BGA AIRWORTHINESS AND MAINTENANCE PROCEDURES

PART 4, LEAFLET 4-1

GLIDER WEIGHT AND BALANCE

INTRODUCTION

1. The objective of weighing is to establish the weight and centre of gravity position of the empty sailplane and subsequently derive the maximum and minimum cockpit loads. Additionally, for some sailplane types, where the wing span bending loads are critical, it is necessary to establish the weight of the non-lifting parts, that is the weight of the sailplane excluding the wings. Subsequent to the weighing the permissible cockpit loads must be calculated and placarded in the sailplane. This leaflet describes the procedures to follow. Further guidance is contained in BCAR Section A5-4, the ANO 2000, Article 18 and in CAAIP Leaflet 1-4.

WEIGHING PROCEDURE

2. BGA sailplanes are to be weighed on the following occasions:

   a. On acceptance from manufacturers after preparation for issue.

   b. After modification action, when required in the relevant modification leaflet.

   c. After major repair, recovering or refinishing.

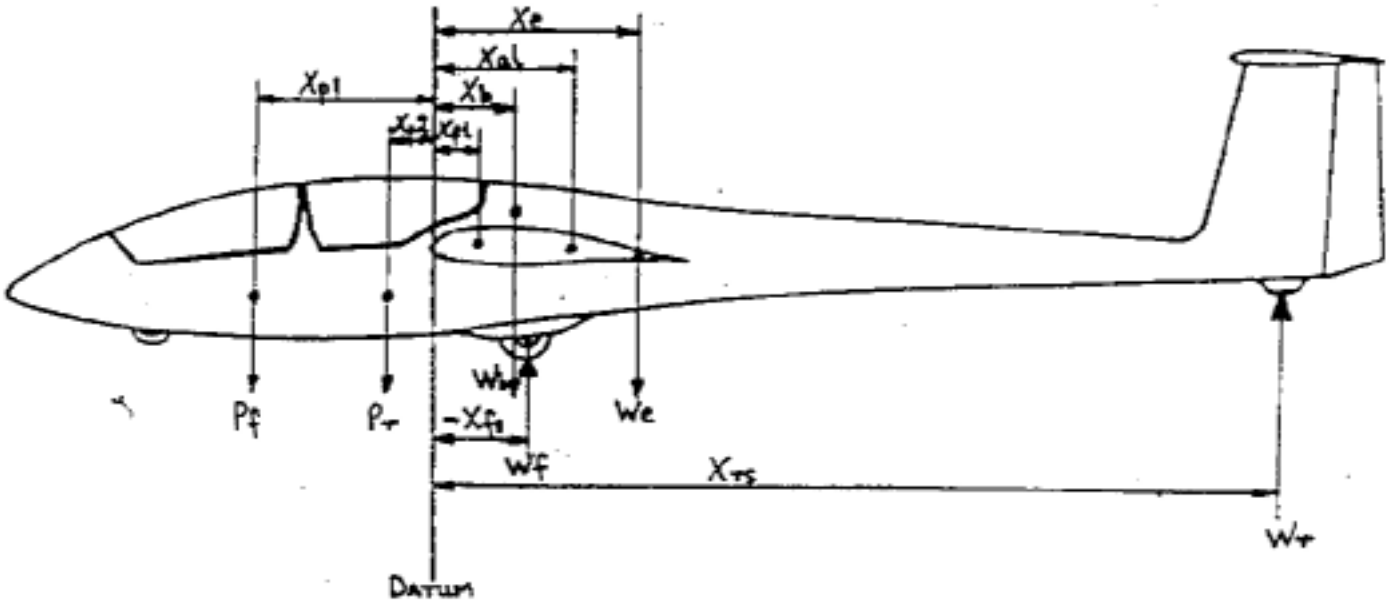
   d. Every 8 years.

3. **Preparation**. Ideally the weighing should be carried out in a closed hangar to prevent the generation of wing lift forces. Two suitable weighing balances, one having a capacity approaching the empty weight of the sailplane are required. Platform type balances are most suitable; however, it is not necessary to use aircraft weighing units. Commercial scales may be used provided their calibration has been checked over the desired range of use within the last 12 months and the calibration chart is available. It is possible to use a number of smaller balances instead of a large one by bridging them with a suitable frame. Check the equipment fit of the sailplane. Instruments, batteries, oxygen systems, seat cushions, fixed ballast are included in the `basic' empty weight; parachutes, barograph and removable ballast (including water ballast) are not.

4. **Procedure**. Select suitable front and rear weighing points on the sailplane. The front point can be the main wheel, one of the skid mounts, or some other strong point; the rear point can be the tail skid. Position the front point on a weighing unit, and lift the tail to bring the sailplane to the required attitude. Position the second weighing unit on a suitable trestle, under the rear point. Level the wings and record the weights registered by the front and rear weighing units. Take account of the calibration correction factor and the weight of any weighing frame. Whilst the sailplane is still in the weighing position, drop a plumb bob from the front and rear weighing points, and the sailplane datum point to the ground, and measure the distances of the front and rear weighing points from the datum point.

5. **Non-Lifting Parts**. For sailplanes where the Leading Particulars specify a maximum weight of non-lifting parts, it will additionally be necessary to weigh the wings to enable the weight of the fuselage and tailplane to be calculated; this is the empty weight of non-lifting parts.

WEIGHING RECORD



6. **Sailplane Leading Particulars**. Record the following data from the sailplane Leading Particulars:

Datum point definition and method of levelling.	
Forward CofG limit:	Xfl aft of datum.
Aft CofG limit:	Xal aft of datum.
Front Pilot CofG:	Xp1 forward of datum.
Rear Pilot CofG:	Xp2 forward of datum (negative if aft).
Baggage CofG:	Xb aft of datum (if applicable).
Max All Up Weight (Dry):	Wd
Max All Up Weight (Wet):	Ww
Max Baggage Weight:	Wb
Max Weight of Non-Lifting Parts:	Wn (if applicable).

7. **Results of Weighing**.

Weight on front weighing point:	Wf
Distance of front point fwd of datum:	Xfs (negative if aft of datum)
Weight on rear weighing point:	Wr
Distance of rear point aft of datum:	Xrs
Weight of Port wing:	Wp
Weight of Starboard wing:	Ws

8. **Derived Results**. (round to nearest 1 kg (2 lb))

a. **Empty Sailplane Weight and CofG**.

Empty Sailplane Weight (We):

Wf + Wr

Weight Non-Lifting Parts (Wnl):

We - Wp - Ws

Empty Sailplane CofG Displacement (Xe):

$$\frac{(Wf \times Xfs) - (Wr \times Xrs)}{We}$$

b. **Single Seaters/Side-by-Side 2 Seaters**.

(1) Minimum cockpit load (aft CofG limits):

$$\frac{We(Xe - Xa1)}{(Xp1 + Xa1)} + \frac{Wb(Xb - Xa1)}{(Xp1 + Xa1)}$$

(2) Maximum dry cockpit load will be the LEAST of:

(a) $\frac{We(Xe - Xf1)}{(Xp1 + Xf1)} + \frac{Wb(Xb - Xf1)}{(Xp1 + Xf1)}$ (forward CofG limits).

(b) Wd - We - Wb (All up weight considerations).

(c) Cockpit limitations (see sailplane Flight Manual).

(d) Wn - Wn1 - Wb (weight of non-lifting parts - if applicable).

(3) Maximum total cockpit load – wet:

Total weight of pilot(s) plus water must not exceed:

Ww - We - Wb

c. **Tandem 2 Seaters**. Front cockpit permissible loads are to be calculated for rear cockpit load (Pr) of both zero, and representative loads in the range 60-110 kg (132-242 lb).

(1) Minimum front cockpit load (aft CofG limits):

$$\frac{We(Xe - Xa1)}{(Xp1 + Xa1)} + \frac{Wb(Xb - Xa1)}{(Xp1 + Xa1)} - \frac{Pr(Xp2 + Xa1)}{(Xp1 + Xa1)}$$

(2) Maximum dry front cockpit load will be the least of:

(a) $\frac{We(Xe - Xf1)}{(Xp1 + Xf1)} + \frac{Wb(Xb - Xf1)}{(Xp1 + Xf1)} - \frac{Pr(Xp2 + Xf1)}{(Xp1 + Xf1)}$ (fwd CofG limits)

(b) Wd - We - Wb - Pr (All-up weight considerations).

(c) Cockpit Limitations (see sailplane Flight Manual).

(d) Wn - Wn1 - Wb - Pr (Weight of non-lifting parts - if applicable).

(3) Maximum total cockpit load – wet:

Total weight of pilot(s) plus water must not exceed:

Ww - We - Wb

9. **Recording.** A full record of the weighing is to be entered on an Annex A or Annex B proforma as appropriate and retained with the sailplane Log Book. Details of equipment fitted and the main results of the weighing record are to be entered in the Log Book, together with the date of the next scheduled weighing.

PLACARDS

10. Placards specifying maximum and minimum permissible cockpit loads are to be prepared in the format detailed at Annex C and firmly fixed on the RH side of the cockpit readily visible to the pilot(s). The placards are to be covered and attached to the cockpit wall using clear fablon. The placarded cockpit loads must be reasonable and realistic. If maximum cockpit loads are less that 90 kg (198 lb) then consideration should be given to reducing equipment weight (eg by fitting smaller lighter batteries or removal of oxygen equipment).

REMOVABLE BALLAST

11. Removable ballast weights clamped to the airframe introduce tremendous scope for error in club sailplanes. If they are used ensure that the placards show the maximum and minimum cockpit loads, with and without the ballast. Lead shot filled cushions must be fitted with loops or straps to secure them to the pilot or his seat straps and must be clearly marked with their weight. Where there is provision for water ballast, the placard must show the maximum weight of the combined cockpit load and water ballast.

Annexes:

A. Weighing Record - Single Seaters and Side-by-Side Two Seaters.
B. Weighing Record - Tandem Two Seaters.
C. Cockpit Placards.

ANNEX A TO
BGA AMP
LEAFLET 4-1

WEIGHING RECORD - SINGLE SEATERS AND SIDE-BY-SIDE TWO SEATERS

Glider Type: BGA Cof No: Serial No:

LEADING PARTICULARS EXTRACT

Datum Point :
Levelling Means :

Fwd CofG Limit (Xfl) :	mm aft.	Max All Up Weight (Dry) (Wd) :	Kg
Aft CofG Limit (Xal) :	mm aft.	Max All Up Weight (Wet) (Ww) :	Kg
Pilot(s) CofG (Xpl) :	mm fwd.	Max Weight Non-Lift Parts (Wn) :	Kg
Baggage CofG (Xb) :	mm aft.	Max Baggage Weight (Wb) :	Kg

EMPTY WEIGHT AND CofG POSITION

Weight on Front Support (Wf) = kg
Weight on Rear Support (Wr) = kg
Weight of Port Wing (Wp) = kg
Weight of Starboard Wing (Ws) = kg

Empty Glider Weight (We) = Wf + Wr = kg
Weight Non-Lifting Parts (Wnl) = We - Wp - Ws = kg

Displacement of Front Support (Xfs) = mm fwd (-ve if aft of datum)
Displacement of Rear Support (Xrs) = mm aft

Empty Glider CofG Displacement $(Xe) = \frac{(Wf \times Xfs) - (Wr \times Xrs)}{We}$

=

= mm aft

MINIMUM AND MAXIMUM COCKPIT LOADS

Minimum Cockpit Load

CofG Based $\frac{We(Xe - Xa1)}{(Xp1 + Xa1)} + \frac{Wb(Xb - Xa1)}{(Xp1 + Xa1)}$

= = kg (lb).

Maximum Cockpit Load

a. CofG Based: $\frac{We(Xe - Xf1)}{(Xp1 + Xf1)} + \frac{Wb(Xb - Xf1)}{(Xp1 + Xf1)}$

=

= kg

b. Max AUW Based: Wd - We - Wb

=

= kg

c. Max Non-Lift Based: Wn - Whl - Wb

=

= kg

d. Flight Manual Limitation:

= kg

The Max (Dry) Cockpit Weight is the LEAST value of a. to d:

= kg (lb)

Maximum Total Loading - Wet

Total weight of pilot(s) plus water must not exceed:

Ww - We - Wb = kg

NOTES:

Date: Name: Signature: BGA Insp Auth:

ANNEX B TO
BGA AMP
LEAFLET 4-1

WEIGHING RECORD - TANDEM TWO SEATERS

Glider Type: BGA CofA No: Serial No:

LEADING PARTICULARS EXTRACT

Datum Point :
Levelling Means :

Fwd CofG Limit (Xfl) : mm aft. Max All Up Weight (Dry) (Wd) : Kg
Aft CofG Limit (Xal) : mm aft. Max All Up Weight (Wet) (Ww) : Kg
Front Pilot CofG (Xpl) : mm fwd. Max Weight Non-Lift Parts (Wn) : Kg
Rear Pilot CofG (Xp2) : mm fwd. Max Baggage Weight (Wb) : Kg
Baggage CofG (Xb) : mm aft.

EMPTY WEIGHT AND C OF G POSITION

Weight on Front Support (Wf) = kg
Weight on Rear Support (Wr) = kg
Weight of Port Wing (Wp) = kg
Weight of Starboard Wing (Ws) = kg

Empty Glider Weight (We) = Wf + Wr = kg
Weight Non-Lifting Parts (Wnl) = We - Wp - Ws = kg

Displacement of Front Support (Xfs) = mm fwd (-ve if aft of datum)
Displacement of Rear Support (Xrs) = mm aft

Empty Glider CofG Displacement (Xe) = $\frac{(Wf \times Xfs) - (Wr \times Xrs)}{We}$

=

= mm aft

MINIMUM AND MAXIMUM COCKPIT LOADS

Minimum Front Cockpit Load

CofG Based: $\frac{We(Xe - Xa1)}{(Xp1 + Xa1)} + \frac{Wb(Xb - Xa1)}{(Xp1 + Xa1)} - \frac{Pr(Xp2 + Xa1)}{(Xp1 + Xa1)}$

= kg (lb)

a. With rear cockpit empty = kg

b. With max rear cockpit load of ……. kg = kg

The placard figure is the GREATEST value of a. or b.

Maximum Front Cockpit Load (Dry)

a. CofG Based: $\frac{We(Xe - Xf1)}{(Xp1 + Xf1)} + \frac{Wb(Xb - Xf1)}{(Xp1 + Xf1)} - \frac{Pr(Xp2 + Xf1)}{(Xp1 + Xf1)}$

= kg

b. Max AUW Based: Wd - We - Wb - Pr

= kg

c. Max Non-Lift Based: Wn - Whl - Wb - Pr

= kg

d. Flight Manual Limitation: Front Cockpit = kg

Rear Cockpit = kg

The Max (Dry) Front Cockpit Weight is the LEAST value of a. to d.

= kg

Maximum Total Loading - Wet

Total weight of pilot(s) plus water must not exceed:

Ww - We – Wb = kg

Loading Table

Rear Cockpit kg (lb)	**Front Cockpit Max (Dry) kg (lb)**	**Max Total Load (Wet) kg (lb)**
60 (132)		
70 (154)		
80 (176)		
90 (198)		
100 (220)		
110 (242)		

Pilot(s) plus water not to exceed

…… kg

NOTES:

Date: Name: Signature: BGA Insp Auth:

BGA Glider Limitations Placard

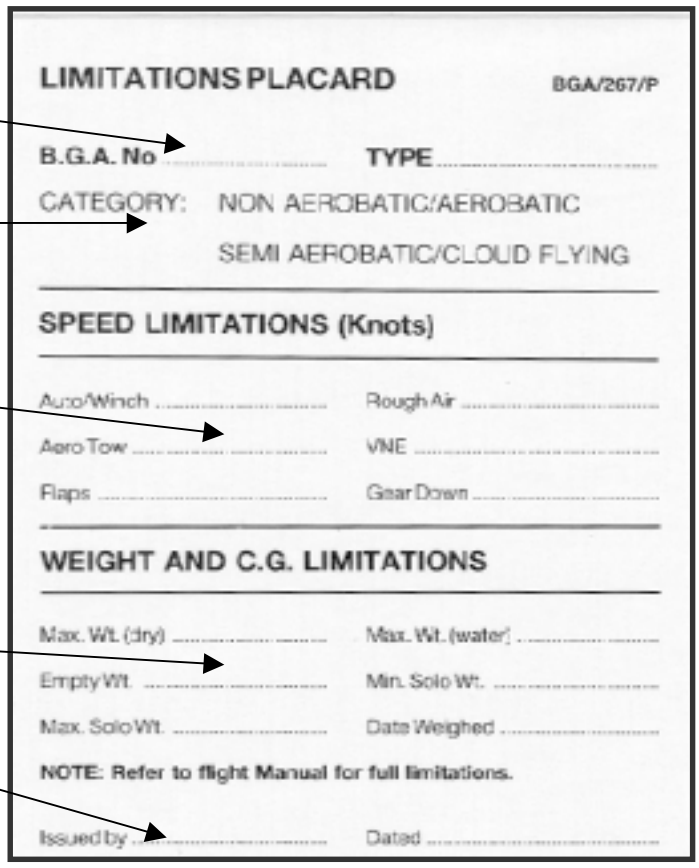
Glider Details

Delete category as applicable

Limitations from Flight Manual, C of A of BGA Data Sheet

Details from weighing report

Signed by BGA inspector and dated



LIMITATIONS PLACARD BGA/267/P

B.G.A. No ..... **TYPE** .....

CATEGORY: NON AEROBATIC/AEROBATIC

SEMI AEROBATIC/CLOUD FLYING

SPEED LIMITATIONS (Knots)

Auto/Winch ..... Rough Air .....

Aero Tow ..... VNE .....

Flaps ..... Gear Down .....

WEIGHT AND C.G. LIMITATIONS

Max. Wt. (dry) ..... Max. Wt. (water) .....

Empty Wt. ..... Min. Solo Wt. .....

Max. Solo Wt. ..... Date Weighed .....

NOTE: Refer to flight Manual for full limitations.

Issued by ..... Dated .....

Note:
The limitations placard may be produced to suit individual gliders with more comprehensive information. The placard must contain the above information as a minimum.