

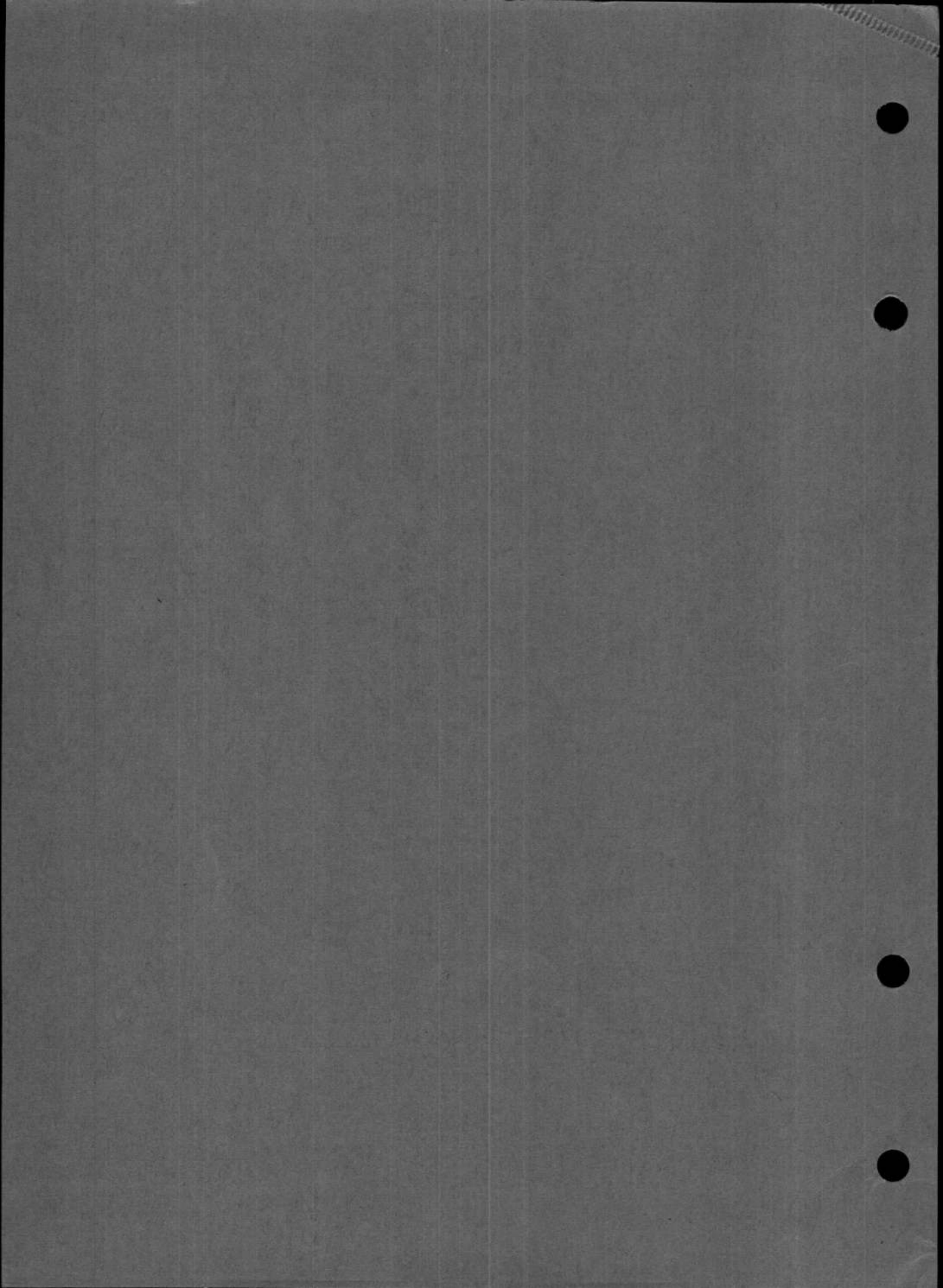
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CHAPTER

1

LOADING AND C.G. DATA



CHAPTER I

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Introduction

1. This chapter deals with the effect of different loads upon the fore and aft position of the centre of gravity (C.G.) of this aircraft.
2. The C.G. position is determined with the aircraft in the rigging position (fuselage datum line horizontal) and the alighting gear lowered, and is found by taking moments about a fixed point known as the C.G. datum point.

Datum point

3. The position of the datum point is arbitrarily selected by the manufacturers and, in this aircraft, is situated on the fuselage side vertically below the C/L of the lower spar wing-to-fuselage joint.

Positive and negative moments

4. The distance of each load from the datum point is known as its "moment arm." The loads are measured in pounds and the moment arms in feet. If a load lies forward of the datum point its moment arm is taken as negative and, therefore, the resultant moment is negative. Conversely, the moment arms and moments of loads aft of the datum point are taken as positive.

F.S./2

Method of calculating the C.G. position

5. The C.G. position is determined from the following expression:—

$$\frac{\text{Tare weight} \times \text{tare moment arm} + \text{weights of loads} \times \text{respective moment arms}}{\text{Tare weight} + \text{total weights of loads}} = \frac{\text{Tare moment} + \text{load moments}}{\text{Total weight}}$$

The C.G. range

6. Approved limits of travel of the C.G. are shown in fig. 1 and the tables. The C.G. must always be kept within this range, even when the load, fuel and oil are wholly or partially expended.

7. The C.G. limits given refer to the aircraft with the undercarriage lowered and the retraction of the undercarriage may cause the C.G. to move beyond the aft limit. This apparent discrepancy is due to the fact that the C.G. position at the flying trials is determined with the undercarriage down, so that the rearward movement caused by the retraction of the undercarriage is automatically allowed for in the tests.

Typical service load

8. The positions of the C.G. of all items of equipment to complete the typical service load (TSL) are given in fig. 1. The items in the tables follow Appendix A order.

Tare weight

9. The tare weight and moment given in the tables includes all fixed fittings and equipment not listed in the tables and takes account of Modifications 1—218. Should subsequent modifications affect the tare weight and moment, details will be given in an amendment to this chapter.

## Typical examples

10. In the following paragraphs calculations are given for the C.G. position under possible conditions of variations of loading during flight. All examples refer to the aircraft with the alighting gear DOWN.

### Aircraft without drop tanks

11. Normal load.	Weight (lb.)	Moment (lb./ft.)
Tare weight	5,949	7,395
Load (all items in table)	2,778	-3,496
<b>Total</b>	<b>8,727</b>	<b>3,899</b>

$$\text{C.G. moment arm} = \frac{(\text{Moment})}{(\text{Weight})} = \frac{3,899}{8,727}$$

$$= 0.447 \text{ ft. aft of datum}$$

12. *Load consumption.* The consumption of all fuel and expenditure of all ammunition modifies the C.G. position as follows:—

Tare weight	5,949	7,395
Load (all items in table except items 4, 21 and 22)	766	-3,276
<b>Total</b>	<b>6,715</b>	<b>4,119</b>

$$\text{C.G. moment arm} = \frac{(\text{Moment})}{\text{Weight}} = \frac{4,119}{6,715}$$

$$= 0.613 \text{ ft. aft of datum}$$

### Aircraft with drop tanks

13. *Faulty loading.* In the following case the aircraft is fitted with drop tanks, but the ballast weight or ammunition has been omitted. The C.G. position is aft of the permissible limit, and the aircraft is, therefore, unsafe for flight.

Tare weight	5,949	7,395
Load (all items in table except 4, 5 and 23)	2,537	-2,331

$$\text{Total} \dots \dots 8,486 \quad 5,064$$

$$\text{C.G. moment arm} = \frac{(\text{Moment})}{(\text{Weight})} = \frac{5,064}{8,486}$$

$$= 0.597 \text{ ft. aft of datum}$$

*Correction.* This can be rectified by adding a ballast weight of 250 lb. in the ammunition tanks.

Tare weight	5,949	7,395
Load (as above)	2,537	-2,331
Add ballast of 250 lb. (item 3)	250	-750

$$\text{Total} \dots \dots 8,736 \quad 4,314$$

$$\text{C.G. moment arm} = \frac{(\text{Moment})}{(\text{Weight})} = \frac{4,314}{8,736}$$

$$= 0.494 \text{ ft. aft of datum}$$

The C.G. is now within the permissible limits (with drop tanks fitted).

### **WARNING**

Since the 100 gall. drop tanks available for this aircraft have an unstabilising effect, it is not permissible to fly with drop tanks on and ammunition tanks empty. Therefore, for combat purposes, the drop tanks should be dropped before ammunition is expended. When ferrying the aircraft with drop tanks fitted, 250 lb. of ballast must be carried in the ammunition tanks.

# LOADING AND C.G. TABLES AND KEY TO FIG. I.

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Ref.	Item No.	REMOVABLE ITEMS OF MILITARY LOAD	Standard Fighter			Standard Version with Auxiliary Drop Tanks		
			Weight (lb.)	Lever Arm (ft.)	Moment (lb./ft.)	Weight (lb.)	Lever Arm (ft.)	Moment (lb./ft.)
See Note I	1	ARMAMENT :—						
	2	4 20-mm. Mk. V guns ... ..	352.0	-3.89	-1,370	352.0	-3.89	-1,370
	3	4 feed mechanisms ... ..	76.0	-2.2	-167	76.0	-2.2	-167
	4	4 firing units... ..	21.2	-2.1	-45	21.2	-2.1	-45
	5	20-mm. gun ammunition—600 rounds ...	375.0	-3.0	-1,125	—	—	—
	6	Ballast in ammunition boxes (250 lb.) ...	—	—	—	250.0	-3.0	-750
See Note II	7	Gyro gun-sight, Mk. IID ... ..	12.0	-6.8	-82	12.0	-6.8	-82
	8	MISCELLANEOUS :—						
	9	G.45 camera and accessories ... ..	7.6	-9.8	-74	7.6	-9.8	-74
	10	Footage indicator ... ..	1.2	-6.8	-8	1.2	-6.8	-8
	11	Torch, type 'A' and battery ... ..	1.4	-5.1	-7	1.4	-5.1	-7
	12	Clock ... ..	0.5	-6.8	-3	0.5	-6.8	-3
	13	Crowbar ... ..	1.0	-5.0	-5	1.0	-5.0	-5
See Note III	14	Charge for oxygen cylinder ... ..	2.5	-3.0	-8	2.5	-3.0	-8
	15	Landing lamp ... ..	5.0	2.3	12	5.0	2.3	12
See Note III	16	CREW :—						
	17	Pilot, parachute and 'K' type dinghy ...	215.0	-5.12	-1,101	215.0	-5.12	-1,101
	18	RADIO :—						
	19	Transmitter-receiver T.R.1464 ... ..	34.5	-2.9	-100	34.5	-2.9	-100
See Note III	20	Control for T.R.1464 ... ..	1.6	-6.8	-11	1.6	-6.8	-11
	21	Receiver R.3121 and detonator ... ..	32.8	-9.0	-295	32.8	-9.0	-295
	22	Control for R.3121 ... ..	1.8	-6.8	-12	1.8	-6.8	-12
	23	FUEL SYSTEM :—						
See Note III	24	Drop tank release gear and fairings ...	—	—	—	14	0.3	4
	25	2 x 100 gall. capacity drop tanks ... ..	—	—	—	120	0.3	36
		TOTAL WEIGHTS AND MOMENTS :— REMOVABLE ITEMS OF MILITARY LOAD...	1,141	—	-4,401	1,150	—	-3,986
		FUEL AT 8.1 LB./GALL. :—						
See Note III	26	106 gall. wing fuel ... ..	859.0	2.23	1,916	859.0	2.23	1,916
	27	96 gall. fuselage fuel ... ..	778.0	-1.3	-1,011	778.0	-1.3	-1,011
	28	2 x 100 gall. wing drop tank fuel ... ..	—	—	—	1,620.0	0.3	486
	29	Aircraft tare to col. 10 of Appendix "A" u/c down ... ..	5,949	1.243	7,395	5,949	1.243	7,395
		TOTAL ALL-UP WEIGHTS AND MOMENTS: UNDERCARRIAGE DOWN ... ..	8,727	0.447 (5.36 in.)	3,899	10,356	0.463 (5.56 in.)	4,800
		Undercarriage retraction ... ..	—	—	136	—	—	136
		TOTAL ALL-UP WEIGHTS AND MOMENTS: UNDERCARRIAGE UP ... ..	8,727	0.462 (5.54 in.)	4,035	10,356	0.476 (5.71 in.)	4,936

Item No.	REMOVABLE ITEMS OF MILITARY LOAD NOT INCLUDED IN TYPICAL LOADINGS	Wt. (lb.)	Lever Arm (ft.)	Mnt. (lb./ft.)
	TARE WEIGHT 5,949 LB.			
	This weight includes the following items			
A	Accumulators 12 volt, 25 amp. hr.	77.2	-0.5	-39
B	Air cylinder ... ..	10.4	-4.3	-45
C	R.I. compass ... ..	6.0	1.8	11
D	Oxygen cylinderless charge ... ..	13.0	-3.0	-39
	Also the following :—			
	Ballast in nose—125 lb. (fixed to front armour plate) ... ..	125.0	—	—
	Gun gear ... ..	170.0	—	—
	Electrical equipment with wiring... ..	254.0	—	—
	Instruments ... ..	47.0	—	—
	Hydraulic gear ... ..	68.0	—	—
	Pneumatic gear ... ..	40.0	—	—
	Wireless equipment, fixed fittings, aerials, etc. ... ..	36.0	—	—
	All armour plating ... ..	160.0	—	—
	Inertia weight in elevator circuit ... ..	13.5	—	—

NOTE I : 4 20-mm. No. 2, Mk. V guns, comprising :—Empty case and link chutes, 4 electric firing units, cocking unit No. 6, 2 left-hand and 2 right-hand belt feed mechanisms.

NOTE II : G.45 camera comprising :—Adapter, type 32, indicator, type 45, mounting, type 27, relay unit and wedge plates.

NOTE III : Wireless units, all including valves.

### WEIGHT AND CENTRE OF GRAVITY RESTRICTIONS

MAXIMUM ALL-UP WEIGHT :— 10,500 lb.  
 MAXIMUM PERMISSIBLE LANDING WEIGHT 8,500 lb.  
 MAXIMUM ALL-UP WEIGHT FOR AEROBATIC FLYING :—8,700 lb.  
 NOTE :—AEROBATICS MAY ONLY BE PERFORMED WHEN DROP TANKS HAVE BEEN JETTISONED.

### LIMITS OF PERMISSIBLE C.G. TRAVEL (UNDERCARRIAGE DOWN)

FORWARD : 0.315 ft. (3.78 in.)  
 AFT : { 0.704 ft. (8.45 in.) less drop tanks,  
 { 0.568 ft. (6.82 in.) with drop tanks.

The above limits are measured aft of the vertical C.G. datum line and parallel to the fuselage datum line. With undercarriage UP, the corresponding limits are :—

Forward : 0.327 ft. (3.92 in.)  
 Aft : { 0.715 ft. (8.58 in.) less drop tanks  
 { 0.582 ft. (7.0 in.) with drop tanks

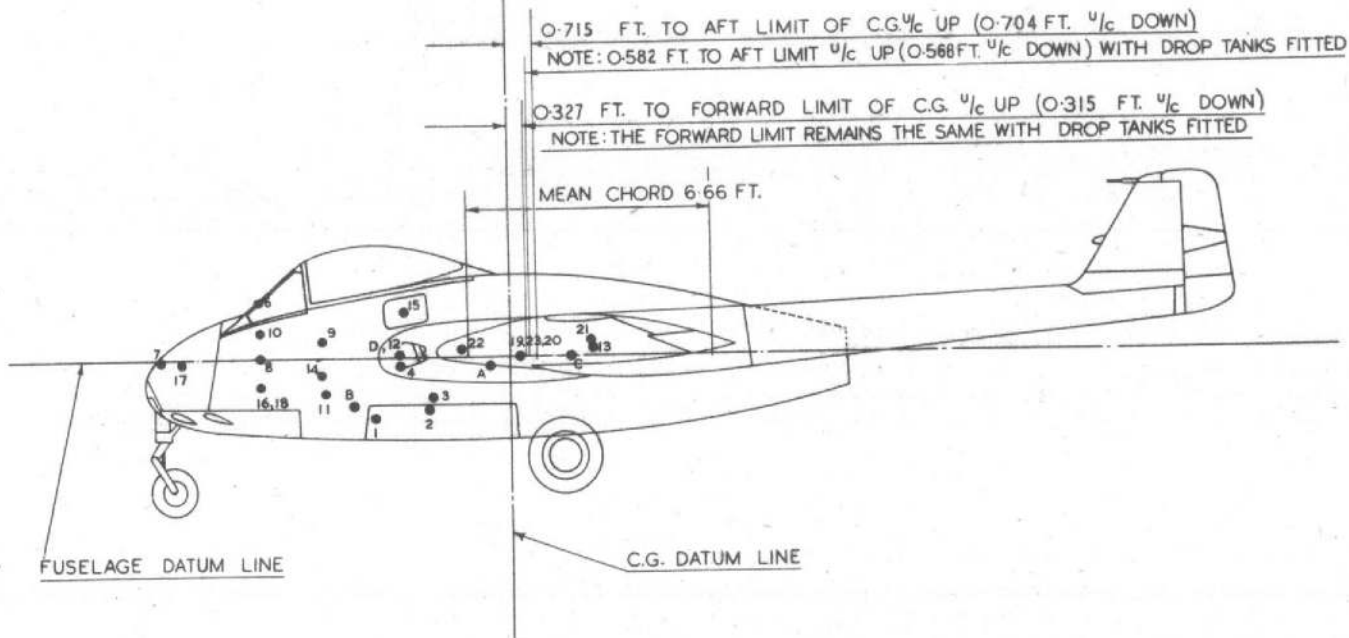
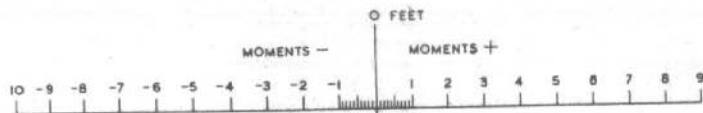
LENGTH OF MEAN CHORD : 6.66 ft. (79.9 in.)

$$\text{EQUATION TO MEAN CHORD : } \frac{\times + 1.35}{6.66}$$

NOTE : The C.G.'s quoted are applicable to aircraft fitted with both Goblin I and Goblin II engines.

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VAMPIRE F. MK.I.

FIG 1

LOADING & C.G. DIAGRAM

FIG 1



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