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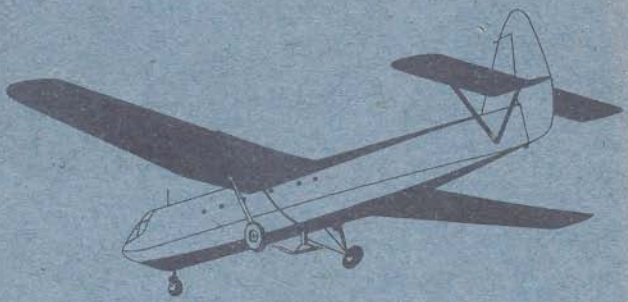
PILOT'S NOTES

FOR

HORSA I GLIDER

WITH APPENDICES FOR TUG AIRCRAFT PILOTS



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NOTES TO USERS

This publication is divided into three parts: Descriptive, Handling, and Notes for tug aircraft pilots (with appendices for individual tug aircraft). Part I gives only a brief description of the controls with which the pilot should be acquainted.

These Notes are complementary to A.P.2095 Pilot's Notes General and assume a thorough knowledge of its contents. All pilots should be in possession of a copy of A.P.2095 (see A.M.O. A93/45).

Words in capital letters indicate the actual markings on the controls concerned.

Amendments to this publication will be issued as necessary and incorporation must be certified on the Certificate on the inside of the back cover.

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Comments and suggestions should be forwarded through the usual channels to the Air Ministry (D.T.F.)

LEADING PARTICULARS

Type	High wing cantilever monoplane glider
Duty	Troop and military equipment carrier

PRINCIPLE DIMENSIONS

Span	88 ft. 0 in.
Length overall, rigging position	66 ft. 11.85 in.
Height overall on wheel undercarriage (to top of rudder)	19 ft. 6 in.
Height overall on skin undercarriage (to top of rudder)	18 ft. 7 in.
Height over pressure head mast, tail on ground	15 ft. 7 in.
Height to wing tips	11 ft. 0 in.
Fuselage diameter	7 ft. 6.25 in.

MAIN PLANE DATA

Aerofoil section	N.A.C.A. 44 series 3.1% reflex
Chord, centre plane at joint to outer plane	15 ft. 7.8 in.
Chord, at tip datum rib	7 ft. 5.76 in.
Incidence at centre plane joints	3.7°
Incidence at wing tip joints	-0.15°
Dihedral	See rigging diagram, Sect.4, Chap.3, fig.1
Area, total	1,104 sq.ft.
Ailerons (two, total) including tabs	118 sq.ft.
Tabs	14.46 sq.ft.
Flaps (four, total)	115.6 sq.ft.
Dive brakes, area	

TAIL PLANE AND ELEVATOR DATA

Span	32 ft.
Chord (including elevators)	6 ft. 7 in.
Incidence	$3\frac{1}{2}$°
Chord, tail plane only	3 ft. 9.75 in.
Chord, elevators	3 ft. 9 in.
Area, total	202.2 sq.ft.
Elevators (two) including tabs	107.2 sq.ft.
Tabs, balance (two)	12.39 sq.ft.
Tabs, trimming, (one)	4.13 sq.ft.

FIN AND RUDDER DATA

Fin area	32.3 sq.ft.
Rudder (including tab)	58.8 sq.ft.
Tab	5.11 sq.ft.

CONTROL SURFACES: SETTINGS AND RANGE OF MOVEMENTS

Ailerons	Neutral	0°
	Up	30°
	Down	20°
Flaps	Down	40° and 80°
Elevators	Up	20°
	Down	13½°
Trimming tab (starboard inner only) -		
Neutral (from centre-line of elevator).	Down	2½°
Balance action (from neutral)	Each way	5°
Trimming movement (from neutral)	Each way	8½°
Balance tabs (port and starboard)	Neutral	0°
	Each way	10°
Rudder	Each way	20°
Balance tab	Each way	15·9°

UNDERCARRIAGE

Type	Nose wheel with main wheels or skid
Main wheels -	
Track (tare weight)	15 ft.
Shock struts	Rubber in compression
Wheel type	Dunlop A.H.2154
Tyre	Dunlop 12·25 in.
Tyre pressure	40 lb./sq.in.
Brakes	Pneumatic, Dunlop
Brake pressure	80 lb./sq.in.
Nose wheel -	
Shock strut	Rubber in compression
Wheel type	A.H.8203
Tyre	Dunlop 9·75 in.
Tyre pressure	40 lb./sq.in.
Skid	Metal-faced wooden member on rubber-block shock strut

TOWING GEAR

Type	Bifurcated
Hook type	2 Malcolm No.6A
Position	Underside of centre main plane

INTRODUCTION

1. The Horsa I glider is a wooden cantilever high-winged monoplane equipped for the transport of troops, military equipment and light vehicles. The major components are constructed in separate sub-sections. The main undercarriage wheels can be jettisoned, alighting then being effected on a castoring nose wheel and a central skid.

2. The fuselage is constructed in three portions, i.e. nose, centre and rear, each being a semi-monocoque structure consisting of spruce and fir longerons, spruce and plywood bulkheads and formers, and birch plywood covering. The cockpit windscreen, which forms part of the sides of the nose fuselage, is panelled with sheets of transparent material. Equipment is loaded into the glider through a large door in the port side of the centre fuselage just aft of the windscreen, pivoting at the bottom and forming a loading ramp in its downward position. Access to the cabin for personnel is obtained through a sliding door in this pivoting door, and a sliding door in the starboard side of the centre fuselage just aft of the trailing edge. Access to the pilots' cockpit is obtained from the central cabin through folding doors. Twelve circular windows are situated in the sides of the centre fuselage and there is one window in each sliding door. These windows, all of which may be jettisoned, are constructed of transparent material.

3. The main plane is in three sections, a centre plane and port and starboard outer planes. The centre plane is sub-divided into a nose portion, two rear portions and a central fairing structure attached to the centre fuselage. Each outer plane is in two portions, a main portion and a smaller portion housing the outer flaps. Each aileron is in two portions. The whole plane forms a single-spar structure with plywood nose, and fabric covering behind the spar. The centre plane main spar and nose spar, are housed in recesses in the centre fuselage. The main spar carries the tow release mechanism, the main undercarriage jettison mechanism and the top attachment bracket for the main undercarriage shock strut.

4. The fin structure is built up on two spars and is ply covered, the spars being bolted to the rear bulkheads of the rear fuselage. The fin carries attachment brackets for the tail plane, which is in two sections, one on each side of the fin structure; each side of the tail plane is braced to the rear fuselage by a strut. The tail plane, elevator, rudder and trimming tabs are of similar construction to the main planes.

5. The main undercarriage comprises two separate triangulated tubular structures pivoting on brackets attached to the centre fuselage, shocks being absorbed by rubber blocks carried by a shock strut interposed between the tube structure and the bracket on the centre plane. When the units are jettisoned the shock strut joints are broken pneumatically at the top and bottom and the wheel-carrying structure disengages at the inner pivoting joints. A castoring nose wheel with rubber block shock absorber is fitted. The main skid is a metal-faced wooden member with a rubber block shock-absorber mounting. A tail skid and tail prop are also fitted.

6. The main flying controls are operated by a control column and handwheel, and a foot-operated rudder bar. Side-by-side dual control is fitted. Fore-and-aft trim is provided by a pilot-controlled tab in the trailing edge of the starboard elevator and balance tabs are fitted to the rudder and elevators. The trailing edge flaps are in four sections, two beneath the centre plane rear portions and two beneath the detachable portions of the outer planes. The flaps are pneumatically operated by two jacks housed in the outer planes. Mechanically-operated dive brakes are housed in slots behind the root ends of the outer plane main spar.

7. The controls for the main undercarriage jettison, the tow release gear and the dive brakes, are operated by levers carried by a control pedestal in the cockpit.

8. Pneumatic services are also provided for the main wheel brakes and the main undercarriage jettison gear.

9. A 12-volt 40 Ah. accumulator provides power for the lighting services. Eight jettisonable equipment containers are housed in bays in the centre plane rear portions, and one parachute flare is carried. Hatches are provided for the operation of Bren guns in the top of the centre fuselage and in the floor of the rear fuselage. T.R.9D radio equipment is installed.

HORSA I GLIDER

PART I
CONTROLS & EQUIPMENT FOR PILOTS

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HANDLING & FLYING NOTES FOR PILOTS

PART III

GENERAL NOTES FOR TUG AIRCRAFT PILOTS
With Appendices for Tug Aircraft

PART I

CONTROLS AND EQUIPMENT FOR PILOTS

INTRODUCTORY

1. The Horsa I is a high-wing, monoplane glider designed for transporting 25 troops with their equipment, or military equipment and light vehicles.

The main wheels of the tricycle undercarriage are jettisonable, and a landing skid protects the fuselage when making belly landings. Benches are fitted in the main cabin for the troops, and eight military equipment containers (with parachutes) are slung in cells, four on each side, under the wing. The pilot's cockpit in the nose seats two pilots side by side. Section 1 describes the pilot's controls and equipment, and other equipment with which the pilot should be familiar. Items of equipment shown in figs.1 to 3 are numbered and these numbers appear in brackets in the text.

PNEUMATIC SYSTEM

2. Compressed air. Three bottles, two outboard of the starboard pilot's seat, and one on the floor across the nose, supply compressed air for operating the flaps, wheel brakes, and undercarriage jettison release. A pressure gauge (12) is fitted. When fully charged there is enough air for three complete cycles of flap operation and for subsequent normal braking on landing.

GLIDER CONTROLS

3. Primary controls are conventional and are normally interconnected by a locking pin (6) connecting two lugs (5) which projects through the front face of the well between the pilots' seats on the starboard side. To disconnect the starboard control column the locking wire should be pulled out and the pin withdrawn to the left by means of the plated tommy forming the head of the pin. The starboard handwheel can be removed by unscrewing the wing nut (18) securing it to its hub.

4. Rudder control bars (7) have toe straps and are adjustable for reach, on the ground, to any of five positions; they are permanently interconnected.

5. Elevator tab control.- The hand-wheel (23), mounted on the left of the control pedestal, operates in the natural sense.

6. Elevator tab indicator.- There is a mark on the cable drum which should be set opposite the arrow on the control pedestal for take-off.

Note: As the wheel can be rotated through approximately one full turn forward and backward from the neutral position, the take-off position should be checked by rotating the wheel back and forth about half a turn to ensure that when the mark is opposite the arrow the control is in the correct setting.

7. Flaps control.- The flaps are controlled by a lever (22) working in a quadrant forming the rear face of the control pedestal. The quadrant is marked UP, 40°, and FULL DOWN and the lever should be set to these positions only. Intermediate flap settings cannot be obtained. A spring in the quadrant enables the 40° position to be selected by feel; slight pressure is required to move the lever in either direction from this setting.

8. Air brakes.- The control levers (9) extend upwards, one at each side of the control pedestal; they are interconnected and are pulled back and down to apply the brakes; spring catches with release trigger grips are fitted to retain the levers in any desired setting. - AIR BRAKES ARE INOPERATIVE ON EARLY, AND NOT FITTED ON LATER, GLIDERS.

9. Wheel brakes control.- A lever (2) with spring catch and release trigger grip, fitted on the port pilot's seat frame on his right, is pulled up to apply the brakes. ON LATER GLIDERS THE RUDDER BARS GIVE DIFFERENTIAL BRAKE CONTROL.

10. Undercarriage jettison release control.- A lever (21) with a red knob shaped to represent a wheel is fitted to starboard of the flap lever. It is retained in the LOCKED position by means of a spring locking pin; to release, the pin is withdrawn and the lever pushed down.

11. Undercarriage emergency jettison control.- Should the pilot's control fail to act there is a mechanical control on the aft face of No.5 bulkhead to starboard, with operating lever stowed alongside, for operation by the second pilot or by one of the troops.

12. Tow release control.- The tow release hooks in the leading edges of the wing centre-section are operated by a red lever (20) extending from the top of the control pedestal. The forward position is marked LOCKED and the rear position RELEASE.

12a. Arrester parachute controls.- When installed the controls consist of a tumbler switch which is set ON to stream the parachutes, and a push-button switch for releasing them if necessary. These switches are on a panel on the port side of the cockpit and are so wired that the push-button switch is operative only when the streaming switch is ON.

13. Instruments.- The following are mounted on a panel above the control pedestal:- ASI (11), artificial horizon (15), rate of climb and descent indicator (16), altimeter (8) and a turn and bank indicator (17). Above this panel is a narrower board carrying the air pressure gauge (12), a flying limitations plate (13) and an adjustable panel light (14), for which a dimmer switch (32) is on the switch panel to the left of the port pilot's seat.

14. Compass.- A compass (19) is mounted on a bracket extending from the starboard side of the control pedestal and a compass deviation card holder (10) is attached to the windscreen frame in line with the port pilot's wheel.

15. Mark II Tow cable angle indicator.-

(i) This indicator is similar to the Mark I - HOTSPUR - type having a horizontal bar (referred to in the Instrument Manual as the horizontal pointer) which moves up and down as the position of the glider, relative to the tug, rises and falls. On the Mk.II the vertical pointer, which pivots about its lower end, is connected to a gyro controlled artificial horizon unit as well as to the cable angle mechanism. It indicates true angle of bank, or cable horizontal angle variation, or a combination of both, and indicates zero whenever the correct amount of bank is being applied.

(ii) In free flight, or on tow in the "high" tow position the cable angle measuring mechanism is out of action and the horizontal bar disappears from view at the top of the instrument. The vertical pointer continues to function, however, but being controlled by the artificial horizon mechanism only may be used in free flight to indicate angle of bank. For angles of bank in excess of 30° the response of the pointer decreases progressively, thus, at 90° bank, the pointer indicates 45° only.

(iii) The zero setting of the pointer is adjustable by means of the wing nut adjuster below the instrument which is turned in the opposite direction to that in which it is desired to rotate the pointer. The pointer can only be zeroed when flying in the "low" tow position with the cable angle mechanism working.

DOORS, SEATS AND COCKPIT EQUIPMENT

16. Pilot's entrance.- There is a door on the port side aft of the cockpit with an access ladder which, is stowed in the main cabin; the door slides upwards and is secured by two latch fastenings which can be operated from inside or outside the glider. This door forms part of a larger door which opens outward about a hinge at its lower edge to form a ramp for the entry of light vehicles etc. From the main cabin the cockpit is reached through a central door in the bulkhead forming the front wall of the cabin.

17. Troops' entrances.- The troops use the door on the port side as well as a similar door on the starboard side aft of the wing.

18. Seats.- The pilots' seats are fixed and are provided with safety lap belts (33).

19. Hood.- The plastic hood affords a wide range of vision and there are two clear vision panels (3) one on each side of the windscreen; these spring up to open and catches are provided to retain them in this position.

20. Map case.- A container (31) for maps, signal index cards etc. is attached to the front of the port pilot's seat frame.

21. Loading charts.- These are stowed in the main cabin about four feet aft of the cockpit bulkhead on the starboard side. On a board above this stowage are painted the tare weight, tare moment and the loading index number of the glider. Full instructions for use is given on the charts.

22. Thermos flasks.- A flask for the pilots is stowed at (24) on the shelf behind and outboard of the port pilot's head. Flask and ration containers for the troops are stowed below the seat benches.

23. Sanitary equipment.- A sanitary bottle for the pilots is stowed in clips on the forward face of the bulkhead outboard of the port pilot's seat back. There is also a sanitary tube for the use of the troops in the main cabin.

OPERATIONAL EQUIPMENT

24. Gun hatches.- There is a hatch in the roof of the main cabin, normally covered by a fabric panel with spring catches, as well as an underbody gun hatch in the tail; these are for use by machine gunners in the event of attack.

25. Equipment container release control.- The equipment containers are released by pull handles on the fuselage sides, at shoulder height, about two feet forward of the rear door line. each handle releases the group of four containers on the same side.

26. Landing flare release control.- There is a flare chute underneath the port pilot's seat. The handle (1) which is pulled up to release the flare, is on the right of the port pilot's seat.

LIGHTING, RADIO & SIGNALLING EQUIPMENT

27. Radio.- There is a T.R.9D set installed with a remote control unit (4) for the pilots mounted on the left of starboard pilot's seat. The head-set jack socket for the port pilot is secured to the seat frame outboard of the seat.

28. Intercommunication.- The T.R.9D set provides intercommunication between the glider and tug pilots.

29. Lights.- There is a fuse box (30) on the switch panel on the port fuselage side by the pilot's seat. This panel carries a morsing key unit (28) with switches for downward identification lights, a two-way switch (27) for navigation lights, two-way switch (29) for the cabin lights and a dimmer switch (32) for the instrument panel light. To enable the cabin lights to be used at night blackout curtains for the cabin windows are stowed in a container on the port forward face of the after bulkhead in the main cabin.

30. Torches.- Four electric torches are stowed in clips in the roof of the main cabin.

31. Signal pistol.- For use this fits into a discharge tube projecting from the floor outboard of the port pilot's seat. Stowage for cartridges (25) is provided on the fuselage side level with the port pilot's shoulder.

EMERGENCY EXITS & EQUIPMENT

32. Parachute exits.- The pilots should use the sliding door in the port side. The troops use this door as well as the door in the starboard side. The two gun hatches can also be used as parachute or crash exits should the main doors jam. To remove the main cabin gun hatch cover, pull string handles, unfasten spring catches and pull beams in.

33. First-aid kit.- This is stowed on the forward face of the rear bulkhead on the starboard side below the transverse seat.

Key to Fig.1

DGL. AL.4.

1. Flare release control
2. Wheel brake lever
3. Clear vision panels
4. T.R.9D controls
5. Lugs connecting port & starboard control column
6. Locking pin for (5)

ADDENDUM TO COVER HORSA II

1. Introductory

The Horsa II is, in general, similar to the Horsa I, the major differences being that the nose section is made to open to enable cargo to be loaded through the front of the aircraft, and a single-point tow cable hook is fitted instead of the wing hooks for bridle towing. Certain other differences and additional equipment are embodied and the following notes give details of these.

2. Nose door and cargo loading

(i) The nose section of the aircraft opens sideways about hinges on the starboard side and is locked in the closed position by locking pins controlled by the upper of two levers fitted on the port side of the forward bulkhead in the main cabin. The lower of the two levers controls a safety latch device to prevent inadvertent operation of the main lever; a further safety precaution consists of a strap which is used to secure the lower safety lever in the down (safe) position.

(ii) To open the nose the strap securing the lower lever is removed, the lever is set to the up position and the upper lever then set to the up position to withdraw the locking pins. The nose is then forced gently open until the self locking folding strut at the top secures it in the open position. To steady the door in the open position in windy conditions, a line is fitted through the handle on the port lower side and this should be held by three men.

(iii) To close the nose section the locking sleeve of the folding strut should be drawn back until it is engaged by the spring "Umbrella" type retaining catch. The procedure is then the reverse of that given in sub.para.(ii). After the nose section is closed, the upper, and then the lower, lever should be set to the down position and the latter secured with the safety strap.

(iv) Folding channels forming a loading ramp are provided to enable vehicles to be driven into the main cabin. For full details see AP.2097B Vol.1.

3. Control pedestal

A new type of Control Pedestal is fitted; the two air brake levers (9), as fitted on the Horsa I being omitted as no air brakes are fitted on the Horsa II. The compass (19) is mounted centrally above the pedestal instead of to one side.

4. Wheel brakes

The lever (2) is not fitted, the brakes being applied by either of two levers on the control hand wheels. A catch on the port lever enables the brakes to be locked on for parking.

5. Mark III tow cable angle indicator

This improved form of indicator is fitted. It is similar in operation to the Mark II. A switch to the left of the dial must be set to ON TOW before flight to effect connection of the indicator to the cable mechanism. The vertical needle does not need to be zeroed as with the Mark II, and no adjuster is fitted. In free flight the switch should be turned OFF to disconnect the instrument. The horizontal bar then becomes inoperative, but does not disappear from sight; the vertical needle continues to function as with the Mark II, see paragraph 15.

6. Landing lamps

A lever for retracting and lowering the lamp is fitted at the top right-hand side of the control pedestal; it is set forward - NORMAL to lower, and back - ELEVATE to raise the lamp.

7. Signal pistol

This is fitted inboard of the starboard pilot's seat instead of on the port side as in the Mark I.

8. Ventilators

Two are fitted, one on each side of the cockpit floor outboard of the seats; they can be adjusted as required.

9. De-icing

De-icing for the pressure head and venturi is incorporated. Details of the controls will be issued by amendment.

Key to Fig.1

1. Flare release control
2. Wheel brake lever
3. Clear vision panels
4. T.R.9D controls
5. Lugs connecting port & starboard control column.
6. Locking pin for (5)

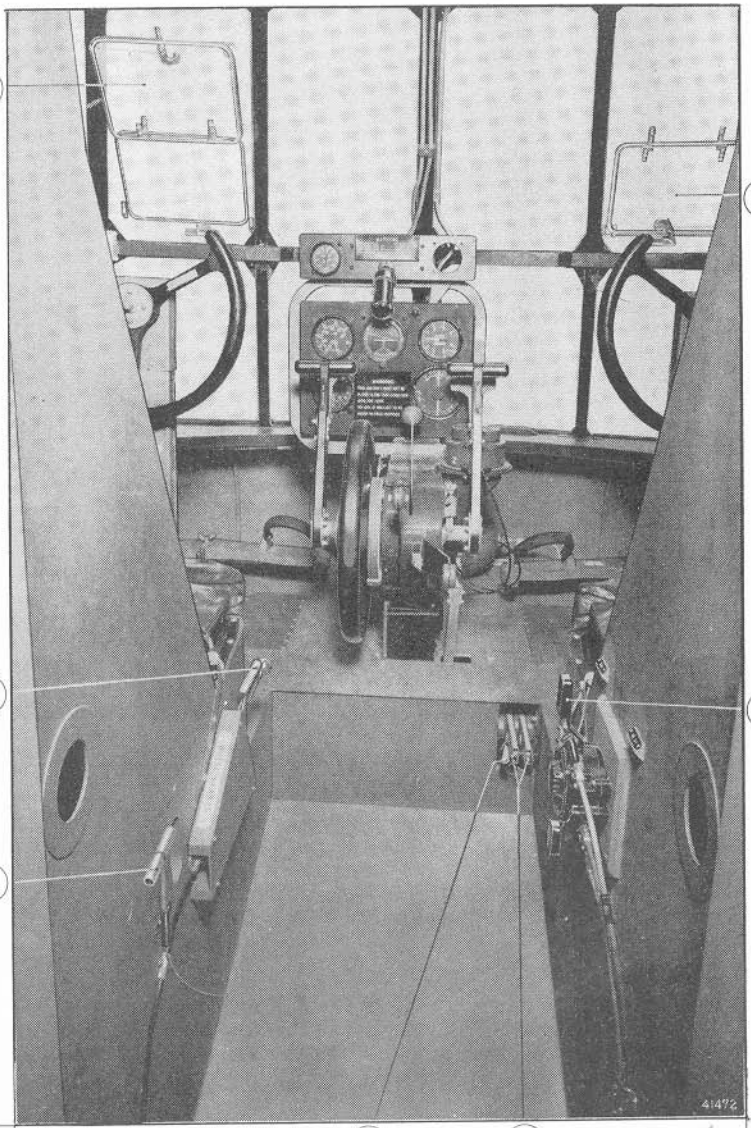

FIG. 1 — COCKPIT - GENERAL VIEW — FIG. 1

Key to Fig. 2

7. Port rudder bar
8. Altimeter
9. Air brake control levers
10. Compass deviation card
11. A.S.I.
12. Air pressure gauge
13. Flying limitations plate
14. Instrument panel light
15. Artificial horizon
16. Rate of climb and descent indicator
17. Turn and bank indicator
18. Wing nut securing starboard control wheel
19. Compass
20. Tow release control lever
21. Undercarriage jettison control lever
22. Flaps control lever
23. Elevator tab control

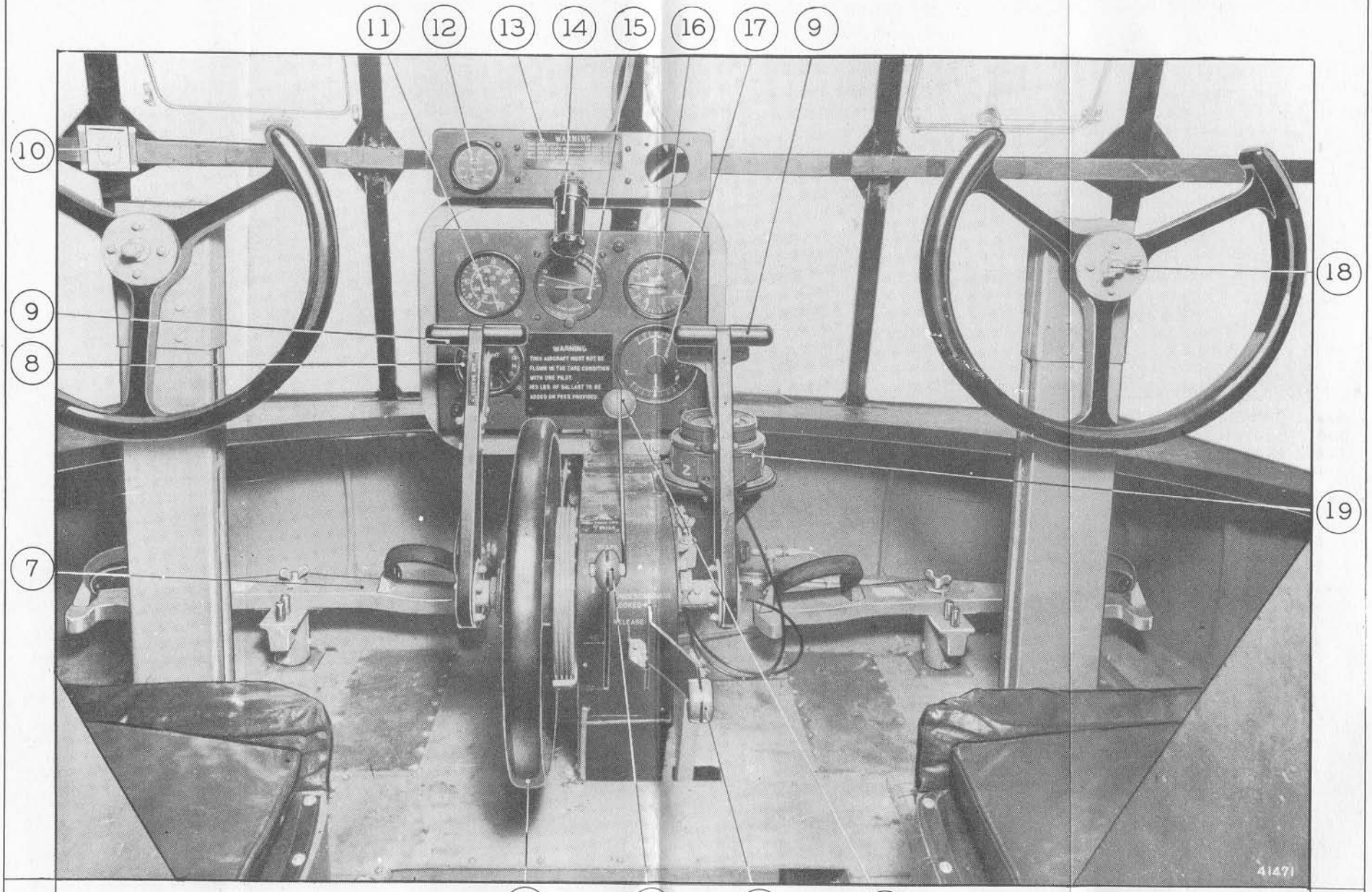

FIG. 2

INSTRUMENT PANEL AND CONTROLS

FIG. 2

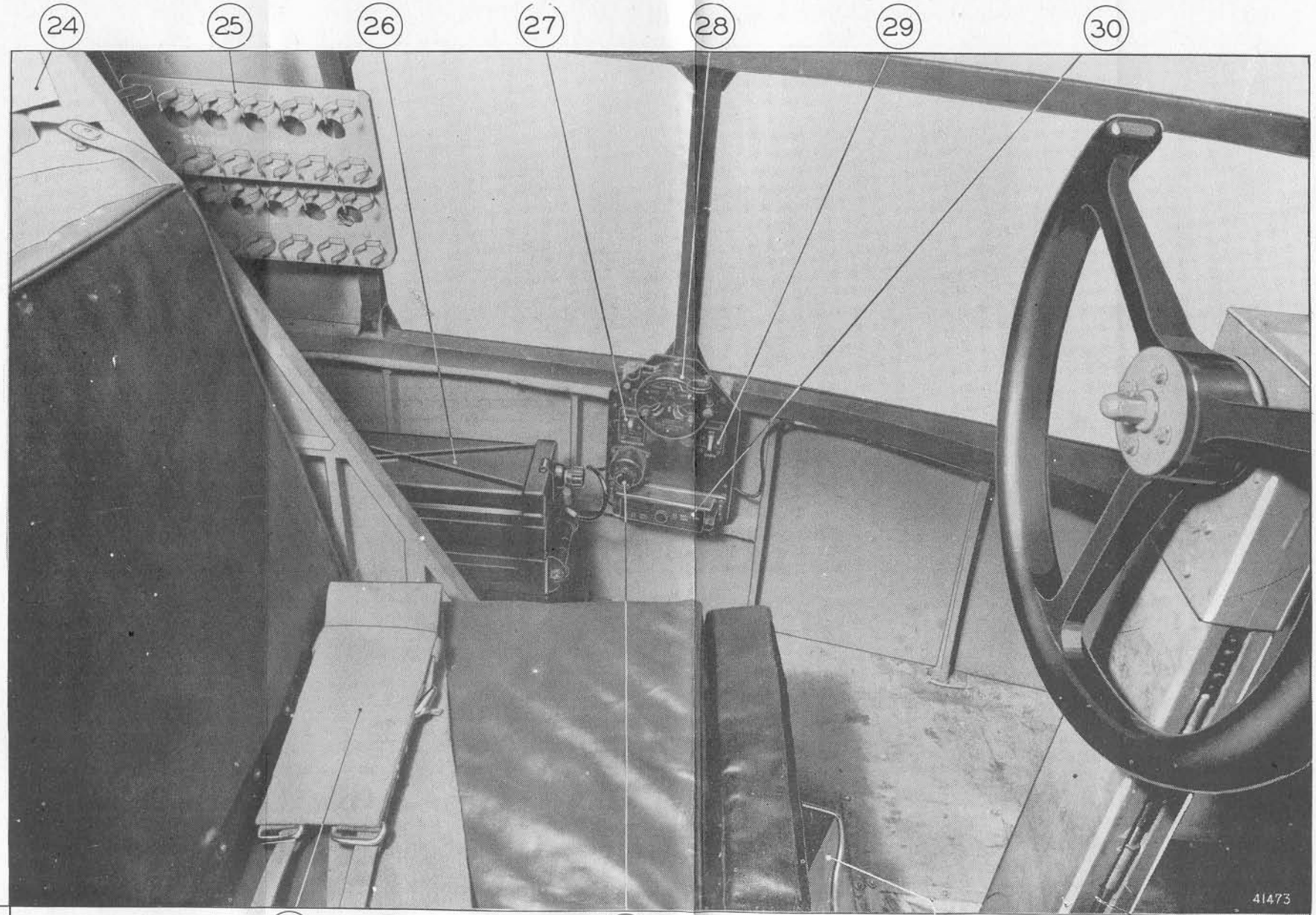

FIG. 3

COCKPIT - PORT SIDE

FIG. 3

Key to Fig.3.

24. Thermos flask stowage
25. Signal cartridge stowage
26. Battery box
27. Navigation light switch
28. Morsing key & identification light switches
29. Cabin light switch
30. Fuse box
31. Map case
32. Instrument panel light switch
33. Safety belt

SECTION 2

HANDLING AND FLYING NOTES FOR PILOT

1. INTRODUCTION

(i) These notes are for the guidance of pilots flying Horsa glider combinations. Tug aircraft pilots should also refer to the appropriate appendix hereto covering the tug aircraft used.

(ii) The method of signalling (intercom or visual) to be used between the glider and tug pilots, both on the ground and in the air, should be in accordance with the instructions laid down by the Command concerned.

Note: It is of vital importance that glider and tug pilots shall agree and understand the code of signals to be used.

(iii) The direction in which glider and tug should turn after casting off should be in accordance with procedure laid down by the Command concerned and should be agreed between the pilots.

2. FLYING LIMITATIONS

Maximum permissible speeds in m.p.h. I.A.S.

Towing	160 - (150 R.A.S.)
Diving	190
Flaps half down	110
Flaps fully down	100

Note (i) The corresponding I.A.S. limitation to be observed by any tug aircraft should be calculated by applying to the R.A.S. figure given in brackets the appropriate tug position error correction reversed. (i.e. where this is plus subtract).

(ii) The above limitations as well as the recommended handling speeds given in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed from time to time.

3. FITNESS OF AIRCRAFT FOR FLIGHT

Ensure that the total weight and C.G. position are within the permitted limits. Heavy loads should in no case be carried without calculating the C.G. position. Rough guides to loading are:

(a) Two pilots, or a first pilot and ballast in the second pilot's place, should be carried.

Note: Gliders must not be flown light without a second pilot or ballast in lieu.

(b) Any load should be disposed evenly about a point one third of the chord length aft of the leading edge at the wing root.

4. PRELIMINARIES

Before entering the cockpit:

(i) See that all passengers are seated and strapped in, and the load secured.

(ii) See that the glider is directly behind the tug and on the same heading, and that the nose wheel is straight.

On entering the cockpit:

(iii) Test operation of the tow release and see that the tow release control is left in the fully forward position.

(iv) See that the undercarriage jettison lever is in the correct position.

Note: On certain gliders the undercarriage is not jettisonable.

(v) Check that all air bottles are turned on, and check pressure.-

(a) Minimum for training (providing the undercarriage is not to be jettisoned) 100 lb/sq.in.

(b) Minimum for operational use - 200 lb/sq.in.

(vi) If used, test inter-communication with tug. When line intercom is used the amplifier switch must be on at all times when on tow. A code of visual signals should, in any case, be agreed between the pilots for use in an emergency should the intercom fail.

(vii) Test all flying controls for full and free movement, and check that the wing nut on the starboard control wheel is secure.

(viii) See that the catches for retaining the clear vision panels in the open position operate properly.

5. PREPARATION FOR TAKE-OFF

(i) Check list before take-off

Flaps	- UP
Air pressure	- Minm. 100 lb. (200 lb for operational flights)
Trim	- Neutral (See Sect.1)
Altimeter	- Zero
Brakes	- Off.

(ii) When ready to take-off instruct pilot by intercom to.-

(a) Take up slack

(b) When cable tautens - take-off.

6. TAKE-OFF

(i) Keep directly behind the tug.

(ii) At an ample margin above stalling speed (see para.11) pull off gently and hold near the ground until tug takes off.

(iii) When the tug is clear of the ground, climb gently to a height which brings the tug end of the tow-rope approximately horizontal. Do not get higher than this.

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7. UNDERCARRIAGE JETTISON

The undercarriage should not be jettisoned until further information is available as to the safe height.

8. CLIMBING

The best towing position is just above the tug, in such a position that the tug end of the tow-rope is in a line with the tug flight path.

9. LEVEL FLIGHT

(i) The towing position may be just above or just below the slipstream.

(ii) Spoilers, when fitted, may be used for taking up slack.

(iii) On turns, keep directly behind (or slightly inside) the tug.

10. CASTING OFF

(i) This should be done in level flight with the glider level with or above the tug. Except in emergency, do not cast off from below the tug. Speed should be at least 90 m.p.h. I.A.S. and after casting off the tug will tum as prescribed.

(ii) If take-off is abandoned, either by the tug or by the glider pilot the rope should be released and the glider should then turn as prescribed.

11. STALLING

(i) Stalling speeds in m.p.h. I.A.S.

	Lightly loaded	Fully loaded
Flaps up	54	69
Flaps down	43	55

(ii) If the stall is approached quickly, or if the control column is held right back after a slow approach, one wing may drop gently.

12. GLIDING

(i) The following speeds in m.p.h. I.A.S., with undercarriage are recommended:

	Light	Heavy
Flaps up	70	85
Flaps half down	65	75

(ii) With flaps fully down the glide path is extremely steep. Flaps can be raised to the half down position without appreciable sink; it is not necessary to increase speed.

13. APPROACH AND LANDING

(i) Up to half flap may be used on the cross wind approach to regulate height.

(ii) Make the final turn towards the landing ground with half flap and when sure of getting into the landing ground, lower the flaps fully.

(iii) The glide path with flaps fully down is steep, and care is necessary, especially in strong winds, not to get too far downwind. Flaps may be raised to the half down position if undershooting. Flaps must not be raised fully at normal flaps down approach speeds, and even if speed is increased in order to raise them fully, this will not correct undershooting at this stage of the approach.

(iv) Recommended speeds for final straight approach, with flaps fully down are:

Light	60 m.p.h. I.A.S.
Heavy	75 to 80 m.p.h. I.A.S.

(v) Flatten out and land on the main wheels in a slightly tail down attitude, lower the aircraft gently onto the nose wheel and then apply brakes (not before all three wheels are on the ground). Note: the brake action is not differential.

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14. AFTER LANDING

(i) Raise flaps.

(ii) When being towed down-wind, controls should be held central, or if the glider is not occupied all control surfaces and the flaps must be locked.

(iii) Park facing into wind with controls and flaps locked.

15. POSITION ERROR CORRECTION

At all speeds the correction may be taken as 10 m.p.h. to be subtracted from A.S.I. reading.

EMERGENCIES

16. ABANDONING TOW BEFORE TUG IS AIRBORNE

The glider pilot should release tow, first if possible, should land (if airborne), apply his brakes and turn as prescribed.

17. ENGINE FAILURE ON TAKE-OFF AFTER TUG IS AIRBORNE

If warned in time the glider pilot should release tow first and land straight ahead. He may make partial turns to avoid the tug or other obstacles but in no circumstances should he attempt to turn back to the airfield. Unless there is ample room for a normal landing the undercarriage should (if possible) be jettisoned.

18. CLOUD FLYING

If cloud is entered the glider will release tow immediately.

APPENDIX I

Notes for WHITLEY V Tug aircraft Pilots when towing - HORSA GLIDERS.

INTRODUCTION

When towing a glider the general performance will not be as good as that of the Tug in normal free flight, this calls for care on the part of Pilot particularly during and after take-off, and on the initial climb. Care is also necessary to avoid overheating of the engines.

1. FLYING LIMITATIONS

The following speed limitation must be strictly observed:

	Readings in m.p.h.	
	On Tug A.S.I.	On Glider A.S.I.
Towing	142	160

Note: The above limitation as well as the recommended handling speeds given in these notes are subject to any temporary restrictions which may be in force at the time of issue, or which may be imposed from time to time. Where such restrictions apply to the glider and are given in terms of glider I.A.S. the corresponding tug I.A.S. must be calculated by applying the appropriate glider P.E.C. (this gives the R.A.S.) and then applying the appropriate tug P.E.C. reversed to obtain the corresponding tug I.A.S. limitations.

2. PREPARATION FOR FLIGHT

(i) See Towing yoke locks and unlocks correctly. Leave in locked position.

(ii) Test rope release gear.

(iii) See crew are at their correct stations.

(iv) Do NOT run up engines at this stage.

3. TAXYING

(i) Taxy out when glider is in position and ready for take-off.

(ii) Stop engines if the take-off is delayed (a starter battery should be at the take-off point).

(iii) When in position the rear gunner will unlock towing yoke and the ground crew will fit tow rope.

(iv) Test T.R.9 or line intercom with glider with engines running.

(v) Operate release control once and reconnect.

Do NOT delay any of this drill and do not take-off if the following temperatures are exceeded.-

Coolant	80°C
Oil temperature	85°C

These temperatures are recommended to ensure that temperature limitations will not be exceeded during subsequent climb. In cool weather take-off at somewhat higher temperatures is permissible if experience indicates that temperature limitations will not be exceeded on climb.

4. TAKE OFF

The engines should be cleared before take-off

Trimming tabs	- Neutral
Flaps	- Light up (5° if run is short) Full load - 5° to 10°.
Rudder	- 1½ to starboard
Boost cut-out	- Pulled

(i) The glider pilot will give the signal by intercom "Take up slack".

(ii) The tug pilot will release his brakes and move slowly forward until the glider pilot signals "Take-off". The tug pilot will know when he has taken up the slack in the tow rope by an increased resistance.

(iii) There must be no pause between taking up the slack and commencing the take-off. This is most important as any hesitation will cause a slack rope which the glider nose wheel may over run.

(iv) Open throttles. Required boost:-

+5½ Glider light
+6½ " half load
+8½ " full load

Up to +10 lb/sq.in. may be used in emergency.

(v) It is important to check swing promptly before it is communicated to the glider.

(vi) The tug should be held down to attain a speed 85-90 m.p.h. I.A.S. light and 95-100 m.p.h. I.A.S. heavy. Where this is impracticable climb at 90 m.p.h. I.A.S. until obstruction is cleared.

(vii) Raise wheels as soon as possible.

(viii) Reduce boost as soon as possible to prevent overheating.

(ix) Reduce engine r.p.m. to 2600.

5. CLIMB

(i) Recommended climbing speeds:-

90 m.p.h. I.A.S. Glider light
100/105 " " " heavy.

(ii) If engines heat up unduly reduce engine speed to 2400 r.p.m. +2 boost, and r.p.m. and boost may be increased again when temperatures have fallen.

6. LEVEL FLIGHT

(i) To ensure keeping well within engine temperature limitations the speed recommended is 105 to 112 m.p.h. I.A.S.

(ii) At 4,000 ft. the recommended speeds for maximum range are:

(a) With the glider at 16,250 lb. - 122 m.p.h.I.A.S.

(b) With the glider at 9,000 lb. - 125 m.p.h.I.A.S.

(iii) Fly in weak mixture at +4 lb/sq.in. boost adjusting r.p.m. (not exceeding 2,600) to give the recommended speed.

7. GENERAL FLYING

All turns should be gentle and should never exceed rate 3 except in emergency.

8. DESCENT ON TOW

Keep airspeed constant and within glider limitations. Recovery from the descent should be slow and the throttles should be opened slowly as the aircraft resumes level flight to maintain a steady speed.

9. BREAKING TOW

The casting off point having been reached, the glider pilot will advise the tug pilot before casting off and will then release. Normally these signals will be given over the intercom, but if this fails the pre-arranged emergency signals will be used.

10. DROPPING TOW ROPE

The tug pilot should take steps to avoid getting in the way of the glider and under training conditions will fly upwind at about 400 ft. and release the tow rope over the rope dropping area.
The tug pilot will instruct the rear gunner to lock the towing yoke in the fixed position.

EMERGENCIES

11. ABANDONING TOW BEFORE TUG IS AIRBORNE

Unless necessary, the tug pilot should not release until after the glider pilot. He will then throttle back and apply brakes, at the same time turning as prescribed to avoid the glider. The glider pilot releases tow and then applies his brakes and turns as prescribed.

12. ENGINE FAILURE ON TAKE-OFF AFTER BECOMING AIRBORNE

If possible the glider pilot should be warned so that he may release tow at his end first. The tug pilot will in any case release tow and will then take normal action disregarding the glider.
If the tug has to land the glider pilot will turn as necessary.

13. TAKE-OFF ABANDONED BY GLIDER

If the glider pilot decides to abandon the take-off and releases the tow, the tug pilot should also release afterwards.

14. CLOUD FLYING

If cloud is entered the glider will release immediately.

PART II

HANDLING AND FLYING NOTES FOR PILOTS

1. INTRODUCTION

(i) These notes are for the guidance of pilots flying Horsa glider combinations. Tug aircraft pilots should also refer to Part III and the appropriate appendix thereto covering the tug aircraft used.

(ii) The method of signalling (intercom or visual) to be used between the glider and tug pilots, both on the ground and in the air, should be agreed and the code of visual signals to be used in emergency (or if intercom is not to be used) should be in accordance with the instructions laid down by the Command concerned.

Note: It is of vital importance that glider and tug pilots shall agree and understand the code of signals to be used. The tug PILOT is CAPTAIN of the COMBINATION.

(iii) The directions in which glider and tug should turn after casting off should be in accordance with procedure laid down by the Command concerned and should be agreed by the pilots.

2. FLYING LIMITATIONS

(i) The maximum permissible weights are.-

HORSA I	-	15,500 lb.
HORSA II	-	15,750 lb.

Weight limitations applying to specific combinations are given in the appropriate tug aircraft appendices.

(ii) Maximum permissible speeds in m.p.h. I.A.S.

Towing	160 - (150 R.A.S.)
Diving	190
Flaps half down	110
Flaps fully down	100

Note (i) The above limitations as well as the recommended handling speeds given in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed from time to time by Special Instruction.

(ii) The Rectified Airspeed (R.A.S.) given in brackets is for the use of tug pilots in converting to tug I.A.S.

3. POSITION ERROR CORRECTION

At all speeds the correction may be taken as 10 m.p.h. to be subtracted from A.S.I. reading.

4. FITNESS OF AIRCRAFT FOR FLIGHT

Ensure that the total weight and C.G. position are within the permitted limits. Heavy loads should in no case be carried without calculating the C.G. position by means of the loading charts.

Rough guides to loading are:-

(a) Two pilots, or a first pilot and ballast in the second pilot's place, should be carried.

Note: Gliders must not be flown light without a second pilot or ballast in lieu.

(b) Any load should be disposed evenly about a point one third of the chord length aft of the leading edge at the wing root.

5. PRELIMINARIES

Before entering the cockpit:

(i) See that all passengers are seated and strapped in, and the load secured. Report the all-up weight to the tug pilot.

(ii) See that the glider is directly behind the tug and on the same heading, and that the nose wheel is straight.

(iia) If arrester parachutes are fitted, see that the door of the parachute box which replaces the afterbody gun hatch is secured by the locking pin and that the release unit is fully locked. Check that the parachute static line is tied to the top of the box.

WARNING On the Horsa II the pilot should check that the nose section locking levers are in the down (safe) position and that the lower lever is secured by the safety strap.

On entering the cockpit:

(iii) Test operation of the tow release and see that the tow release control is left in the fully forward position.

(iv) See that the undercarriage jettison lever is in the correct position.

Note: On certain gliders the undercarriage is not jettisonable.

(iva) If arrester parachutes are fitted, check ON-OFF switch - OFF.

(v) Check that all air bottles are turned on, and check pressure.-

(a) Minimum for training (providing the under-carriage is not to be jettisoned 150 lb/sq.in.

(b) Minimum for operational use - 200 lb/sq.in.

(vi) If used, test inter-communication with tug. When line intercom is used the amplifier switch must be on at all times when on tow. A code of visual signals should, in any case, be agreed between the pilots for use in an emergency should the intercom fail.

(vii) Test all flying controls for full and free movement, and check that the wing nut on the starboard control wheel is secure.

(viii) See that the catches for retaining the clear vision panels in the open position operate properly.

(ix) Check that all clamps have been removed and that the elevator clamps are stowed in the cockpit.

WARNING - Keep feet clear of the aileron cable pulleys at the base of the control column.

6. PREPARATION FOR TAKE-OFF

(i) Check list before take-off

Flaps	-	UP
Air pressure	-	Minm. 150 lb. (200 lb. for operational flights)
Trim	-	Neutral (See Part 1)
Altimeter	-	Zero
Brakes	-	Off

(ii) When ready to take-off instruct pilot by intercom to.-

(a) Take up slack.

(b) Take-off - when the glider starts moving.

7. TAKE-OFF

(i) Keep directly behind the tug.

(ii) At an ample margin above stalling speed (see para.14) pull off gently and hold near the ground until tug takes off.

(iii) When the tug is clear of the ground, climb gently to maintain a "high tow" position as defined in para.10.

(iv) If the Mk. II indicator is to be used, allowing three minutes after take-off for the gyro to erect, zero the pointer; this should be done with the tug flying straight and the glider central below the slip-stream (the instrument only functions in the low tow position).

NOTE: With the Mark III tow cable angle indicator the switch to the left of the instrument should be set to ON TOW and there is no necessity to zero the pointer.

8. UNDERCARRIAGE JETTISON

The undercarriage should not be jettisoned at less than 200 ft. as it may bounce and hit the tail. In training conditions the undercarriage should only be dropped, when authority has been given for doing this, by the parachute method and should not be released at less than 200 ft. or 115 mph IAS. Avoid jettisoning the undercarriage if the wind speed exceeds about 10 mph as it may be damaged if it lands with much drift; practice drops over runways or other hard surfaces should be avoided.

9. CLIMBING

Keep straight behind the tug and avoid getting too high above it lest trim difficulties are introduced for the tug.

10. BEST POSITION ON TOW

To obtain the maximum rate of climb and range it is of importance that, once steady climbing conditions have been reached and in level flight, the glider shall maintain the correct position in relation to the tug flight path. Recommended positions are as follows:-

(i) High Tow Position. Directly behind the tug and one half the wing span of the tug above it (with experience this position may be gauged by observing the relationship between the tug tailplane and mainplane) it is not sufficient to keep just clear of the slipstream.

(ii) Low Tow Position. Directly behind the tug and one half the wing span of the tug below it. This position is to be preferred, except during initial climb, for the following reasons:-

(a) The glider tends to maintain position more naturally than in the high tow position.

(b) The correct vertical position is such that the glider is just clear of the slipstream and can therefore be more precisely gauged.

NOTE

(i) In both high and low tow positions the glider should not be allowed to get more than one tug wing span above or below it, as otherwise cable drag becomes excessive.

(ii) The charts - Figs. 1 & 2 - show the relationship between the salient features of tug aircraft, as seen from the glider when flying in the BEST and

LIMIT positions on both high and low tow. The true BEST and LIMIT positions will vary with tug loading and IAS, in particular in some conditions the LOW-BEST position as illustrated may be found to be on the edge of, or just within, the slipstream. The silhouettes, which are based on incidence angles at certain specific loadings and speeds, must therefore be taken as a general guide only. Pilots will find the most comfortable high and low tow positions by experience and, as it is tiring to maintain one position for long periods, some variation is permissible provided, generally, that the outline of the tug remains between the positions depicted by the silhouettes marked BEST and LIMIT. Reproductions of the individual tug silhouettes on cards to a larger scale are available on application to APFS., Fulham Rd., London, S.W.3 using R.A.F. Form 294A and quoting the following references.-

WHITLEY	Tow	Position	Card	No.2
HALIFAX	"	"	"	No.3
ALBEMARLE	"	"	"	No.4
WELLINGTON	"	"	"	No.5
LANCASTER	"	"	"	No.6
DAKOTA	"	"	"	No.7
STIRLING	"	"	"	No.8

11. LEVEL FLIGHT

(i) Small amounts of slack in the tow rope can be ignored but the control column should be eased forward slightly to prevent snatch as the slack is taken up by the tug. If the slack is appreciable, it should be taken up by easing the control column slightly back until the rope is almost taut, when the column should be eased forward to minimise snatch.

(ii) On turns, keep directly behind (or slightly inside) the tug.

(iii) Cloud Flying.- If cloud is entered the glider pilot should release tow immediately unless a tow cable angle indicator is fitted and authority has been given for blind flying.

12. BLIND FLYING (using Mk. II Tow angle indicator)

(i) On tow. Fly in low tow position; correction should be made with the elevator and ailerons assisted as necessary by rudder. Inclination of the vertical pointer indicates departure of the glider from its correct angle of bank and the pointer should be "pushed" gently back to zero with the ailerons.

As soon as the pointer reaches the zero position a touch of opposite aileron should be applied to stop the pointer moving and to prevent the glider overshooting its correct position. This technique applies equally in level flight and when turning, climbing or descending. Movement of the horizontal bar indicates corresponding departure of the glider from its correct vertical position which should be corrected by pushing gently on the elevator control so as to push the bar back to the zero position. In rough weather some oscillation of the horizontal bar occurs (due to surging of the cable) but the vertical position of the glider is indicated by the mean of the limits of oscillation and no attempt to correct oscillation is necessary, (with the Mark III indicator this oscillation is not so pronounced).

(ii) In free flight. The vertical pointer can be used in a similar manner to an artificial horizon to indicate angle of bank, correction being applied by aileron as when on tow, (with the Mark III indicator the switch should be at OFF. The horizontal bar does not disappear but should be disregarded).

13. CASTING OFF

(i) This should be done in level flight with the glider level with or above the tug. Except in emergency, do not cast off from below the tug. Speed should be at least 90 mph IAS and after casting off the tug will turn as prescribed.

(ii) With military loads stowed, the compass deviation may be considerably affected. If it is necessary for the glider to fly on a compass course after casting off, the tug should fly steadily on the required course, and should give the compass reading to the glider pilot by intercom, before release. The glider pilot should note the corresponding reading on his own compass.

(iii) If take-off is abandoned, either by the tug or by the glider pilot, the rope should be released and the glider should then turn as prescribed.

14. STALLING

(i) Stalling speeds in mph IAS.

	Lightly loaded	Fully loaded
Flaps up	54	69
Flaps down	43	55

(ii) If the stall is approached quickly, or if the control column is held right back after a slow approach, one wing may drop gently.

15. GLIDING

(i) The following speeds in mph IAS, (with undercarriage) are recommended:

	Light	Heavy
Flaps up	70	85
Flaps half down	65	75

(ii) With flaps fully down the glide path is extremely steep. Flaps can be raised to the half down position without appreciable sink; it is not necessary to increase speed.

16. APPROACH AND LANDING

(i) Up to half flap may be used on the cross wind approach to regulate height.

(ii) Make the final turn towards the landing ground with half flap and when sure of getting into the landing ground, lower the flaps fully.

(iii) The glide path with flaps fully down is steep, and care is necessary, especially in strong winds, not to get too far downwind. Flaps may be raised to the half down position if undershooting but it must be remembered that response is slow. Flaps must not be raised fully at normal flaps down approach speeds, and even if speed is increased in order to raise them fully, this will not correct undershooting at this stage of the approach.

(iv) Recommended speeds for final straight approach, with flaps fully down are:

Light	60 mph IAS
Heavy	75 to 80 mph IAS

(v) Flatten out and land on the main wheels in a slightly tail down attitude, lower the aircraft gently onto the nose wheel and then, when all three wheels are on the ground, apply brakes.
Note: the brake action is not differential. ON LATER AIRCRAFT THE BRAKE ACTION IS DIFFERENTIAL.

(vi) Landing technique using arrester parachutes 4/6

The approach is made normally at speeds up to 100 mph IAS. At about 50 feet operate the tumbler switch and immediately begin to level out. (There is a three second delay between the operation of the switch and the opening of the parachutes.)

When the parachutes open there is a slight tendency for the nose to drop which can be corrected by the use of elevator. As the glider drops on to the ground suddenly after the parachutes have opened, do not hold off higher than 30 feet.

WARNING. If the parachutes stream prematurely, either on or off tow, both the tumbler switch and the jettison button must be operated immediately, as the action of the parachutes is to cause the glider to stall suddenly.

17. AFTER LANDING

(i) Raise flaps.

(ii) When being towed down-wind, controls should be held central, or if the glider is not occupied all control surfaces and the flaps must be locked.

(iii) Park facing into wind with controls and flaps locked.

18. EMERGENCIES

(i) Although the tug pilot is CAPTAIN of the combination the glider pilot may, in emergency, cast off and take other action on his own initiative; he should, however, warn the tug pilot first if possible.

(ii) Abandoning tow before tug is airborne.- The glider pilot should release tow, first if possible, should land (if airborne), apply his brakes and turn as necessary.

(iii) Engine failure on take-off after tug is airborne.- If warned in time the glider pilot should release tow first and land straight ahead. He may make partial turns to avoid the tug or other obstacles but in no circumstances should he attempt to turn back to the airfield. Unless there is ample room for a normal landing the undercarriage should (if possible) be jettisoned.

(iv) Failure of towing hook or bridle. Should the hook or bridle on one side fail, there is no need to cast off. Position on tow can be maintained and turns executed without difficulty as follows:-

(a) By using the ailerons only. Rudder need only be used to check the initial yaw and until the glider takes up a position such that the cable is in line dead behind the tug, the glider flying slightly to the side away from that on which the cable remains attached.

(b) An alternative position is dead behind the tug and in line with it; this can be maintained by holding on a little aileron to fly slightly wing down towards the side on which the cable remains attached.

19. DITCHING

(i) See A.P.2095 and note: The pilot's roof hatch (if fitted) should be opened as soon as a ditching is decided upon. If no pilot's roof hatch is fitted, one or more hood panels should be broken out with any available instrument. If passengers are being carried they should open the upper gun hatch cover and make preparations for breaking out additional exits in accordance with the drills set out in A.D.3913 and A.D.3913A. No attempt should be made to break out exits except at former Nos.3 and 15 which are painted red, and, after alighting, at the adjacent skin areas which are painted yellow. On later Mk.II gliders two escape hatches are fitted in the roof, one to starboard of the centre line forward of the forward sliding door, and one on the centre line between the gun hatch and the rear sliding door. To open a hatch the emergency handle on the port side of the panel is pulled; this rips the securing tape and the hatch can then be pushed out. Luminous arrows in the cabin point to the hatches enabling them to be located in the dark. A Luminous Instruction Label is also fitted on each hatch.

(ii) The undercarriage causes violent deceleration and diving so that, if still in place, it should be jettisoned. The flaps increase rate of descent and nose down attitude, but they may be lowered to the 40° position to reduce forward speed, provided that visibility is good and the pilot feels confident of judging height accurately enough to flatten out in time to prevent the impact being taken by the nose.

(iii) On impact, although the deceleration should not be severe, the lower part of the nose is almost certain to break in and the fuselage will rapidly fill to wing level, after which the wings should keep the glider afloat for a considerable time.

Warning

For all flights, whether training or operational involving flying over the sea, the undercarriage ground locking device should be left unlocked to enable the pilot to jettison the undercarriage should a ditching become necessary.

20. REMOVAL OF TAIL SECTION - For quick unloading of cargo.

The pilot should be familiar with the procedure for rapid removal of the tail section; he should also ensure that the crew know the drill for doing this as laid down in A.P.2453D, Vol.I, Part 3, Sect.1.

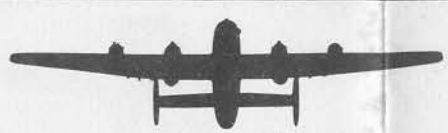
A.P. 2097-A, P.N.

TOW POSITION CHART

P. N., PART II

HIGH TOW

HIGH LIMIT



HIGH LIMIT

HIGH LIMIT

HIGH LIMIT

HIGH BEST

HIGH BEST

HIGH BEST

HIGH BEST

WHITLEY | HALIFAX | ALBEMARLE | WELLINGTON

LOW TOW

LOW BEST

LOW BEST

LOW BEST

LOW BEST

LOW LIMIT

LOW LIMIT

LOW LIMIT

LOW LIMIT

1. WHEN FLYING IN THE BEST POSITIONS ON HIGH (OR LOW) TOW, THE TUG AIRCRAFT SHOULD APPEAR AS SHOWN IN THE SILHOUETTES MARKED HIGH (OR LOW) BEST

2. THE GLIDER SHOULD NOT BE ALLOWED TO GET ABOVE (OR BELOW) THE POSITIONS IN WHICH THE TUG AIRCRAFT APPEARS AS SHOWN IN THE SILHOUETTES MARKED HIGH (OR LOW) LIMIT.

FIG. 1

FIG. 1

F.S./5

A.P.2097-A, P.N.

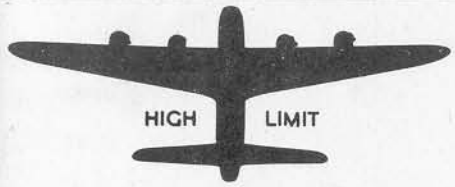
TOW POSITION CHART

P.N., PART II

HIGH TOW

DAKOTA

LANCASTER



STIRLING

RESERVED FOR ADDITIONAL TUG

LOW TOW

1. WHEN FLYING IN THE BEST POSITIONS ON HIGH (OR LOW) TOW, THE TUG AIRCRAFT SHOULD APPEAR AS SHOWN IN THE SILHOUETTES MARKED HIGH (OR LOW) BEST.
2. THE GLIDER SHOULD NOT BE ALLOWED TO GET ABOVE (OR BELOW) THE POSITIONS IN WHICH THE TUG AIRCRAFT APPEARS AS SHOWN IN THE SILHOUETTES MARKED HIGH (OR LOW) LIMIT.

FIG. 2

FIG. 2

PART III

GENERAL NOTES FOR TUG AIRCRAFT PILOTS

All normal limitations and handling recommendations in Pilot's Notes for individual tug aircraft should be observed, as modified and added to, by the instructions contained in these notes, as well as in the appropriate appendix covering the particular Tug aircraft to be used. These appendices apply only to those Marks of the respective aircraft which have been formally released for towing the particular gliders.

1. GENERAL

(i) When towing a glider the general performance will not be as good as that of the tug in normal free flight. This calls for care on the part of the pilots, particularly during and after take-off, and on the initial climb. Care is also necessary to avoid overheating the engines.

(ii) The method of signalling and code of visual signals to be used in emergency (or if intercom is not fitted) must be agreed with the glider pilot. The TUG AIRCRAFT PILOT is at all times CAPTAIN of the COMBINATION but glider pilots may in emergency, or if cloud is entered, cast off and take other action on their own initiative; if possible, they should, however, warn the tug pilot first.

(iii) The direction in which glider and tug will turn after casting off should be agreed between the pilots.

2. LIMITATIONS

(i) Weight:- Combinations are cleared to fly at specified maximum weights; these are quoted in the appropriate tug appendices.

(ii) Speed:- Speed limitations are quoted in the appropriate appendices in terms of tug and glider ASI readings. Where, however, temporary speed restrictions are in force for the glider, the tug pilot shall ascertain the corresponding speed in terms of the tug aircraft ASI reading, as follows:-

Correct the glider limiting IAS for position error. This gives speed limitation in terms of rectified airspeed (RAS).

Apply to this RAS figure the appropriate tug position-error correction reversed, i.e. if the pec. is plus, subtract and vice versa.

(iii) Engine limitations:- Unless otherwise specified in the appropriate appendix the normal limitations for the type should be observed.

3. PRELIMINARIES

(i) The tug pilot as CAPTAIN of the combination should check that aircraft weights are in accordance with limitations and that the state of both aircraft, and distribution of loads, are in accordance with any special conditions specified in the combination release.

(ii) To avoid overheating during take-off and climbing, run the engines as little as possible on the ground. If, after reaching the take-off point, take-off is delayed, engines should be stopped. A ground battery should be at the take-off point for restarting.

(iii) Check position of glider.

(iv) Check that the rope is properly attached, test quick release, re-attach rope making sure that the hook is locked and that the release control is in the locked position. If the hook is attached to a towing yoke, check that this is unlocked.

(v) After agreeing the code of visual signals with the glider pilot or pilots, test the intercom. (if to be used) with glider with engines running. With line intercom. the switch must be set to MIX or held to LINE at all times with a glider in tow.

4. TAKE-OFF

(i) Checks before take-off

(a) CHECK LIST - See appropriate appendix

Note: The trim for take-off recommended may vary with tug loading and is given as a guide only.

(b) Except in very cool weather, and when experience indicates that temperature limitations will not be exceeded on climb, do not take-off if the engine temperatures are in excess of any recommended in the appropriate appendix.

(c) Clear engines before take-off; this is essential if ground running has been protracted.

(ii) Taking off

NOTE: It is advisable to have a member of the crew available to operate the tow release if it becomes necessary to abandon tow during take-off. It is recommended that the same member of the crew be detailed for this duty on each take-off, as good co-operation is important.

(a) When ready, the glider pilot will give the signal "Take up slack".

(b) To avoid taking up slack too suddenly the engines may be opened up slowly against the brakes which should be released progressively to allow the tug to move forward slowly and steadily. The glider pilot will signal "Take off" when the glider begins to move, and the tug pilot should then open up without hesitation to ensure that the rope does not go slack and the glider overrun it.

(c) Any tendency to swing should be checked promptly before it is communicated to the glider.

(d) Ease the tug off the ground and raise undercarriage and flaps (if used) in accordance with recommendations in the appropriate appendix. NOTE. It will usually be necessary to retrim after raising the undercarriage and flaps, the exact setting depends upon the tug weight and c.g.position, as well as upon the glider weight and position relative to the tug (the higher it flies, the greater the tail "up" pull on the tug), and no exact settings can be quoted.

5. CLIMBING

(i) Climb steadily at the speed recommended in the appropriate appendix. If the recommended speed is below the safety speed of the aircraft the pilot should, in the event of engine failure before a safe height is reached, warn the glider pilot (if possible), release tow, shut throttles and make the best landing possible.

(ii) Use maximum climbing boost and rpm.

(iii) Oil cooler shutters (if not automatic) and gills (or radiator shutters, if not automatic) should be adjusted as necessary; gills should, however, not be open beyond the setting recommended in the appropriate appendix, as otherwise the drag is excessive.

(iv) (a) If oil and/or cylinder (or coolant) temperatures approach limitations increase IAS to the speed recommended in the appropriate appendix.

(b) If overheating is still experienced reduce rpm as recommended but maintain the same increased IAS unless any other speed is specifically recommended in the appropriate appendix.

NOTE: These measures will reduce rate of climb and ceiling.

6. CRUISING

(i) The combination may be flown at the highest speed which can be maintained using maximum cruising power provided that the maximum permitted towing speed is not exceeded.

(ii) The relevant appendices quote an IAS recommended for maximum range and for use if engine temperatures exceed limitations when flying at a higher speed (this speed is also the minimum comfortable speed at which the combination can be flown for long periods). To fly at the above IAS use weak mixture (except when this is not possible - see (iv)) and the highest obtainable boost (not exceeding the maximum permitted for weak mixture cruising) adjusting the rpm, which may be as low as practicable, as necessary.

(iii) Adjust oil cooler and radiator shutters (if non automatic) or gills as necessary. Gills should, however, not be opened beyond the settings recommended in the relevant appendices.

(iv) If the recommended IAS cannot be maintained at the required operational height at maximum weak mixture power, or if, when flying at the recommended IAS, the engines still over-heat, change to rich mixture (if a mixture control is fitted), and on all British engines (for American engines see NOTE) increase to the highest obtainable boost (not exceeding the maximum permitted for rich mixture cruising) adjusting rpm, which may be as low as practicable, to give the recommended IAS. In those cases where these measures may be necessary the relevant appendices will include a note to this effect. In certain cases better cooling in rich mixture may be obtained by flying at a higher speed than that recommended for maximum range - When this applies the relevant appendices give full details.

NOTE: With American engines, minimum rpm restrictions apply when cruising at boosts in excess of the maximum permitted in weak mixture. It is, therefore, necessary to use a combination of the highest boost and lowest rpm (within the limits set out in tabular form for the individual engines in the appropriate appendices) which will give the recommended IAS. This may be done as follows:

(a) Set rpm to the highest permitted for rich mixture cruising.

(b) Adjust boost until flying slightly faster than the recommended IAS.

(c) Then reduce rpm as necessary.

(d) If it is then found that the combination of boost and rpm is not in accordance with the table, both boost and rpm should be adjusted until the best combination (i.e. highest boost and lowest rpm permitted), which gives the required IAS, is found.

(v) The use of rich mixture results in loss of range so that (unless rich mixture is being used because temperatures cannot be maintained within limitations in weak mixture) as fuel is used and weight is reduced sufficiently to enable the recommended IAS to be maintained at maximum weak mixture power, a change to weak mixture boost and rpm (and to weak mixture if a control is fitted) should be made.

(vi) The use of S gear reduces range and generally involves higher engine temperatures. It is seldom necessary to fly so high that greater power will be obtainable in S gear than in M gear while, particularly in hot weather, cooling is usually fairly critical on all tugs with a glider on tow. It is recommended, therefore, that S gear should not be used; its use is in fact prohibited on all tugs with Hercules engines.

(vii) Turns should be commenced gradually and at the recommended cruising speed should not be allowed to exceed rate 1. At higher speeds, up to the maximum permitted, turns up to rate 1½ or rate 2 in emergency are practicable.

(viii) Descent on tow.-

(a) Maintain rpm as set for level flight and adjust throttles to maintain a steady I.A.S. about 10 to 15 mph below the maximum permitted, with a rate of descent not exceeding 800 ft. per min. The use of partial flap may be found to assist.

(b) Radiator shutters or gills, and oil cooler shutters (if adjustable) should be adjusted as necessary.

(c) Recovery should be gradual, throttles being opened slightly to maintain speed.

(ix) Flying in cloudy weather:- Avoid flying into cloud; if it is unavoidable, the glider pilot will cast off (unless a tow cable angle indicator is fitted and authority for blind flying has been given).

7. CASTING OFF

The tug pilot will give the order to cast off and should not (except in emergency) release until the glider has done so. The tug pilot should avoid getting in the way of the glider. After casting off retrim as necessary. No precise settings can be recommended for the reasons given in the note to para.4(ii)(d).

NOTE: Should the glider require to fly on a compass course after release, a special compass check may be necessary.- see Part II, para.13.

8. DROPPING THE ROPE

Under training conditions fly upwind at about 400 ft. and release the rope over the rope dropping area. If a towing yoke is fitted the pilot should instruct crew to lock it.

9. EMERGENCIES

(i) Abandoning tow before tug is airborne - Unless necessary, the tug pilot should not release until after the glider pilot. He will then throttle back and apply brakes. The glider will cast off, apply brakes and turn as necessary to avoid the tug.

(ii) Engine failure on take-off after tug is airborne - If possible the glider pilot should be warned so that he may release tow at his end first. The tug pilot will in any case release tow and will then take normal action disregarding the glider. If the tug has to land the glider pilot will turn as necessary.

(iii) Take-off abandoned by the glider.- If the glider pilot decides to abandon the take-off and release the tow, the tug pilot should also release.

(iv) Engine failure in flight -

(a) In the event of engine failure, before deciding to abandon tow, the tug pilot should instruct the glider pilot to jettison the undercarriage as well as any items of loose equipment possible; he should also jettison any loose equipment in the tug and as much fuel as practicable.

(b) If height cannot be maintained and the tug pilot decides to release the glider, he should warn the glider pilot who should release first if possible, or in any case immediately after the tug releases.

(c) If the rudder has been trimmed for no load with the dead engine, the change of rudder trim will be considerable after releasing the glider. This should be trimmed out as speed is gained.

(d) On four-engined aircraft if the tow is being continued after engine failure apply appropriate trim. Before releasing the glider it is then essential to return rudder trim to neutral by throttling back on the opposite engine.

NOTE

See also appropriate appendix as follows:-

Tug	Appendix
WHITTLEY	I
HALIFAX	II
ALBEMARLE	III
WELLINGTON	IV
LANCASTER	V
DAKOTA (C.47)	VI
STIRLING	VII
HUDSON	VIII

7. CRUISING

(i) The speed recommended for cruising at normal operational loads is 125 to 130 mph IAS
(120) (125)
At extended load (61,350 lb. on LANC II) the speed is increased to 130 to 135 mph IAS and proportionally
(125) (130)
at intermediate loads with either Lanc.I,II or III.

(ii) On Lancaster II

Gills - as for climbing

(iii) Rich mixture power may be required to maintain height at full operational loads in very hot weather.

8. TURNS, DESCENT ON TOW, CASTING OFF, ROPE DROPPING AND EMERGENCIES See Part III

APPENDIX I

Notes for WHITLEY tug aircraft Pilots when towing HORSA I GLIDERS.

1. FLYING LIMITATIONS

(i) Maximum permissible weights are:-

HORSA	~~15,250~~ 15,500 lb.
WHITLEY	23,000 lb.
~~HORSA II~~	~~15,600 lb.~~ 15,750. A.L.5.

A.L.2. A.L.4.

(ii) Maximum speeds:-

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	142	160

Note: All limitations and handling speeds quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed.

3. PRELIMINARIES

(i) Check weights and fitness of aircraft for flight - see Part III.

(ii) Check glider stationing, towing yoke unlocked, test quick release (this is lever on the starboard side which is pulled towards the pilot to release), agree code of signals and test intercom. - see Part III.

(iii) Check that the rear turret guns are central and elevated at least 10°.

4. CHECKS BEFORE TAKE-OFF

(i) Set Flaps - - UP (to 10° at full weights if take off run is restricted).

Trim - Elevator -) Neutral
Ailerons -)
Rudder - 1½ divisions starboard.

Boost control cut-out - Pulled

Radiator shutters - Fully open

(ii) The recommended maximum temperatures for take-off are:-

Coolant - 80°C
Oil - 85°C

5. TAKE-OFF

(i) Ease the tug off at about 85 mph IAS.

(ii) Fly level until a speed of 95/100 mph IAS is reached.

(iii) As soon as safely airborne raise the undercarriage and then flaps (if down) and reduce power to climbing boost and rpm to prevent overheating.

6. CLIMB

(i) The recommended speed for best climb is between 100 and 105 mph IAS.

(ii) If engines overheat increase speed to 110/115 mph IAS.

7. CRUISING

(i) The recommended speed for maximum range and for cooling if engines overheat at a higher speed is 105/110 mph IAS.

(ii) Rich mixture power may be required for cooling in hot weather.

(iii) Warning: With the glider flying high the rear turret cannot be rotated as it may foul the yoke should this rise above the horizontal. The yoke may also foul the guns if, when central, their elevation is less than 10°.

8. TURNS, DESCENT ON TOW, CASTING OFF AND ROPE DROPPING See Part III.

9. AFTER DROPPING ROPE

Check with crew that towing yoke is locked. With the yoke locked turret and guns can be used normally.

10. EMERGENCIES See Part III.

APPENDIX II

Notes for HALIFAX tug aircraft Pilots when towing HORSA I GLIDERS.

1. FLYING LIMITATIONS

(i) Maximum permissible weights are

HORSA	~~15,250~~ 15,500 lb.
HALIFAX II	47,000 lb.
HALIFAX V	~~47,500~~ 54,300 lb.

AL/2.

(ii) Maximum permissible speeds are: ~~HORSA II 15,600 lb.~~ 15,450. ALS. AL.4

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	140	160

Note:- All limitations and handling speeds quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed.

3. PRELIMINARIES

(i) Check weights and fitness of aircraft for flight - See Part III.

(ii) Check glider stationing, test quick release, (this is a "pull" handle on the right of the throttle box; it is pulled to release), agree code of signals and test intercom. - See Part III.

4. CHECK BEFORE TAKE-OFF

Set - Flaps - 15° Heavy (20° To 25° Light).
Trim - Rudder, Ailerons - Neutral
Elevator - 1½ divisions back
Radiator shutters - Fully open

5. TAKE-OFF

(i) At 95 to 100 mph IAS ease the tug off.

(ii) Fly level until a speed of 115 to 120 mph IAS is reached (This is below the safety speed - see Part III).

(iii) Raise the undercarriage as soon as safely airborne.

(iv) Maintain take-off power until the flaps are up; they should not be raised below 200 ft. (500 ft. on the Halifax V). The flaps should, if possible, be raised in stages by selecting flaps UP and at once returning the control to NEUTRAL, repeating the operation several times. If flaps are raised quickly the aircraft will sink but at 200 ft. (or 500 ft.) this is not dangerous.

6. CLIMBING

(i) The speed recommended for best climb is 120 mph IAS.

(ii) If engines overheat, speed may be increased to 125 mph IAS; rate of climb should still be adequate. No reduction of rpm should be necessary.

7. CRUISING

The recommended speed for maximum range and for cooling if engines overheat at a higher speed is 120 to 125.

8. TURNS, DESCENTS ON TOW, CASTING OFF, ROPE DROPPING AND EMERGENCIES - See Part III.

APPENDIX III

Notes for ALBEMARLE tug aircraft Pilots when towing HORSA I GLIDERS.

1. FLYING LIMITATIONS

(i) Maximum permissible weights are

HORSA I	15,500 lb.
HORSA II	~~15,600 lb.~~ 15,700. AL.5.
ALBEMARLE I & II also V & V.	31,200 lb. AL.6

(ii) Maximum permissible speeds are.-

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	145	160

Note: All limitations and handling speeds quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed.

3. PRELIMINARIES

(i) Check weights and fitness of aircraft for flight - see Part III.

(ii) Check glider stationing, test quick release (this is a pull knob on the right of the throttle box; it is pulled to release), agree code of signals and test intercom. - See Part III.

(iii) The recommended maximum temperatures before take-off are:

Cylinder - 190°C
Oil - 60°C

4. CHECKS BEFORE TAKE-OFF

Set Flaps - 25°
Trim
Elevator - 2 to 4 divisions back
Rudder - neutral
Gills - 1/2 open (to marks on air intake)

5. TAKE-OFF

AL 6

(i) Ease the tug off at 95 To 100. mph LAS.

(ii) Do not commence to climb until a speed of 100 mph LAS is reached. This is below the safety speed - see Part III para.5.

(iii) Raise the undercarriage, retrimming as necessary (about 5 divisions back), as soon as safely airborne and then raise the flaps to 10°.

(iv) Reduce power to climbing boost and rpm.

6. CLIMBING

AL 6

(i) The speed recommended for best climb is ~~115~~/120 110/115 mph LAS.

(ii) Gills should not be opened beyond the 3/4 open position (some buffeting may be experienced with gills more than 1/2 open).

(iii) If overheating is experienced, increase to 125 mph LAS and then, if necessary, reduce rpm to 2400 but the rate of climb will be considerably reduced.

7. CRUISING

(i) Leave flaps set to 10° and retrim against nose heaviness as necessary. The wing tanks should be used before fuselage tanks, particularly at full operational load when these are filled as this helps to reduce nose heaviness.

(ii) The recommended cruising speed using 10° of flap is 110/115 mph LAS which gives a greater range than a higher speed without flap. The aircraft is in fact more comfortable to fly at any cruising speed using some flap since, even at full operational loads, the control column force, fully trimmed (even with restricted range (10°) tabs), should not be excessive. ALTHOUGH NO GATE IS FITTED AT THE NEUTRAL POSITION, THIS MAY BE DONE BY CAREFUL MANIPULATION OF THE LEVER.

AL 5

Note: Flaps may be set to intermediate positions by operating the selector intermittently and leaving it at the neutral position when the indicator shows the desired setting.

(iii) At tug weights up to 31,200 lb. the combination may be flown safely at speeds as low as 105 mph IAS using 15° of flap (the stalling speed being about 85 to 90). At low speeds, even with the elevator trim fully back, the aircraft feels nose heavy. Friction in the aileron control system may give an impression of lack of sensitivity and lateral instability which is enhanced by the pilot's inability to see the outer wings. Practice in slow flying down to the stall with 15° flap (without a glider in tow) should familiarise the pilot with the feel of the aircraft in these conditions.

(iv) Gills should not be opened beyond the 1/2 open position, except in extreme cases when they may be set 3/4 open but some buffeting may be experienced.

(v) Rich mixture power may be required to maintain the recommended speed at full operational loads, and to maintain temperatures within limitations in very hot weather.

WARNING. To prevent the c.g. moving too far forward the WING tanks should be used before the FUSELAGE tanks. If the AUXILIARY (overload) tanks are filled they should be used as early as possible after climb has been completed in the normal manner.

8. TURNS, DESCENT ON TOW, CASTING OFF, ROPE DROPPING, AND EMERGENCIES - See Part III.

APPENDIX IV

Notes for WELLINGTON tug aircraft Pilots when towing HORSA I GLIDERS

1. FLYING LIMITATIONS

(i) Maximum permissible weights are:-

HORSA	~~15,250~~ 15,500 lb.
WELLINGTON III	28,500 lb.
WELLINGTON X	~~30,000~~ 30,550 lb.

HORSA II

~~15,000 to~~ 15,750. AL 5. AL. 4. AL/2.

(ii) Maximum speeds:-

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	145	160

Note: All limitations and handling speeds quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed. BUT CYLINDER TEMPERATURE UP TO 290°C ARE PERMITTED WITH A GLIDER IN TOW. AL 6

3. PRELIMINARIES

(i) Check weights and fitness of aircraft for flight - see Part III.

(ii) Check glider stationing, towing yoke unlocked, test quick release (this is lever with a black knob by the port pilot's right knee which is pulled up to release), agree code of signals and test intercom. - See Part III.

(iii) Check that the rear turret guns are central and elevated at least 10°.

4. CHECKS BEFORE TAKE-OFF

(i) Set Flaps - UP

Trim - Elevator - Normal
Ailerons - Normal
Rudder - Normal

Gills - Fully open

5. TAKE-OFF

(i) At 85 mph IAS (~~80 at reduced loads~~) ease the tug off, trimming back as necessary.

(ii) Fly level until a speed of 100 mph IAS is reached. This is below safety speed - see Part III, para.5

(iii) As soon as safely airborne raise the undercarriage and reduce to climbing power.

6. CLIMB

(i) Retrim back as necessary

(ii) The recommended speed for best climb is 105 mph IAS.

(iii) If engines overheat increase speed to 110/120 mph IAS. Rate of climb at operational weights will be considerably reduced if speed is further increased, or rpm reduced.

7. CRUISING

(i) The recommended speed for maximum range and for cooling if engine overheat at a higher speed is 108 to 113 mph IAS.

(ii) Rich mixture power may be required to maintain height and/or for cooling in hot weather.

(iii) Warning: With the glider flying high the rear turret cannot be rotated as it may foul the yoke should this rise above the horizontal. The yoke may also foul the guns if, when central, their elevation is less than 10°.

8. TURNS, DESCENT ON TOW, CASTING OFF AND ROPE DROPPING
See Part III.

9. AFTER DROPPING ROPE

Check with crew that towing yoke is locked. With the yoke locked turret and gun can be used normally.

10. EMERGENCIES - Part III.

APPENDIX V

Notes for LANCASTER tug aircraft Pilots when towing HORSA I & II GLIDERS.

1. FLYING LIMITATIONS

(i) Maximum permissible weights are.-

	Normal Operational	Extended Load
HORSA I	15,500 lb.	
HORSA II	15,750 lb.	
LANCASTER I & III	47,000 lb.	57,500 lb.
LANCASTER II	48,100 lb.	61,350 lb.*

* Restricted to 58,000 lb. in tropical conditions.

(ii) Maximum permissible speeds are:-

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	150(140)	160

Note:-

(a) The tug speeds (not in brackets) quoted above and throughout this appendix apply with the ASI connected to the static vent. The speeds quoted in brackets are for use when the ASI is not connected to the static vent.

(b) All limitations and handling speeds quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed.

3. PRELIMINARIES

(i) Check weights and fitness of aircraft for flight - See Part III.

(ii) Check glider stationing, test quick release. (The control is a red toggle labelled GLIDER RELEASE mounted on the floor aft of the throttle box; it is pulled up to release), agree code of signals and test intercom. - See Part III.

4. CHECK BEFORE TAKE-OFF

Set - Flaps		- 15° (to 25° at light loads)
Trim -	Rudder Ailerons Elevator	- Normal
LANC I & III	Radiator shutters	- Fully open (by means of manual override switch); they should be left so set (except in very cool weather) at all time with a glider on tow.
LANC II	Gills	- 1/3 open
	Oil cooler shutters (preset)	- 3/5 open (in hot weather it may be found necessary to set 4/5 open to prevent excessive oil temperature rise during ground running).

5. TAKE-OFF

(i) At normal operational loads, ease the tug off at 95 (90) mph ASI. At extended loads, an increase in take-off speeds is necessary, on the Lancaster I or III at 57,500 lb. to 105 mph ASI and on Lancaster II at 61,350 lb. to 115 mph.

(ii) After take-off, speed must be allowed to increase by 15 to 20 mph before commencing to climb (this will be below safety speed - see Part III).

(iii) Raise the undercarriage as soon as safely airborne and maintain take-off power until a height of not less than 100 ft. is reached; reduce to climbing power and then raise the flaps in stages.

6. CLIMBING

(i) The speed recommended for best climb is 125 to 130 mph IAS. at normal operational loads. At extended loads an increase in climbing speed to 145 to 150 mph IAS is recommended. On Lancaster I or III at extended load, in cool weather, a better rate of climb is obtainable by climbing at 140 to 145 mph IAS. provided excessive engine temperatures are not experienced.

(ii) On the Lancaster II gills may be opened fully if temperatures rise excessively.

(iii) There should be no necessity to increase speed or to reduce rpm for cooling except on the Lancaster III at extended load in hot weather when the climbing speed should be increased to 150 mph IAS.

APPENDIX VI

Notes for DAKOTA (C47, C47A & C53) tug aircraft Pilots when towing HORSA I GLIDERS.

1. FLYING LIMITATIONS

(i) Maximum permissible weights are.-

DAKOTA	26,000 lb. (20,850 IN TROPICAL CONDITIONS)
HORSA	15,500 lb.
HORSA II	~~15,600 lb.~~ 15,750.

A.L.5. PG. 4

(ii) Maximum speeds.-

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	145	160

Note: All limitations and handling speeds quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed but the following concession is permitted for use when towing a glider only.-

	Boost	rpm	temp. cylr.
RICH MIXTURE CRUISING	39 ins	2450	250°C

NOTE: At the following boosts, rpm must not be reduced below the figures quoted.

At Boost	Min. rpm
39 ins. Hg.	2350
37 " "	2250
35 " "	2150
33 " "	2050

Below this change to AUTO-WEAK unless this causes overheating.

Note: It is suggested that the above table be copies on a suitable card for easy reference in flight.

3. PRELIMINARIES

(i) Check the glider stationing, test the quick release (this is a knob on the bulkhead behind the second pilot's shoulder; it is operated by the SECOND PILOT and is pulled to release), agree code of signals and test intercom.

Note: Certain C47, and C47A and C53 aircraft have the towing hook mounted externally. With this fitting angular displacement of the glider relative to the tug should be limited to 25 degrees up, 20 degrees down, and 20 degrees either side to prevent damage to the hook mounting. When this applies the tug pilot as CAPTAIN of the combination should impress upon the glider pilot the advisability of following as closely as possible (consistent with maintaining best towing position - see Part II para.10) the line of the tug flight path.

(ii) When operating at high weights in hot weather the recommended maximum temperatures for take-off are:

Cylinder	-	200°C
Oil	-	55°C

4. CHECKS BEFORE TAKE-OFF

Set -	Flaps	- Nil to 15°(Nil at 26,000 lb.)
	Trim	
	Rudder & Ailerons	- Neutral
	Elevator	- 2 divisions back
	Oil cooler flaps	- Fully open
	Gills	- TRAIL (May be fully open in hot weather if experience indicates necessity - but see para.6(ii)).

5. TAKE OFF

(i) Ease the aircraft off at 90 to 95 mph IAS

(ii) Commence to climb at 105 to 110 mph IAS (at 26,000 lb, at 95 mph IAS). This is below the safety speed - see Part III para.5.

(iii) Raise the undercarriage as soon as safely airborne, and then, at a safe height, flaps (if down).

6. CLIMBING

(i) The speed recommended for best climb is 110/115 mph IAS (at 26,000 lb, at 105 mph IAS).

(ii) Gills should not be opened beyond the TRAIL position unless temperatures rise excessively, when they may be fully opened; some buffeting may be experienced.

(iii) If engines still overheat, increase to 120/125 mph IAS. At full operational weights rate of climb will be considerably reduced if speed is increased above this or rpm reduced.

7. CRUISING

(i) The speed recommended for maximum range, is 110 to 115 mph IAS.(UNDER TROPICAL CONDITIONS, 105 TO 110 MPH IAS). AL 6

(ii) Gills - as for climbing

(iii) Rich mixture power may be required to maintain the recommended speed, and in very hot weather for cooling. In rich mixture better cooling may be obtained by flying at a higher speed than that recommended for maximum range; this should be done by increasing rpm and boost progressively, until satisfactory cooling is obtained. Speed should not be increased more than is essential for cooling as range is reduced at high speeds. In weak mixture no improvement in cooling should be obtained by flying faster than the speed recommended for maximum range. See Part III, para.6(iv) and para.2 of this Appendix.

8. TURNS, DESCENT ON TOW, CASTING OFF, ROPE DROPPING AND EMERGENCIES - See Part III

Note that on casting off there is some change of trim to tail heavy.

APPENDIX VII

Notes for STIRLING tug aircraft Pilots when towing HORSA I GLIDERS.

1. FLYING LIMITATIONS

(i) Maximum permissible weights are

HORSA	15,500 lb.
STIRLING	55,500 lb.
STIRLING III	56,600 lb.
STIRLING IV	59,900 lb.
	(58,000 lb. in tropical conditions)
HORSA II	~~15,600 lb.~~ 15,750. A.L.5.

(ii) Maximum permissible speeds are.-

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	150	160

Note: All limitations and handling speed quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed.

3. PRELIMINARIES

(i) Check weights and fitness of aircraft for flight - see Part III.

(ii) Check oil cooler shutters - preset, inner - open
outer - 2/3 open

(iii) Check glider stationing, test quick release (this is a long lever on the right of the throttle box; it is pulled to release), agree code of signals and test intercom. - See Part III.

(iv) The recommended maximum temperatures before take-off are.- Cylinder 180°C
Oil 65°C

4. CHECKS BEFORE TAKE-OFF

Set Flaps	- 1/3 out
Trim	
Elevator	- 3 divisions forward
Rudder	- neutral
Gills	- 1/3 open

5. TAKE-OFF

(i) As speed is gained, trim elevator back as necessary and ease the tug off at about 95/100 mph IAS.

(ii) Fly level and close to the ground until a speed of 120 mph IAS is reached. At tug weights of over 56,000 lb. a shorter take-off run can be obtained by commencing to climb at 110 mph IAS but it must be remembered that this is very much better below the tug safety speed - see Part III para.5.

(iii) Raise the undercarriage, as soon as safely airborne and reduce to climbing power as the wheels come up.

(iv) Raise flaps and retrim as necessary. With the glider flying in the high tow position considerable tail down trim will be required.

6. CLIMBING

(i) The speed recommended for best climb is 130/135 mph IAS.

(ii) Gills should not be opened beyond the 2/3 open position.

(iii) If overheating is experienced, increase to 135 to 140 mph IAS. In hot weather it may also be necessary to reduce rpm (in particular on the inner engines) by 100 rpm.

7. CRUISING

(i) Retrim elevator as necessary - See para.5(iv)

(ii) The speed recommended for maximum range is 130/135 mph IAS.

(iii) Gills should not be opened beyond the 2/3 open position.

(iv) Rich mixture power may be required to maintain height, and in hot weather for cooling, at full operational loads.

8. TURNS, DESCENT ON TOW, CASTING OFF, ROPE DROPPING AND EMERGENCIES.

See Part III.

APPENDIX VIII

Notes for HUDSON tug aircraft Pilots when towing HORSA I GLIDERS.

1. FLYING LIMITATIONS

(i) Maximum permissible weights are.-

HUDSON	16,700 lb.
HORSA	~~15,250 lb.~~ 15-500
HORSA II	~~15,600 lb.~~ 15,750 A.L.S.

AL/2. AL/4

(ii) Maximum speeds.-

	Readings in mph	
	On Tug ASI	On Glider ASI
Towing	145 (125 knots)	160

Note: All limitations and handling speeds quoted in these notes are subject to any temporary restrictions which may be in force at the date of issue, or which may be imposed subsequently from time to time by Special Instruction.

2. ENGINE LIMITATIONS

The normal limitations should be observed but the following concession is permitted for use when towing a glider only.

	Boost	rpm
RICH MIXTURE CRUISING (IN M GEAR ONLY)	37.5	2300

NOTE: At the following boosts, rpm must not be reduced below the figures quoted.-

At Boost	Min. rpm
37.5 ins. Hg.	2300
35.5 " "	2200
33.5 " "	2100
31.5 " "	2000

Below this change to AUTO-WEAK unless this causes overheating.

Note: It is suggested that this table be copied onto a suitable card for quick reference in flight.

F.S/15

3. PRELIMINARIES

(i) See that the turret and all items of removable equipment as recommended in the DTD release have been removed and that fuel and ballast are carried in accordance with the further provisions thereof. Check weights and fitness of both aircraft for flight - See Part III.

(ii) Check the glider stationing, test the quick release. (The control is a lever mounted above the pilot's electrical control panel. With the lever in the fully forward position the towing hook is locked and when pulled back, pressing the trigger knob to release catch, the tow rope is released), agree code of signals and test intercom.

NOTE: Certain of these aircraft may have this lever labelled FORWARD TO RELEASE - BACK TO JETTISON. This label should be removed and, in any case, should be disregarded as it refers to the operation of the tail parachute and not to glider towing.

4. CHECKS BEFORE TAKE-OFF

Set - Flaps - Nil to 15°
Trim - all tabs - Normal
Oil cooler flaps - Fully open

5. TAKE OFF

(i) Ease the aircraft off at 80 to 85 knots IAS.

(ii) Commence to climb at 90 to 95 knots IAS. This is below the safety speed - see Part III para.5.

(iii) Raise the undercarriage as soon as safely airborne, and then, at a safe height, flaps (if down).

6. CLIMBING

(i) The recommended speed is 95 knots IAS.

(ii) No increase in speed or reduction of rpm should be necessary for cooling, but at an increased speed of 100 knots the rate of climb should still be adequate.

7. CRUISING

(i) The speed recommended for maximum range, is 94 to 98 knots IAS.

(ii) Rich mixture power may be required to maintain the recommended speed, and will be necessary in very hot weather for cooling. In rich mixture better cooling may be obtained by flying at a higher speed than that recommended for maximum range; this should be done by increasing rpm and boost progressively, until satisfactory cooling is obtained. Speed should not be increased more than is essential for cooling as range is reduced at high speeds. In weak mixture no improvement in cooling should be obtained by flying faster than the speed recommended for maximum range. See Part III, para.6(iv) and para.2 of this Appendix.

8. TURNS, DESCENT ON TOW, CASTING OFF, ROPE DROPPING AND EMERGENCIES - See Part III.

PART IV

NOTES ON GLIDER PICK-UP BY TUG IN FLIGHT
(Applying to the Dakota/Horsa combination.

DESCRIPTIVE

(i) Tug equipment. A winch is installed in the tug aircraft and a steel wire cable wound on the winch drum passes down a pick-up arm which extends downwards at an angle from the port side of the fuselage. At the end of this cable a hook is attached. The equipment also embodies a cartridge-fired cable cutter enabling the glider and cable to be cast off in emergency. This cutter is operated by means of two push-buttons labelled GLIDER EMERGENCY RELEASE immediately above the pilot's head; to operate the cutter the two buttons must be pressed simultaneously. A safety switch is fitted forward of the rear fuselage door; this renders the push-buttons inoperative when set down and live when set up. The switch should be set down while adjustments are being made to the winch to protect the operator from blast should the push-buttons be operated inadvertently; it should be set up before pick-up and at all times in flight.

(ii) Ground equipment. A pick-up station is erected on the ground, consisting of two light poles, painted yellow, at a distance apart. A nylon rope loop is attached to the top of these poles by means of metal clips carrying small yellow flags to enable them to be seen from a distance. Attached to this loop is a length of nylon rope connected to the glider in the normal manner. Two yellow ground strips about 9 ft. x 3 ft. are placed, one at the base of each pole to enable the tug pilot to locate the station from a distance; they can also be used for signalling by setting them at pre-arranged angles.

GENERAL METHOD

(i) Pick-up. The glider is placed at an angle of about 100° to a line passing at right angles between the poles, with all kinks and excessive slack removed from the nylon rope, so that the glider is approximately 300 ft. behind and to one side of the station. The tug flies low over the station, leaving the glider on his left, so that the pick-up arm strikes the nylon loop, which slides down the arm and is engaged by the hook. The initial snatch shock is absorbed by the elasticity of the nylon rope and by the initial acceleration of the winch drum as the steel cable pays out. The drum is provided with a brake, previously set to come into action progressively and so retard the drum.

As the drum slows down, the glider is pulled forward until, when the drum is brought to rest, the glider (now airborne) is flying at the same speed as the tug.

(ii) After Pick-up. When well clear of the ground, and with the length of nylon rope plus the 600 ft. to 900 ft. of steel cable (which unwound from the drum during pick-up) constituting the tow rope, the steel cable can be wound in by starting the electric motor on the winch and slowly winding in until the desired length of cable is obtained; or until the hook at the end of the cable is brought close inboard, when the glider will be on tow at the end of a nylon rope of normal length.

3. TECHNIQUE FOR THE DAKOTA PILOT WHEN PICKING UP THE HORSA GLIDER

(i) Checks. On receiving the pre-arranged signal from the ground, or glider, that the latter is ready for pick-up, the pilot should check with the winch operator that the safety switch is set up (live), and that the pick-up arm is lowered.

(ii) Approach and pick-up. A narrow circuit should be made so as to keep the station well in view. Speed on the circuit should be as near 110 mph IAS as can be maintained - this is to assist the winch operator in his work; the aircraft is then turned at right angles to the ground station. Just prior to the final turn-in for approach, the propellers should be set to 2550 rpm and the aircraft should be put into a powered glide, using between 15" and 20" Hg. boost. The aircraft is now aimed at a point between the glider and the ground station and is allowed to accelerate in this powered glide up to the contact speed of 140 to 145 mph IAS. On this final approach the aircraft should be trimmed slightly nose heavy.

The lowest point in the flight path of the tug is reached approximately halfway between the glider and the station; at this point the climb is commenced and power is applied steadily by opening the throttles smoothly up to 48 ins.Hg. boost; thus, the aircraft is in a climbing attitude over the station and full power is attained just after contact. This technique is important because, if the aircraft is not accelerating at the moment of contact, considerable sink may be experienced.

(iii) Climb. On the subsequent climb, in no circumstances must the aircraft be flown at a speed below 105 mph IAS; the desired climbing speed being from 105/115 mph IAS. As soon as a safe height of about 500 ft. is reached the tug pilot can throttle back to normal climbing boost and rpm, but during climb no turns to the right must be made. If necessary, gentle left-hand turns may be made; but below 500 ft. all turns should be avoided.

(iv) Winding in. Once a cruising height of not less than 1000 ft. above the terrain has been reached, the cable may be wound in as follows:-

(a) The glider pilot should be advised by pre-arranged signal that this is to be done so that he can take up the correct position.

(b) The tug should be flown at 110 mph IAS while the cable is wound in.

(v) Casting off. The glider will cast off first and the tug crew should then disengage the nylon rope loop from the tow hook and secure it with the burden release (by means of the rope loop attached near the cargo door) preparatory to dropping it over the dropping area.

(vi) Checks before landing. Before landing, the pilot must check with the winch operator that the pick-up arm is raised and secured.

(vii) Emergencies

(a) In case of an incomplete pick-up after contact with the loop, the tug pilot should immediately assume maximum climb to not less than 1000 ft.

(b) If at any time after contact the tug pilot should get into difficulties, the glider and cable should be released by operating the GLIDER EMERGENCY RELEASE pushbuttons.

4. TECHNIQUE FOR THE HORSA PILOT WHEN BEING PICKED UP BY DAKOTA AIRCRAFT IN FLIGHT

(i) Before pick-up. After all pre-flight checks have been completed, the crew are in position, and the glider is ready for pick-up, the tug pilot should be given the pre-arranged signal, "ready for pick-up".

(ii) Take-off

(a) Set all trimmer tabs neutral, check brakes unlocked, and hold the control column central.

(b) The glider will start to move very soon after the tug engages the nylon loop and will be airborne in about 250 to 400 ft.

(iii) Initial climb. As soon as the acceleration period is concluded, i.e. as soon as the glider reaches the tug speed, the glider pilot should climb sharply to ensure that the cable, of which there may be upwards of a thousand feet between the tug and glider at this stage, does not sag and foul any obstructions on the ground; the pilot should, however, move the control column forward immediately he sees the sag is being taken up.

WARNING: Since the Dakota is fitted for towing from beneath the fuselage and not from the tail, care must be taken not to climb too high and thus permit the cable to foul the elevators or tail-wheel of the tug.

(iv) Emergency release. Except in extreme emergency the glider pilot should not cast off until a safe height of at least 1000 ft. is reached, since upwards of 1000 ft. of cable would be left dragging from below the tug.

(v) Position on climb and in level flight with long cable. On climb, when well clear of the ground, and in level flight, the glider should fly in any low tow position found comfortable. To ensure that the cable does not foul the tug, avoid flying too high.

(vi) Winding in the cable. When the tug signals that he is about to wind in the steel cable, the glider should fly slightly to the left of the tug approximately in line with the left-hand tail-tip. This is to ensure that the cable does not chafe unduly on the main pulley of the tug, as this is slightly offset.

(vii) Normal position on tow. After the cable has been close-hauled the glider should fly in a normal low-tow position, as defined in Part II.

(viii) Casting off. Casting off should normally be carried out from the high tow position in the usual way, but the glider should not get high enough above the tug to result in the cable fouling the elevator or tail wheel.

SECTION 4 - INSTRUCTIONS FOR GROUND PERSONNEL

CHAPTER 1 - LOADING AND C.G. DATA

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CHAPTER 1 - LOADING AND C.G. DATA

1. Introduction.- The purpose of these notes is to enable the position of the centre-of-gravity (C.G.) of the glider to be determined for any particular loaded condition. For the determination of C.G. position the glider is considered standing with the rigging datum line horizontal. All measurements are taken forward or aft of the vertical datum and parallel to the horizontal datum line.

2. Definition of Centre of Gravity position.- The position of the C.G. of the glider is defined by its distance in inches behind the vertical datum. This distance is known as the moment arm of the C.G. and is given by the expression:-

$$\frac{\text{Total moment (Tare + Removable load)}}{\text{Total weight (Tare + Removable load)}} = \text{C.G. moment arm}$$

The moment of any individual item is the product of its weight (lb.) and its moment arm (in.), which is its distance from the vertical datum. The moment takes the sign of the moment arm, which is positive aft of the vertical datum and negative forward of this datum. For example, if it is desired to add a weight of 50 lb., 100 in. forward of the datum, its moment will be:-

$$50.0 \text{ lb.} \times -100.0 \text{ in.} = -5{,}000 \text{ lb.in.}$$

The weight, moment and moment arm of the glider in the tare condition, and of items of removable equipment are given in the Loading and C.G. diagram (see fig.1).

3. C.G. datum point.- The C.G. datum point is the intersection of the vertical datum, which is midway between the spar bulkheads Nos.4 and 5, and the horizontal datum line which is the centre-line of the fuselage. The datum is marked on the fuselage by means of a C.G. datum plate and is indicated internally by means of a white line painted on the cabin floor.

4. Ballasting positions.- Stowage pegs are provided for twelve standard ballast weights (17½ lb. each) just aft of the cockpit bulkhead.

5. Special concrete ballast blocks (140 lb. each) are also available but these are not intended for operational use. Paras. 8, 9 and 10 deal with the use of these weights.

6. Permissible limits of C.G. travel.- The approved limits of C.G. travel are from 3.0 to 8.0 in. aft of vertical datum at maximum permissible weight and from 3.0 to 18.0 in. aft of datum at light load (up to 10,500 lb. all-up weight) (see diagram of C.G. limits, fig.2). In fixing these limits allowance has been made for the forward movement of the C.G. which occurs when the main wheels are jettisoned and no further allowance is necessary. The C.G. must be within these limits, however, after equipment and/or troops have been dropped by parachute.

7. Examples on determination of C.G. position.- The tare weight shown on the Loading and C.G. diagram (see fig.1) includes the weight of all items of fixed equipment called for in the Appendix "A". The first step is to ascertain the effect on the tare weight and corresponding moment of any structural or equipment items not fitted or of any extra items installed (a list of major items which seriously affect the tare weight and moment is given later in these notes). The following examples will illustrate the procedure to be followed when loadings other than the Typical Service Loads shown in the Loading and C.G. diagrams are to be carried:-

EXAMPLE 1. Glider less main skid, loaded to Typical Service Load "A" - Troop transport, but with no load in equipment containers.

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
A.U.W "A" Load (from fig.1)	14,500	+ 4.5	+ 65,564
Deduct			
Main skid	270	+ 24.0	+ 6,480
Equipment in wing containers (Ref.No.11)	541	+ 44.5	+ 24,075
Total deductions	811	-	+ 30,555
New A.U.W.	13,689	+ 2.5	+ 35,009

The C.G. position 2.5 in. aft of datum is forward of the front C.G. limit. As there is no ballasting position aft of datum a slight re-arrangement of the load must be made in order to bring the C.G. within permissible limits, as follows:-

New A.U.W.	13,689	+ 2.6	+ 35,009
Deduct			
Troop in seat No.16 (Ref.No.26)	220	+ 18.0	+ 3,960
	13,469	-	+ 31,049
Add			
Troop in seat No.26 (Ref.No.17)	220	+182.0	+ 40,040
New A.U.W. with load re-arranged	13,689	+ 5.2	+ 71,089

C.G. position = 5.2 in. aft of datum

EXAMPLE 2. Typical Service Load "A" assumes that the glider lands with this load; however, the troops and equipment may be jettisoned in flight by means of parachutes. It is necessary, therefore, to ascertain that the C.G. position, after jettisoning troops and equipment, is within the prescribed limits.

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
A.U.W. "A" Load (from fig.1)	14,500	+ 4.5	+ 65,564
Deduct			
1 Troop as co-pilot	220	-252.0	- 55,440
1 Troop in seat No.4	220	-220.0	- 48,400
1 Troop in seat No.5	220	-195.0	- 42,900
20 Troops in seats Nos.6 to 25	4,400	0.0	0
1 Troop in seat No.27	220	+182.0	+ 40,040
Vacuum flasks, 24 off	48	- 9.0	- 432
Reconnaissance flare	23	-244.0	- 5,612
Equipment containers in wing	541	+ 44.5	+ 24,075
Total deductions	5,892	-	- 88,669
New A.U.W.	8,608	+ 17.9	+ 154,233

The C.G. is within the light-load range; therefore no adjustment of the load is necessary. If, however, the C.G. should move aft of the permissible limit after troops and equipment have been jettisoned, ballast must be installed before take-off to prevent this.

EXAMPLE 3. Glider loaded to Typical Service Load "B" - Motor Cycle Transport, but less load in equipment containers.

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
A.U.W. "B" load (from fig.1)	14,500	+ 5.4	+ 77,913
Deduct			
Equipment in wing containers	1,235	+ 44.5	+ 54,958
"B" Load less equipment in containers	13,265	+ 1.7	+ 22,955

The C.G. position 1.7 in. aft of datum is forward of the front C.G. limit. In order to bring the C.G. within the prescribed limits ballast must be carried in the wing containers or at equivalent positions in the fuselage.

Add			
Ballast in wing containers or equivalent positions	400	+ 44.5	+ 17,800
New A.U.W.	13,665	+ 3.0	+ 40,755

IMPORTANT: Gliders operating at "B" load must carry a minimum of 400 lb. in. the wing containers, or equivalent positions.

EXAMPLE 4. Glider loaded to Tare + Removable Military Load (see fig.1) 1 pilot only, less main skid and air brakes.

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
Tare + Removable Military Load (from fig.1)	8,417	+ 18.9	+ 158,801
Deduct			
Main skid	270	+ 24.0	+ 6,480
Air brakes and control	60	0.0	0
Total deductions	330	-	+ 6,480
New A.U.W.	8,087	+ 18.9	+ 152,321

The C.G. position 18.9 in. aft of datum is aft of the rear C.G. limit. Ballast must be added on the stowage at the forward end of the cabin in order to bring the C.G. within prescribed limits, as follows:-

Add			
Ballast weights (9 off)	157.5	- 227.0	- 35,753
Final A.U.W.	8,244.5	+ 14.2	+ 116,568

C.G. position = 14.2 in. aft of datum

EXAMPLE 5. Glider in tare condition plus minimum equipment necessary for flight, pilot only.

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
Tare weight (from fig.1)	7,550.0	+ 28.0	+ 211,400
Add			
Signal pistol and cartridges	7.5	- 246.0	- 1,845
Pilot's writing pad	1.5	- 260.0	- 390
Main wheels	560.0	+ 34.0	+ 19,040
T.R.9D radio	52.0	- 215.0	- 11,180
Pilot and parachute (no equipment)	200.0	- 252.0	- 50,400
A.U.W.	8,371.0	+ 19.9	+ 166,625

The C.G. position 19.9. in. aft of datum, is behind the aft limit of permissible C.G. travel. Therefore ballast must be carried on the stowage provided at the forward end of the cabin.

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
Add			
Ballast weights (9 off)	157.5	- 227.0	- 35,753
TOTAL	8,528.5	+ 15.3	+ 130,872

C.G. position = 15.3 in. aft of datum. Note.- Gliders flying with pilot only must carry 9 standard lead ballast weights (17½ lb.each) on stowage at forward end of cabin.

8. Use of concrete ballast weights.- For test flight purposes concrete ballast weights (140 lb. each) are available when it is not desired to use "live" load. These weights are designed to key into the floor slats and are provided with lashings at each end to secure them to the rails running fore and aft in the centre fuselage. Using these concrete weights alone or in conjunction with wing equipment containers loaded to a pre-determined weight and lead weights (17½ lb. each) on the stowage at forward end of the cabin, any desired all-up weight and C.G. position may be obtained.

9. The position of the concrete weights in the fuselage (see fig.3) is limited by the extent of the lashing rails and by the main skid shock-absorber cover in the floor. The following table gives the most convenient positions for the ballast blocks together with their corresponding moments: -

Ref.	Weight (lb.)	Arm (in.)	Moment (lb.in.) Positive	Moment (lb.in.) Negative
a	140	- 135.0		18,900
b	140	- 128.5		17,990
c	140	- 122.0		17,080
d	140	- 116.5		16,310
e	140	- 110.0		15,400
f	140	- 104.0		14,560
g	140	- 98.0		13,720
h	140	- 92.0		12,880
i	140	- 86.0		12,040
j	140	- 80.0		11,200
k	140	- 74.0		10,360
l	140	- 68.0		9,520
m	140	- 62.0		8,680
n	140	- 56.0		7,840
o	140	- 49.5		6,930
p	140	- 43.5		6,090
q	140	- 38.5		5,390
r	140	- 32.5		4,550
s	140	- 26.5		3,710
t	140	- 20.0		2,800

Ref.	Weight (lb.)	Arm (in.)	Moment (lb.in.) Positive	Moment (lb.in.) Negative
u	140	- 14.0		1,960
v	140	- 8.0		1,120
w	140	- 2.0		280
x	140	+ 4.0	560	
y	140	+ 10.0	1,400	
z	140	+ 16.0	2,240	
aa	140	+ 21.0	2,940	
bb	140	+ 27.0	3,780	
cc	140	+ 51.5	7,210	
dd	140	+ 57.5	8,050	
ee	140	+ 64.0	8,960	
ff	140	+ 70.5	9,870	
gg	140	+ 77.0	10,780	
hh	140	+ 82.5	11,550	
ii	140	+ 89.0	12,460	
jj	140	+ 95.0	13,300	
kk	140	+ 101.0	14,140	
ll	140	+ 107.0	14,980	
mm	140	+ 113.0	15,820	
nn	140	+ 119.0	16,660	
oo	140	+ 125.0	17,500	
pp	140	+ 131.0	18,340	
qq	140	+ 136.5	19,110	

10. The following examples illustrate the procedure to be followed when using concrete ballast weights to replace "live" load:-

EXAMPLE 1. Glider loaded to maximum A.U.W. (14,500 lb.) C.G. on front limit (3.0 in. aft of datum).

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
Tare + Removable Military Load (from fig.1)	8,417	+ 18.9	+ 158,801
Add			
Second pilot	220	- 252.0	- 55,440
Ballast on stowage at forward end of cabin, 7 weights (17½ lb. each)	123	- 227.0	- 27,921
28 Concrete ballast weights Ref.a to bb inclusive	3,920	(See table)	- 208,390
4 Concrete ballast weights Ref.cc to ff inclusive	560	(See table)	+ 34,090
9 Concrete ballast weights Ref.ii to qq inclusive	1,260	(See table)	+ 142,310
TOTAL	14,500	+ 3.0	+ 43,450

C.G. position = 3.0 in. aft of datum

EXAMPLE 2. Glider loaded to light load (10,500 lb.) C.G. on aft limit (18.0 in. aft of datum).

	Weight (lb.)	Arm (in.)	Moment (lb.in.)
Tare + Removable Military Load (from fig.1)	8,417	+ 18.9	+ 158,801
Add			
Second pilot	220	- 252.0	- 55,44
Ballast on stowage at forward end of cabin, 2 weights (17½ lb. each)	35	- 227.0	-
6 Concrete ballast weights, Ref.v to aa inclusive	840	(See table)	+ 5,740
7 Concrete ballast weights, Ref.ff to ll inclusive	980	(See table)	+ 87,080
TOTAL	10,492	+ 18.0	+ 188,236

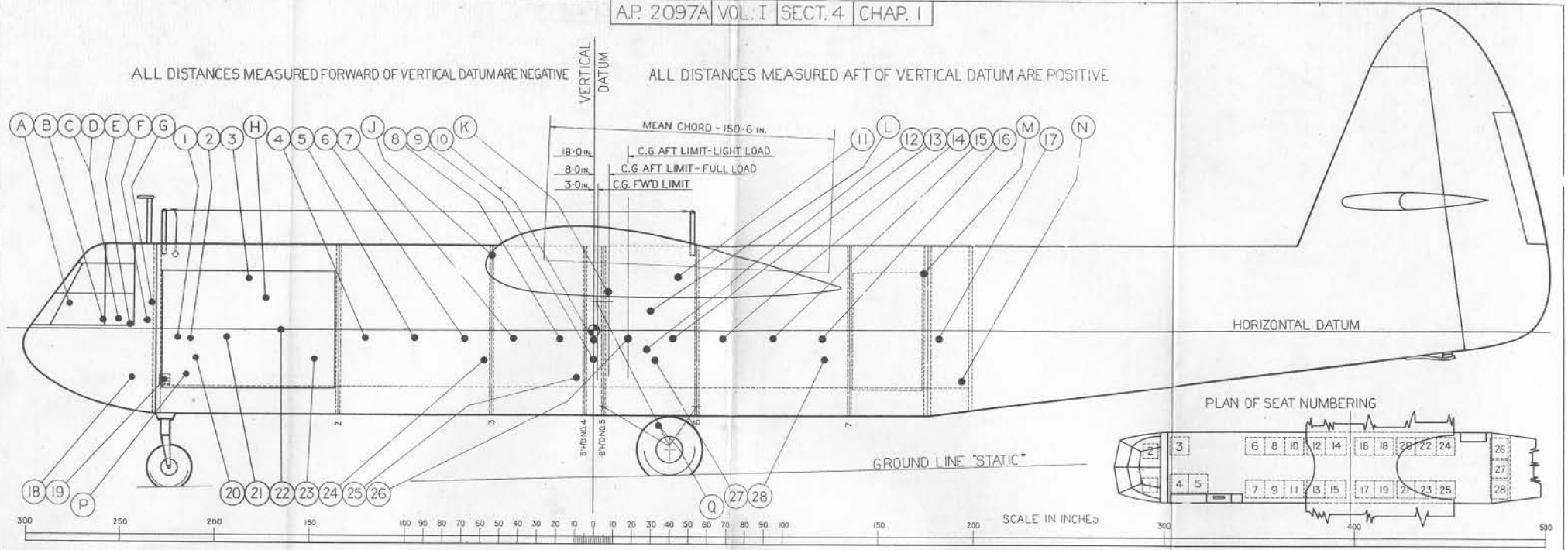
C.G. position = 18.0 in. aft of datum

11. Effect of alterations.- The following items are included in the tare weight given on the Loading and C.G. diagram (see fig.1). Their effect is given below since they may not be included on all gliders.

Item	Weight (lb.)	Arm (in.)	Moment (lb. in.)
Main skid	270	+ 24.0	+ 6,480
Dive brakes and controls	60	0.0	0
Undercarriage jettison cont	5	- 100.0	- 500

12. Modifications.- The following modifications are satisfied or embodied on the glider as shown in fig.1:-

Nos. 1 - 12, 14, 16 - 20, 23 - 25, 27 - 29, 31 - 33, 35, 44 - 47 inclusive.



REMOVABLE MILITARY LOAD

ITEM	REF	WEIGHT LB.	ARM IN.	MOMENT LB. IN. POSITIVE	MOMENT LB. IN. NEGATIVE
TARE WEIGHT	L	7,550·0	+ 28·02	1,400	
SIGNAL PISTOL & CARTRIDGES	E	7·5	-246·0		1,845
ELECTRIC TORCHES	J	4·0	- 54·0		216
PILOT'S WRITING PAD	B	1·5	-260·0		390
CLOCK	A	0·5	-278·0		139
MAIN WHEELS	Q	560·0	+ 34·0	19,040	
EMERGY JETTISON HANDLE	K	1·0	+ 8·0	8	
SANITARY CONTAINER	G	1·0	-234·0		234
VACUUM FLASK & EMERGY RATION CONTAINER	F	7·0	-236·0		1,652
FIRST AID OUTFIT	N	2·5	+194·0	485	
MISC. EQUIPMENT (NOTE 1)	M	2·0	+174·0	348	
ENTRANCE LADDER	H	8·0	-173·0		1,384
T.R.9D RADIO	P	52·0	-215·0		11,180
TOTAL		647·0		19,881	17,040
PILOT & PARACHUTE	C	220·0	-252·0		55,440
		—	—	231,281	72,480
TARE + REMOVABLE MILITARY LOAD		8,417·0	+ 18·9	158,801	—

C.G. POSITION = 18·9 IN. AFT OF DATUM

NOTE: 1. ITEM REF. M. MISC. EQUIPMENT CONSISTS OF BLACK-OUT COVERS, CONTAINER STRUTS & KEYS.

NOTE: 2. THE C.G. POSITION 18·9 IN. IS AFT OF THE REAR C.G. LIMIT. THEREFORE WHEN GLIDER IS FLOWN PILOT ONLY, 9 STANDARD BALLAST WEIGHTS (17½ LB. EACH) MUST BE CARRIED ON THE STOWAGE AT FORWARD END OF CABIN.

ITEMS OF DISPOSABLE LOAD

ITEM	REF	WEIGHT LB.	ARM IN.	MOMENT LB. IN. POSITIVE	MOMENT LB. IN. NEGATIVE
PLATFORM FOR CENTRE GUNNER	12	10·0	+ 28·0	280	
RECONNAISSANCE FLARE	18	23·0	-244·0		5,612
SAFETY BELTS FOR SEATS Nos. 3-5	2	6·0	-213·0		1,278
SAFETY BELTS FOR SEATS Nos. 6-25	10	38·0	0·0	—	—
SEATS Nos. 3-5	20	17·0	-210·0	—	3,570
SEATS Nos. 6-25	9	120·0	0·0	—	—
MAIN DOOR REMOVABLE PANEL	22	26·0	-165·0		4,290
MAIN DOOR EXTENSION RAMP	3	24·0	-182·0		4,368
EQUIPMENT CONTAINERS IN WING	11	AS REQ'D	+ 44·5		
VACUUM FLASKS 24 OFF	25	48·0	- 9·0		432
2 TROOPS IN SEATS Nos. 3 & 4	1	440·0	-220·0		96,800
1 TROOP IN SEAT No. 5	21	220·0	-195·0		42,900
2 TROOPS IN SEATS Nos. 6 & 7	4	440·0	-121·0		53,240
2 TROOPS IN SEATS Nos. 8 & 9	5	440·0	- 95·0		41,800
2 TROOPS IN SEATS Nos. 10 & 11	6	440·0	- 68·5		30,140
2 TROOPS IN SEATS Nos. 12 & 13	7	440·0	- 42·0		18,480
2 TROOPS IN SEATS Nos. 14 & 15	8	440·0	- 18·0		7,920
2 TROOPS IN SEATS Nos. 16 & 17	26	440·0	+ 18·0	7,920	
2 TROOPS IN SEATS Nos. 18 & 19	13	440·0	+ 42·0	18,480	
2 TROOPS IN SEATS Nos. 20 & 21	14	440·0	+ 68·5	30,140	
2 TROOPS IN SEATS Nos. 22 & 23	15	440·0	+ 95·0	41,800	
2 TROOPS IN SEATS Nos. 24 & 25	16	440·0	+121·0	53,240	
3 TROOPS IN SEATS Nos. 26, 27 & 28	17	660·0	+182·0	120,120	
MOTOR CYCLE COMBINATION	23	800·0	-148·0		118,400
MOTOR CYCLE COMBINATION	24	800·0	- 58·0		46,400
MOTOR CYCLE COMBINATION	27	800·0	+ 32·0	25,600	
MOTOR CYCLE COMBINATION	28	800·0	+122·0	97,600	
BALLAST WEIGHTS 9 OFF (17½ LB. EACH)	19	157·5	-227·0		35,753

"A" LOAD TROOP TRANSPORT

ITEM	REF	WEIGHT LB.	ARM IN.	MOMENT LB. IN. POSITIVE	MOMENT LB. IN. NEGATIVE
TARE + REMOVABLE MILITARY LOAD		8,417·0	+ 18·9	158,801	
PLATFORM FOR CENTRE GUNNER	12	10·0	+ 28·0	280	
RECONNAISSANCE FLARE	18	23·0	-244·0		5,612
SAFETY BELTS FOR SEATS Nos. 3-5	2	6·0	-213·0		1,278
SAFETY BELTS FOR SEATS Nos. 6-25	10	38·0	0·0	—	—
SEATS Nos. 3-5	20	17·0	-210·0	—	3,570
SEATS Nos. 6-25	9	120·0	0·0	—	—
SECOND PILOT	D	220·0	-252·0		55,440
1 TROOP IN SEAT No. 4	1	220·0	-220·0		48,400
1 TROOP IN SEAT No. 5	21	220·0	-195·0		42,900
2 TROOPS IN SEATS Nos. 6 & 7	4	440·0	-121·0		53,240
2 TROOPS IN SEATS Nos. 8 & 9	5	440·0	- 95·0		41,800
2 TROOPS IN SEATS Nos. 10 & 11	6	440·0	- 68·5		30,140
2 TROOPS IN SEATS Nos. 12 & 13	7	440·0	- 42·0		18,480
2 TROOPS IN SEATS Nos. 14 & 15	8	440·0	- 18·0		7,920
2 TROOPS IN SEATS Nos. 16 & 17	26	440·0	+ 18·0	7,920	
2 TROOPS IN SEATS Nos. 18 & 19	13	440·0	+ 42·0	18,480	
2 TROOPS IN SEATS Nos. 20 & 21	14	440·0	+ 68·5	30,140	
2 TROOPS IN SEATS Nos. 22 & 23	15	440·0	+ 95·0	41,800	
2 TROOPS IN SEATS Nos. 24 & 25	16	440·0	+121·0	53,240	
1 TROOP IN SEAT No. 27	17	220·0	+182·0	40,040	
VACUUM FLASKS 24 OFF	25	48·0	- 9·0		432
EQUIPMENT CONTAINERS IN WING	11	541·0	+ 44·5	24,075	
		—	—	374,776	309,212
A.U.W. "A" LOAD		14,500·0	+ 4·5	65,564	—

C.G. POSITION = 4·5 IN. AFT OF DATUM

"B" LOAD - MOTORCYCLE TRANSPORT

ITEM	REF	WEIGHT LB.	ARM IN.	MOMENT LB. IN. POSITIVE	MOMENT LB. IN. NEGATIVE
TARE + REMOVABLE MILITARY LOAD		8,417·0	+ 18·9	158,801	
RECONNAISSANCE FLARE	18	23·0	-244·0		5,612
SAFETY BELTS FOR SEATS Nos. 3-5	2	6·0	-213·0		1,278
SEATS Nos. 3-5	20	17·0	-210·0		3,570
MAIN DOOR REMOVABLE PANEL	22	26·0	-165·0		4,290
MAIN DOOR EXTENSION RAMP	3	24·0	-182·0		4,368
SECOND PILOT	D	220·0	-252·0		55,440
2 TROOPS IN SEATS Nos. 3 & 4	1	440·0	-220·0		96,800
1 TROOP IN SEAT No. 5	21	220·0	-195·0		42,900
3 TROOPS IN SEATS Nos. 26, 27 & 28	17	660·0	+182·0	120,120	
MOTOR CYCLE COMBINATION	23	800·0	-148·0		118,400
MOTOR CYCLE COMBINATION	24	800·0	- 58·0		46,400
MOTOR CYCLE COMBINATION	27	800·0	+ 32·0	25,600	
MOTOR CYCLE COMBINATION	28	800·0	+122·0	97,600	
VACUUM FLASKS 6 FF	25	12·0	- 9·0		108
EQUIPMENT CONTAINERS IN WING (A MINIMUM OF 400 LB. MUST BE CARRIED)	11	235·0	+ 44·5	54,958	
		—	—	457,079	379,166
A.U.W. "B" LOAD		14,500·0	+ 5·4	77,913	—

C.G. POSITION = 5·4 IN. AFT OF DATUM

NOTE. WEIGHT OF ITEM No. 11 - EQUIPMENT CONTAINERS IN WING, IS LIMITED BY LOAD AND BY A.U.W. MAX. LOADED WEIGHT OF EACH CONTAINER = 330 LB

MAX. PERMISSIBLE ALL-UP WEIGHT IS LIMITED TO **14,500 LB.** PENDING INVESTIGATION OF STRENGTH FACTORS AT INCREASED WEIGHT

LIMITS OF PERMISSIBLE C.G. TRAVEL IN. AFT OF DATUM =
3·0 TO 8·0 FULL LOAD (14,500 LB.)
3·0 TO 18·0 LIGHT LOAD (10,500 LB.)

TARE WEIGHT 7,550·0 LB.
INCLUDES THE FOLLOWING ITEMS:-

ACCUMULATOR	47·0 LB.
SAFETY BELTS FOR PILOT & CO-PILOT	4·0 LB.
SAFETY BELTS AT SEATS Nos. 26, 27 & 28	6·0 LB.
MAIN SKID	236·0 LB.

DOES NOT INCLUDE:-
MAIN WHEELS 560·0 LB.

FIG. 1

LOADING & C.G. DIAGRAM

FIG. 1

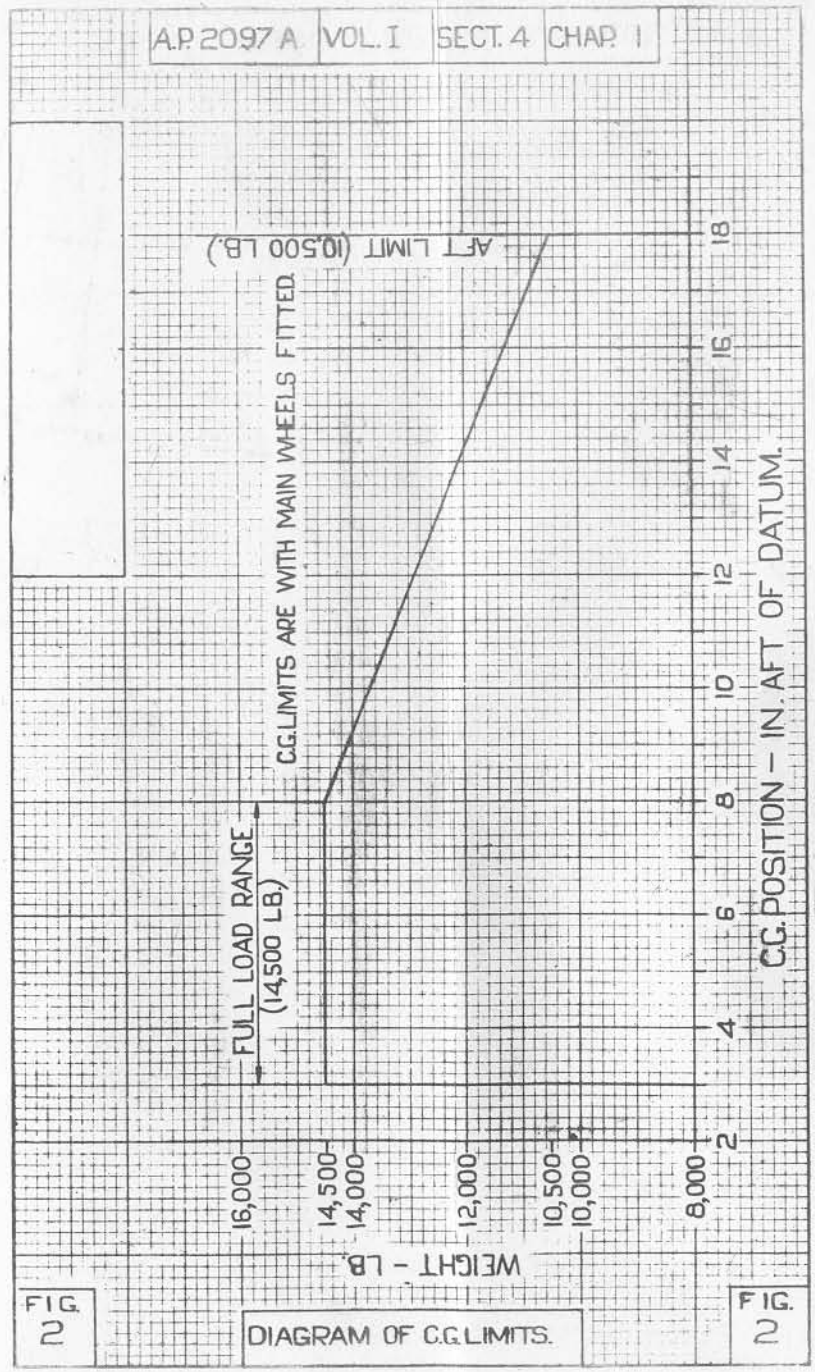


FIG. 2 DIAGRAM OF C.G. LIMITS. FIG. 2

A.P. 2097A | VOL. I. | SECT. 4 | CHAP. 1

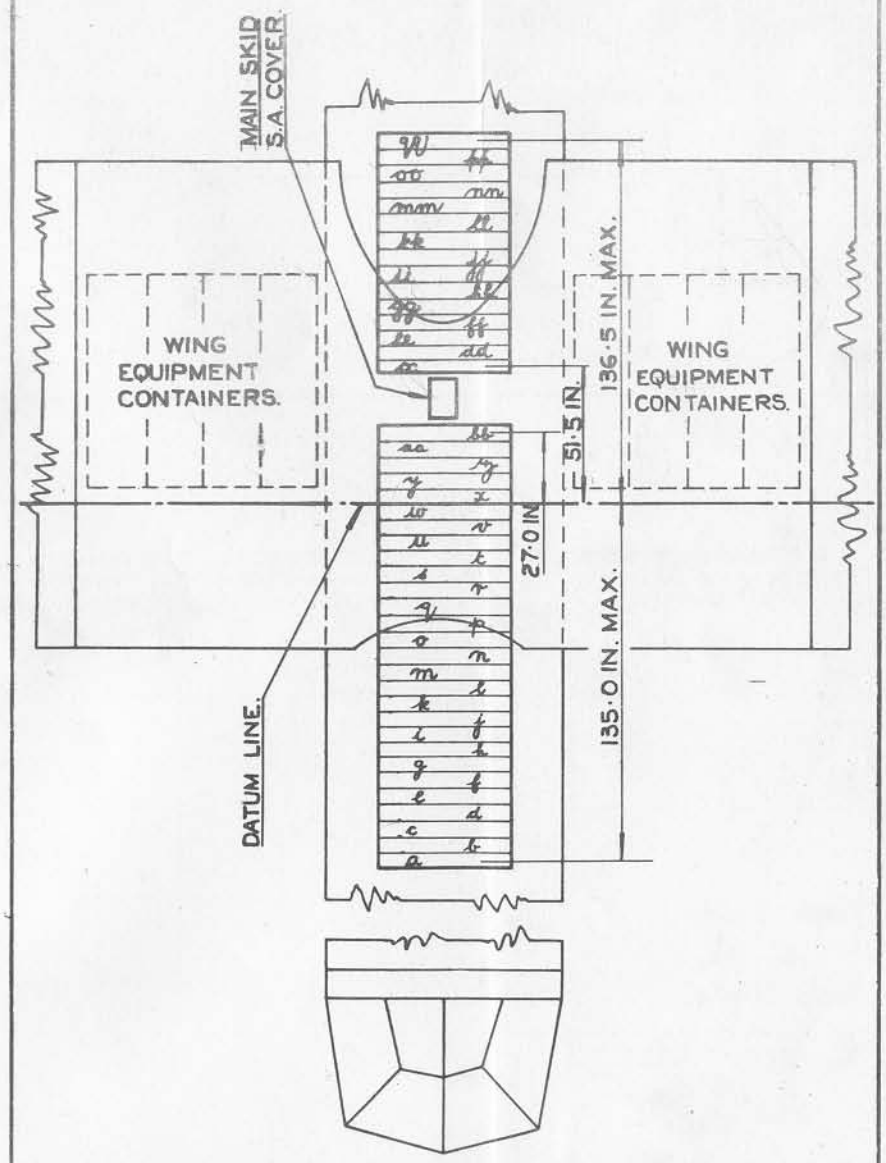
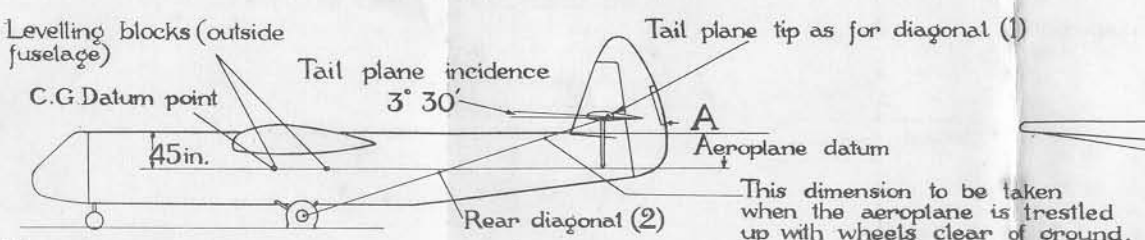
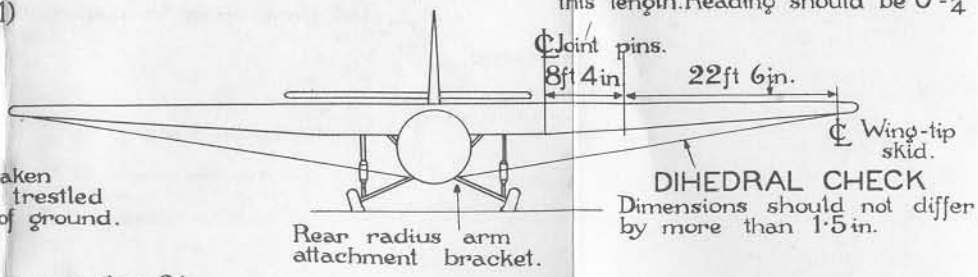


FIG. 3 CONCRETE BALLAST WEIGHT POSITIONS. FIG. 3





DIHEDRAL CHECK

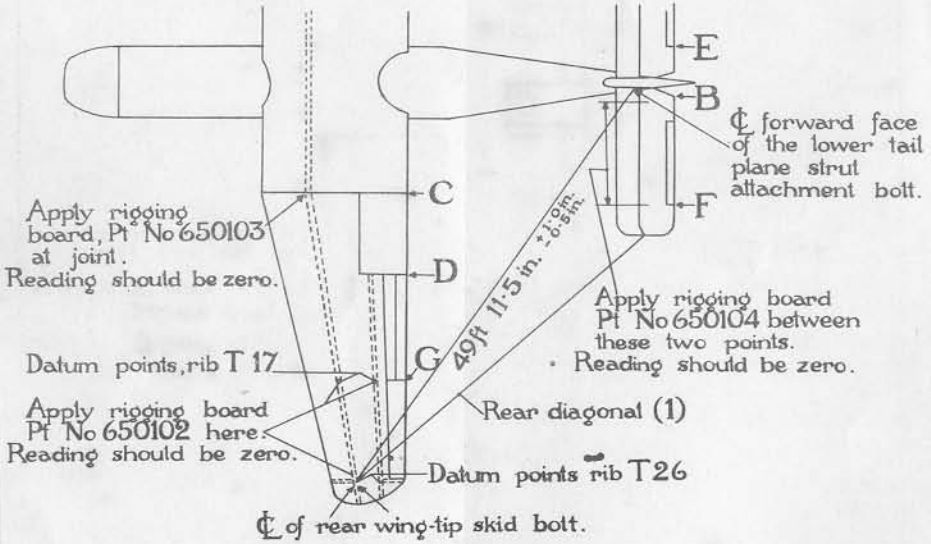
Dimensions should not differ by more than 1·5 in.

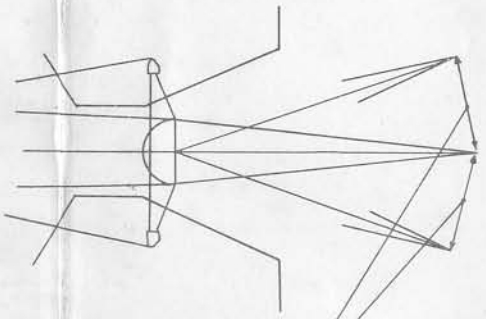
Measure from here

2in. bar temporarily inserted to form an anchorage for measuring tape.

DIAGONAL CHECKS

(1) Rear diagonals to wing tips must not differ by more than 2 in.
(2) Diagonals to tail plane tips must not differ by more than 1·5 in.



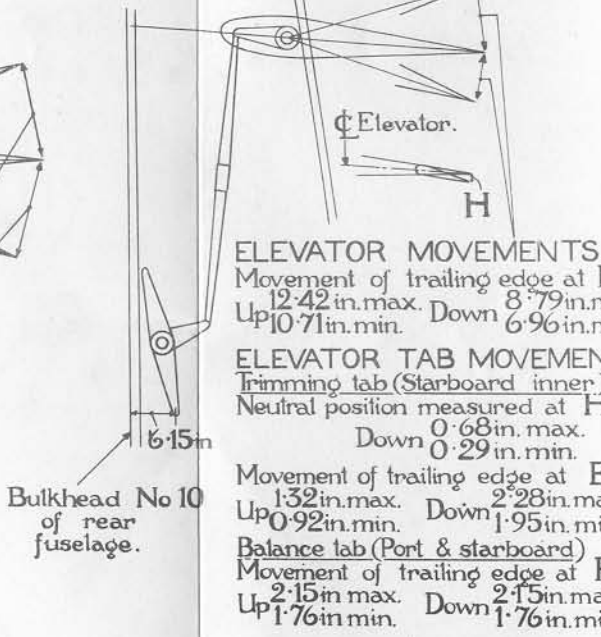


RUDDER MOVEMENTS

Either side of ℄ measured at point A
19·54 in. max.
16·02 in. min.

RUDDER TAB MOVEMENTS

Either side of ℄ of rudder measured at point A
2·46 in. max.
2·17 in. min.

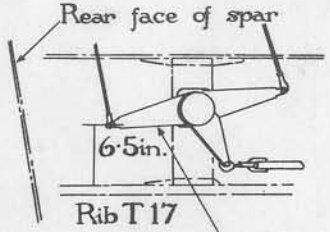


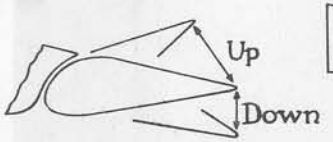
ELEVATOR MOVEMENTS

Movement of trailing edge at B
Up 12·42 in. max. 10·71 in. min.
Down 8·79 in. max. 6·96 in. min.

ELEVATOR TAB MOVEMENTS

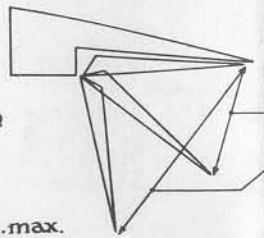
Trimming tab (Starboard inner)
Neutral position measured at H
Down 0·68 in. max. 0·29 in. min.
Movement of trailing edge at E
Up 1·32 in. max. 0·92 in. min.
Down 2·28 in. max. 1·95 in. min.
Balance tab (Port & starboard)
Movement of trailing edge at F
Up 2·15 in. max. 1·76 in. min.
Down 2·15 in. max. 1·76 in. min.





AILERON MOVEMENTS

measured at point D
Up 16·75 in. max. 15·2 in. min.
Down 11·65 in. max. 10·1 in. min.



FLAP MOVEMENTS

measured at C
0°-40° :- 31·8 in. max. 28·85 in. min.
0°-80° :- 58·6 in. max. 56 in. min.

FIG. 1

RIGGING DIAGRAM

FIG. 1

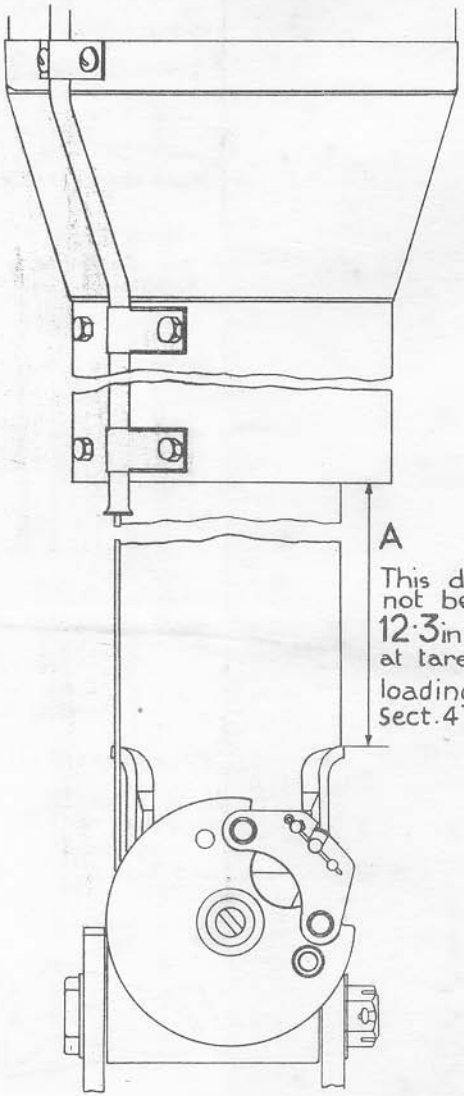


FIG. 2 SHOCK STRUT EXTENSION MEASUREMENT FIG. 2

AMENDMENT CERTIFICATE

Incorporation of an amendment list must be certified by inserting date of incorporation and initials below.

A.L. NO.	INITIALS	DATE	A.L. NO.	INITIALS	DATE
1	RH	12.10.44	11		
2	RH	12.10.44	12		
3	RH	12.10.44	13		
4	RW.	8.2.45.	14		
5	RW.	8.2.45.	15		
6	BB.	7.5.45	16		
7			17		
8			18		
9			19		
10			20		