

THE BRITISH MICROLIGHT AIRCRAFT ASSOCIATION

GUIDE-LINES FOR INSPECTORS

"Is what I, the Inspector, am looking at, likely to perform its function as the designer intended it to do?"

ANY COMMENTS ON THESE NOTES, OR FEEDBACK OF ANY KIND  
FROM INSPECTORS WILL BE MOST WELCOME.

## THE REVISED HANDBOOK FOR BMAA INSPECTORS

In this redrafted version of the Inspector's Handbook, I have attempted to deal with all of the comments received from BMAA Inspectors.

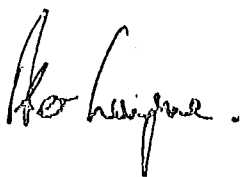
I have also added in most of the salient points raised in general correspondence since I took on the job of Chief Inspector, and those which arose during the Inspectors' Seminars. This has enabled me to scrap a large number of separate letters sent out to you.

The "Spotlight" section of the Handbook has been expanded a little, with more detail on some specific types of aircraft. Wherever possible, I have also added cross-references to Defect Reports.

In order to reduce the total quantity of paper being sent out we have had to resort to A3 to A4 reductions. If any of you find these too hard to read, and particularly need to have a special piece of information, I can provide individual pages on request. But if the item is, for example, one relating to Quicksilvers, on which I have added quite a lot of extra information, you must contact Aerolite Ltd. who will supply the necessary information sheet for an appropriate fee.

You can safely scrap all of the existing contents of your Inspectors' Handbook folder, except for the copies of inspection forms for machines which you have signed off and to which you may need to refer when next you look at those aircraft.

May I take this opportunity of thanking most of you for carrying out an extremely difficult job in a satisfactory manner. There are, inevitably bound to be one or two slapdash inspectors. But they will begin to reveal themselves, now that the BMAA-operated Airworthiness system is moving into its second full year of implementation, with the consequent increase in strict formality, and I can then finally 'tidy-up'.



Peter Lovegrove  
15 February 1986

## FOREWORD

You are a BMAA Inspector. You have agreed to accept the responsibility of deciding whether the aircraft which you are about to inspect is, or is not, fit for flight. When you have done your job, a BMAA Check Pilot will examine its flying qualities. EVERY TIME YOU START AND FINISH AN INSPECTION, PLEASE REMEMBER THAT.

If any owner refuses to accept your decisions, then let him do so but immediately consult your Area Inspector and/or send your findings in writing to the Chief Inspector. DO NOT ARGUE with the owner. Let him know, firmly, that under the Airworthiness scheme your findings are what count, unless and until overridden by the Area Inspector or the Chief Inspector.

You will, of course, make errors occasionally, as will all of us working within the scheme. Do not let that deter you from making the decision which you honestly believe is right.

Do not feel obliged to be lax in your inspection, because the owner is a friend. (Relatives of deceased or totally-incapacitated pilots feel no restraint in their pursuit of compensation!)

These guide-lines will continue to undergo revisions, deletions and additions, hopefully, mostly by incorporation of information coming from Inspectors like yourself. You may find a copy of Section S useful along with the Civil Aviation Inspection Procedures, most sections of which have been in use in all branches of light and general aviation for several decades.

One important point to remember is that some microlight aircraft which you will inspect have never before been examined by anyone acting in an official capacity as you are. This is a situation which will always exist to some extent. Most of the Orphan machines are of designs which, in general, will never be able to show full compliance with Section S. A simpler approach, Type Acceptance, is being pursued, relying essentially on good inspection for general workmanship, materials of construction and methods of construction.

YOU ARE NOT EXPECTED TO ASSESS THE OVERALL DESIGN. We do expect, however, that you will discover and report to us any clear cases where, in your view, a design feature is patently unsuitable or inadequate for the function which it is expected to perform, or for the loads which it is expected to carry.

Read and make use of the information contained in the owner's log-book for the aircraft under inspection.

HE MUST, BY LAW, MAINTAIN AN UP-TO-DATE LOG-BOOK FOR HIS ENGINE AND AIRFRAME. IF HE HAS NONE, DO NOT INSPECT THE MACHINE.

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## CHAPTER 1

## DACRON FABRIC

### 1.1

The standard of fabric work to be found on microlights can vary greatly. In some of the poorer quality sails, it is found that the clearance holes for struts, cables, etc., have simply been cut out with a hot knife and tend to look somewhat ragged.

Stitching is not always duplicated where it could perhaps benefit from being so. Nevertheless, although this sort of sail-work looks rather awful, it is generally acceptable and is never known to have failed, so do not reject it on the grounds of scruffiness!

At the other end of the scale, one finds immaculate sail-work which can give no cause for concern about the basic manufacturing standards. However, the standard of handling and treatment by the owner(s) may be a totally different story. One too often hears about idiots who trample about ON their sails in heavy flying boots whilst they rig their machines.

Inspectors should therefore not be too biased about the original form of the sail. If hot-knife cutting has been used round holes then look for tears leading away from the holes rather than at the holes themselves. This sort of hole-cutting does tend to give a thickening at the edges which means that there is a somewhat brittle lip of solid plastic - for that is what it is - just waiting to crack, giving the ideal start of a rip.

### 1.2

Inspect the stitching for any signs that it may have started to unravel. Judge where you think doubled stitching should have been used and has not; then check whether any sort of failure has begun in those areas. For example, if ribs or wing structure are so placed that intense pressure is brought to bear on specific areas of the sail, it is reasonable to expect to find rips, abrasions, or some kind of imminent failure at those points.

### 1.3

Look carefully for severe discolouration or any other indications of deterioration of the Dacron, especially if the machine has spent any significant length of time tied down in the open, with or without covers on the flying surfaces. Even if the sun has not been able to do its worst, dampness (acid dampness, in Britain!) will probably have been trapped under the covers and may have harmed the Dacron.

Ultra-violet light readily attacks thread as well as fabric. Draw back a thumb-nail over the line of thread and if it is badly affected it will powder. If this happens, professional advice should be sought from a sailmaker to eliminate any possible risks.

A good general test for the condition of Dacron is to hit the centre of a panel with the thumb. If an impression is left, or worse, if the thumb goes through, there is a problem!

If small tears are present in fabric which appears discoloured or shows other evidence of age, try to determine if the tears can be easily extended by pulling the edges apart. It should always be very difficult to extend rips in good sound fabric.

#### 1.4

Pay particular attention to "homemade" patchwork. Try to find out exactly what conditions prevail underneath the patch or tape.

#### 1.5

Pay particular attention to the highly stressed areas of flex-wings, especially dual-seat machines. Typical of such areas are the wing-tip sail-attachment points and the inboard trailing edges. The lines where the keel pockets are sewn to the main wing panels are also areas of high stress.

#### 1.6

The fabric on control surfaces should be fairly taut. If it is loose then these surfaces can sometimes be prompted to flutter or vibrate in flight. This tendency is often aggravated by the fact that hardly any microlights - certainly of the "Orphan" era - ever have any kind of mass balancing on the control surfaces.

If only slightly loose, the fabric can sometimes be tightened by dismantling the relevant framework and sleeving the appropriate leading- or trailing-edges or spars. Wrapping the tube(s) securely with tape before reassembly is often adequate. Good quality PVC tape ("Lassovic") or glass-fibre tape are ideal; rubbish like black insulation is certainly not suitable. This method of rectification is well-known and effective, (but only where a little tightening of the fabric is needed), and can save the owner from an expensive re-manufacture of fabric coverings.

It is interesting to note that single-skinned control surfaces are often more prone to fluttering and vibration than double-skinned ones. This is because of the very disturbed airflow over the tubes which form the framework, acting on the under-surface of the single skin.

If the owner has commented on a tendency for control-surfaces to flutter, it could be pointed out to him that double-skinning has sometimes proved to be an effective cure.

### 1.7

The design of some machines is such that they are very prone to fabric damage due to ground contact. For example, if an aircraft has a very narrow or softly sprung undercarriage, the chances are that it is all too easy to ground-loop, especially in the hands of a novice. Tail-draggers often fall into this category too. Even on some tricycle-undercarriaged machines, the rudder is still fairly easy to scrape along the ground during take-off or landing. Many flex-wings often allow the tips of the wings to touch the ground.

As a consequence of these various forms of ground-contact, there may be considerable wear on the fabric at the wing-tips or at the base of the rudder, with the risk of dangerous splitting. Check carefully for this.

### 1.8

Finally, it is worth pointing out that time is itself the main ingredient in any problem with Dacron. To date, many machines are still too 'young' to exhibit any such troubles. However, sailmakers are now beginning to see evidence of serious time-induced defects and inspectors must therefore be very vigilant.

If the fabric on the aircraft has been there for ten years or more, it must be replaced, irrespective of its apparent condition.

## CHAPTER 2

### POWER PLANTS, REDUCTION GEARS, PROPELLORS AND EXHAUSTS

#### 2.1

There are, it seems, as many types of engine, reduction drive and propellor as there are microlights! Therefore, all one can do here is to give some general notes which will lead inspectors to approach the survey in the right manner.

**ALWAYS ASSUME THAT THE ENGINE IS 'LIVE' AND ABOUT TO BURST INTO ROTATION, EVEN WITH THE THROTTLE FULLY CLOSED AND THE IGNITION SWITCH IN THE 'OFF' POSITION.**

Carry out the following scrutiny:

#### 2.2

In order of preference, propellor bolts should ideally be secured with:-

- (a) castellated nuts with split-pins or stainless-steel wire-locking,
- (b) plain nuts, each with a small hole through the corner junction or two of the flats, with stainless-steel wire-locking threaded through the ring of nuts
- (c) Simmonds-type self-locking nuts. (These are the type cut from one piece of steel and with two thin slits at right-angles to the axis of the thread). For this type of nut to be acceptable, the bolts should ideally be of the 'aircraft' type and the threads **MUST**, in any event, be totally undamaged.
- (d) as a final choice, Nyloc nuts may be used. Because of the risk of heat being easily developed in the event that a propellor becomes even marginally loose, Nyloc nuts are certainly not the most appropriate choice, but cannot be totally rejected by the inspector because the CAA says that he can accept them.

Butterfly nuts and spring clips can only be accepted as the means of securing the propellor-bolts, if they are necessarily used, as on the Eagle, and are always carefully checked before and after flight.

Propellor bolts should ideally be of aircraft quality, or appropriate high-tensile commercial type of at least British Standard 'S' grade.

Under no circumstances must plastic washers be tolerated on propellor-retention bolts.

#### 2.3

Is the propellor chipped, split or has its cladding become at all loosened?

Is there any evidence that the propellor has been damaged and repaired? Has the repair been properly carried out and is it significant enough for the propellor to have needed re-balancing? If so, has it been re-balanced? Should the repair ever have been done at all; instead, should the propellor have been scrapped? It should be noted that the repair of propellers by splicing is **NOT** permitted. Even propellers repaired by professional manufacturers have failed in flight.

Is the propellor still tight upon its flanges?

Is there the slightest sign of any burn-marks around the bolts or flanges?

Are there any signs of oil penetrating beneath the paint/varnish in any preferred locations, and if so, why? Are there any signs of cracks, large or minute, developing on the blades, particularly near their roots?

If there are any doubts at all about the complete integrity of the propellor, ask the owner to replace it.

#### 2.4

Is the engine firmly fitted to its mounting plate(s) or bracket(s)?

Are the rubber vibration-isolation mounts in good condition with no sign of 'perishing', splitting, peeling away from their metal pieces or are they saturated with oil?

Have any cheap, low-quality rubber mounts, with a pad of rubber sandwiched between the two discs, each with a stud, been used for any critical application, where their failure could leave the engine free to vibrate badly, or flail about? (Some of the early Chargus trikes had their engines break free because of failures in this type of isolation-mount.)

Have rubber isolation-mounts been used on the exhaust mounting? If so, is the installation such that they cannot burn?

Nyloc nuts must never be used in a warm environment, e.g. near to an exhaust system, because the Nylon softens and flows - permanently losing its effectiveness as a locking medium. A suitable alternative is a castellated nut with a split-pin, or a Simmonds-type nut. Are safety wires fitted across critical rubber mounts?

#### 2.5

Are all cables joined to the components they are supposed to meet? Are all cables secured properly against flapping and vibration?

#### 2.6

Are the ignition leads in first-class condition, free of burns, cuts, splits and are the ends fully into and secured to the coils, etc.? Are all leads properly fixed, so that they cannot flutter against sharp edges or hot surfaces?

Are the ignition leads to the cockpit switch in good order? Is it CERTAIN that the switch works properly? Are the leads adequately secured against flapping, along their whole lengths?

The airframe should NOT be used as the return path for the ignition-switch lead.

DO NOT ACCEPT THE USE OF A 12-VOLT SWITCH FOR THE IGNITION; INSIST ON A 240-VOLT MAINS-RATED VERSION BEING USED. (Such switches are normally marked with the high voltage (240 V.A.C.) they will tolerate.)

## 2.7

Are the throttle and choke cables in good order and fully secured to their respective fittings? Do the cockpit levers work properly and without sticking? Could the throttle or choke unit fall to pieces if any screws loosened? When used as end terminations are the small nipples sound, properly fixed and free from corrosion?

## 2.8

Are the pulleys of the reduction gear secure upon their shafts and bearings? Are they in good condition? Is there any measurable play in the bearings? Are the inners and outers of the bearings not cracked?

Some manufacturers attempt to secure the inners of the ball-races to the shaft simply by compressing a sleeve over the shaft between the two inners, with a nut on the end of the shaft beyond one of the bearings. Check that this spacer-sleeve is tightly gripped. Has it a record of loosening? Has there ever been a change of material specification for it?

Check that any bearings are properly lubricated.

Grub-screws are absolutely forbidden in any stressed part of a rotating shaft. The only place at which they may acceptably be situated and their location-holes tolerated, is in the extreme end of the shaft, outside the bearing at the opposite end to the propellor, where there is virtually no stress.

If a toothed-belt system is used, are the retaining rims firmly attached to the pulley(s)?

What is the condition of the drive-belts? Are they frayed, oily or showing any other signs of serious wear? Are they adequately tight on the pulleys? If toothed, do they have plenty of tooth-form left on them, not grossly rounded-off and almost ready to slip even if the belt tension were increased?

On toothed-belt reduction-drive systems, ensure that there is good axial alignment between the driver and driven pulleys. If this is not so, there is a very real risk of failure of the engine-pulley flange as the belt continually bears hard against it.

DISCONNECT THE SPARK-PLUG(S) and cautiously rock the propellor to see if there is sufficient belt tension. If a toothed-belt system has wear on the belts or the teeth of the pulleys there may sometimes be a detectable back-lash in the motion as you rock the propellor, if the belt is not well-tensioned. (Typically, 6 to 7 mm movement in one direction at mid-span, is acceptable.)

DO PLEASE REMEMBER - THE ENGINE MAY FIRE IF YOU DON'T REMOVE  
THE SPARK-PLUGS LEADS COMPLETELY!

TAKE CARE!

## 2.9

What is the state of the exhaust system? Are there any cracks starting, especially around the supporting lugs? Are the rubber mounts in good condition? (Check as for engine mounts). Are the flanges leaking and showing excessive signs of black oil? Are there any badly rattling bits hear within?

If retaining springs are fitted at the engine, are they worn at the ends? Are the loops to which they are attached on the exhaust unit worn? Exhausts

should always have at least one retaining wire fitted in case of spring failure.

#### 2.10

Are all of the bolts on and immediately around the engine and its ancillaries properly tightened and adequately locked?

#### 2.11

Some engines - particularly the single-cylinder types like the Fuji and Hiro - have synthetic-rubber mounts which connect the carburettor to the engine cylinder. These connectors are very prone to splitting, leading to weak mixture (and a very hot engine!) or to complete severance of the carburettor from the cylinder. Check very carefully for splitting of the connector, or parting of the rubber from its flanges. Ask for a safety wire to be fitted across from the carburettor to the engine body, in case the plastic or rubber mount fails.

#### 2.12

Quadrant throttles must move forward to increase power. Pull throttles must move forward away from the pilot for increased power. Twist-grip throttles must act as for motor-cycles, i.e. backwards over the top to increase power.

Up until now, we have been able to accept a variety of throttle directions. Now, we must begin to enforce standardisation. So, when you inspect a machine with a throttle contrary to the norms above, instruct the owner to rectify it in a specified time. If you have been doing your job well, most of your 'customers' will already have done this or be prepared for having to do it, since the subject has been raised many times before.

## 3.1

Many different types of tank are used on microlights. Track record has shown that plastic bottles of up to about two gallons (10 litres) capacity are generally satisfactory, provided that they are properly supported and restrained. With tanks of capacity greater than 10 litres, inspect carefully for any signs of weak or thin regions and look for rather more support than is needed for the smaller tanks. Bits of rubber bungee cord round a plastic bottle lodged on a tube is NOT an acceptable set-up!

The tank must not be capable of being worn away in holes by virtue of the way in which it is supported. Nor should the builder have used thick wads of felt, foam rubber, or the like, to cushion it and make up for the absence of proper support, since these conflict with Section S in that they will soak up and hold spilled fuel.

Ensure that the tank cannot rub against any sharp edges or structural members which can press hard on it.

## 3.2

The fuel tank must have an air-vent which is incapable of being blocked or easily oriented wrongly, thus producing a vacuum inside the tank rather than positive pressure.

## 3.3

It should be possible to observe the level of the fuel in the tank at all times without having to assume difficult or possibly dangerous postures in flight.

## 3.4

PVC hose of the type typified by 'Griflex' and reinforced with Nylon mesh, is adequate but not really ideal for fuel lines on any microlight. The petrol leaches out the plasticiser and other constituents leaving a darkened, very brittle tube. Connections to valves, carburettor-inlet fittings or primer squeeze bulbs are very likely to become loose allowing fuel out or air in. In this state, the tube can also crack fairly easily. Where such tube is used vertically between two stubs on the fuel-tank, as a sight-gauge, it has been known to contract off them, with protracted use, so should be installed with some slight slackness and not a taut fit.

If an owner has used this type of tube it must be totally replaced at least annually. If the deterioration process is seen to be quicker than usual because of the type of fuel or oil used, for example, then replacement must be more frequent. So inspectors should check the tube for colour, hardness and looseness on the various fittings.

### 3.5

Black fuel-proof tubing, as sold by D.I.Y. Motorist's shops, is:-

- (a) much more flexible than Griflex,
- (b) less prone to embrittlement,
- (c) more durable overall,
- (d) not much more expensive than Griflex.

Thus owners have very little reason not to use it and inspectors should ask for its adoption where a view of the fuel level is not required.

When its location clearly presents a fire risk - for example, because it is close to the exhaust - fuel tube must be of a fire proof type.

### 3.6

Where fuel-lines are routed along the fuselage members, as they often are, adequate steps must have been taken to ensure that abrasion against the edges of fittings, etc., cannot occur with vibration or fluttering caused by the air-stream over the plane in flight.

If a new tank has been fitted, has it been located in a changed position? Has this added to the height through which the fuel-pump has to draw fuel? Does the pump capacity still give the manufacturer's guaranteed margin over what the engine needs at full power? Can a full tank now upset the permitted Centre of Gravity requirements?

Note that the CAA demand that gravity-fed fuel systems be capable of delivering 150% of the fuel flow required by the engine at full sustained power. On pumped systems, 125% should be available under the same conditions. Fuel-flow tests should be conducted with the tank filled only to a very low level and with the airframe in the most adverse attitude normally encountered.

However, microlights which are Type-Approved will have had the fuel-flow checked and shown to be adequate. With Orphan aircraft, it can be assumed that adequate fuel-flow has been demonstrated "by usage".

A reasonable check is to determine how long it takes to empty the carburettor bowl at full throttle (simply by shutting off the fuel-tap). Then run the engine at full throttle (tap open, of course) for at least twice that period. There should be no drop in r.p.m. detectable.

### 3.7

Rubber squeeze-bulbs can develop splits, through use or because of 'perishing'. This can lead to air entering the fuel line, or petrol leaking out. The valves can fail, albeit a very rare occurrence. Check these bulbs carefully; their life may be limited.

### 3.8

Some engines - particularly single-cylinder types like the Fuji and the Hiro - have synthetic-rubber mounts which secure the carburettor to the engine cylinder. These connectors are very prone to splitting, leading to weak mixture (and a very hot engine!) or complete severance of the carburettor from the engine. Check carefully for splitting or parting of the rubber flange.

## CHAPTER 4

### OBLIGATORY OR MANDATORY MODIFICATIONS REQUIRED ON SPECIFIC MICROLIGHTS

#### 4.1

Inspectors need to recognise that the BMAA can impose OBLIGATORY modifications, which it feels necessary for the safe operation of a given aircraft. The CAA can impose MANDATORY modifications, with full legal enforcement and, often, automatic international adoption.

#### 4.2

It is probable that all Orphan microlights have some weaknesses in them which have been recognised and for the correction of which, modifications have been devised. In some cases, these modifications will only affect the pleasure of handling or the convenience of assembly or dismantling the aircraft. In other instances, the aircraft may not be fully safe and airworthy unless the modification is made.

Before going to survey a machine the inspector should check or find out what modifications are obligatorily or mandatorily required for that type of aircraft, if any by referring to the 'Spotlight' section of this Handbook and/or the TADS for the aircraft type. If, when he examines the aircraft, he finds that they have not been done, **THAT MACHINE IS GROUNDED UNTIL THEY ARE SATISFACTORILY COMPLETED, THE INSPECTOR HAS NO DISCRETION IN THIS SITUATION.** (But the owner can appeal to the CAA to overrule a BMAA imposed OBLIGATORY modification.)

The Technical team is the original source of such information (mainly obtained from the 'Godfathers'). But the inspectors should ask the Chief Executive or, in his absence, the Chief Inspector for details, as the Technical team will have passed on any such information as soon as it comes to hand.

All obligatory and mandatory modifications will eventually have been gathered together into the TADS, as a "List of mandatory modifications". This TADS will be kept up to date with information from the Orphan group's Godfather. During its compilation, for the aircraft's Type-Acceptance submission, individual items will have been discussed with the Technical team, who needed to know:-

- (a) the nature of any defects,
- (b) the cause of these defects and arguments to support the diagnosis,
- (c) the arguments to support the validity of the 'fixes',
- (d) the design for the 'fixes' themselves.

#### 4.3

If an inspector finds a fault on a machine which, he considers, prevents it being flown in safety, then that fault is termed a "Class 1 Defect". The owner will always be instructed to rectify such defects before the aircraft is ever flown again.

#### 4.4

Do not confuse Class 1 Defects with Obligatory or Mandatory Modifications. One of these modifications may sometimes arise from the reporting of a Class 1 Defect, if the latter is considered generic to the aircraft type, but this is by no means standard.

### 3.9

On some engines, particularly single-cylinder ones, the fuel pump may fail to deliver fuel fast enough at high throttle settings due to the effects of heat and vibration. This can usually be traced to a direct mounting of the pump on the crankcase which allows easy transmission of the offending heat and vibration. (This fault has been noted by the distributor and some owners of certain sizes of Rotax engines, for example. The "Fix" is the distributor's.)

Check that the owner knows that if the problem is experienced, the cure is to mount the pump clear of the engine crankcase.

### 3.10

On some machines, diesel-fuel filters have been used to clear the petrol or petrol/oil mixture. If these are found, the owner should be advised that they sometimes use material for the filtering process which is attacked by petrol in the longer term, giving a progressively smaller area for fuel flow. The result of this is a gradually reducing fuel-flow.

The simple transparent-plastic (polycarbonate) fuel-filters, made specifically for cars and motorcycles, may look crude but they are actually safer of our sort of application. An added bonus is that one is able to observe water if it collects in them, and thereby be prompted to look further at the state of the fuel.

## CHAPTER 5

### RECOMMENDED (BUT NOT OBLIGATORY OR MANDATORY) MODIFICATIONS

#### 5.1

As with the Obligatory or Mandatory modifications, the Recommended changes to any particular aircraft will have been brought to the attention of the Technical team through the activities of the Godfather system.

Unlike the Obligatory or Mandatory modifications, these changes may, for a time, be left to the owner to implement or not as he sees fit. Certainly it can be assumed that the aircraft will not fall out of the sky if such changes are not made in the very short term. However, it may well be that something rather costly may be likely to happen which could be avoided by following the advice of the Godfather. The latter will, after all, only have passed on sound guidance gleaned from the members of his particular group. Obviously it could be ignored but common sense should tell the owner to listen. There will certainly be occasions when the inspector should feel bound to advise the owner to act as though a Obligatory or Mandatory modification were involved. This applies especially to lone fliers, who cannot normally benefit from the help of a Club or group of fliers.

#### 5.2

Inspectors should be particularly aware that the BMAA also depends upon them to note any generic engineering weaknesses in machines which they examine. When reported to the Chief Inspector or Technical team, these may then form the basis for other Recommended, Obligatory or Mandatory modifications. It is only by this route that we shall gradually bring all aircraft up to a reasonably common standard of airworthiness which the CAA cannot, nor would wish to refute. Machines which currently only have the option of being Exemption aircraft, headed for the scrap-heap at the end of 1987, could well be brought under the Permit umbrella, much to the benefit of their owners, if a close record is kept of their operation, maintenance and execution of repairs and rectifications.

#### 5.3

If an inspector observes a fault of this type, that is, one which will not cause the aircraft to crash, it is termed a "Class 2 Defect".

Whilst the inspector will simply advise the owner to rectify the fault, he should make a proper record of it, so that, when the machine is next inspected, his attention will be drawn to the fault by reference to the record. He will then be alerted to ascertain whether the fault has been rectified or has possibly increased to "Class 1 Defect" level.

## CHAPTER 6.

## CASTINGS, FORGINGS AND HEAVY EXTRUSIONS

### 6.1

It is not common to find specialised castings used in the construction of microlights. The Weedhopper is one notable exception to this statement. Several castings are used on that machine, all made 'in-house' to a rather agricultural standard. However, although the quality of the castings is somewhat poor, their dimensions are generous - to say the least! - and the required strength is achieved by excesses of material and at the expense of unnecessary weight.

None of these castings has been known to fail, although one engine did exhibit a gas leak through a flaw in the crankcase, easily repaired by welding due to the simple composition of the casting alloy used. So inspectors should be prepared to find and accept items of casting which may be clumsy but, by that very nature, be acceptable for their prescribed use.

### 6.2

Rather specialised fittings have appeared on a few microlights. A lowly-stressed casting is used on the Hiway 250 trike, also on the Hiway Hiro engine-mounting and on the Tartan trike engine-mounting.

One machine uses a short section of a heavy-duty yacht mast extensively machined to allow it to act as the mount for a pair of engines. In such a case all the inspector can reasonably do is to scrutinise the 'lump' very carefully. USE YOUR TORCH AND A "SHERLOCK HOLMES" MAGNIFYING GLASS (OF AN 8X to 15X MAGNIFICATION, BOTH ITEMS OF WHICH NO SELF-RESPECTING INSPECTOR MUST EVER BE WITHOUT!) looking for any signs, such as black oil-filled cracks, of imminent or future failures.

### 6.3

The inspector is justified in assuming that any special castings or extrusions on a given type of machine have been shown by track record to be acceptable, unless he has specifically been given information to the contrary. Of course, that does not absolve him of the responsibility for looking for cracks or any evidence of failure, as with any other part of the structure.

### 6.4

There is a solitary known case of a forged propellor-hub progressively splitting. So, although a component may be the product of a large and well-founded Company, until that component has proved itself by several years of use, the inspector must never assume it to be satisfactory. Nothing must be glossed over.

## 7.1

Springing may or may not be employed. Where the suspension is achieved solely through the yielding of squishy tyres, it is inevitable that the airframe will have to tolerate extra loads. The shocks from taxiing over rough ground or from heavy landings, beyond what can reasonably be absorbed by the 'give' in the tyres, has to be absorbed partly by flexure of some of the airframe members and by movement in the various bolted fittings. Without this movement the airframe might more often crack.

The extent to which the fittings have been abused by this response to landing shocks, etc., will be manifested as general enlargement of the bolt-holes in them, in their attachment to the adjacent tubes or by bending of the bolts. It may be possible to see aluminium dust collecting round a fitting which has been especially badly worn, even though static loading may prevent the joint from 'rattling'. Washers or bolt-heads may, for example, obscure the actual enlargement of the holes, so the inspector may have to rely on observations of such secondary effects to tell him that all is not well on a particular fitting. He must then look more closely at it, asking for dismantling if necessary.

A classic example of this situation is the axle-bracing wire fitted to most monopole trikes. Heavy landings (and, in some cases, just a repetition of light ones), elongate the axle bolt-holes, allowing the axles to flatten and spread. The secondary effect of this, easily observed in this case, is that the side wires which brace the top of the pylon to the axles, become noticeably slack.

## 7.2

Where springing is used, it may be by means of rubber (as bushes or bungee cord) or by steel springs.

If rubber bushes are used, they should be free of splits, not soaked in petrol or oil and show no obvious signs of 'perishing'. Bungee cord should not show any signs of being slack or incorrectly tied off.

With steel springs, look for any evidence - again with torch and magnifying glass - of minute cracks starting near the most highly stressed regions of the leaves, usually close to the anchorages. Check that the springs have not taken a significant set, leaving the aircraft sitting on the ground with one wing markedly low. Remember, if the suspension, be it sprung or not, has dropped to allow the fuselage to come unacceptably close to the ground then, in a poor landing, that fuselage may actually dig into the deck, leading to a hazardous situation.

### 7.3

The sorts of bearings used on the wheels of microlights are many and varied. Whatever they are, they need to be checked for wear and resulting play which can only be found if the axle is propped so that the wheel is clear of the ground, as when checking a car's steering.

Ball and roller bearings are used in some of the more expensive arrangements but it is much more common to find wheels with Nylon or Delrin sleeves acting as bearings. These are generally OK but do tend to pick up grit and wear themselves or the adjacent surfaces. Contrary to common belief, if a soft material abuts against a hard surface and collects grit or any other abrasive, then in any subsequent movement - as with spinning wheels - it is the hard surface which wears most. So, if plastic sleeve-bearings are rotating directly on hard axles or in metal wheel-pressings, look for signs of undue wear in the metal, rather than only in the plastic.

Prolonged taxiing, as in training, often overheats Nylon/metal bearings; the result may be expanded and distorted wheel-hubs.

Occasionally aluminium alloy has been used for wheel bearings. Not surprisingly, this proves a poor choice and, in every known case of its use, has seized up, because it so readily over-heats. Should the inspector find any of these, he should recommend that they be replaced with Delrin or Nylon. Oilite is another possible alternative, provided that it is kept properly oiled.

It is often simple to fit grease nipples to microlight wheels. If, and only if, you know where they are fitted safely on identical wheels, recommend this to the owner. Grease nipples have the merit that they encourage greasing!

### 7.4

Nose-wheel bearings are not usually as vulnerable as those in main-wheels because they carry so little weight at any time. Nevertheless, they must be checked to ensure that they are properly lubricated and that there is no excessive play.

Note that with some aircraft the failure of a nose-wheel on landing could cause a serious accident with grave risk to the pilot.

### 7.5

The structure which supports the wheels/undercarriage also forms a vital part of some aircrafts' primary structure; watch for this and take it into account, if necessary.

## 8.1

All pneumatic tyres should be carefully inspected for signs of splits, cuts or obvious signs of 'perishing'. The latter is quite prone to occur if the machine has been kept in the open for any length of time. If it has occurred, it is most easily detected by squashing the tyre and scrutinising its side-walls; a multiplicity of small cracks will be visible. The presence of this sort of failure is not disastrous, but the owner should be advised to watch its progression carefully. (Cheap imported tyres of the Taiwanese "Goodwear" ilk, are extremely prone to this sort of rapid failure.)

Certainly, if found, this should be recorded in the aircraft's log-book, so that the next time an inspector sees that particular machine, he will check whether the fault has been allowed to worsen without any attention being given to it. A tyre which bursts on landing could prove fatal to the pilot or any bystander, under the very worst circumstances.

The running surface should be examined for embedded objects, which could work their way in and cause a puncture. The actual depth of tread is not too important, except from the risk of small sharp objects too easily penetrating it. Two-ply tyres on dual machines, used on gritty runways, run a serious risk of this sort of failure. The basic integrity of the tyre as a whole is very important; that is, it should not be about to puncture or rip apart for any preventable reason.

## 8.2

Plastic tyres were once sold in quite large numbers and were really rather dangerous. They split too easily and could tear completely off the rim in a yawed landing. It now appears that none have survived, but Inspectors should be alert for them on little-used machines.

## CHAPTER 9

## GENERAL AIRFRAME MEMBERS AND FITTINGS

### 9.1

The primary structure of all microlights should normally be of SEAMLESS DRAWN TUBING and usually of HT-30-TF specification. This may possibly not be so on older machines and inspectors will need to use their discretion.

### 9.2

In the main, the tubes which form the airframes of most microlights are joined by alloy plates or by brackets and lugs cut from standard extruded channels or angles of aluminium-alloy. Some have an anodised finish; others are left plain.

In fairly rare instances, they are made from special castings, as in the case of the fittings at the inboard ends of the leading edges of some wings.

### 9.3

There is not too much difficulty in inspecting fittings, whatever their type. Obviously one looks for cracks or badly enlarged bolt-holes. Sometimes, aluminium dust, maybe blackened a little with oil or grease, is the only visible sign that concealed wear has occurred and further scrutiny is needed.

The assessment which the inspector has to make is whether the fitting is so badly worn or bent that replacement is necessary, and the frequency with which inspection in these local areas is necessary.

In many instances, the wear will have been caused by poor design, i.e. insufficient bearing area. If this is the cause suspected by the inspector, as distinct from poor maintenance, then he may need to contact the Godfather or Chief Inspector about the need for a common design fix to all aircraft of that type as a mandatory modification.

### 9.4

Check the airframe tubing for corrosion. Many machines are built from mill-finish tube and severe corrosion can occur in some environments.

Pay particular attention to tube joints and fitting-attachment points. Wax finish or WD40 affords some protection but etch-primer paint is far better for alloy structures.

A coat of etch-primer and a gloss finish also have the attribute that they allow Dacron to slide very freely on to the leadings and trailing edges, for example.

## 9.5

Where tubes are concealed by sail material it is often difficult to check for unwanted bends. In these cases a good substitute is a tape measure, used to check symmetry between the two sides of the rigged aircraft. Structural members in compression, e.g. flex-wing down-tubes, merit extra attention when looking for bends. Here, even a slight bend means a MANDATORY REPLACEMENT or, possibly, the need for larger or sleeved tubes.

Many flex-wings still flying are conventional hang-glider wings, mainly with floating cross-booms. Where these wings have been used for hang-gliding, unfasten the sail at the keel, if necessary, and peer inside the envelope. Check very carefully that the cross-tubes are not bent forward by previous nose-impact in a heavy landing. THESE, AND THE CENTRE ASSEMBLY WHICH JOINS THEM, ARE PRONE TO CRITICAL DAMAGE OF A TYPE WHICH HAS RESULTED IN A WING FOLDING IN FLIGHT!.

A heavy landing on a flex-wing can also distort the keel of the wing, or bend some hang-channel bolts, which are not always easily noticeable.

## 9.6

Dents in tubes, although fairly rare, can be found on machines subjected to rough handling. Significant dents in covered tubing, perhaps the precursor to total buckling, can often be detected by feeling along the tube, with the sail-cloth pulled taut. Provided that a dent is very small, with no evidence of a local cut in the tube wall it is not necessarily a serious matter. (Dents of depths, say, of 6 mm maximum in a 50 mm (2") diameter tube, may be regarded as small.)

## 9.7

Wear can occur between two aluminium-alloy tubes in loose contact but can often be difficult to spot without dismantling. Tell-tale signs may be dust around the interface or tubes abutting more closely than their virgin state would permit!

Abrasion of this kind can easily occur during transport, so check the machine in its rigged and de-rigged (ready for transport) state if this can readily be done.

## 9.8

Where components are bolted to tubes the acceptable standards are as follows:-

A simply "Drill, ream and bolt through" technique is permissible but, ideally, and as a guide, only when the TUBE WALL-THICKNESS, INCLUDING SLEEVES, IS NOT LESS THAN ONE-SIXTEENTH of the tube outside diameter.

Also as a guide to Inspectors, the centre distance of any drilled hole should ideally be NOT LESS THAN TWO HOLE DIAMETERS from the end of the tube.

## 9.9

If 'pop' rivets are used on flex-wing structures, they usually eventually loosen and may even drop out. Aluminium rivets are worst in this respect. Check any which are found, for security, and warn the owner that he/she should be prepared to replace pop rivets at regular intervals.

#### 9.10

All welds on steel or alloy fittings and steel tubes should be carefully examined.

Welded fittings which are coated with plastic - by the 'dip' process - are NOT acceptable. Plastic coatings which key badly to steel fittings can not only hide shoddy welding but encourage corrosion by trapping water. Inspectors should insist on such fittings being stripped and cleaned to expose the welds fully and then, if the latter is satisfactory, plated and primed and painted before reassembly. If the welding is clearly poor, the component must be replaced with a new one which is properly made.

#### 9.11

If a tubular member of an airframe has been damaged and replaced between inspections, the inspector MUST insist on seeing the invoice, receipt, or other evidence that the tube is seamless drawn tubing.

If not the owner must be able to convince him that, for other reasons, the repair material is adequate for its purpose otherwise the machine must NOT be "signed off".

#### 9.12

If it is important that the dimensions of fittings be well matched, such as the fitting of the trike-to-wing connector in its channel; check carefully that there is no serious play. If there were, it could promote a left- or right-turn bias, if slid to one extreme of the available play.

#### 9.13

One monopole trikes, look carefully for signs of over-stressing of the pylon at the top of the seat-frame. A "straight-ahead" but heavy landing can bend the tube excessively forwards or to the rear. A heavy landing on one main-wheel can bend the pylon to that side. Dismantle the pylon from the trike, if necessary for a proper examination.

#### 9.14

Always fold down the vertical frame or monopole of a trike, to relax the loads on it and show up wear at the pylon base and top joint.

## CHAPTER 10

## CONTROL MECHANISMS AND HINGES

### 10.1

Flight controls are an essential part of the primary structure. On a flex-wing machine, this concerns only the hinge at the hang-point. On hybrid and fixed-wing machines loss of control can occur for any of several reasons, viz:-

PROBLEM	CAUSE
(1) The control becomes jammed	Inadequate clearances. Foreign items becoming entrapped.
(2) The circuit has become too sloppy.	Inadequate maintenance. Excess wear. Poor design. Components under strength.
(3) Control breaks in flight.	As above.

One of the inspector's jobs is to highlight any area where these events might occur. If in doubt, seek advice.

### 10.2

The controls for the rudders, elevators, ailerons and spoilers on two- or three-axis machines are usually so simple that they can be considered to be covered by the ground rules for scrutinising tubes, fittings and fasteners. But inspectors should remember that quite small amounts of play in close-coupled control columns, pushing and pulling on equally short control horns on rudders, elevators or ailerons, can leave undesirable scope for rattle, giving the chance for flutter to occur should speeds get out of hand with over-exuberant pilots. The risk is admittedly quite small, but the design of control-surface hinges on most two and three-axis microlights leaves little margin to cope with vibrations of any kind.

### 10.3

In the ordinary sense, possible exceptions to the general idea of controls being tubes, fittings and fasteners, are the push-pull cables - such as Teleflex - used to operate the tail surfaces of some machines; also the somewhat complicated mixer-controls for aircraft with Vee-tails. However, the latter are really rather simple and can again be regarded as assemblies of trivial parts; the only special consideration is that small amounts of wear in any unbushed bearing holes may again introduce a disproportionate amount of 'slop' in the movement of the control surfaces, giving the chance for unwanted oscillations to occur.

#### 10.4

Sheathed cables can present a significant amount of friction in the control runs if lubrication is lacking. If the cable has been installed unwisely, with an excessive number of bends or if the bends are of too small a radius, the friction effect becomes even worse. To determine whether the problem is in the cable when a control feels excessively stiff, disconnect the control surface and, whilst holding the rear end of the sheath in its normal position, operate the control column or actuating arm. If the control still feels too stiff, the cable must be lubricated. The simple way to do this, is to make a Plasticine funnel round the upper end and pour very THIN lubricating oil (certainly, for throttle and choke cables, NEVER any thicker than "3 in 1" oil) into the funnel. Keep pouring until oil emerges from the other end. This may sometimes take quite a long time to happen, if the cable is too dry initially.

#### 10.5

Irrespective of the degree of lubrication, it may be possible for the inner (cable) of a Teleflex system to buckle when a push is applied to it, if too long a length is unsupported between the control column and the actual sheath, or between the latter and a control horn. And when such buckling has occurred it will happen more easily on later occasions. Unsupported lengths of such cable must therefore be removed from the design by relocation of the sheath or possibly, replacement of the cable and sheath. The risks associated with such a problem are only marginally less if the cable needs to be operated in a push-for-down mode.

#### 10.6

The hinges for the control surfaces on many microlights are crude to say the least, albeit they are effective. The inspector must not be surprised to find simple bolts through alloy tubes, or bits of 3 mm plate, or scraps of channel, often without trace of lubrication. These may well be acceptable on a particular aircraft and in a given location. But, if the inspector has any doubts, he should contact the Godfather or the Chief Inspector.

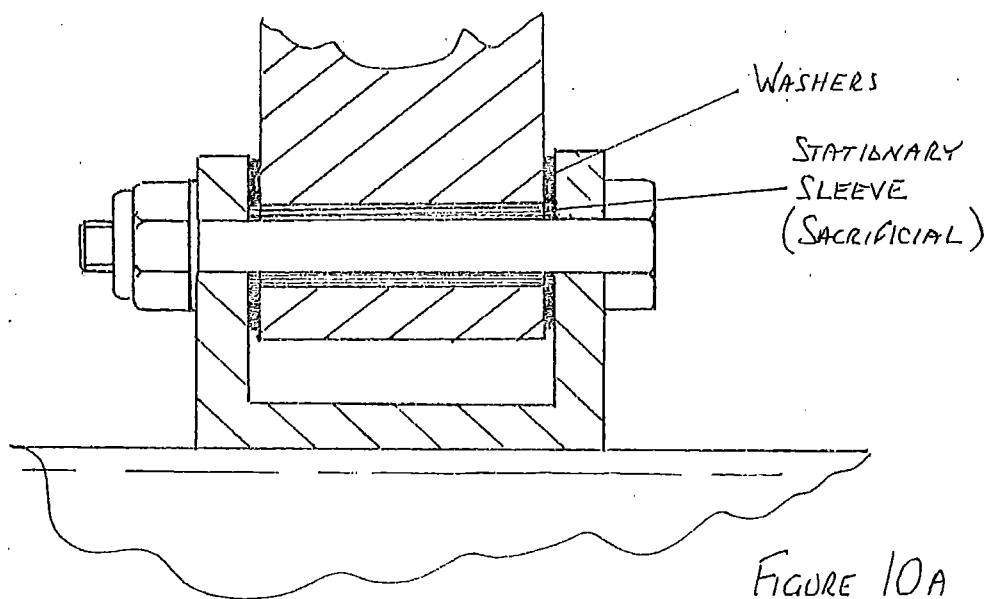
#### 10.7

What is certainly OBLIGATORY is that the bolts which are used as hinges for any rotating surface such as the rudder or elevator, as with the control column itself, MUST be fitted with castellated nuts and split-pins or spring-clips. Bolts on rotating controls, control surfaces, etc., MUST NOT be secured with Nyloc or Simmonds-type nuts. An inspector MUST NOT accept any secured thus.

#### 10.8

The following types of detail fitting are totally FORBIDDEN on primary flight controls:-

- (a) Holes tapped directly into the ends of aluminium-alloy tubes to receive the screwed shanks of Rod-ends. The use of inserts such as "Helicoils" is also totally forbidden for use in such attachments.
- (b) Bolts used as pivots without some means of preventing the actual bolt from rotating within its supporting structure. The simple way to achieve this is by fitting a sleeve over the bolt and clamped between the ears and lugs, etc., of the supporting structure. The member being moved, e.g. a control horn, then rubs against this stationary (and replaceable) sleeve. (See Figure 10A)



#### 10.9

Inspectors need to ascertain that the aircraft has the correct amount of movement on the rudder, elevator, ailerons, spoilers and/or flaps.

Clearly, this means that they have to obtain information on what these movements should be, before setting out to do the inspection, until the aircraft is Type-Accepted and a TADS compiled. The information will, in the majority of instances, have emanated from the Godfather system and should be available from the appropriate person fulfilling that role for the aircraft in question. However, it might also be available from the Chief Inspector or the Chief Executive.

In the course of time, all such information should be recorded in the aircraft's log book, so that all the inspector needs to do is to check that it is still valid.

As a rough guide, typical maximum deflections for the various control-surfaces are as follows:

Rudder	$\begin{matrix} +30 \\ -30 \end{matrix}$	elevator	$\begin{matrix} +30 \\ -25 \end{matrix}$	aileron	$\begin{matrix} +25 \\ -25 \end{matrix}$
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The deflection of spoilers and flaps depends almost totally on their design, location and intended mode of operation.

YOU CANNOT DEPEND ON THE OWNER TO GIVE YOU RELIABLE DATA ABOUT CONTROL MOVEMENTS. He may not know or he may think he does but has his facts wrong in complete innocence. He may be daft enough to try to deceive you into accepting what his aircraft exhibits, irrespective of whether he knows it to be right or wrong.

The check-flight will normally demonstrate whether the control movements are adequate for safe piloting.

#### 10.10

Where rod ends are used in any control mechanism, check that they are limited in the amount of misalignment with which they are required to cope. Most rod ends have a specified maximum misalignment of about 9 to 10 degrees; some have only 7.5 degrees. If in doubt, assume the lowest figure applies.

Check that the rod is properly screwed on to its shaft or bolt. Many rod ends have small 'witness' holes in their shanks, through which a wire can be pushed. The wire should be stopped by the threaded shaft within.

Rod ends must be properly secured against accidental unscrewing. Lock-nuts are commonly used for this.

Check that where rod ends have been used at both ends of a shaft or push-rod they are NOT left- and right-hand threaded. (If both loosen, the shaft can fall out completely as has happened in commercial and light aviation.) They MUST BOTH be left-hand or right-hand threaded.

## CHAPTER 11

## CABLES

### 11.1

Cables of diameter less than 2mm (3/32 inch) may not always be acceptable, unless they have been shown to be so by track record for the type of aircraft concerned, or where they form the inner half of Bowden-type cables. Another acceptable application is where they are installed to provide a means of actuating minor equipment, whose failure would not hazard the overall flying capability or safety of the aircraft.

### 11.2

All cables must be fitted with thimbles and ferrules at their ends. Carbon-steel cables must have aluminium ferrules; stainless-steel cables must have plated copper ferrules. If the inspector has any doubts about the quality of the hardware, etc., then he should ask.

The thimbles must be tight in the cable loops. The ends of the thimble must not have been snipped off to allow closer abutment against the ferrule; this can lead to premature failure of the cable for any of several sound reasons.

Check that the centre of the curved part of each thimble is not cracked. Plastic inserts, such as 'Never-Kinks', which spread the loads over the whole of that curve are available and may sometimes be recommended, with benefit.

Devices which grip the cable by means of screw-tightened clamps are NOT acceptable on an aircraft, irrespective of whether the plastic coating has been stripped locally from the cable. Hang-gliding accidents (under less loaded conditions than apply to powered flex-wings), occurred some years because of use of these clamps on plastic-covered cable.

### 11.3

The cables should be examined for corrosion which may appear as reddish rust spots on carbon-steel cables and thereby be easily recognised. Alternatively, it may only appear on plastic-coated cables - for example, as dark discolourations under the plastic. This can be caused by oil or grease being forced out of the mass of strands as corrosion forms inside them.

Corrosion can also be revealed by white powder forming at the junction of aluminium ferrules and galvanised steel cables. Any aircraft which has been used or stored near the coast is especially prone to this form of corrosion.

### 11.4

In some designs the builders have been recommended to adjust the tension of cables by simply varying the amount of twist in the cable. This is an acceptable practice so long as it is used in moderation; but NOT in reverse, that is, unwinding the cable in an attempt to lengthen it. It is also easily possible to make provision for cable adjustment by the incorporation of turnbuckles or the use of tag-plates at the end of the cables, with a multiplicity of holes drilled in them so that the ones which give the optimum tension can be selected. It is seldom necessary to adjust a cable to limits closer than about 1.5mm (1/16 inch); this is easily achieved.

When checking a cable to determine whether it has been adjusted excessively by twisting, release it from the end fixing. If it has been over-twisted, it will tend to lay in a coarse spiral and should be replaced.

Some of the smaller types of stainless-steel turnbuckles, intended for fairly light duty on dinghies, have been freely sold for use on microlights. They are often not suitable as the threads are poorly cut having a 'rattly' fit and the lock-nuts are under-sized with inadequate flats to ensure proper locking. The clevis pins may also be indifferently drilled.

In general, all cables and their associated equipment such as turnbuckles, ferrules, thimbles, etc., should be from reputable firms known to supply high-quality reliable equipment.

Types which, at present, seem to be of an acceptable standard are those made by:-

R.W.O.  
I.Y.E.  
SEASURE  
CAPTAIN WATTS

but do not automatically assume them to be satisfactory. Others may prove to be acceptable but the Chief Inspector must be consulted.

Since a correct aircraft turnbuckle (of the standard '10 cwt' type, for example) costs little more than these boat adaptations, its not unreasonable to expect aircraft components to be used in this specialised application. Nor can weight be a criticism on which aircraft turnbuckles can be rejected, since the 10 cwt type weighs only a few ounces.

In the absence of inspection holes, one needs to unscrew the eyebolt or clevis parts from the barrel, in order to find what thread is engaged. Do not assume that both ends have the same thread lengths; they sometimes do not because you will find one clevis and one eyebolt end. But before you ask the owner to undo the turnbuckle, carefully measure its lengths, so that it can easily be put back to its original setting and locked up. That will save the owner a lot of bother getting back to the settings he had. Make a thumb-nail sketch in the airframe log-book with dimensions and simply refer to it next time. (Get the owner to do the measuring before you get there, if he will, to save time and expense. He will also learn why he is doing it and check as he does maintenance, in future.)

#### 11.5

There has been a debate as to whether a cable needs two ferrules at each end, or one. Systems such as the NicoPress type, or similar, have been designed so that one ferrule will give a termination which matches the strength of the cable to which it is applied. Of course, a second ferrule will tidy up the excess length of cable which extends beyond the ferrule but, if properly made off and trimmed, this length will be so short as to need no extra clamping.

The inspector should look for proper setting of the crimps on the ferrule irrespective of whether there is one or a pair of ferrules used. The end of the cable must not be 'lost' inside the end of the ferrule if only one is fitted. There MUST be about 5 to 8mm outside a single ferrule.

NICOPRESS crimps are, by far, the most common. Whenever possible they should be checked by slipping a "Go, No-go" gauge over the ferrule. (Such a check may not be possible if the whole end of the cable up to the edge of the thimble has been sleeved in heat-shrunk sleeving). This check will be carried out by any responsible rigging-maker at regular intervals during his production runs and, if necessary, the swaging tools adjusted accordingly. However, on the reasonable assumption that quality control on microlight manufacture has been less than perfect, it is wise to recommend two ferrules per cable end, especially if cables are to be replaced.

A dab of paint on the free end of a cable, and starting about 6 mm (1/4 inch) from the first or only ferrule will be a good 'witness' as to whether the cable is sliding through the ferrule.

#### 11.6

Where a pulley is used to guide a cable through a change of direction, the pulley must be of reasonable diameter in relation to the diameter of the cable and its component strands. Figures like 200 times the strand diameter or 20 times the cable outer diameter are excellent guides to the minimum diameter of pulleys to be used, unless smaller sizes have proved totally satisfactory in a specific application. If the Inspector encounters a pulley installation about which he is concerned, he should consult his Area Inspector or the Chief Inspector.

All pulleys MUST be fitted with a adequate means of ensuring that the cable cannot jump out of the pulley groove and jam down the side of it. This usually means that a special catch plate has to be fitted over the pulley. Alternatively, the pulley may be a very close fit in its mountings, with no space on either side. If it also sits between structural members so that the cable cannot actually leave the pulley completely, but must always drop back into it, this is acceptable.

#### 11.7

Fairleads are sometimes used to change the direction of a cable by up to 3 degrees. Changes greater than this require pulleys. (Seek advice in doubtful instances.)

Fairleads should be of a suitable material, such a Delrin or Tufnol. Metals such as aluminium alloy should not be used. The cables should not be greased where they run over a fairlead.

#### 11.8

It is essential that the terminations/attachments on rigging wires allow the thimbles to rotate freely on the bolts, plugs or bushes which anchor them. If the thimble, and hence the cable, cannot rotate freely, then any out-of-line loads are going to cause fatigue failure between the thimble and ferrule or where the cable exits from the ferrule. This is the outcome of repeated bending; the latter can be the result of nothing more unusual than simple flapping of the cable.

#### 11.9

When examining cables be careful to take into account the exact role they play and the factors which might affect it.

For example, a little excessive tension on flying and landing wires might not seem too bad a thing; but wait! IF THE CABLES CARRY LOADS BEFORE TAKING ON ANY OF THOSE WHICH THEY WERE DESIGNED TO SUPPORT, THEY WILL REACH THEIR FAILURE POINT SOONER.

Secondly, the additional load due to pre-tensioning may add to the wear in the airframe. An example of this is that excessive tension in flying and landing wires gives added bearing loads on the tubes and bolts at the roots of the wings. Avoidable wear may soon be induced.

Another very important point for inspectors to note in connection with the use of cables on flex-wings, is the risk that some of them may engage with the propellor under certain conditions if adequate clearance is not provided. The cables in question are those from the base of the control-frame up to the rear of the keel. In severe turbulence, or in a heavy landing, the keel may flex downwards and the cables will momentarily slacken and drop. There is equally a strong possibility that the engine will move on its rubber mounts and, depending on their exact location and the resilience of the whole suspended mass, it may swing upwards. **THE NET EFFECT OF ALL THIS HAS ACTUALLY HAPPENED ON SEVERAL OCCASIONS.** To prevent it doing so, there **MUST** be at least 60mm (2.5 inches) between the propellor tips and the cables, with the control bar fully forwards, on all flex-wings.

#### 11.10

Whilst pulleys and fairleads are acceptable and necessary means of changing the direction of cables, wear of the latter can, and will, still occur. Look carefully for any evidence of broken strands, permanent bends in the cable, etc..

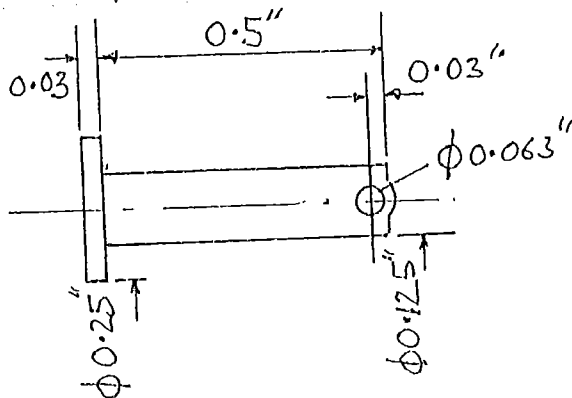
#### 11.11

Some clevis pins, fitted to turnbarrels, had holes drilled so dangerously near their ends that they were actually breaking out. (See sketch below.)

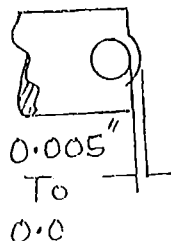
With such a small end-clearance, the end of the pin may break out, with wear and vibration, and the clevis could be released. Such pins must definitely be replaced.

Also, if pins are of this poor standard, whole turnbarrel may be of equally unacceptable standard. Check and decide whether total replacement is needed.

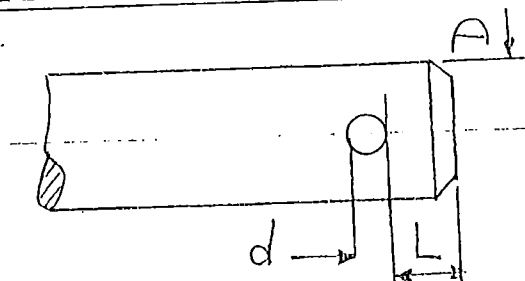
**ADDITIONAL COMMENTS:** Some nominal guidance as to the size and location of drilled holes in such pins, is given in the sketches below. It is suggested that the size of the hole is best limited to about 1/3 of the pin diameter. A 1/4" diameter pin, therefore, ought to have no greater than 0.085" diameter drilled through it. The distance between the tangent to the hole and the end face of the pin ought to be at least 3/4 of the hole diameter. In the case of the example, then, this distance would be 3/4 of 0.085", say, 0.060". One could sum up this example by saying that a 1/4" diameter clevis pin should have a clearance hole for a 1/16" diameter split-pin, drilled about 3/32" from the end face of the pin.



FAULTY CLEVIS  
PIN.



#### RECOMMENDED MARGINS



$$d_{MAX'M} = \frac{D}{3}$$

$$d_{MIN'M} = \frac{3d}{4}$$

## CHAPTER 12

## BOLTS AND FASTENERS

### 12.1

Inspectors must assume, and they will not be disappointed, that owners may use any old commercial bolt which appears to fit their need. There has been considerable evidence of this in all spheres of amateur aviation; BMAA members do not have a monopoly on crass stupidity! It is the inspectors' job to stamp out this sort of dangerous practice.

### 12.2

Bolts which support components which intentionally rotate, such as those which form the hinge-pins of rudders and elevators, **MUST** be secured with a castellated nut and split pin or a spring clip of the safety-pin type. The split pin is the more preferable, especially if the hinge is not to be dismantled frequently.

Nyloc and Simmonds-type nuts are **NOT** acceptable for components which rotate in flight. However, for components like wing leading or trailing-edges for example, which might be slightly rotated (whilst being swung out into position during assembly) and which can be properly ground-checked afterwards, a Nyloc or Simmonds-type nut of a standard aircraft type is acceptable.

**NUTS WHICH DO THEIR LOCKING BY FRICTION SHOULD NOT BE USED MORE THAN ONCE, IF ON RE-ASSEMBLY, THEY CAN BE TURNED BY A STRONG HAND.**

### 12.3

"Pip-pins" are very popular for use on microlights, because of their ease of dismantling and assembly. However, inspectors should check to determine whether the particular application is adequately catered for by the use of a pip-pin. If a joint needs some measure of clamping applied to it, as would be afforded by a nut and bolt, it is not acceptable to use a pip-pin which can only really operate as a simple double-shear device.

Basically, the inspector should not normally accept any pip-pin assembly, particularly on primary structure, unless there is some evidence that the pip-pin is of a specified aircraft quality, and the installation is of a well-defined and unambiguous design which cannot be erroneously assembled.

**BEWARE OF THE POOR QUALITY BOAT-TYPE PIP-PINS; THEY ARE NOT USUALLY ACCEPTABLE.**

Where pip-pins are used and the inspector sees no real problem indicated, he should examine the hole to ensure that there are no scoured 'tracks' along which the pip could travel, allowing the pin to fall out without the pip depressed. In the rough-and-tumble of regular dismantling and reassembly, pins can and do get dragged out with the pip still proud. Because many of the tube-end fittings used on microlights are so robustly designed(!) they are often made from rather soft alloy which takes the total load adequately but which scours easily under the local high stress of a pip-pin being ripped along it. Holes which are over-sized either from the manufacturing stage, or by wear, can further reduce the amount of metal needing to be removed to allow unwanted slipping of the pin.

#### 12.4

In many designs of microlights, wooden plugs were used inside the structural tube-members, to support them against crushing loads where cross-bolts were passed through the tubes for the attachment of fittings, etc.. These plugs are notorious for their ability to crush under the loads from over-tightened nuts and for their tendency to dry out and shrink.

Wooden plugs almost invariably cause rusting of the bolts which pass through them, sometimes to the point where the bolt is locked into the wood and cannot be withdrawn. If the machine is known to have such plugs, the inspector should use his discretion as to how many bolts he wants withdrawn for close inspection. There are bound to be some which hold critical items in place; for example, wing leading-edges or struts. It would be prudent to see that such bolts were in good condition.

As a generalisation, ALL wooden plugs are unacceptable unless specific measures are taken to prevent them from corroding the bolts, splitting and falling out, etc..

If owners ask for advice on suitable alternatives to wood, they should be advised to use Nylon, rigid PVC or Delrin. Alternatively, a transverse tubular bush may be used to sleeve the bolt and brace the tube walls, if accessible (as at the end of tubes).

#### 12.5

Pins are sometimes used to join components together. These may be ordinary clevis pins, with washers and spring-clips. In at least one application, a length of round bar has been used as a long pin with a spring-clip in each end. Such an arrangement is most unwise. There is no justification for having two fallible spring-clips when a clevis pin with one spring-clip could just as easily be used.

#### 12.6

It is not always recognised that the crude screws on hose-clips, such as the 'Jubilee' type, are prone to work loose if under severe vibration. They should always be wire-locked with stainless-steel wire.

#### 12.7

The bolts which secure a propellor to its hub and flange, should ideally be of aircraft quality or appropriate high-tensile commercial bolts of at least British Standard 'S' grade and be fitted:-

- (a) with castellated nuts locked with stainless-steel wire and split-pins
- (b) with plain nuts with drilled corners, again, wire-locked
- (c) with Simmonds-type (all-steel) nuts
- or (d) as a last choice, and really least suitably, with Nyloc nuts.

In designs where the propellor is secured by set-screws (either socket-head or hexagon-head), which screw directly into the hub itself, these are acceptable, PROVIDED that stainless-steel wire locking is used to secure them to each other. Note that it is safe to drill a small hole for the wire through the side of the socket head, or through a corner junction between two flats, on a hexagon-head screw or bolt. IT IS EXPRESSLY FORBIDDEN TO DRILL A HOLE STRAIGHT ACROSS BETWEEN TWO OPPOSITE FLATS ON A HEXAGON-HEAD BOLT. There have been many instances of bolts failing due to fatigue resulting from cracks which start at such a hole and propagate so as to neatly break the head from the bolt-stem at the junction.

The reason why Nyloc nuts are least acceptable for the securing of propellor-bolts is that the slightest looseness of the propellor will lead to heating; the plastic locking material will then flow (at quite low temperatures) and the nut will be free to fall off.

BUTTERFLY (WING) NUTS ARE NOT GENERALLY ACCEPTABLE FOR SECURING PROPELLOR-BOLTS, NOR MUST SPRING-CLIPS BE USED TO SECURE PROPELLOR NUTS, UNLESS THEY MUST BE EMPLOYED IN ORDER TO ALLOW NORMAL ROUTINE DISMANTLING OF THE AIRCRAFT (as with the Eagle).

#### 12.8

Bolts should usually have a specified torque applied to their nuts. Often, this is not too important. However, for the bolts which secure propellers or hold the heavy engine masses, it is very important. Inspectors should enquire about the torques used here.

#### 12.9

All bolts and clevis-pin heads should be at the top so that they stay in place if the nut falls off or the spring-clip goes missing.

If they have to be angled, they should, if possible, be located so that the force of the air-stream will tend to push them into their holes, should nuts or clips go missing.

Horizontal or angled bolts or pins should always have their heads along one side of the member, to help in careful preflight inspection.

The inspector need not insist on these points at first but they should be given as firm recommendations and progressively enforced during successive inspections. It is part of the training in good airmanship and actually makes inspections and pre-flight checks much easier.

#### 12.10

The use of Nylon washers under propellor-nuts (usually to secure the 'pop-over' type of domed cover), is extremely dangerous. Owners should be advised to remove them and fit plain washers.

#### 12.11

##### ACCEPTABLE APPLICATIONS OF OVER-LENGTH BOLTS

First of all, note that:-

It must not be possible for the shank-end of the thread of a bolt to be made to enter the nut by clumsy or inexperienced assembly or over-torquing, since it will seize up there.

There is such an infinite choice of bolt lengths that there is no excuse for using one which gets into this dangerous range. But, if there is some reason why the bolt which is chosen is slightly over-length, there are two alternative methods to make it acceptable to the inspector, so long as the bolt is in shear.

If a bolt is in tension, it is normally safe to assume that, once it is torqued - as tensioned bolts must be - the designer would not wish it to have extra and avoidable 'stretch' available in it. So the owner or whoever maintains the machine must obtain the correct bolt for the location in question. There is no room for alternative remedies there.

Where bolts are in shear, which the bulk of our bolts are, fortunately (mainly because shear is so much more convenient for making our kind of assemblies), we do have these two little tricks to help us.

First of all, all the bolts must present plain smooth shank against which the components being joined will bear. It is never too difficult to meet this requirement; a bolt can always be obtained which will do this and let the thread start just within the outermost of the components being joined, leaving the thickness of the washer to prevent one getting into the risky category mentioned above.

Nevertheless, for haste or because they already own a bunch of expensive bolts, or because a fitting has been removed from a joint, owners will sometimes have over-length ones on their machines. Provided that these long bolts used are in shear and provided one of the measures described here is used, inspectors can accept them.

Firstly, several washers can be put on, instead of one, to take up excess length.

The second trick, and a more acceptable one anyway, is to fit a turned spacer on the bolt. Its bore should ideally be reamed to be a good fit on the shank of the bolt.

Experience has shown that the material used for the spacer is not critical; various aluminium alloys, cadmium-plated or primed steel, etc., are quite acceptable.

But let me repeat, **DO NOT ALLOW AN OVER-LENGTH BOLT TO BE USED, WITH EXTRA WASHERS OR A SPACER, ON A TENSIONED BOLT.**

#### 12.12

Irrespective of whether the microlight is an Orphan or a Section S machine with a Permit, you do not accept stiff-nuts without 1 1/2 turns of thread showing through them. I have the assurance of the CAA that this could not have been part of the approved construction. So, if no threads show, a new bolt is needed from the manufacturer or his agent. You do not sign off the machine until the fault has been rectified.

#### 12.13

Always remove those pretty plastic covers to examine the state and fit of the Nyloc nuts beneath.

## 13.1

Whatever the engine and silencer system, some type of vibration-absorbing mounts often have to be used in the attachment arrangements.

These should be examined to determine that

- (a) they are not split or 'perished',
- (b) oil or petrol has not saturated them, leading to potential softening and failure,
- (c) the simple cheap (car engine 'steady') type, with a pad of rubber sandwiched between two studded, steel discs, has not been used where separation of the mount (rubber from discs) could allow the engine or silencer to become very free to flail about or oscillate badly,
- (d) where used to mount any silencer unit, they are not so placed as to be vulnerable to burning.

## 13.2

Apart from applications where the rubber mounts are acting as simple steadies, where total failure would not be catastrophic, the simple 'pad-and-discs' type of mounts are seldom acceptable. Instead, the various types which effectively trap the bolt must be used. Then, should a failure occur, the pilot will have adequate warning and be able to shut down his engine or at least lower its speed, and select a precautionary landing site.

Basically, if the failure of any rubber isolation-mount could be dangerous, owners should be advised to fit a safety wire across them.

## 14.1

Inspectors must be prepared to find, but not necessarily accept, a wide variety of seats and safety harnesses. The belts supplied on machines or in kits have often been little more than poorly adapted car-seat belts. These are fine in their designed environment but are usually unacceptable when the end fittings have been cut off and the attachment made by wrapping the belt round a tube and sewing it with a length of carpet thread, or by clamping the pieces of belt together with a couple of odd screws from the local D.I.Y.!

## 14.2

If the design calls for the belt(s) to be looped round a tube, this can be assumed to be satisfactory on 'track record'. But the inspector must expect a proper standard of fixing at the belt ends. For example, this could be achieved by stitching the end of the belt back to the main length, forming a loop, BEFORE the belt is fitted to the tube. The stitching should form a rectangular 'lay' (of double cross-stitching) of basically 60 to 80 mm length and about 40mm width (for a 50mm wide belt). Besides following this typical outer rectangular pattern, the stitching should cross the two diagonals. Suitable high-tensile polymer thread should be used.

An alternative which the CAA inspectors were happy to accept on track records for ultralight gyroplanes with their tubular seat-frames was to clamp the end of the belt to the main part - again, forming the required loop - with two plates bolted through the belt. The plates were often made from 16 to 18 s.w.g. (1.2 to 1.5mm) aluminium alloy, well smoothed off around their edges, to prevent their chafing the webbing. Suitable bolts were then 4 off of the 4BA size but today, 4 off of M4 aircraft bolts with washers and Nyloc nuts would be appropriate.

## 14.3

The CAA calls for all light and ultralight aircraft to have shoulder harness, as a mandatory feature. Few of the Orphan microlights meet this requirement, nor is it clear that it is necessary. At present, inspectors need not insist on shoulder harness being installed.

It may prove impossible to retro-fit shoulder harness to some microlights because of the total absence of structure which could provide an appropriately strong anchorage. Strictly speaking, this is a design problem rather than an inspection matter. However, the inspector should try to assess whether the aircraft configuration is such that the pilot is likely or not to sustain injury to his head or chest, when he slumps forward in a crash.

## 14.4

In order for the wearer to be able to tighten the seat-belt or harness correctly - particularly where pilots of very different stature use the aircraft - it may be most important that the loops of the belt are able to slide freely around or along the tubes or bars to which they are attached. Check to see what is required and that it is available.

#### 14.5

Obviously, on all microlights, the seat-belt buckle must be a fully reliable type, not easily able to be knocked open accidentally nor refusing to be opened readily when needed. Some of the types which have been used are opened with a dangerously light touch and cannot be accepted. Any recognised aircraft type and the higher-quality automobile types (if not tampered with, or drastically modified), should normally be acceptable.

#### 14.6

Seats may be rigid, being made by a glass-fibre moulding or a plywood platform, or they may more often be sling seats made by draping a length of Dacron or similar fabric between two suitably placed structural members.

In the case of rigid seats, all the inspector can do is to look for any signs of cracking of the glass fibre, splitting or rotting of the plywood, or imminent failure of any bolts associated with the mounting of the seat.

Sling seats, being fabric, are prone to the same sort of damage as the sails, etc., except that the intensity of the stresses on the attachments of the seat fabric is by far the higher. Where the seat fabric is looped round the tubes and stitched back, the inspector should look carefully to establish that there is no sign of ripping or failure of the stitching.

#### 14.7

General points about seat-belts: The main purpose of the seat-belt is the obvious one of ensuring that the pilot will remain in his seat, with zero or minimal injury, under all the worst flight or crash conditions. Until or unless the aircraft has been assessed against the requirements of Section S, which requires that the seat AND belt can resist 9g forwards, 4.5 upwards, sideways and 4.5 downwards, the inspector can only try to ensure that the seat and belt arrangement is of good workmanship with sound anchorages to the aircraft structure.

## CHAPTER 15

## THROTTLE AND CHOKE

### 15.1

These are not unduly expensive or demanding items. However, they should not be capable of unscrewing themselves. Many types are assembled only by one screw which, if it loosens and drops out, allows the whole unit to fall apart.

### 15.2.

The throttle should always be mounted on the left-hand side of the aircraft, usually on the fuselage member most conveniently placed to bring the throttle readily to the pilot's hand. If this involves no major reconstruction of the machine or relocation of primary controls (because, say, a short control column has been installed along the left side of the machine), the inspector should recommend the owner to reposition the throttle on the left side, along with the ignition switch.

The throttle arrangement should be such that FORWARD motion of a quadrant throttle, movement TOWARDS the panel of a pull-out throttle, or REARWARDS OVER THE TOP a twist-grip (as for motor-cycles) all INCREASE power. If this is not the case on the first inspection, it takes on the category of a 'Recommended' modification, preferably to be executed by the time the next inspection is required.

### 15.3

If a choke is fitted, its location and mode of operation are less important.

### 15.4

The flexible cables associated with the throttle and choke need to be checked for freedom of movement. There must be adequate lubrication and complete absence of too-tight bending radii in the sheathing. Tests should be made to ensure that the end-nipples do not jump out of the throttle, choke or engine fittings when these controls are actuated, because of such friction with the sheath.

If stiff piano-wire is used for such control runs, extra care is required during the routing of them to ensure free movement. Corrosion can also occur rather more easily because of the absence of a bundle of fine strands to hold grease or oil. Check that adequate attention has been given to these points.

### 15.5

Throttle cables are very often required to return under the fairly light forces produced by the carburettor spring. Even engine oil is usually too viscous for lubrication of such cables. "Plus-gas" or "WD40" are suitable lubricants and have excellent corrosion-resistant properties.

## 16.1

It appears that the Section S requirement is only for an airspeed indicator and an altimeter. No conditions are spelled out as to what these must be; thus we can assume that as long as they seem reasonable and the owner/pilot is happy with their performance then they are acceptable. However, some simple but sensible calibration of them should have been carried out, at least annually. In-flight calibration, if able to be made against acceptable references, is very useful. If fitted, air-speed indicators should be sufficiently rigidly mounted so that no changes in attitude can occur and thereby possibly cause large errors.

## 16.2

The requirements do not seem to insist on the installation of a compass although commonsense would suggest it. If one is fitted, there should be reasonable evidence of it having been installed properly with adequate thought about its immediate environment. Most simple compasses have no compensation magnets or deviation cards. It is therefore important to check that no large ferrous masses (or even small ones, if they are too close to the compass) or magnets are within influencing distance. Remember that electrical indicating instruments have strong magnets in them as do loudspeakers and some microphones.

Electrical wiring with current flowing can produce strong magnetic fields and thereby upset a compass.

## 16.3

If the instruments are mounted on some kind of flexible mounts, these should be checked to see that they are not about to let the instrument pack fall off. Some of the small rubber mounts suffer from the same weaknesses as the cheap car engine 'steadies' and can part company just as abruptly. So, again, the owner should be encouraged to install safety wires across such bushes.

## 16.4

If the Air-Speed Indicator has a venturi or pitot-static, check that it is in good condition, not corroded, blocked, bent or otherwise leading towards giving erroneous information to its associated instrument. If rubber or plastic tube is used to make the air connection(s), ensure it is in good condition and not split, perished or loose on the various fittings.

Check also that the venturi faces the correct way, that is, the end closest to the 'throat' is at the front.

## 16.5

Where electrically powered instruments are installed, is the battery-attachment system adequate? If the power is taken from the engine's generator, is the wiring to a safe and acceptable standard?

## 17.1

The electrical wiring for most microlights is fairly simple. If it consists only of the engine's ignition wiring, it is virtually just two leads. DO NOT ACCEPT any arrangement where the airframe is used as the return circuit for the ignition switch. Any sensible and careful person who can wire a mains plug should be able to make a sound job of this or easily find many people who can.

## 17.2

Where an AC generator, built into the engine, is used to drive instruments, strobes or even electrically heated clothing, in some instances the wiring can be a little more complex. But it does not require a competent electrician to decide that a great ball of wires, wrapped up in a bundle of sticky black insulating tape, is not acceptable on an aeroplane! Experience suggests that the inspector may have to insist that any such blotches of tape be removed, before he can examine the state of the wiring beneath. He must assume that such rubbishy taping may even be hiding simply twisted wires, with no trace of solder or crimps in sight. It has been known!

Inspectors must be firm on this matter. If a short-circuit occurs in the power-generation coils of the engine this is very likely to overheat and, maybe burn out the ignition coils and so produce an engine failure.

If there are any known ignition faults with the engine concerned, has the owner taken the recommended rectification steps?

No owner can claim that there is any difficulty in finding a skilled electrician in his area. Almost certainly, every Club or group will have such a member on its strength.

ALL ignition switches should have their 'ON' and 'OFF' positions clearly marked. Ignition switches should be located easily to the pilot's hand but be installed inside a channel, so as not to be knocked 'off' accidentally.

## 17.3

The Chotia 460 engine has twin spark-plugs and two sets of contact breakers. So this engine will have a switch for the ignition, which has a 'Start' and a 'Run' position on it. These must be fully and clearly marked as such.

## 17.4

Apart from obvious signs of potential (sorry about the pun!) failure because of the vibrating unsecured leads, corrosion, etc., one of the commonest forms of failure is the breaking away of leads from terminals because of vibration.

This is often aggravated when the leads are soldered to the terminals and excess heating has allowed the solder to flow up between the strands of the flexible cable, thus making it stiff and prone to break. The horrors of the use of acid-cored solder or crude use of gas-heated soldering irons need no elaboration; the inspector will be able to see the results and probably have to reject them.

Check the crimps by firmly tugging the wire once. There have been instances of electrical leads being over-crimped, with some of the strands cut through. Check for this fault and that the leads, adjacent to the crimp, have been adequately tied down.

17.5

DO NOT ACCEPT THE USE OF 12-VOLT RATED SWITCHES FOR THE IGNITION, INSIST ON 240-VOLT MAINS-RATED SWITCHES BEING USED. (Such switches are normally marked with the high voltage (240 V.A.C.) they will tolerate.)

## CHAPTER 18

## PLACARDS AND REGISTRATION MARKINGS

### 18.1

Such placards as the CAA require, relating to Exemptions, etc., must be correctly worded and clearly visible from the pilot's normal seated position, irrespective of his stature.

What is meant by a "Placard" is quite simply just a small piece of paper or card carrying the necessary information in a clearly readable form. That is, it should be carefully printed in block capitals or preferably typed.

(Do not confuse the placard with the mild- or stainless-steel fire-proof Identification Plate, carrying the owner's name and address and the aircraft's registration letters (See 18.2 below).

Because it is impractical to refer to documents, such limitations as maximum and minimum cockpit weights, speed, engine RPM and manoeuvring limitations must be permanently displayed. It is acceptable to mark instrument dials or glasses for some of these.

CERTAIN STATUTORY MARKINGS MUST BE DISPLAYED BEFORE AN INSPECTOR CAN PROCEED WITH ANY INSPECTION OR SIGN THE AIRCRAFT OFF. THEY ARE LISTED BELOW:-

### 18.2

A fireproof carbon- or stainless-steel plate must be attached to the aircraft, close to the pilot's seat and prominently displayed. This plate must bear the nationality and registration marks of the aircraft, together with the name and address of the registered owner. (If the machine is second-hand, it MUST bear the current owner's name and address.)

### 18.3

The nationality and registration marks must be displayed on the under-side of the left wing, or across the whole wing. Roman-charactered letters must be used, of a colour which contrasts sharply with its background, and formed from solid lines. The tops of the letters must be towards the front of the wing.

The minimum height of these letters must be 500mm (19.7 inches) and their overall width and that of the hyphen, must be two-thirds of their height.

The width of the 'strokes' of the letters and hyphen must be one-sixth of the height of the letters.

Each letter must be separated from adjacent ones, or from the hyphen, by a space equal to half of the height of the letters.

### 18.4

If the machine has a suitable rudder, or side-wall to the fuselage, these nationality and registration marks should be displayed there also, in Roman-character letters contrasting sharply with their background, and in solid lines.

If displayed on the vertical tail surfaces, the letters should be at least 300mm (12 inches) high, if feasible, but not less than 150mm (6 inches) and of the same geometry as given above (Section 18.3) for wing markings. But they should not lie less than 50mm (2 inches) from all edges of the vertical surface.

#### 18.5

If on the side-walls of the fuselage, the letters may be sloped by up to 30 degrees, but only with the tops of the letters towards the rear of the aircraft.

#### 18.6

Single-seat machines must carry a placard bearing the following information pertinent to them:-

Vne = ?  
Empty Weight = ?  
Maximum all-up weight = ?  
THIS AIRCRAFT IS NOT CLEARED FOR AEROBATICS  
OR SPINNING.

#### 18.7

Dual-seat machines must carry a placard bearing the following information pertinent to them:-

Vne = ?  
Empty Weight = ?  
Maximum all-up weight = ?  
MINIMUM LOADINGS:  
Front seat + ? Rear seat = ? Total = ?  
MAXIMUM LOADINGS:  
Front seat + ? Rear seat = ? Total = ?  
THIS AIRCRAFT IS NOT CLEARED FOR AEROBATICS  
OR SPINNING.

#### 18.8

Typical examples of suitable placards are:-

##### (A) Single-seat flex-wing

Vne = 45 m.p.h.  
Empty weight = 122 kg.  
Maximum all-up weight = 235 kg  
THIS AIRCRAFT IS NOT CLEARED FOR AEROBATICS  
OR SPINNING

##### (B) Dual-seat fixed-wing

Vne = 75 kt.  
Empty weight = 146 kg  
Maximum all-up weight = 321 kg.  
MINIMUM LOADINGS:  
Front seat = 75 kg. Rear seat = 0 kg. Total = 75 kg  
MAXIMUM LOADINGS:  
Front seat = 95 kg. Rear seat = 80 kg. Total = 175 kg  
THIS AIRCRAFT IS NOT CLEARED FOR AEROBATICS  
OR SPINNING

18.9

As part of the conditions under which their Exemptions are granted, all machines must additionally carry a separate placard stating the following:

OCCUPANT WARNING!  
THIS AEROPLANE DOES NOT HAVE A CERTIFICATE  
OF AIRWORTHINESS OR A PERMIT TO FLY, NOR  
HAS IT BEEN SHOWN TO BE IN COMPLIANCE WITH  
ANY PUBLISHED CODE OF AIRWORTHINESS  
REQUIREMENTS.

18.10

Placards should be fitted in waterproof covers or stuck behind clear Fablon. They can then be wrapped round suitable tubular members of the airframe in the cockpit area, if there is no nacelle coaming to which to attach them. The chosen locations must be such that the pilot can easily see and read the placards when he is seated in the aircraft; they must stay readable.

## CHAPTER 19

### WEIGHT AND BALANCE CALCULATIONS FOR 2- AND 3- AXIS AIRCRAFT

#### 19.1

Many owner/pilots seem to be scared of doing a 'weight and balance' sum. We say "sum" because "calculation" is almost too pretentious a term for it. Many do not even know the exact dry weight of their aircraft. They will, instead, rely on some figure that the manufacturer mentioned or that they read somewhere.

#### 19.2

The inspector should expect to see an accurate weight recorded for the machine in question. It must be validated by some reliable witness. This can easily be obtained by the owner taking the empty trailer to the local Public Weighbridge, and then doing the same with the aircraft loaded. The difference in weights is that of the machine.

Alternatively, he can use the bathroom scales in the manner mentioned below, provided that he can believe their calibration.

Future inspectors of that machine may wish to check the current weight against that listed in the aircraft's log book; this is a good starting point for deciding if illicit changes have been introduced.

#### 19.3

For fixed wing, that is, two and three-axis 'conventional format' aircraft, the inspector should ask to see the 'Weight and balance' sheet for them. (If this is not available for the first inspection, it should be done by the second one.)

If the figures look reasonable and sensible, he won't have to spend all day over them since the continued safe flying of the aircraft has demonstrated that they are OK.

#### 19.4

The owner should know and have marked the range and optimum position for the Centre of Gravity on any Hybrid or 3-axis machine.

#### 19.5

To measure exactly where the C.G. falls on a particular aircraft, proceed as follows:- (I have made it as simple as possible, so don't be put off, or let the owner try to opt out)

- (1) The owner will need to find a reliable bathroom scale (ideally one that has been checked for accuracy, possibly with borrowed weights) plus two flat pieces of wood of thickness equal to the height of the scale.
- (2) The aircraft should be fully assembled with the fuel-tank empty.
- (3) The wheels should then be blocked so that the fuselage keel, or some equivalent reference member, is exactly in the horizontal position. For a tail-dragger, this means placing the tail on a box or chair.

- (4) The owner should then measure back from the chosen reference-point, (the forward tip of the fuselage might be suitable), to the centre of the axles of the main-wheels, if necessary, by dropping a plumb-line (a weighted string or thread) down from the fuselage to the axle. Where the plumb-line leaves the fuselage keel is the location of the axle.
- (5) The bathroom scale should then be put under the nose-wheel (if there is one) with the two equal blocks under each main-wheel. The fuselage keel will still be sitting horizontally but will be lifted by the height of the scale.
- (6) The weight on the nose-wheel can now be read off as indicated by the scale.
- (7) Now swap the scale from the nose-wheel to one of the main-wheels, putting one of the equal blocks under the nose-wheel, so that the fuselage keel is still horizontal.
- (8) Read the indicated weight on that main-wheel.
- (9) Swap the block and scale between the two main-wheels and read off the weight on this remaining wheel.
- (10) Repeat all of this, that is, measure the weight on each wheel firstly with the pilot in the seat and then with the pilot and full fuel in the tank.
- (11) Enter the figures on a sheet like that shown in 19.6 and carry out the simple sums as indicated. From these the C.G. location for each of the tested conditions will be obtained.
- (12) Remember: There will be an optimum C.G. position for that aircraft and findings should be close to it or certainly be safely within the forward and aft limits.
- (13) Although the above has been written around tricycle under-carriaged aircraft, the procedure is only slightly different for tail-draggers; where the above refers to nose-wheels, insert tail wheels.

Do not forget, if the wheel at which you are measuring the load is on the far side of the point which you have taken as reference, its distance becomes a negative figure and so does the 'moment'. So, in the final totting-up, subtract this number, don't add it. A simple way to get around this little irritation is to take a reference point in space, say, one metre in front of the nose of the machine. That way, everything is on the 'positive' side of the reference point.

## 19.6

### LISTING THE MEASUREMENTS AND WORKING THEM OUT

(As long as one stays within the same units throughout, you can work in inches and pounds weight or millimetres and kilogrammes.)

#### WITH NO PILOT AND NO FUEL

	WEIGHT (lb or kg)	x	DISTANCE FROM CHOSEN REFERENCE (in. or mm)	=	MOMENT (lb.in or kg.mm)
NOSE WHEEL	_____	x	_____	=	_____
LEFT MAIN WH	_____	x	_____	=	_____
RIGHT MAIN WH	_____	x	_____	=	_____
TOTAL WEIGHT (W)	_____		TOTAL MOMENT (M)		_____

TOTAL MOMENT (lb.in or kg.mm) divided by the TOTAL WEIGHT (lb or kg) equals C. of G. position (in inches or millimetres) from the selected reference point.

That is:-

$$\text{POSITION OF C. of G.} = \frac{M(\text{total})}{W(\text{total})} = \dots\dots\dots L(\text{c. of g.})$$

WITH PILOT BUT WITHOUT FUEL

NOSE WHEEL	_____	x	_____	=	_____
LEFT MAIN WH	_____	x	_____	=	_____
RIGHT MAIN WH	_____	x	_____	=	_____
TOTAL WEIGHT (W)		_____	TOTAL MOMENT (M)		_____

POSITION OF C. of G. =  $\frac{M(\text{total})}{W(\text{total})}$  = .....L(c. of g.)

---

WITH PILOT AND WITH FUEL

NOSE WHEEL	_____	x	_____	=	_____
LEFT MAIN WH	_____	x	_____	=	_____
RIGHT MAIN WH	_____	x	_____	=	_____
TOTAL WEIGHT (W)		_____	TOTAL MOMENT (M)		_____

POSITION OF C. of G. =  $\frac{M(\text{total})}{W(\text{total})}$  = .....L(c. of g.)

---

So Centre of Gravity range for your machine is:-

EMPTY:.....(mm or inches behind reference point)

WITH PILOT: WITHOUT FUEL:.....(mm or inches behind reference point)

WITH PILOT: WITH FUEL:.....(mm or inches behind reference point)

## 20.1

ALL SCORPION AIRCRAFT ARE GROUNDED AND CANNOT BE GIVEN ANY FORM OF AUTHORISATION TO FLY. INSPECTION OF THESE MACHINES SHOULD THEREFORE NOT BE UNDERTAKEN.

(NOTE: This Scorpion is a dual or single-seat, 3-axis, 'conventional' format machine; do not confuse the name with the single-seat flex-wing 'Super Scorpions' made by Hiway.)

## 20.2

THE HUNTAIR PATHFINDER-2 THREE-AXIS MACHINE IS GROUNDED AND CANNOT, AT PRESENT, BE GIVEN ANY FORM OF AUTHORISATION TO FLY.

(NOTE: The Huntair Pathfinder-1 is satisfactory. It is NOT grounded, and inspections and check flights can be carried out in the normal manner.)

## 20.3

MOTO-DELTA FLEX-WING AIRCRAFT USE A FORM OF GLASS-FIBRE CONSTRUCTION WHICH READILY LEADS TO THE INCORPORATION, DURING MANUFACTURE, OF VERY DANGEROUS WEAKNESSES IN THE STRUCTURE OF BOTH THE ROGALLO WING AND THE TRIKE. THE METHOD OF 'FILLING' AND PAINTING OF THE AIRFRAME IS SUCH AS TO CONCEAL SUCH FLAWS COMPLETELY.

THERE ARE ONLY TWO MACHINES KNOWN IN BRITAIN, ALTHOUGH THEY ARE NOT BELIEVED TO BE FLYING AT PRESENT.

THERE IS NO WAY TO DEMONSTRATE THAT THE STRUCTURE IS SOUND, APART FROM A PROOF-LOADING TEST. INSPECTORS, IF ASKED TO EXAMINE A MOTO-DELTA, MUST INSIST ON SUCH A TEST BEING CONDUCTED, TO THE SATISFACTION OF THE BMAA AIRWORTHINESS ENGINEERING TEAM, BEFORE A TEST FLIGHT CAN BE AUTHORISED.

## 20.4

MITCHELL B-10 WINGS ARE CONSIDERED SUSPECT, FROM THE AIRWORTHINESS VIEW-POINT, BECAUSE A PROOF-LOADING TEST ON A SPECIMEN MACHINE PRODUCED FAILURE AT AN UNACCEPTABLY LOW LOADING. THEIR HANDLING IN FLIGHT IS ALSO A MATTER OF SOME CONCERN.

IT IS RECOMMENDED THAT THEY BE GROUNDED, ALTHOUGH THIS IS NOT AT PRESENT MANDATORY BY THE CAA. HOWEVER, BMAA COUNCIL HAVE INFORMED THE CAA THAT IN THE ABSENCE OF SUFFICIENT DATA THE ASSOCIATION WAS NOT PREPARED TO DEAL WITH THIS AIRCRAFT UNDER ITS AIRWORTHINESS MANDATE AND BMAA INSPECTORS/CHECK PILOTS ARE INSTRUCTED NOT TO INSPECT/FLY THIS TYPE.

(NOTE: A specimen of the Mitchell U-2 has not yet been proof-loaded or shown to be weak. If an owner can produce a set of proof-loading figures for testing a U-2 and they are acceptable to the BMAA technical team, then, if subsequently the U-2 is satisfactorily tested, the inspector can check and sign it off.)

## 20.5

Inspectors are fully authorised to examine both Permit (Type-Approved) and Type-Accepted 'Orphan' aircraft.

They should apply to the Deddington Office of the BMAA for a copy of the Type Approval (or Acceptance) Data Sheet (TADS) for the particular aircraft which they are being asked to examine.

Inspectors should note that neither a Permit microlight nor a Type-Accepted one can be modified in any 'major' manner without the written approval of the manufacturer (for a Permit aircraft) or the Godfather/BMAA Technical Team (for a Type-Accepted aircraft).

So, if you encounter propellor bolts which have been swapped for larger than original ones, or extra fuel tanks, etc., you have absolutely no option but to refuse to clear that machine until the owner can present you with the appropriate written confirmation from the manufacturer or the BMAA Technical Team, and Godfather for the type, that the modification in question is fully approved by them. This is not you being bloody-minded; it is, quite simply, the Law under which you are operating. Note, too, that the onus is on the owner to produce the evidence of acceptability, not on you.

## 20.6

As he carries out the examination of a microlight for the purposes of maintaining its standard of airworthiness, the Inspector should remember that he is actually checking for three fundamental features, viz:

- |                   |                                                                                                                                   |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| (A) "CONDITION"   | What is the physical state of the component?<br><br>Is it corroded, bent, cracked, loose, etc.?                                   |
| (B) "ASSEMBLY"    | Are the components put together, fitted, assembled, installed, connected, services or adjusted correctly, in the approved manner? |
| (C) "FUNCTIONING" | Does the component or assembly operate correctly, in the approved manner?                                                         |

None of these asks the Inspector to judge whether the machine has been altered from its original form. If he (or she) sees something which he considers makes the aircraft unairworthy, he must reject it. But he certainly cannot and will not be expected to know whether a part is 'as built'. He can only use his judgement to decide how the thing before him stands up to the above three standards.

What this does ask of the Inspector is that he is competent to examine the machine before him and to know if a specific feature is unacceptable for any reason. That says that an Inspector who is very familiar with all of the basic requirements and pitfalls of a flex-wing will cope with them quite readily; but he may be rather inept when it comes to dealing with fixed-wings.

So, irrespective of what it says on your blue ticket, do not inspect types of aircraft about which you are not totally confident of your abilities. You could be putting yourself at quite unnecessary risk, were anything to go wrong later. We have enough Inspectors of both disciplines, so there is no need to go 'out on a limb'.

#### 20.7

If an Inspector has to ask the owner to do some dismantling, in order to meet specific requirements from the Chief Inspector, the owner must also do the reassembly. It is the Inspector's job to carry out whatever special inspection is called for on the component parts and to reinspect the reassembled unit afterwards. The owner must do the assembly to ensure that the Inspector acquires no legal responsibility for the engineering work on the machine.

#### 20.8

The question of whether the Inspector lets the owner take a full role in the inspection or carries it out with minimal participation by him/her, depends on his attitude and that of the owner. As a generalisation however, it is best to have the owner somewhere within call but to get on with the job entirely on one's own. Do not be pressurised to do the job in the owner's time-scale. You are responsible for doing a competent job, not the owner and, if you miss something, no-one will thank you for it or admit later that they rushed you.

The exception to all of this is that the owner MUST do all of the rigging of the aircraft. If you help, you do it as a labourer, relying entirely on instructions. The object of this is to observe what mal-practices the owner introduces into the assembly, so that you can determine what damage he is doing to his airframe and advise him accordingly, as well as having useful clues yourself as to where to look for wear and tear.

#### 20.9

If an Inspector cannot fully examine a component like, for example, a painted propellor, all he can do is make a note on the form that the inspection has been limited. For example, "Propellor painted. No oil-filled cracks apparent".