Example:



Your value: l_t = ... metres

STEP TWO:

Calculate the area of tailplane + elevators, or foreplane (inclusive of any flaps)

Your value: S' = ... square metres.

STEP THREE:

Calculate the wing mean geometric chord.

Your value: $\bar{c} = \frac{\text{wing area}}{\text{wing span}} = \frac{\text{sq.metres}}{\text{metres}}$ = ... metres

STEP FOUR:

Calculate tail volume coefficient $\bar{V} = \frac{S' l_t}{S \bar{c}}$ = ...

Example: If wing area = 10 sq. metres,
tail area = 2 sq. metres,
l_t = 3 metres
$\bar{c}$ = 1.2 metres

Then $\bar{V} = \frac{2 \times 3}{10 \times 1.2} = \frac{6}{12} = 0.5$

STEP FIVE:

Find q_a and $C_{mo}q_d$ from the table below: (Read against the speed value for V_a to obtain q_a ; & against speed value for V_d to obtain $C_{mo}q_d$)

V kt.	q_a Kg/sq. metre	V kt	q_a Kg/sq. metre	V kt.	q_d Kg/sq. metre	$C_{mo}q_d$ Kg/sq. metre	V kt	q_d Kg/sq. metre	$C_{mo}q_d$ Kg/Sq. metre
40	26.8	62	63.7	86	122	12.2	107	190	19.0
42	29.2	64	67.8	88	128	12.8	109	197	19.7
44	32.1	66	72.1	90	134	13.4	111	204	20.4
46	35.0	68	76.6	92	140	14.0	113	211	21.1
48	38.2	70	81.1	94	146	14.6	115	219	21.9
50	41.4	72	85.8	96	153	15.3	117	227	22.7
52	44.8	74	90.7	98	159	15.9	118	231	23.1
54	48.3	78	101	100	166	16.6	120	238	23.8
56	51.9	80	106	102	172	17.2	122	246	24.6
58	55.7	82	111	104	179	17.9	124	255	25.5
60	59.6	84	117	106	186	18.6	126	263	26.3

STEP SIX:

Calculate the upward and downward test loads per unit area for the tailplane or foreplane:

Example:

For an aircraft having V_a = 50 Kts, V_d = 90 Kts,

and a tail volume coefficient ($\overline{V}$) of 0.5

Downward limit load on tailplane = $1.5 \times 41.4 + \frac{13.4}{0.5}$ = 62.1 + 26.8

= 88.9 Kg/sq. metre

Hence, test load (= limit load x 1.5 x test load factor),
(downwards)

= 88.9 x 1.5 x 1.25 (for structure of welded commercial-quality steel tube)

= 167 Kg/sq.metre

Upward limit load on tailplane = $1.5 \times 41.4 - \frac{13.4}{0.5}$ = 62.1 - 26.8

= 35.3 Kg/sq.metre

Hence, upward test load = 35.3 x 1.5 x 1.25

= 66.2 Kg/sq.metre

FIN & RUDDER LOADS

The fin & rudder must be able to carry, with the prescribed test load factors and factor of safety, the maximum aerodynamic force which it would be capable of generating in free air at V_a ; The maximum normal force coefficient shall be taken as not less than 1.5.

Example: Limit load on fin & rudder = 1.5 q_a

in the case above, V_a = 50 Kts & q_a = 41.4 Kg/sq. metre (from table)

Hence, limit load on fin & rudder = 1.5 x 41.4 = 62.1 Kg/sq.metre

and test load on fin & rudder = 62.1 x 1.5 x 1.25 (for structure of welded commercial-quality steel tube)

= 115 Kg/sq.metre

COMBINED LOADS

The empennage and the fuselage must be able to carry the combined effects of the full test loads on the horizontal and vertical surfaces simultaneously, (all eight possible combinations)

STANDARD METHOD FOR PROOF TESTING - continued

SUPPORT OF AIRCRAFT FOR STRUCTURAL TESTING OF EMPENNAGE

The aircraft is to be trestled or otherwise supported at the wing root attachments to the fuselage, and if necessary at the pilot's seat. The fuselage must be cantilevered from the wing root to the empennage.

It is permissible to support the empennage whilst the test loads are being placed in position; if the supports are removed progressively until the empennage and fuselage are carrying the full test load without support, it may be possible to detect any areas which need structural reinforcement without causing major damage to the test specimen in the process.

EMPENNAGE TEST PROCEDURE

Trestle the aircraft as required for the test-case. Note: Fin & rudder loads may be applied via ropes and pulleys.
Support the empennage and apply two-thirds of the test load, to be uniformly spread over the tailplane and fin; (leaving the elevators & rudder unloaded).
Remove the supports and verify that the empennage controls are free to move over their full travel.
Replace the supports and secure the controls inthe cockpit in the central position.
Apply the remaining one-third of the test load, uniformly over the elevators and rudder.
Remove the supports and verify that the structure can carry the load for at least three seconds.

WITNESS REPORTS:

WING TESTS: Conducted by . . . .

Of address . . . .

Witnessed by . . . . Signature . . . .

Of address . . . .

Date of testing . . . .

EMPENNAGE TESTS: Conducted by . . . .

Of address . . . .

Witnessed by . . . . Signature . . . .

Of address . . . .

Date of testing . . . .

AUSTRALIAN ULTRALIGHT FEDERATION TECHNICAL BULLETIN No. 4

FLIGHT HANDLING REQUIREMENTS FOR AIRCRAFT FOR CERTIFICATION UNDER ANO 95.25.

Compliance with these flight handling requirements must be demonstrated by suitably-documented flight tests.

Pre-requisites for flight testing include the establishment of adequate occupant restraint (For example, by compliance with AUF Technical Bulletin No. 1); establishment of the aircraft empty weight and centre of gravity (See AUF Technical Bulletin No. 2); and demonstration of the structural soundness of the aircraft (Refer AUF Technical Bulletin No. 3).

Before flight testing is commenced, the maximum weight of the aircraft should be established (See paragraph 2.1 of this bulletin), together with the forward and aft centre of gravity limits (Para 2.2 of this bulletin), since the tests must be performed at specified weight and centre of gravity positions which are defined in terms of these limits.

It is recommended that the pilot who is to undertake the tests be acceptable to the Dept. of Aviation for the purpose, as otherwise the test results may not be accepted.

FLIGHT TEST SCHEDULES:

All test flying should be performed and recorded against a formal flight test schedule; it is recommended that the schedule pro-forma which is available from the Dept. of Aviation under the identification code AF 36 be used (where appropriate) for this purpose.

AIR SPEED INDICATOR CALIBRATION:

Since flight tests include the determination of stalling speed, and since many tests involve flight at the design diving speed, it is important that the errors in the air speed indicating system be known. Errors are not only due to mechanical error of the airspeed indicator instrument itself (Instrument Error), but are also produced by the disturbed airflow caused by the shape of the aircraft, together with the error due to the angularity of the airspeed sensors to the local airflow. These two effects are, in combination, referred-to as "Position Error". Calibration of position error requires flight test with special instrumentation (usually, a pivotting-vane pitot-static head mounted on a boom ahead of the aircraft) and should be done under the supervision of a qualified person with experience in such testing, and should be done at as early a stage in the flight test program as possible.

USE OF PARACHUTES:

Pilots are recommended to wear a suitable parachute at all times during flight testing; if necessary, the aircraft should be modified (e.g. by the installation of a jettisonable door or canopy) to allow for pilot exit in case it is necessary to abandon the aircraft.

Aircraft engaged in spin recovery testing should be fitted with a spin recovery parachute, the design and installation of which should be under the supervision of a qualified aeronautical engineer. The use of a full aircraft recovery parachute system is optional but should not be considered a substitute for a personal parachute worn by the pilot.

2. HANDLING REQUIREMENTS - GENERAL

This section describes minimum stability and handling requirements for ultralight aircraft, intended for certification under A.N.O. 95.25

2.1. Maximum Weight

Applicants must declare the maximum weight of the aircraft. This maximum shall -

(1) - Be no greater than the least of (a), (b) and (c),
- (a) The greatest weight for which compliance with the relevant structural and engineering requirements has been established.
- (b) The greatest weight for which compliance with the relevant handling requirements has been demonstrated.
- (c) The greatest weight for which the minimum performance requirements are met.

NOTE: *Obviously, the aircraft must not be overloaded from either the structural, handling, or performance stand-points. It follows that a stated maximum weight is necessary. How else will the pilot know if he is exceeding safe boundaries? Also, the maximum weight must be sufficiently great in relationship to the carrying capacity (in a quantitative sense) of the aircraft. If there are two seats, somebody will fill them, and the aircraft had better be able to carry this load. Similarly, fuel tanks will be filled on occasion. It is, however, reasonable to expect the pilot to trade bodies for fuel in order to remain within weight limitations. This paragraph comes from B.C.A.R. Section K,K1-1,4.1.*

and,

(2) - be not less than the greater of (a) and (b),
- (a) The empty weight of the aircraft, plus the weight of an adult occupant in each seat provided, plus the weight of fuel and oil necessary for at least 30 minutes of operation at normal cruise power at sea level.
- (b) The empty weight of the aircraft plus the weight of minimum crew, plus the weight of full fuel and oil.

NOTE: *The weight of an adult occupant shall be taken at no less than 90kg.*

2.2. Centre of Gravity Range

Applicants must declare a centre of gravity datum for the aircraft, and the allowable range of centre of gravity positions with respect to this datum. The centre of gravity range shall -

(1) - be no greater than the lesser of (a) and (b),

(a) The range stated by the designer or manufacturer.

(b) The range for which compliance with the relevant handling requirements has been demonstrated.

and,

(2) - be no less than the range of centre of gravity movement which would occur as a result of the consumption or jettisoning of the maximum quantity of fuel and any other consumable or jettisonable item (e.g. agricultural chemical), when the aircraft is occupied only by a pilot of weight not exceeding 60 kg.

NOTE: Speeds referred to in this bulletin are Equivalent Air Speeds (E.A.S). This may be found as a product of the True Air Speed (T.A.S.), and the square root of the ratio of the prevailing air density to that at standard sea-level conditions in the I.C.A.O. standard atmosphere. E.A.S. may also be considered as being the Indicated Air Speed corrected for instrument and position error. E.A.S. is equal to T.A.S. in the standard atmosphere at sea level. All speeds are in knots.

NOTES: *The reason for the 60kg pilot weight is that a heavier pilot will tend to mask the effects of in-flight changes due to fuel use, etc., to a greater degree than a light pilot. It is therefore necessary to cater for a reasonably light pilot in this requirement. Standard pilot weight for design purposes is 77kg (170 lb).*

The requirement for an adequate centre of gravity range does not appear in this form elsewhere; the minimum range criteria given assume that ballast may be used to achieve a correct C. avoided. The minimum C. of G. range cannot be less than is necessary to allow for such changes as can occur in the course of a flight.

2.3. Airspeed Limits

The never exceed airspeed (maximum allowable airspeed - Vne) shall be established and not be greater than -

(1) - 0.9 of the Design Diving Speed.

(2) - 0.9 of the highest speed for which the aircraft has been demonstrated to be free from flutter or detrimental vibration.

(3) - The highest speed achievable without engine overspeed occurring with the throttle shut.

whichever is the least.

NOTES: *The principal behind design diving speed and never-exceed speed, is to have a ten percent. safety margin between the maximum placarded speed and the highest speed to which the prototype has been tested. This safety margin allows for minor inaccuracies in airspeed indicators, slop in the control systems, etc.*

2.4. Flight Handling in the Pitching Plane

2.4.1. Pitch Control Authority

The primary pitch control must be capable of holding the aircraft in the preferred take-off and landing attitudes, with the most adverse centre of gravity positions and power settings ranging from zero to fifty percent for landing, and maximum power for take-off.

NOTE: *Sufficient control power must exist to safely take-off and land. The landing case at forward C. of G. is usually the most critical; the inability to get the tail down can lead to landing bounce and loss of control, especially on tail-wheel aircraft.*

2.4.2. Ability to trim Pitch Control Forces

The maximum out of trim force must not exceed 70 Newtons (fifteen pounds force) at any centre of gravity position, power setting, or speed, within the allowable range, unless a cockpit-adjustable trimming device is installed, which is capable of reducing the out-of-trim forces to within this limit under all allowable flight conditions.

NOTE: *Out-of-trim forces must not exceed the value necessary to reach proof load.*

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2.4.3. Pitch Control Force to reach Proof Load

The Pitch Control Force increment per "G" shall be not less than $\frac{70}{n_1}$ newtons, where n_1 is the positive limit manoeuvre load factor.

2.4.4. Pitch Control Forces due to Change of Power

A change of engine power from zero to maximum power, or vice-versa, must not produce a pitch control force greater than 160 newtons (35 lb force), under the following conditions -

(1) - Airspeed - 1.4 times stalling speed.
- Wing Flaps - retracted.
- Trim - set for initial condition (as far as possible) and not moved thereafter.

(2) - Airspeed - minimum recommended landing approach speed.
- Wing Flaps - extended (if fitted).
- Trim - set for initial condition (as far as possible) and not moved thereafter.

NOTE: *The values used are drawn from B.C.A.R. section K, K2-8, 5.1. Large out-of-trim forces due to application of power in a "go round" situation are most undesirable in the context of pilots with minimal training or experience. The concept of aircraft which can be flown without a pilot licence and the associated training, is not compatible with anything less than very well-mannered handling characteristics.*

2.4.5. Pitch Control Forces due to Change in Flap Setting

The pitch control force resulting from the changes in wing-flap position in the conditions specified below, must not exceed 160 newtons (35 lb force) -

(1) - Speed - 1.2 times the stalling speed in the cruising configuration.
- Power - power off and maximum power.
- Trim - set for initial condition (as far as possible) and not moved thereafter.
- Flap Position - move from the retracted position to that of maximum extension, and vice-versa.

(2) - Airspeed - maximum permitted with flaps extended (Vf).
- Power - power off and maximum power.
- Trim - set for initial condition (as far as possible) and not moved thereafter.
- Flap Position - move from the retracted position to that of maximum extension, and vice-versa.

2.4.6. Wings Level Stall

Each aircraft type must be controllable in roll and yaw (or in the combined roll/yaw sense, in the case of two-control aircraft), by unreversed use of the appropriate controls, up to the point at which the aircraft stalls (or the minimum speed at full nose up pitch control). The wings level stall characteristics shall be demonstrated by reducing the speed in level flight by not more than one knot per second until the aircraft pitches uncontrollable nose-down or until the pitch control stop is reached. Normal use of the pitch control and engine power is allowed after the pitching motion has unmistakably developed. During the recovery it shall be possible to prevent more than fifteen degrees of roll or yaw by normal use of controls. This shall be demonstrated with -

(1) - All possible configurations of airbrakes, wing flaps, and landing gear.

(2) - All *critical centre of gravity positions* within the allowable range.

(3) - Power off and seventy five percent power.

The trim shall be set for 1.5 times the stall speed or the minimum trim speed, whichever is higher.

NOTE: *This requirement calls for "civilised" behaviour up to the stall, and is in line with generally accepted aircraft behaviour standards; no lesser standard could reasonably be applied for ultralights. Post stall wing dropping beyond the degree indicated is likewise not acceptable in the light of current aircraft behaviour standards. The wording is adapted from A.N.O. Part 101.26.*

2.4.7. Turning Flight Stalls

When the aircraft is flown in a co-ordinated 30° banked turn from which the speed is reduced at not greater than one knot per second by progressively tightening the turn with the pitch control until the aircraft stalls or until the pitch control reaches the stops, it will be possible to regain level flight without -

(1) - loss of altitude in excess of two hundred feet.

(2) - uncontrollable tendency to spin.

(3) - exceeding 60° of roll in either direction, from the established 30 ° bank.

(4) - exceeding either maximum speed or the limit load factor.

NOTES *These requirements are, again, merely normal "civilised stalling behaviour to current accepted standards.*

The value of 200 feet is an attempt to quantify "excessive" in the context of ultralight aircraft.

The requirements come from B.C.A.R. Section K, and A.N.O. 101.26.

The roll requirements mean that the aircraft must not roll inward past the vertical nor outward past 30° bank the other way.

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2.4.8. Longitudinal Stability and Control Friction Effects

(1) - At all speeds and centre of gravity positions within the allowable ranges, a forward movement of the primary pitch control must be needed to increase the speed of flight.

(2) - At all centre of gravity positions within the allowable range, to obtain and maintain speed above or below the trimmed speed, a forward or backward force at the cockpit pitch control respectively, shall be necessary at all speeds between the minimum and maximum permissible.

(3) - When the aircraft is flown hands-off at a selected speed which shall be between 1.3 Vs and 0.8 Vne (in the case of an aircraft fitted with pitch trim a speed of, 1.4 to 1.6 Vs may be used), and the pitch control is displaced sufficiently to change the airspeed by at least 20%, the force on the control being relaxed very slowly thereafter, the aircraft must return to a speed within 15% of the original value.

NOTES: Use of roll and yaw controls is assumed, to maintain straight flight.

The "stick position versus speed" criterion is a measure of the stick-fixed longitudinal stability - i.e. are the tail surfaces large enough? (B.C.A.R. Section E. E 2-3).

The "stick force versus speed" criterion is a measure of the stick-free longitudinal stability, which is determined by tail surface size, elevator floating characteristics (i.e. aerodynamic balance of the elevators), etc. (B.C.A.R. Section E, E2-3).

Friction in the pitch control system must not be such as to mask the effects of instability. The value of 15% as a free-return speed margin (as compared with 10% allowed by B.C.A.R. Section K, K 2-10, 2.1.2), reflects the slower speeds at which ultralight aircraft fly - there are not such great aerodynamic forces available to overcome friction - but the control systems may be just as complex as any light aeroplane.

2.4.9. Dynamic Longitudinal Oscillation

When disturbed sharply with the pitch control free there shall be no sustained oscillation in the control surfaces or their supporting structure, or severe oscillation in the attitude of the aircraft. This shall be tested to Vne - see 2.5.5.

NOTE: *Tail surfaces lacking mass-balance are prone to oscillation when the aircraft is sharply disturbed in pitch; once started, such oscillation can rapidly build up until failure of the aircraft occurs. This test ensures that the aircraft is free from this vice (B.C.A.R. Section E, E 2-3, 2-2).*

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2.4.10. Dynamic Wings-Level Stall

A sharp stall, in which the pitch control is brought to the full nose-up position from an initial speed 10% to 15% above the stall speed, so as to produce a nose-up attitude of approximately 45° above the horizon at the instant of stall, shall not result in a pitch-down attitude beyond the vertical and shall not cause a loss in altitude in excess of two hundred feet, when normal recovery actions are initiated as soon as the pitch-down has unmistakably developed. Recovery must be possible without exceeding the maximum speed or the limit load factor.

NOTE: *The stalling characteristics, when the aircraft is entered somewhat deeper into the stall than occurs in a one knot per second deceleration, can change dramatically; this must be investigated. In essence, the standard called for requires that the aircraft not go over onto its back or enter an inverted spin, or tumble end-over-end. The numbers are an attempt to quantify "violent" stalling and excessive loss of height, in relation to ultralight aircraft (B.C.A.R. Section E - paraphrased, E 2-3, 4.2.6).*

2.5. Flight Handling in the Rolling Plane

2.5.1. Control Authority in the Rolling Plane

At a speed of 1.4 Vs it must be possible by using a favourable combination of controls, to roll the aircraft from a steady 45° banked turn through an angle of 90°, so as to reverse the turn in b/3 seconds, where b is the wing span in metres, unless the aircraft is fitted with a placard prominently visible to the pilot, on which is displayed the words-

"THIS AIRCRAFT HAS LIMITED CONTROL AUTHORITY:
OPERATIONS IN WIND CONDITIONS EXCEEDING # KNOTS
ARE NOT RECOMMENDED

The value to be inserted in place of # is the lesser of ten or the manufacturer's recommendation.

NOTES: *Aircraft must have sufficient control authority to be controllable in turbulence near the ground, if they are to be flown in such conditions. The roll control authority criterion used here is that applicable to sailplanes and has proven to be a useful criterion. Since ultralights under A.N.O. 95.25 will have wing loadings comparable to sailplanes, the value is appropriate to ultralights (see B.C.A.R. section E, E 2-3, 3.7).*

Ultralights intended to be used in light conditions, do not need this level of control power; however a warning placard is necessary to draw the pilot's attention to the limitation.

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2.5.2. Roll Control Secondary Effects

At a speed of 1.2 Vs, when full roll control is applied abruptly, with the yaw or directional control held central, the adverse yaw shall not exceed 15°.

NOTE: *Roll control often produces adverse yawing effects (aileron drag). This requirement is to ensure that such effects are not excessive. Aircraft having two-control systems with combined roll-yaw controls (e.g. by spoilers) will usually comply with this requirement; however, they should still be subjected to this test to ensure reasonable harmony between the roll and yaw effects of their control systems (B.C.A.R. Section E, E 2-3, 3.3).*

2.5.3. Lateral Stability

When the roll control is released in a side-slip at any speed between 1.2 Vs and Vne, the tendency to raise the low wing shall be positive. This shall be demonstrated with all flap positions and all critical centre of gravity positions.

NOTE: *This requirement ensures that the aircraft has sufficient dihedral on the wings, and covers static aileron over-balance (e.g. due to upfloat of frise ailerons at Vne). The wording is modified from B.C.A.R. Section E, E 2-3, 3.3.*

2.5.4. Roll Control Required to Prevent Self-Tightening in Turns

In steady circling flight, the roll control displacement required to counteract the rolling tendency towards the centre of the turn, must not exceed one third of the available control travel from the neutral position; and the force required must not exceed approximately 25 newtons (5lb force); this shall be tested in a turn at 30° angle of bank and 1.2 Vs, with as little slip or skid as possible, under the following conditions -

(1) - level flight,
(2) - power-off glide,
(3) - maximum power climb,

and there must be sufficient control to overcome any tendency to self-tighten in any turning or spiral descent manoeuvre which may be performed within the allowable flight limitations of the aircraft.

NOTE: *There have been reported accidents involving two-control aircraft in which the aircraft could not be rolled out of a turn. This problem leads to an ever-tightening spiral dive, with the potential outcome being the break-up of the aircraft, if it does not strike the ground first. This requirement is intended to produce reasonably pleasant turning flight characteristics, and to prevent uncontrollable self-tightening behaviour. The requirement is extrapolated from B.C.A.R. Section E, E 2-3, 3.5.*

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2.5.5. Roll Control Oscillation and Dynamic Stability

When disturbed sharply in straight flight, there shall be no sustained oscillations in the roll control system, and the cockpit control shall return quickly to the approximately central position. The test shall cover the entire allowable speed range up to Vd

NOTES: This test shall be performed with the roll control free, and a sharp disturbance shall be produced by a suitable blow on the cockpit control; the magnitude of the disturbance is sufficient if a transient roll attitude response of the aircraft as a whole results from the blow.

This requirement covers simple flutter of non-mass-balanced ailerons and equivalent aerodynamic and inertial oscillations in other forms of roll control systems. The testing should start at a low speed and work up to maximum speed in small increments. This test also covers torsion-bending flutter of the wing as a whole (B.C.A.R. Section E, E 2-3, 3.1).

\# *1.11 times Vne is the normal value of the design speed, Vd. It is necessary to test to Vd for proof of compliance purposes, in order that a positive safety margin shall exist for normal operations up to Vne. This test may be sufficient flutter clearance for one-off machines; however it is not a substitute for stiffness testing for series-production types.*

2.6. Flight Handling in the Yawing Plane

2.6.1. Control Authority in the Yawing Plane

The yaw control must be capable of producing a side-slip sufficient for the purposes of cross-wind landing in cross-wind components of up to eight knots, unless the aircraft is fitted with a placard, prominently displayed to the pilot, on which are the words -

"THIS AIRCRAFT HAS LIMITED CONTROL AUTHORITY:
OPERATIONS IN WIND CONDITIONS EXCEEDING
KNOTS ARE NOT RECOMMENDED"

The value to be inserted in place of # is the lesser of ten or the manufacturer's recommendation.

NOTES: * *The form of yaw control authority requirement called up in B.C.A.R. Section E, relates to the special problem of aileron drag in sailplanes. There is no discrete requirement in B.C.A.R. Section K. However, the requirements to handle crosswind of 15 Km/h appears in J.A.R. 22. Since ultralights under A.N.O. 95.25 have wing loadings comparable with sailplanes, a similar value is appropriate.*

\# *It is reasonable enough to placard the aircraft against wind conditions of ten knots, when the crosswind capability is limited to eight because ultralights can, if necessary, reduce the effective crosswind component by landing obliquely on the landing strip;and in any case,a precise 90° Crosswind is rarely encountered, so that the full wind value is not usually reflected in the effective crosswind component.*

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2.6.2. Directional Stability

When the yaw control is released in a side-slip (or in the case of a two control aircraft, the roll control is centralised in a banked attitude of at least 30° in nominally straight flight) at any speed between 1.1 Vs and Vne, the tendency must be positive for the aircraft to yaw towards the low wing (i.e. swing out of the side-slip). This shall be tested at the most aft centre of gravity position within the allowable range, with each flap position, and power off up to maximum power.

NOTE: *High power conditions must be tested because power effects, especially from forward mounted* propellers, are often de-stabilising. The requirement comes from B.C.A.R. Section K, K2-10, 4.2, with extrapolation to cover two-control machines. It determines if the basic weather-cocking stability is adequate.

2.6.3. Yaw Control Forces

Yaw control forces must not reverse with yaw control deflection at any speed. There must be no tendency for the yaw control to remain "locked over" when it is released in a full control side-slip at minimum speed. This shall be tested at all flap settings, power off and maximum power, and the centre of gravity in the maximum rearward position of the allowable range. Increased yaw control travel must result in increased side-slip.

NOTE: *This test is designed to detect rudder over-balance, including that due to stalling, i.e. "rudder lock". From B.C.A.R. Section K, K 2-8, 6.2.*

2.6.4. Yaw Control Oscillation and Dynamic Stability

When disturbed sharply in straight flight, there shall be no sustained oscillation of the yaw control system, and the cockpit control shall quickly return to the approximately central position (making due allowance for such effects as may be present to allow for propeller slip-stream effects).

NOTE: This test shall be performed with the yaw control free, and a sharp disturbance shall be produced by a suitable blow on the cockpit control, sufficient to produce a perceptible yaw response of the aircraft as a whole.

Tests shall cover the entire allowable speed range up to Vdl

This test covers rudder dynamic stability and flutter.

2.6.5. Note:

The sizes of directional stability surfaces and yaw controls may be dictated by spin recovery requirements rather than directional control and stability.

2.7. Spinning

Each aircraft type must be either -

(1) - Demonstrated to be characteristically incapable of spinning (see note 2.7.1 below), or,

(2) - demonstrated to be capable of recovery from a one-turn spin, power off, in all configurations intended to be used in normal operation, with the controls applied normally for recovery, in not more than one additional turn, without exceeding either the limiting air speed or the limit flight load factor, or,

(3) - in the case of aircraft for which intentional spinning is to be permitted, it shall be possible, after all reasonably practical methods of entry in the cruise configuration, to recover from a spin in either direction, by the standard* method, without the use of engine, when action for recovery is initiated after eight turns. The aircraft shall recover from the spin in not more than one and one half additional turns, and without exceeding the limiting airspeed or the limit flight load factor.

NOTES: The standard spin recovery is; Full opposite rudder, pause while maintaining rudder, apply progressive forward pitch control (maintaining full opposite rudder) until the rotation ceases.

This requirement is adapted from B.C.A.R. Section K, K2-12, 3.1 and 3.2.

2.7.1. Note - Aircraft Characteristically Incapable of Spinning

When it is desired to demonstrate that an aircraft is characteristically incapable of spinning, a series of tests shall be made in which attempts are made to spin the aircraft from all reasonably practical methods of entry in all configurations intended to be used in normal operations, under the following conditions -

(1) - a weight 3% in excess of the maximum weight,

(2) - a centre of gravity position 3% of the mean geometric wing chord, aft of the most aft position of the allowable range,

(3) - a pitch control surface travel 4° in excess of that to which the control is normally limited by stops, in the nose up sense, and,

(4) - an available yaw control travel 7° in both directions in excess of that to which the control is normally limited by stops.

NOTE: *see appendix to B.C.A.R. Section K, K 2-12.*

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2.7.2. Note - Spin-Recovery Parachute System

It is recommended than aircraft engaged in spin trials be fitted with a suitable spin-recovery parachute system.