BRITISH GLIDING ASSOCIATION

BGA TECHNICAL COMMITTEE

TECHNICAL NEWSHEET TNS 9/10/90

PART 1 Airworthiness "AGGRO" - Gliders - Please add to the 1990 BGA Yellow Pages.

1.1 ASW 20 - Elevator Not Connected - Fatal accident at the Mynd. The safety locking pin was secured by a piece of string, but since the elevator connection had not been made, it served no useful purpose! This is no less than a third such incident involving ASW19/20 Sailplanes. So why not make a duplicated inspection after rigging?

1.2 PZL "Junior". Elevator Connector not properly made, and was found to be unsecured on the DI on the following day! The Flight Manual gives specific instructions on how to correctly rig the glider. (Coventry G.C.).

1.3 Unsecured Radio - escaped from its rack at the base of the instrument panel and geometrically locked the Control Stick in a distinctly aft position during a winch launch. It was finally extracted by further aft movement of the stick. Whereas the locking mechanisim worked correctly, it failed to engage in the slot in the rack. Having installed your equipment, you need to check that it is secure. (RAFGSA Bannerdown).

1.4 Skylark - horizontal split in the fin (see diagram). May have been induced by "Shock Load" after tailskid snagged on landing. (RAFGSA Bannerdown).

1.5 KA13 Keel Tube at Fin Post - Cracked, possibly due to corrosion and a heavier than usual landing! (Essex G.C.).

1.6 M-200 Carman - Failure of the lower rudder hinge - reported by Ouse G.C.

1.7 Pilatus B4 Drag Spar Bushings - are not secured when de-rigged, so that you may fly without one, unless you are careful when you rig your glider! (Cotswold G.C.).

1.8 Nimbus 2 Rudder Pedal Locking - Spring may fail, causing loss of rudder control. (Reported by Tim McFadyen - Cotswold G.C.).

1.9 ASW 20 - Failure of Water Ballast - dump valve cables due to corrosion. (Reported by Tim McFadyen - Cotswold G.C.).

1.10 DG 600 Flight Manual Ammendments - are introduced by Tech Note 370-1 from UK Agents.

PART 2. Airworthiness 'AGGRO' Powered Aeroplanes

2.1 PIK 20E - Propellor Hub Bearing - Modification. LBA ALD 90-239 (herewith) is Mandatory in accordance with CAA Airworthiness Notice No. 36. Will have been mailed to Registered Owners by CAA.

2.2 Propellor Anti-Errosion Tape. The attached extract from G.A.S.I.L is self explanatory.

Advice from Hoffman suggests that any form of tape is detrimental to performance.

Experience has shown that painted propellers (other than at the tip) demonstrate some degree of degraded performance, unless the paint is applied thinly.

Propellor aerofoils are becoming more sophisticated in search of improved performance and of noise reduction. So it is unwise to "modify" such aerofoils. Keep Your Propellor CLEAN.

2.3 Corroded Fuselage Tubular Structure, and Inspection Standards - are addressed in extract from GASIL 8/90 herewith.

Could apply to any type of Tug, Glider of similar construction. Bolts into wood corrode!

2.4 Flying (Gliding) Club Safety Boards - CAA are making you a free offer in GASIL extract.

2.5 Rallye 235 Water Drains From The Elevator - GASIL extract herewith tells you how to fill it up!

2.6 Compression Shakes in Wooden Structures - Extract from GASIL 7/90 reminds us of what to look for, in any type of wooden flying machine.

2.7 Imported (New & Used) S.L.M.G's - Applying for UK Certification through the BGA, must now submit both CAA Form 3 and CAA Forms 202L, together with such fees as are defined in Airworthiness Notice No. 25.

Issues and renewals are taking some 28 days from date of submission by BGA to CAA.

PART 3 General Matters.

3.1 Changes in BGA Recommended Practices - in respect of :-

RP.33. Energy Absorbent Cushions,
(to minimise spinal injuries), and

RP.34. Minimum Weights for solo (inexperienced) pilots.,

Are copied herewith for your Action.

3.2 Seat Harnesses. Paraquip, 42 Tennyson Road, Headless Cross, Redditch, Worcestershire, B97 5BJ, (0527-43869), specialise in manufacturing such equipment.

3.3 Weight and Balance. This unnecessarily complicated business, is simply explained in the H.Q. Air Cadets "GRASSHOPPER" Loading & C.G. Data, reproduced herewith for your edification.

3.4 INSPECTOR RENEWALS are now due.

Please complete the recently circulated forms a.s.a.p. to ensure that your personal insurance indemnity does not lapse.

C of A renewals will not be accepted from Inspectors who fail to renew on time.

3.6 Carburretor Icing. The enclosed copy of A.I.S. 59/1990 should be made available to your club members, together with all the other pearls of airworthiness wisdom contained herein!

ACTION PLEASE CLUB TECHNICAL OFFICERS

R.B. STRATTON
CHIEF TECHNICAL OFFICER

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British Gliding Association

TO: Member Clubs

3rd September 1990

RECOMMENDED PRACTICES

Two new recommended practices have just been introduced by the BGA and will be put into Laws & Rules , the next time the document is re-printed.

The new RP's are listed below and in order to bring them to the notice of as many pilots as possible, it would be appreciated if you could display this on your Club Notice Board.

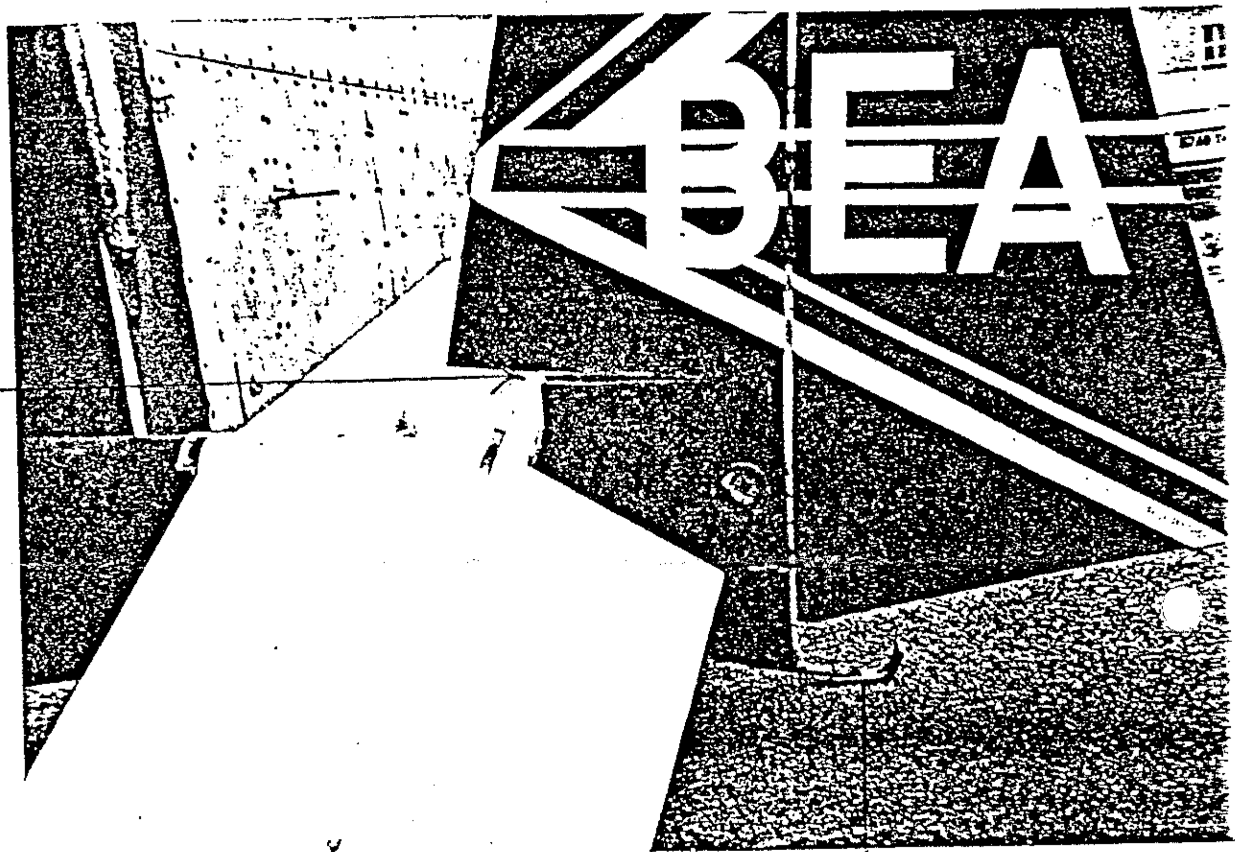
RP33. It is recommended that all gliders, whether club or privately owned, should be equipped by the owners/operators with cushions containing energy absorbent materials. (Conventional soft foam actually stores energy and can be dangerous in an accident). The cushions should have attachments compatible with the glider for which they are provided and be secured so that they cannot move or foul any controls, even under extreme attitudes or accelerations.

RP34. The current airworthiness code sets a design minimum cockpit load for gliders of 70 kg (153 lb). Some older types have minima significantly higher than this figure. Lighter pilots should be aware that the use of ballast may be necessary in accordance with the aircraft placard to ensure safe flight. It is recommended for an additional margin of safety during type conversions and for inexperienced pilots that further ballast should be carried to establish a cockpit load of at least 15 kg (33 lb) in excess of the placarded minimum. In all cases the ballast should be secured in the aircraft so that it cannot move even under extreme attitudes or accelerations.

BARRY ROLFE
Administrator.

SKYLARK FIN FAILURE.

SPLIT.



POSSIBLE SNAGGING OF TAIL SKID?

SKYLARK FIN FAILURE.

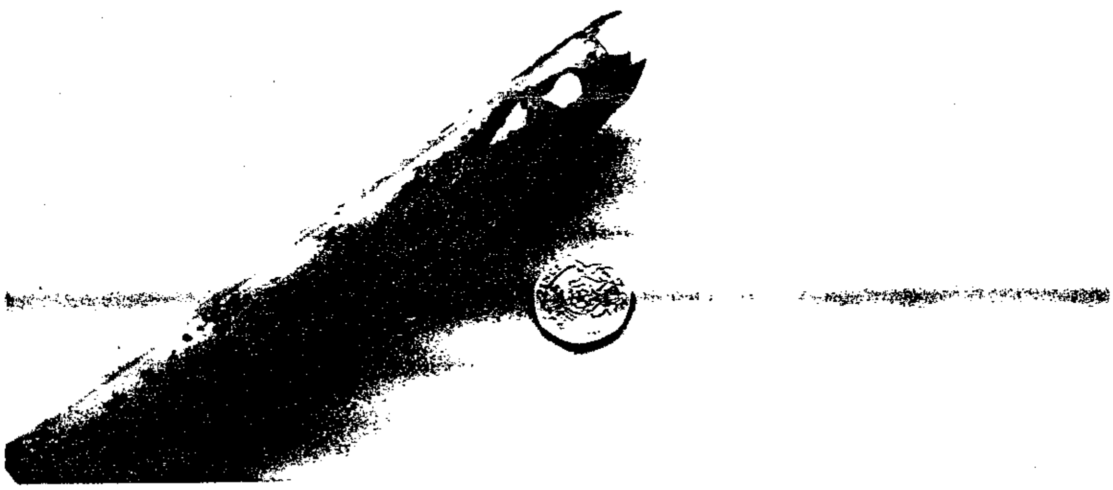
Engineers Supplement

SEE ALSO P/E ITEMS IN MAIN GASIL

E1. CORRODED LOWER FUSELAGE TUBULAR STRUCTURE

Aircraft Type	:	Mooney M20
Date	:	April 1990

During the Star annual inspection, the fuselage tubular structure was inspected in accordance with Mooney Service Bulletin M20-208B. The lower left-hand fore/aft tube, (forward of the wing main spar attachment fitting and cluster weld), was inspected and found to be paper thin due to severe internal corrosion along the bottom surface and the tube could be penetrated with a screwdriver over a length of 4½ inches.



The fuselage was separated from the wing assembly and the corroded section of tube removed. A welded insertion repair was carried out using the inner sleeve method in accordance with FAA Publication AC 43-13-1A Section 74 and Figure 2.7.

The rest of the tubular structure was inspected and no further signs of internal corrosion was found.

CAA Comment

The above occurrence is the only UK reported case of significant structural corrosion within the forward fuselage frame. It does however highlight the importance of a close visual inspection of the structure during the Star check.

E2. DOOR CAME OPEN DURING TAKE-OFF RUN

Aircraft Type	:	Socata TB10 Tobago
Date	:	April 1990

During taxying, the pilot noted a slightly higher than normal degree of engine and propeller noise. Take-off run was normal until rotation, at which point the left-hand door came open by about 3 or 4 inches. The take-off was abandoned and the aircraft brought to a halt on the runway. On examination the forward door catch was found to be broken, the rear door catch had held the door partially closed.

It was noticed that the failed hook was made of a light alloy whereas the replacement supplied now is made of steel. The owner has resolved that the remaining hooks will be replaced by steel hooks at the next fifty hour check.

CAA Comment:
Have any other readers experienced problems in this area?

E3. INSPECTION STANDARDS

Aircraft Type	:	Robin DR400-140
Date	:	February 1990

During maintenance, the aileron and rudder bearings were found to have excessive play. Whilst changing the bearings and parts, it was noted that the bolts holding the bearing halves to the airframe were excessively corroded on the shanks and threaded section. These bolts passed through wood structures to the anchor nuts. The bolts most affected were the rudder bolts. There was also corrosion on aileron bolts and the aileron balance weight attachment bolts.

This is the third aircraft of this type which this particular engineering company had encountered and the most serious deterioration to date. Also, on the same aircraft, the engine was removed for repair and on removing the engine frame to remove corrosion it was discovered that the airframe to engine frame bolts had been stretched and were lightly corroded.

The Company point out that they have discovered over a number of years of dealing with Robin's that corrosion will always occur where bolts pass through wood.

Aircraft Type	:	Cessna 185
Date	:	November 1989

The aircraft was descending through 7000 feet when total failure of the aileron control cable in the right wing resulted in loss of aileron control. Roll control was achieved using the secondary effect of rudder and a approach and successful landing was subsequently made.

Engineering examination showed that the left-hand aileron control cable, Part No. 510105-322 had failed in the area of the pulley above the right-hand door post. Laboratory examination of the cable confirmed that a 119 strands of the 130 strand cable had failed due to wear at the pulley section.

The aircrafts logbooks showed an annual inspection to the LAMS schedule had been certified less than 50 hours prior to the incident.

CAA Comment

The above two incidents illustrate the importance of proper inspection as required in the LAMS Schedule Section 3. Continued airworthiness is dependent upon proper inspection procedures being diligently carried out.

5. PROPELLER ANTI-EROSION TAPE

P/E

Aircraft Type : Socata TB10 Tobago
Date : May 1990

The owner of the aircraft frequently uses from a dusty and stony airstrip and so he covered the leading edge of his propeller with some propeller tape. The tape was purchased from an aviation supplier.

At the time the tape was put on the propeller, the propeller was cleaned with cleaner and the tape could not, in the opinion of the pilot, have been more firmly stuck on. It was some days before the aircraft flew again. Three weeks later, the aircraft was on a flight from Venice to Cannes at about 1000 feet, a climb was initiated. An unusual noise was noted coming from the front of the aircraft and it was only possible for the aircraft to climb at a fraction of the normal rate. The pilot landed the aircraft as soon as possible.

It appears that the tape had become unbonded at the back of the propeller and thus impaired the performance of the propeller.

In the opinion of the pilot, the tape had come unstuck due to the high temperatures that the aircraft experienced whilst it was parked.

CAA Comment

The incident was unusual since any unbonding of propeller tape normally results in a total loss of the tape from the propeller blade and, other than a slight imbalance, no other adverse effects are normally experienced.

The effect of the tape coming unstuck on the rear face and remaining bonded to the front face of the blade would be to modify drastically the aerofoil section and destroy its lift. This gave rise to the significant loss of propeller thrust which the pilot experienced. It seems likely that the high temperatures may have led to the unbonding of the tape.

It is very important that the pre-flight inspection of the aircraft should include the condition of the propeller blades. Airworthiness Notice 55 (Routine Maintenance of Propeller Blades) further emphasises the CAA's concern in respect of nicks, dents and corrosion.

6. ENFORCEMENT ACTION AGAINST PILOTS

P

On a lighter note, GASIL has been passed the following gem of information from the oldest known printed pilot book from Northern Europe which was published between 1502 and 1510. The Law relating to pilots translates as follows:

> "*A PILOT undertakes to guide a ship to Saint-Malo or another place. If he fails and the ship perishes because he did not know the way, and the merchants suffer loss, he is bound to pay damages if he can. If he has not the means to do so he must have his head cut off. If the master or any of the seaman or any of the merchants cut off his head, they are not liable to make amends. But all the same they ought to make sure before doing so whether or not he has the means to pay. This is the judgement.*"

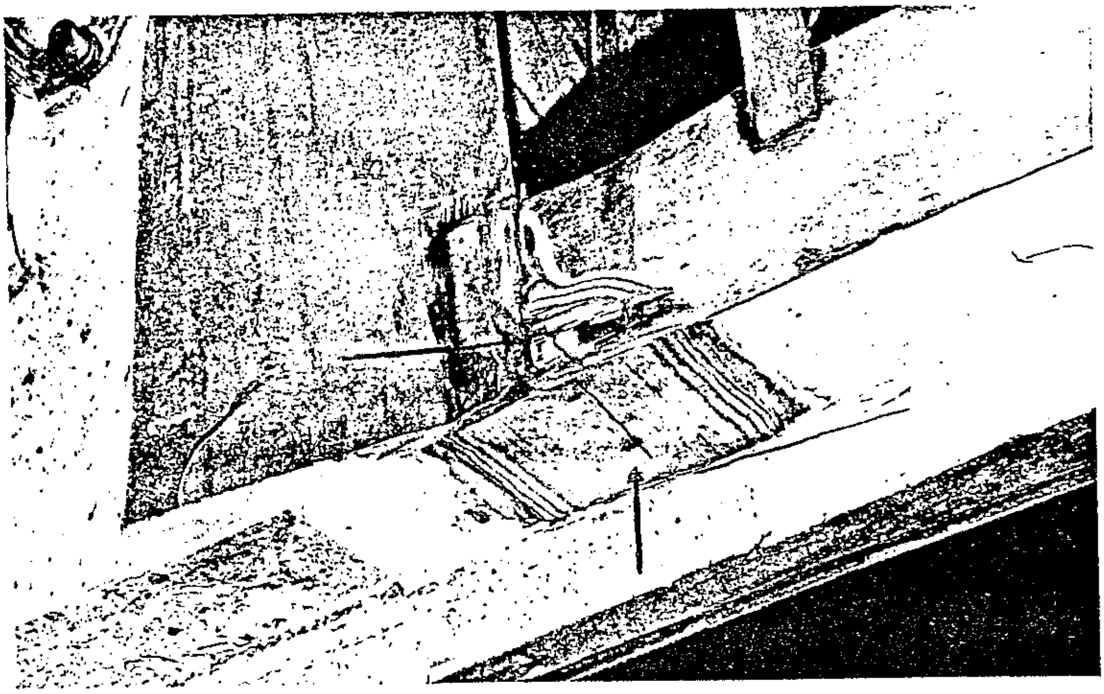
Engineers Supplement

SEE ALSO P/E ITEMS IN MAIN GASIL

E1 COMPRESSION CRACK IN WEB LOWER SPAR BOOM

Aircraft Type : Slingsby T67A
Date : May 1990

During inspection, a compression crack was found in the web and lower spar boom of the left hand wing rear spar between ribs 12 and 13 opposite the landing gear attachment. It was originally found by the operator and repaired to Slingsby repair scheme which was to patch with 5 ply inside and outside webb. The crack has now been found to have gone through both patches. The wood condition of spar boom indicates damage by water ingress. Damage is immediately above the wheel which is unguarded.



E2 CRACKED ELEVATORS

Aircraft Type : Piper PA 38 Tomahawk
Date : February 1990

During inspection, the elevators were found to have cracks on the trailing edge. These cracks were approximately 2 inches outboard from the root end of the skin Part No 77618-03. It was noticed that elevator movement causes flexing in the area of the cracks and although the flexing also occurs on elevators with no cracks this is less than on ones with cracks.

CAA Comment:

Have any other operators experienced similar problems?

7. FLYING CLUB SAFETY BOARD

P/E

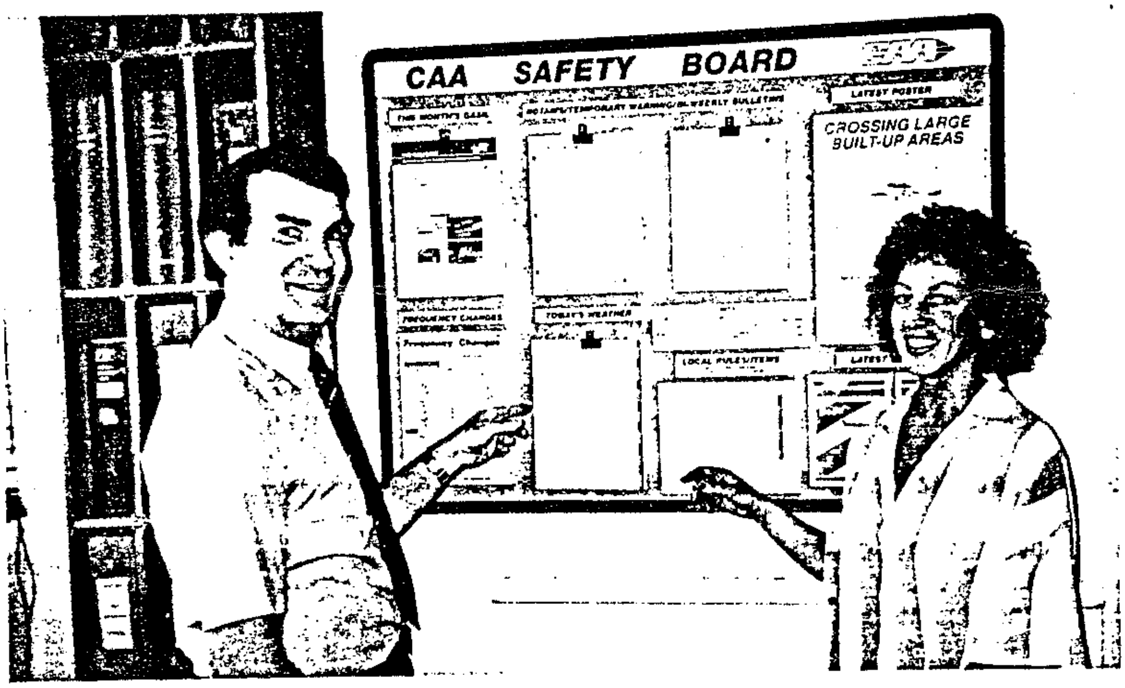
The CAA Safety Promotion Section now has available very smart 4ft. x 3ft. Safety Boards which are free of charge to all flying clubs. They are available in either fawn and navy blue and come complete with all of the appropriate printed headers, and indeed bulldog clips, already positioned.

Within the next year it is hoped that one of these boards can be provided to every flying club in the UK so that all local and visiting pilots will be familiar with them and will know right away where to obtain NOTAM information, weather information, frequency changes etc.

As distribution is very expensive, the Safety Promotion Section will be delivering some during the Autumn and Winter Safety Evening visits. However, if a club member is visiting Aviation House at Gatwick, perhaps for an exam or a medical, then they are very welcome to collect one and take it back to their club.

But, please phone us first so that we are expecting you.

The first of the boards was presented by John Thorpe, the Head of Safety Promotion to Linda Tombs of the Mercury Flying Club at Shoreham.



8. WATER DRAINS

P/E

Aircraft Type : Rallye 235
Date : June 1990

Over a nine day period, the aircraft had been left outside with the elevator secured in the full up position by tying the controls with the seat harness. There had been a long period of heavy rain in this interval and when the aircraft was next examined and the elevator released, several pints of water flowed from the corrugations at the rear of the control tip.

The reporter makes the observation that had this frozen during winter time there would be a serious imbalance of the control. Unfortunately, there appear to be no drain holes on the forward lower surface of the tips.

CAA Comment

Have any other readers experienced problems in this area?

Translation.

LUFTFAHRT-BUNDESAMT

3300 Braunschweig
Airport
1st August 1990

I 63-303.61/90-239

DRAFT AIRWORTHINESS DIRECTIVE

90-239 EIRIAVION

Date of Issue:
1st August 1990

Concerns: Powered Glider
Aircraft No. 814
PIK 20 E
All serial numbers.

Re:
Fixing of the Propeller Hub Bearing

Motive/Reason:
There is a possibility of the propeller bearing coming loose after the locking plate has sheared off.

Measures
1. Dismantle the propeller
2. Unscrew the groove nut and remove the locking plate.
   a) Check the nut in the spindle for straight edges, so that acceptance of the force is guaranteed by the locking plate.
   b) If there are any deformations on the spindle nut, fit a suitably thick shim of the dimensions (diameter) of the inner bearing-ring in front of the bearing.
   c) Test the groove nut for perfect condition.
   d) Check the bearing according to the data in the Operating and Servicing Manual.
   e) Connect up using a new locking plate in accordance with the data in the Operating and Servicing Manual.
   f) Refit the propeller.
3. Until further notice, measures 1 and 2 are to be carried out after every 10 engine operating hours.

Deadline
Before the next flight.

Note: The LBA is endeavouring to find a Type Specialist for the PIK 20 E in W. Germany, with whom it should be possible to work out some improvement of the construction and its realization. It is then intended to revise this Airworthiness Directive.

Performance and Certification
These measures may be carried out by an expert. Execution is to be certified in the aircraft's log by a duly authorized Examiner. The regulations concerning the keeping of working records as per Art. 15 of the Aircraft Operating Order must be observed.

HEADQUARTERS AIR CADETS

GRASSHOPPER

PRIMARY GLIDER

LOADING AND C OF G DATA

INTRODUCTION

1. As with any other flying machine, it is most important when operating the Grasshopper to ensure that its Centre of Gravity (C of G) is kept within the manufacturers stated limits. The C of G will vary with the weight of the pilot and as a result of adding or removing ballast weights from the front and rear brackets. A Table at para 12 lists various pilots weights and details the number of ballast weight to be added. Provided the aircraft is always loaded in accordance with this table, the C of G will remain within the safe operating limits. To allow the subject to be better understood, this chapter explains firstly how the C of G is calculated and secondly, why it is so important for the aircraft to be correctly loaded whenever it is operated.

DEFINITIONS

2. Centre of Lift. When flying, the weight of the aircraft is supported primarily by the wings which produce lift. Lift is distributed over the whole of the wings in variable amounts but when calculating its value, it is convenient to consider that the total lift from the wings acts from a single point. This point is known as the centre of lift.

3. Centre of Gravity. The C of G of the aircraft is the point about which the total weight of the aircraft may be said to act. It may also be considered to be the point of balance.

4. Tare Weight. The tare weight is the unladen weight of the aircraft, that is without the pilot and ballast weights.

5. Tare C of G. The tare C of G is the C of G position of the unladen aircraft.

6. All Grasshopper gliders will have the same tare weight and tare C of G on manufacture but changes may occur during the life of individual aircraft as a result of the aircraft being repaired or resprayed. Such changes would however be very small and would have no significant effect on the tare C of G and tare weight.

DETERMINING THE POSITION OF CENTRE OF GRAVITY

7. The C of G is determined by finding the turning moment of individual items of equipment about a given datum, adding together all the moments and dividing the total moment by the total weight. The turning moment of individual items of

equipment is calculated by multiplying the weight of the equipment by its distance from the selected datum. If the turning moment is clockwise it is considered to be a POSITIVE moment and if anti-clockwise, a NEGATIVE moment. A simple example of determining C of G is shown in Figure 1.

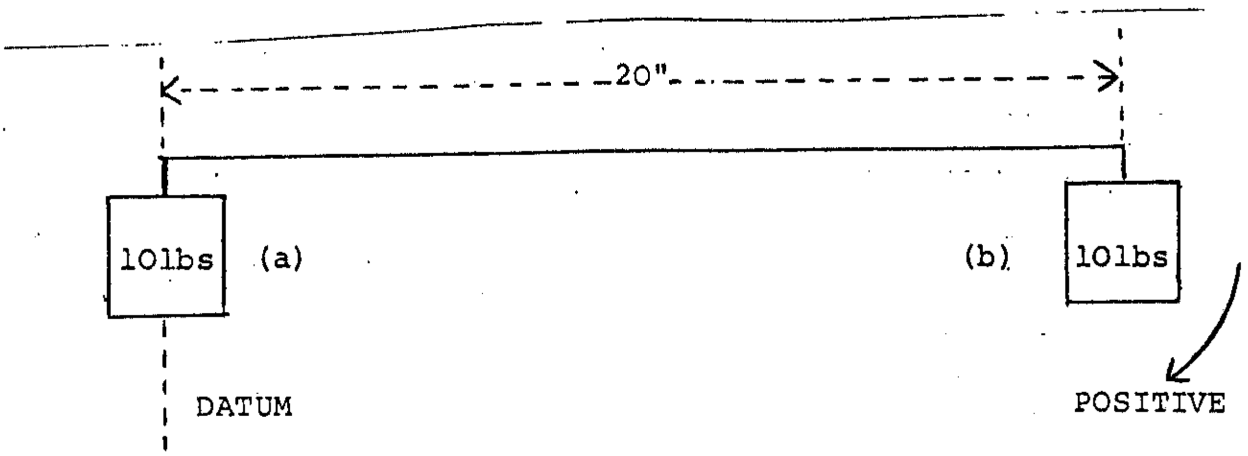


FIG 1

CALCULATION

	Weight (lbs)	X	Distance from datum (inches)	=	moment (lbs/ins)
(a)	10	X	0	=	0
(b)	10	X	+20	=	+200
Total Weight	20			Total Moment	+200

$$\frac{\text{Total Moment}}{\text{Total Weight}} = \text{C of G Position}$$

$$= \frac{+200}{20} = +10 \text{ inches}$$

The C of G position is 10 inches to the right or on the positive side of the datum.

8. Provided all the moments are taken about the SAME datum, the position of the datum is immaterial as illustrated by Figure 2, which uses the basic values used in Figure 1.

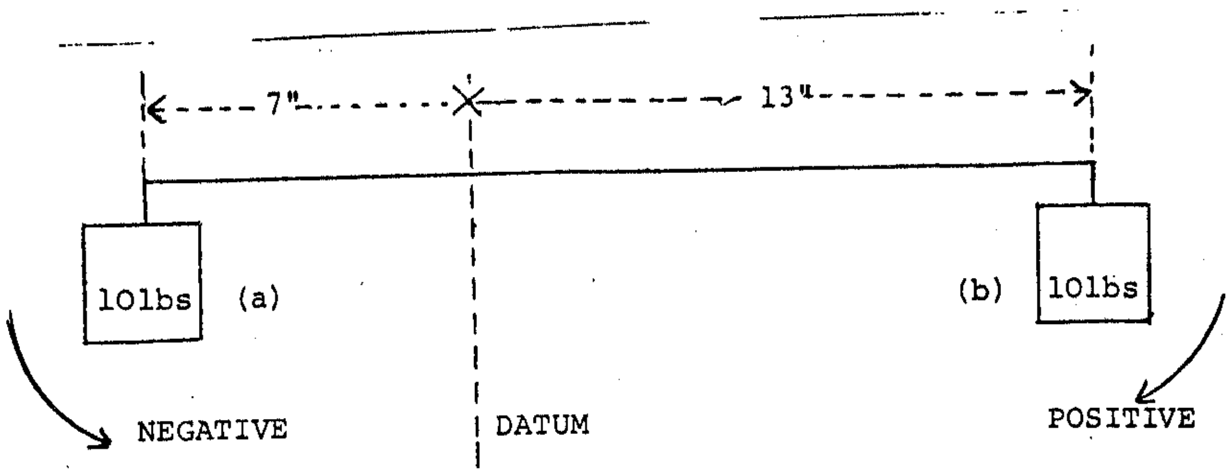


FIG 2

CALCULATION

	Weight (lbs)	X	Distance from datum (inches)	=	Moment (lbs/ins)
(a)	10	X	-7	=	-70
(b)	10	X	+13	=	+130
Total Weight	20			Total Moment	+ 60

$= \frac{+60}{20} = +3$ inches

The C of G is 3 inches to the right or on the positive side of the datum.

9. The manufacturers datum for the Grasshopper lies on a line perpendicular to the keel and tangential to the mainplane leading edge, Figure 3. The tare weight of a Grasshopper on manufacture is 287 lbs and the tare C of G is 31.2 inches on the positive side of the datum. When calculating the C of G of any aircraft, by convention, the aircraft is always considered to be facing left. Positive movements will therefore make the aircraft tail heavy. Negative moments will make the aircraft nose heavy. For safe operation, Grasshoppers must always be loaded so that the C of G remains within +12.5 inches and +19 inches of the datum. The ideal position of the C of G is +16.9 inches from the datum.

10. The following example shows the calculation for determining the C of G of a Grasshopper which has a tare weight of 287 lbs, a tare C of G of +31.2 inches, and 2 ballast weights attached to the front bracket, when it is flown by a pilot weighing 100 lbs.

Weight (lbs)		X	Distance from datum (inches)	= Moment(lbs/ins)
Aircraft	287	X	+31.2	= +8,954.4 (287 lbsX +31.2 ins)
Ballast on front bracket	20	X	-43 (Fig 3)	= - 860
Pilot	100	X	-12.5 (Fig 3)	= - 1250
Total Weight	407		Total Moment	+ 6844.4

$$= \frac{+6844.4}{407} = +16.82 \text{ inches}$$

The C of G of this aircraft, at +16.82 inches from the datum, is within the acceptable limits of +12.5 inches and +19 inches. The aircraft would therefore be loaded correctly for flight and is within 0.08 inches of the ideal position (+16.9 inches) By selecting the ideal C of G position and working back through the calculation, the exact ballast weight required to achieve the ideal for any weight of pilot can be calculated.

EFFECT OF C OF G POSITION IN FLIGHT

11. The Grasshopper can be flown at various combinations of angle of attack and airspeed. High angle of attack, low airspeed. Low angle of attack, high airspeed. There is however, an optimum angle of attack for best performance. This is about 4 degrees and the aircraft should be flown at an airspeed which permits this angle of attack to be maintained. The ideal aircraft loading is one where, at 4 degrees angle of attack, the C of G is immediately below the centre of lift as this will allow the pilot to maintain the optimum in flight attitude with the elevators in the neutral position, giving him maximum elevator control movement both fore and aft for manoeuvre. When the C of G is not immediately below the centre of lift a couple will exist between the lift and weight forces, which, unless corrected, will rotate the aircraft away from the optimum in flight attitude. Nose down when the C of G is in front of the centre of lift. Tail down when the C of G is to the rear of the centre of lift. To prevent the couple from rotating the aircraft is is necessary to move the control column in the appropriate direction to provide a correcting upwards or downwards lifting force on the elevator. If the C of G position is such that the couple is tending to make the aircraft rotate tail down, forward movement of the control column will provide a compensating upwards force on the elevators which will prevent rotation taking place. But having used part of the forward elevator movement to maintain the optimum in flight attitude, less forward control column movement will be available to manoeuvre. It follows that the further back the C of G the greater would be the rotating effect of the lift/weight couple and the greater would be the movement forward of the control column to prevent pitch up taking place. On a badly loaded aircraft the pilot could find

that on becoming airborne the control column would be fully forward to maintain level flight leaving no room to manoeuvre. In extreme cases of mis-loading the aircraft would, on becoming airborne, rotate immediately to a stalled conditions from which the pilot would be unable to recover. For an aircraft loaded with its C of G too far forward the situation would be reversed, the control column having to be moved rearward to prevent the aircraft pitching down. Again in the extreme case there would be insufficient rearward movement available with the control column to control the pitch and on becoming airborne, should this be achieved, the aircraft would enter an uncontrollable dive which would terminate when the aircraft hit the ground.

TABULATION OF PILOTS WEIGHT AND BALLAST

12. Whenever the Grasshopper is operated, including static stand operation, it is to be loaded in accordance with the following table. This will ensure that the C of G will always be within the safe operating limits.

Pilot's Weight(lb)	Ballast Required(lb)	Location of Ballast
60 to 79	40	Front brackets
80 to 99	30	Front brackets
100 to 119	20	Front brackets
120 to 139	10	Front brackets
140 to 149	0	Rear brackets
150 to 159	10	Rear brackets
160 to 240	20	Rear brackets

CONCLUSION

13. Provided the aircraft is always loaded in accordance with the table contained in para 12 above the C of G position will always be within the manufacturers limits of +12.5 inches and +19 inches. If however the aircraft is loaded in a manner which produces a C of G outside these limits, it will be unsafe to fly and in cases of gross mis-loading, it would become uncontrollable and therefore extremely dangerous to operate.

REMEMBER

CORRECT LOADING IN ACCORDANCE WITH THE TABLE CONTAINED IN PARA 12 IS ESSENTIAL FOR SAFE OPERATION

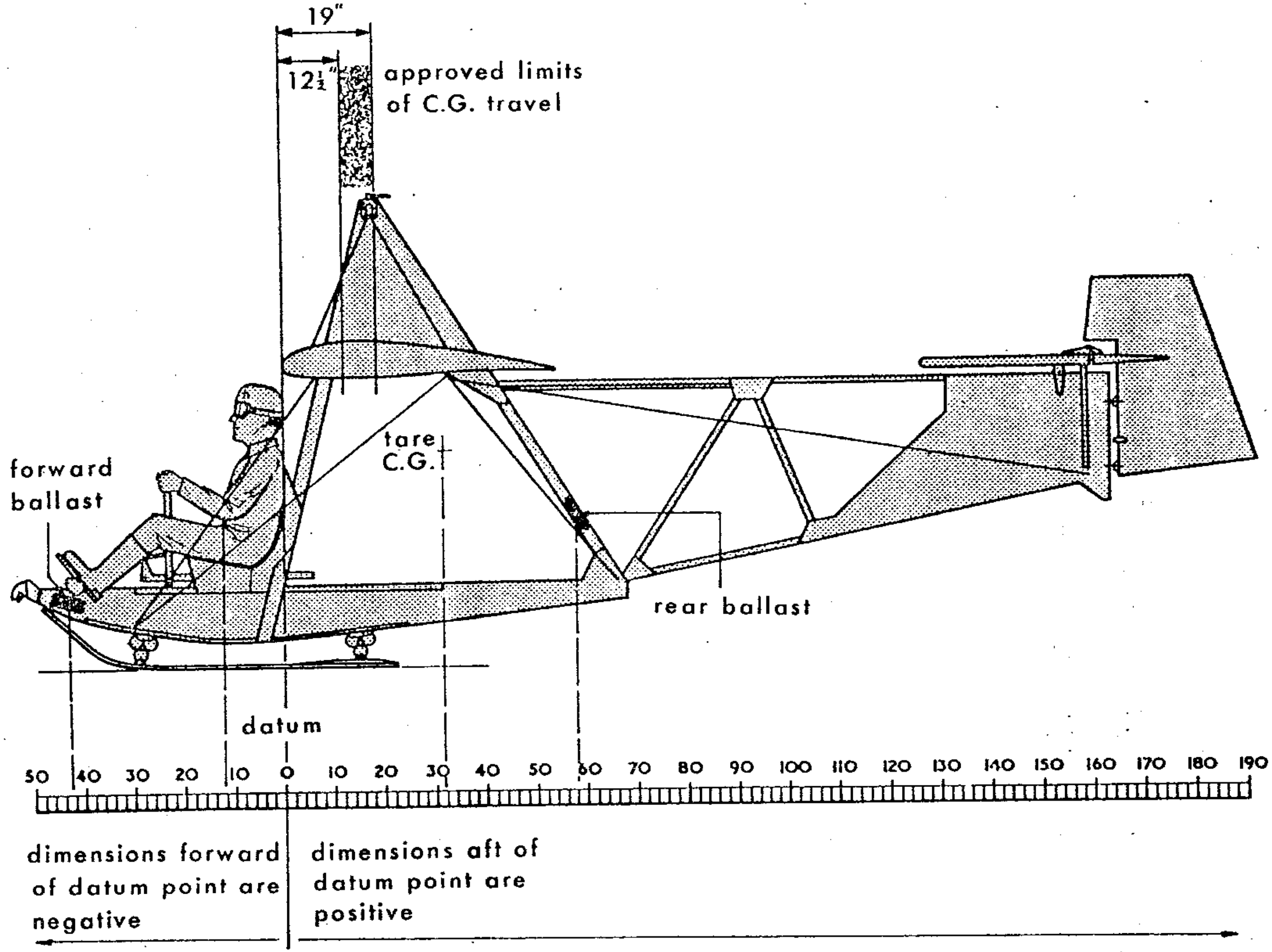


FIG 3 LOADING AND C G DIAGRAM

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Control Tower Building, LONDON/Heathrow Airport
Hounslow, Middlesex TW6 1JJ
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59/1990
(Pink 8)
2 August

INDUCTION SYSTEM ICING ON PISTON ENGINES AS FITTED TO AEROPLANES, HELICOPTERS AND AIRSHIPS.

1 Introduction

1.1 Piston engine induction system icing, commonly, but not completely accurately, referred to as 'carburettor icing' may occur even on warm days, particularly if they are humid. IT CAN BE SO SEVERE THAT, UNLESS CORRECT ACTION IS TAKEN, THE ENGINE MAY STOP. Induction system icing is more likely at low power setting such as those used during descent, holding, on the approach to a landing or during auto-rotation on a helicopter.

1.2 During the past 5 years there have been, in the UK, an average of 10 occurrences - including 7 accidents - per year in which engine induction system icing might have been a factor. After a forced landing or accident the ice may well have disappeared before an opportunity occurs to examine the engine, so that the cause cannot positively be identified.

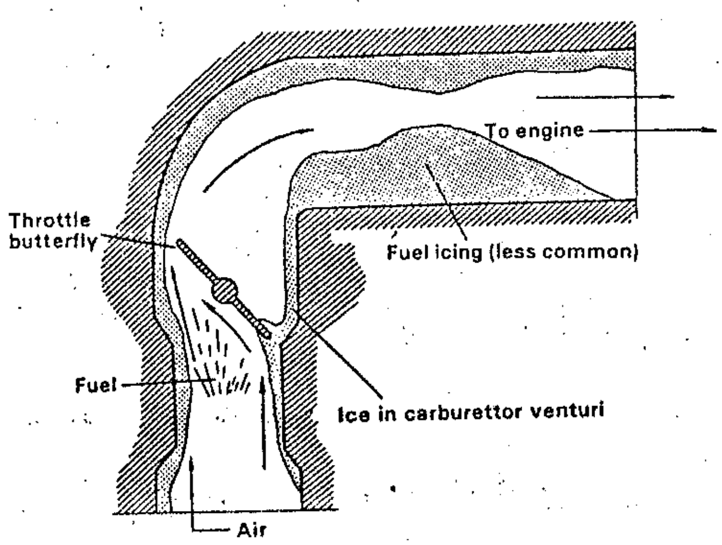
1.3 Some aircraft and engine combinations are more prone to icing than others and this should be borne in mind when flying another aircraft type.

2 Induction System icing

2.1 There are three main types of induction system icing:

(i) **Carburettor Icing.**
The most common type of induction system icing is carburettor icing which is caused by the sudden temperature drop due to fuel vaporization and reduction in pressure at the carburettor venturi. The temperature reduction may be as much as 20° - 30° C and results in moisture in the induction air forming ice. The ice gradually builds up, constricting the venturi and, by upsetting the fuel/air ratio, causes a progressive decrease in engine power. Engines which have a conventional float type carburettor are more prone to this type of icing than are those which have a pressure jet carburettor, ie the Stromberg type of carburettor. Engines with a fuel injection system are not, of course, subject to carburettor icing.

BUILD-UP OF ICING IN INDUCTION SYSTEM



CAA Carto DO C(G)6 Drg No 8805b 23-11-84 10-5-90

Fuel Icing is the result of water, held in suspension in the fuel, precipitating and freezing in the induction piping, especially in the elbows formed by bends.

(iii) **Intake or Impact Ice.**
Ice which builds up on air intakes, filters and on carburettor heat or alternate air valves etc is known as Intake or Impact ice (for consistency the term Impact ice is used throughout this AIC). Impact ice can accumulate in snow, sleet, sub-zero temperature cloud or in rain when the temperature of the rain or the aircraft is below 0°C. This type of icing affects fuel injection systems as well as carburettor systems.

2.2 Testing has shown that, because of the greater volatility and possible greater water content, carburettor and fuel icing is more likely to occur with MOGAS than with AVGAS.

2.3 Reduced power settings are more conducive to icing in the throttle area because there is a greater temperature drop at the carburettor venturi and the partially closed butterfly can more easily be restricted by the ice build-up.

3 Atmospheric Conditions

3.1 Carburettor icing is not confined to cold weather and will occur in warm weather if the humidity is high enough, especially when the throttle butterfly is only partially open as it is at low power settings. Flight tests have produced serious icing at descent power with the ambient (not surface) temperature above 30°C, even with a relative humidity as low as 30%. At cruise power, icing can occur at 20°C with a relative humidity of 60% or more. Ice accretion is less on cold, dry, winter days than on warm, humid, summer days because the water vapour content of the air is lower. Thus, where high relative humidity and ambient temperatures of between -10°C and +25°C are common, as is the case in the UK and Europe, pilots must be constantly alert to the possibility of icing and should take the necessary steps to prevent it. If the appropriate preventive action has not been taken in time it is vital to be able to recognise the symptoms (see para 4.2) so that corrective action can be taken before an irretrievable situation develops. Should the engine stop due to icing it may not re-start or, even if it does, the delay may result in a critical situation.

3.2 Carburettor or fuel icing may occur even in clear air and these are, therefore, the most insidious of the various types of icing because of the lack of visual clues. The risk of all forms of induction system icing is higher in cloud than in clear air but because of the visual clues the pilot is less likely to be taken unawares.

3.3 Specific warnings of induction system icing are not included in standard weather forecasts for aviation. Pilots must use their knowledge and experience to estimate the likelihood of its occurrence from the weather information available. When information on the dewpoint is not available, pilots in the UK and Europe should always assume a high relative humidity, particularly when:

(i) the surface and low level visibility is poor, especially in the early morning and later evening and particularly when near a large area of water;

(ii) the ground is wet (even with dew) and the wind is light;

(iii) just below the cloud base or between cloud banks or layers;

(iv) in precipitation, especially if it is persistent;

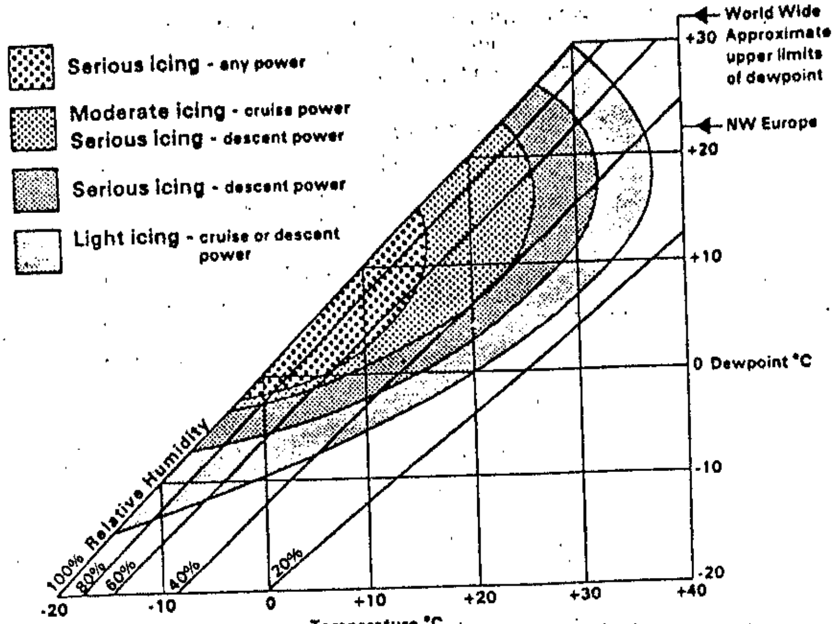
(v) in cloud or fog - these consist of water droplets and therefore the relative humidity should be assumed to be 100%;

(vi) in clear air where cloud or fog has just dispersed.

conducive to the formation of induction system icing for a typical light aircraft piston engine. Particular note should be taken of the much greater risk of serious icing with descent power. The closer the temperature and dewpoint readings the greater the relative humidity.

CARBURETTOR ICING IN AIR FREE OF CLOUD, FOG, OR PRECIPITATION

-risk and rate of icing will be greater when operating in cloud, fog and precipitation.



3.5 Impact icing occurs when flying through snow or sleet, or in cloud in which super-cooled water droplets are present. It can occur, but is less frequent, when flying through super-cooled rain or to an aircraft which has a surface temperature below 0°C when flying through rain which is above freezing temperature. The ambient temperature at which impact ice may be expected to build up most rapidly is about -4°C in conditions in which visible ice is forming on other parts of the aircraft.

4 Prevention, Recognition and Remedial Practices

4.1 Prevention

4.1.1 Whilst the following provides a general guide to assist pilots to avoid induction system icing, the Pilot's Operating Handbook or Flight Manual must be consulted for specific procedures applicable to a particular airframe and engine combination. The procedures are likely to vary between different models of the same aircraft type:

(i) Carburettor icing is prevented by heating the intake air in an exhaust heat exchanger before it reaches the carburettor. (Design Requirements typically demand a temperature rise of 50°C at 75% power). This is usually achieved by use of a manually operated carburettor heat control, marked HOT or COLD and which, in the HOT position, by-passes the normal intake filter and derives the induction air from a heated source. The HOT position should be selected in time to prevent the formation of ice, because if the selection is delayed the use of hot air might be too late to melt the ice before the engine stops;

(ii) Engines with fuel injection normally have an alternate air intake, marked ON or OFF, located within the engine cowling and operated by a valve downstream of the normal intake. Although the air does not pass through a heat exchanger it derives some heat from the engine. Some engine installations have automatic alternate air selection activated by pressure sensitive valves;

(iii) Other than on take-off, the HOT position should be selected periodically when icing conditions are suspected or when flying in conditions of high humidity with the outside air temperature within the high probability ranges indicated on the chart at paragraph 3.4. Unless expressly permitted the continuous use of the HOT position should be avoided, especially during hovering flight in a helicopter. It should be selected intermittently for long enough to pre-empt the loss of engine power; this time period w[illegible] vary dependent on the prevailing conditions;

should be selected prior to descent, approach and landing.

4.2 Recognition

4.2.1 Should no preventative action have been taken, or was taken too late, or was insufficient, the onset of induction icing may be recognised in the following ways:

(i) With a fixed pitch propeller, a slight drop in RPM is the first sign which may indicate the onset of icing in the induction system. If not rectified there will be a loss of airspeed and possibly height. The loss of RPM may be gradual with no associated rough running. The usual reaction is to open the throttle slightly to restore the RPM and this action masks the early symptoms. As the icing increases there will be rough running, vibration and further RPM reduction; a loss of airspeed or height will result and ultimately, THE ENGINE MAY STOP. Thus the main detection instrument is the RPM gauge used in conjunction with the Air Speed Indicator;

(ii) Where a constant speed propeller is fitted and in a helicopter the loss of power would have to be large before the RPM reduced, hence the onset of induction system icing could be even more insidious. However, the effect of icing will be shown by a drop in manifold pressure and then by a reduction of airspeed or height. The primary detection instrument is, therefore, the manifold pressure gauge. Engine rough running may provide an additional indication;

(iii) An exhaust gas temperature indicator will show a decrease in Exhaust Gas Temperature (EGT) with the onset of icing but engine rough running would, probably, have already been detected.

4.3 Remedial Action

4.3.1 When the presence of induction system icing is suspected the HOT or alternate air ON position must be selected immediately.

(i) The recommended practice with most engines is to use full heat whenever carburettor heat is applied. The control should be selected fully to the HOT position. Partial heating can induce induction system icing because it may melt ice particles, which would otherwise pass into the engine without causing trouble, but not prevent the resultant mixture from freezing as it passes through the induction system. Alternatively partial heat may raise the temperature of the air into the critical range.

(ii) With some engine installations the use of partial carburettor heat may be considered, particularly where an intake temperature gauge is fitted. An intermediate position between HOT and COLD should only be used if an intake temperature gauge is fitted and appropriate guidance is given in the Flight Manual.

Note: It should be remembered that the selection of the HOT position after ice has already formed may, at first appear to make the situation worse because of the reduction in power due to the use of hot air and to an increase in rough running as the ice melts and passes through the engine. If this happens the temptation to return to the COLD position must be resisted in order that the hot air may have time to clear the ice. This may take 15 seconds or more and may seem a very long time in difficult circumstances.

5 Maintenance and Handling Procedures

5.1 Maintenance

5.1.1 Periodically check the induction heating system and controls for proper condition and operation. Pay particular attention to the condition of seals which may have deteriorated and are allowing the hot air to become mixed with cold air and thus reducing the effectiveness of the system.

5.2 Start Up

5.2.1 Start up with the carburettor heat control in the COLD position or with the alternate air selector in the OFF position, as applicable.

5.3.1 The use of hot or alternate air while taxiing is not normally recommended because in most engine installations this air is unfiltered, hence there is a risk of dust and foreign matter being ingested. However, if engine run down occurs this may indicate that induction system icing is present and the use of hot air will be the only way of preventing further problems.

5.4 Pre Take-Off Engine Run Up

5.4.1 Check that there is the appropriate decrease in RPM and/or manifold pressure when the HOT position is selected (about 75 - 100 RPM and 3-5" manifold) and that power is regained when the COLD position is re-selected. If it is suspected that induction system icing is present the HOT position should be selected and maintained until the ice has cleared and full power is restored.

5.5 Immediately Prior to Take-Off

5.5.1 Induction icing can occur when taxiing at low power or when the engine is idling. If the weather conditions appear to be conducive to the formation of induction icing then the HOT position should be selected before take-off for sufficiently long to remove any accumulation which may have occurred. If the aircraft is kept at the holding point in conditions of high humidity it may be necessary to run up the engine to the take-off power setting more than once to clear any ice which may have formed. The take-off must not be commenced if the pilot has any suspicion that carburettor icing is present.

5.6 Take-off

5.6.1 When the throttle is fully open for take-off the pilot should check that the manifold pressure and/or RPM are correct for the aircraft type. The static RPM with a fixed pitch propeller will be less than the maximum RPM approved for the engine but the relevant value should be known for each aircraft. Carburettor heat must not be selected to HOT nor alternate heat to ON during take-off unless specifically authorised in the Flight Manual or Pilots' Operating Handbook.

5.7 Climb (including hovering flight in a helicopter)

5.7.1 Be alert for symptoms of induction icing, especially when visible moisture is present or when the dew point and ambient temperatures are close, indicating high relative humidity.

5.8 Cruise

5.8.1 Monitor the RPM, manifold pressure, induction or carburettor air temperature gauge, or EGT for a slow decline which would indicate the onset of induction system icing. Periodically select the HOT position to check for the presence of induction icing. Maintain the HOT selection and remember that it may take 15 seconds or more to clear the ice and the engine may run roughly as the ice melts. If the icing is so severe that the engine stops maintain the HOT selection as the residual heat may still be sufficient to melt the ice and enable power to be restored. If impact icing is encountered select HOT or alternate air ON in case the selector valve becomes immovable due to packed ice. Avoid clouds as much as possible.

5.9 **Descent and auto-rotation flight in a helicopter**

5.9.1 As reduced throttle openings are much more conducive to the formation of carburettor icing, the HOT position should be selected before the throttle is closed for the descent or an auto-rotation, ie, before the exhaust temperature starts to fall. Maintain the HOT selection during prolonged periods of flight at reduced throttle settings, eg, during long descents at low power, and increase engine power to cruise settings at intervals of approximately 500 ft so as to increase exhaust temperatures in order to melt any ice which has formed.

5.10 **Downwind**

5.10.1 Include a check of the carburettor heat in the pre-landing checks and observe the reduction and subsequent increase in manifold pressure and/or RPM.

5.11 **Base Leg and Finals**

5.11.1 Unless stated to the contrary in the Pilot's Operating Handbook or Flight Manual the HOT position should be selected on base leg as the power is reduced for the approach. On some engine installations, to ensure better engine response and to permit a go-around to be initiated without delay, it is recommended that the carburettor heat should be selected to COLD at about 200/300 ft on finals.

5.12 **Go-Around or Touch and Go**

5.12.1 If the carburettor heat has not been selected to COLD on finals this should be done concurrently with the application of go-around power, or as shortly thereafter as is possible.

5.13 **After Landing**

5.13.1 Ensure that the carburettor heat has been selected to COLD or the alternate air to OFF before taxiing.

6 **Main Points**

6.1 It is better to prevent ice building up than to attempt to melt it.

6.2 Induction system icing forms insidiously.

6.3 Icing can occur in warm and humid conditions, and is a possibility at any time of the year in the UK and Northern Europe.

6.4 Be aware of the possibility of the formation of induction system icing and be prepared to take appropriate preventive measures in time.

6.5 Carburettor icing is more likely to occur at low power settings.

6.6 When flying in conditions conducive to the formation of carburettor icing the HOT position should be selected periodically and certainly at the first indication of a reduction in RPM/manifold pressure/airspeed or height.

6.7 Some aircraft/engine combinations are more susceptible than others.

6.8 Use of MOGAS increases the possibility of carburettor icing.

6.9 Unless the Flight Manual or Pilot's Operating Handbook authorises a different procedure the HOT/ALTERNATE air control should be selected fully ON or OFF.

6.10 If ice has been allowed to form it will take some time to melt and the engine may run roughly while this is happening - PERSIST!

7 This circular replaces the information previously published in AIC 1/1985 (Pink 68) lapsed.