Chapter 3
LOADING AND C.G. DATA

(Completely revised)

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LIST OF ILLUSTRATIONS

Introduction

1. The data in this chapter is provided to enable the centre of gravity (C.G.) of an aircraft to be computed for any distribution of load. This enables investigation to be made into changes in C.G. which may result from expenditure of fuel, bombs, etc. and/or movement of crew immediately after take-off, or at any stage of the flight.

2. The basic weight and C.G. quoted in the following examples are average figures only and when computing a loading, the true basic weight and C.G. relative to the aircraft under consideration must be substituted.

3. The C.G. can also be determined practically by weighing the aircraft; reference must be made to A.P.1464D, Vol.1, Sect.1, Chap.3 and Sect.2, Chap. 3B of this Book.

DEFINITION OF C.G.

4. The C.G. is defined by its distance in feet, measured parallel to the fuselage datum line, from a reference point known as the C.G. loading datum (para.5). This distance is called the moment arm (para.6) of the C.G. and is determined from the following expression:-

$$\frac{(\text{Basic weight} \times \text{basic moment arm}) + (\text{Weight of loads} \times \text{respective arms})}{\text{Basic weight} + \text{Total weight of loads}}$$

$$= \frac{\text{Basic moment} + \text{Load moment}}{\text{Total weight}}$$

DATUM POINTS

5.

(1) *Loading datum*
The loading datum point is the intersection of the front fuselage datum and the front spar datum. This is shown on the loading and C.G. diagram (fig.7 and 8).

(2) *Weighing datum*
The weighing datum points are located on both port and starboard sides of the fuselage by a removable plug which is situated 31·205 ft. forward of the loading datum and 1·25 inches above the front fuselage datum. These locations are provided for the suspension of a plumb line when determining the C.G. by weighing.

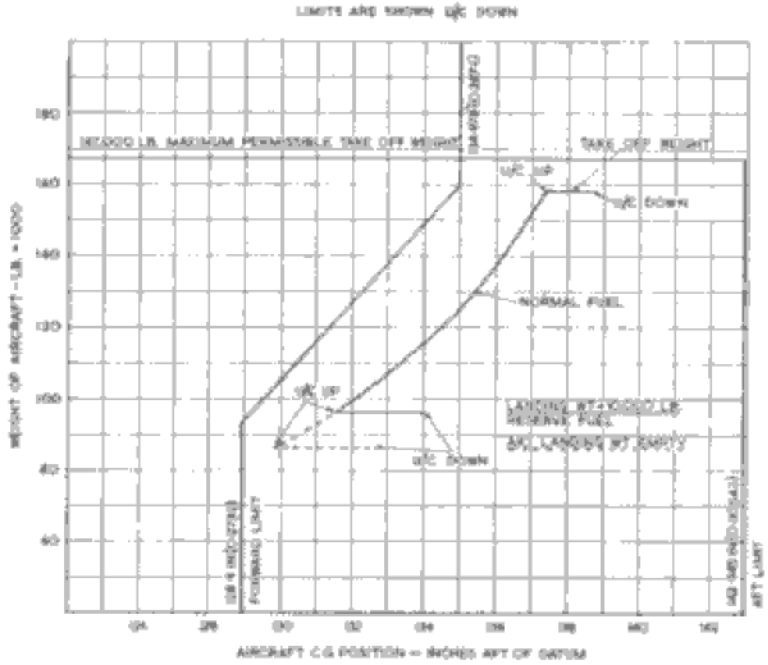

Fig. 1. Graph showing C.G. movement during flight

MOMENT AND MOMENT ARMS

6. The moment of an item is the product of its weight (lb.) and its moment arm (ft.), measured parallel to the fuselage datum line from the datum point. The moment arm of a load lying forward of the datum point is negative, although the load itself is positive. Therefore, the resultant moment is negative. The moment arm of a load lying aft of the datum point is positive and, therefore the resultant moment is positive.

WEIGHT AND C.G. LIMITATIONS

7. Maximum all-up and landing weights

Maximum all-up weight	167,000 lb.
Maximum landing weight	109,350 lb.

C.G. limits

Maximum forward limit: 128·90 in. - (10·742 ft.) aft of C.G. datum point.

Maximum aft limit: 142·94 in. (11·912 ft.) aft of C.G. datum point.

C.G. MOVEMENT IN FLIGHT

8. A loading which gives a satisfactory C.G. for take-off may be so affected by expenditure of fuel, etc., that the C.G. passes beyond its limit. The possibility of this occurrence must always be considered (para. 19). The effect of retracting the undercarriage has been taken into consideration in establishing the safe C.G. range and may, therefore, be neglected (para. 20).

AIRCRAFT BASIC WEIGHT

9. The Aircraft Basic Weight includes trapped fuel and oil, all fixed and removable operating equipment common to all roles, to which it is only necessary to add the variable or expendable load items for various missions.

BASIC WEIGHT AND MOMENT RECORD SHEET

10. This sheet is provided with each aircraft and is a continuous history of changes in structure or equipment affecting the weight and moment. It gives the current basic weight and moment of the aircraft to be used at the start of any loading calculation, the initial entry being the basic weight and the moment obtained from the C.G. report for the individual aircraft. It then proceeds to tabulate all equipment which falls into the category of service fit items and shortages, showing also the amount of ballast fitted. This list reduces the aircraft to the delivery condition, i.e., the basic weight of the aircraft as received by the service and is termed Delivery Basic Weight. The reference on this sheet to the Basic Index is for C.G. computer use only.

AB.123	VULCAN B	1		R.A.F. FORM 4908
Aircraft No.	Aircraft Type	Mark	Serial No.	

AIRCRAFT BASIC WEIGHT AND MOMENT RECORD

1	2	3				4		
		DETAILS OF CHANGE				CORRECTED BASIC FIGURES		
		Weight	Moment					
DATE	REASON FOR CHANGE	+ - LB.	+ - HORIZONTAL LB.FT. ~~OR INDEX UNITS~~	+ - VERTICAL ~~LB.FT. OR INDEX UNITS~~		WEIGHT LB.	HORIZONTAL MOMENT LB.FT. ~~OR INDEX UNITS~~	~~VERTICAL MOMENT LB.FT. OR~~ BASIC INDEX
	DELIVERY BASIC WEIGHT &					85,057.3	949,552	- 1.914
	MOMENT from C.G. Report							
	No. WTS/698/10.							
	D.2 Ballast and boxes							
	(1,004 + 30)	- 1,034	+ 26,022					
	D.1 Ballast and box							
	(807 + 90)	- 897	+ 31,993					
5UB/5748	Amplidyne	+ 39.5	- 1,347					
	Gloves & first aid kit - D.1	+ 4.5	- 144					
	First aid outfit - cabin	+ 6.0	- 160					
	Dinghy Type M.S.5	+ 115.8	- 2,582					

Basic Index = $\frac{\text{Basic Weight (Arm in ft. about aircraft Datum - 11.388 ft.)}}{10{,}000}$

Fig.2. R.A.F. Form 4908 (1)

AB.123	VULCAN B	1		R.A.F. FORM 4908
Aircraft No.	Aircraft Type	Mark	Serial No.	

AIRCRAFT BASIC WEIGHT AND MOMENT RECORD

1	2	3					4		
		DETAILS OF CHANGE					CORRECTED BASIC FIGURES		
		Weight		Moment					
				HORIZONTAL		VERTICAL			
DATE	REASON FOR CHANGE	+ −	LB.	+ −	LB.FT. ~~OR INDEX UNITS~~	+ −	~~LB.FT. OR INDEX UNITS~~	WEIGHT LB.	HORIZONTAL MOMENT LB.FT. ~~OR INDEX UNITS~~	~~VERTICAL MOMENT LB.FT. OR~~ BASIC INDEX
	Periscopic sextant Mk. 2									
	C/W Case 1 off	+	11.5	−	265					
	A.R.I.5851 Green Satin									
	removable equipment	+	251.1	+	2,840					
	A.R.I.5380 Radio altimeter Mk.6									
	high level removable equipment	+	38.7	−	525					
	A.R.I.5810 N.B.S. removable									
	equipment	+	1033.6	−	28,000					
	CURRENT BASIC WEIGHT &									
	MOMENT							84,627	977,384	+ 1.362

Basic Index = $\frac{\text{Basic Weight (Arm in ft. about aircraft datum} - 11.388 \text{ ft.})}{10,000}$

Fig.3. R.A.F. Form 4908 (2)

REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT

11. The removable equipment included in the basic weight is as follows:-

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	A.R.I.5870			
10B/16327	Scanner unit Type 121 } with connectors 280 lb.			
10D/19023	Frame assembly 4032 }			
10U/16761	Amplifier 40 lb.			
10D/18638	Modulator 50 lb.	489·0	- 35·7	- 17,457
10D/703	Analyser 52 lb.			
10D/18637	Transmitter/receiver TR.3702 58 lb.			
6W/5	Gyro unit Mk.6 9 lb.			
10QB/6493	Indicating unit Type 301	51·0	- 18·8	- 959
14A/4260	Camera	9·0	- 19·7	- 177
10L/16060	Control unit Type 626	1·8	- 20·0	- 36
10LB/6376	Control unit Type 595	10·0	- 18·8	- 188
10L/16154	Control unit Type 903	6·5	- 19·7	- 128
10DB/8811	Power unit Type 729	39·0	- 15·2	- 593
10VB/6250	Waveform generator Type 68	35·0	- 13·0	- 455
10D/18640	Automatic calculator Type 5	34·0	- 14·1	- 479
9D/10	Navigation panel	33·0	- 19·6	- 647
9D/8	Directional indicator	1·3	- 29·4	- 38
9D/2	Calculator Type 1, Mk.1	44·0	- 11·7	- 515
9D/3	Calculator Type 2, Mk.1	60·0	- 29·0	- 1,740
9D/4	Calculator Type 3, Mk.1	85·0	- 26·9	- 2,287
10LB/6366	Control unit Type 585	53·0	- 18·8	- 996
9D/11	Power unit	55·0	- 13·3	- 732
9D/1111	Time of fall control unit	3·0	- 29·2	- 88
9D/1110	Time of fall calculator	20·0	- 20·8	- 416
9D/12	Resistance unit	4·0	- 17·3	- 69
	Total weight and moment of A.R.I.5810 removable equipment	1,033.6	- 27·1	- 28,000
	A.R.I.18064			
10D/17937	Transmitter-receiver TR.1985	27·0	+ 36·2	+ 977
10D/17938	Transmitter/receiver TR.1986	27·0	+ 36·2	+ 3,152
	Total weight and moment of A.R.I.18064 removable equipment	54·0	+ 36·2	+ 1,954

REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Item No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
5UB/5748	Motor generator - time amplidyne	39·5	- 34·1	- 1,347
-	Periscopic sextant Mk.2 C/W Case	11·5	- 23·0	- 265
-	Oxygen charge, 5 bottles	35·0	+ 3·2	+ 112
7B/1484	Signal pistol 1.5 in., Mk.1	4·1	- 20·7	- 85
	Signal pistol cartridges 12 off	4·1	- 22·3	- 91
12D/1256	Ejector seat cartridges, Set No.3, Mk.1	3·0	- 27·0	- 81
-	First aid outfit - cabin	6·0	- 26·7	- 160
-	Gloves and first aid kit - nose section	4·5	- 32·1	- 144
-	Auto pilot equipment	127·0	- 19·0	- 2,413
-	Persicope at navigator's Station	40·0	- 17·9	- 716
-	Windscreen anti-icing fluid 2.6 gall.	21·2	- 33·6	- 712
-	Windscreen anti-icing fluid 12 gall. (Mod.549)	98·0	- 32·2	- 3,152
	A.R.I.5851			
10D/18843	Trans/receiver Type TR.3710	116·0	+ 17·5	+ 2,030
10Q/16094	Tracking unit Type 100	48·0	+ 19·4	+ 931
ED9/9553/C				
10B/17373	Waveguides	1·1	+ 18·1	+ 20
ED9/9552/C				
10B/16389	Aerial Type 501	40·0	+ 18·1	+ 724
10Q/16095	Control unit and indicator Type 101	21·0	- 18·8	- 395
6B/541	G.P. indicator Mk.4	25·0	- 18·8	- 470
	Total weight and moment of A.R.I.5851 removable equipment	251 1	+ 11·3	+ 2,840
	A.R.I.5380			
10Q/88	Pulse altimeter indicator Type 16	10·0	- 19·5	- 195
10D/2597	Trans/receiver Type 1579	28·7	- 11·5	- 330
	Total weight and moment of A.R.I.5380 removable equipment	38·7	- 13·6	- 525
	AD.7092D			
10D/19598	Receiver Type AD. 7092D	15·7	- 2·3	- 36
-	Receiver controller Type 1274	2·8	- 19·2	- 54
	Total weight and moment of AD.7092D removable equipment	18·5	- 4·9	- 90

REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Item No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	A.R.I.5378			
10Q/73	First pilot's indicator	4·9	- 29·7	- 146
10Q/73	Second pilot's indicator	4·9	- 29·7	- 146
10D/2585	Transmitter/receiver Type 1576	27·0	- 10·3	- 278
10K/17035	Power unit Type.814	10·8	- 9·4	- 102
	Total weight and moment of A.R.I.5378 removable equipment	47·6	- 14·1	- 672
	A.R.I.5874			
10L/293	Control unit Type 7216	16·1	- 19·0	- 306
10D/19065	Transmitter S.T.18, Type 4188	17·0	- 18·8	- 320
10D/19064	Receiver Type 4187	26·5	- 18·8	- 498
10D/19067	Power and radio unit Type 4192	36·0	- 18·8	- 677
5UC/6010	Voltage regulator	10·8	- 19·0	- 205
10L/16205	Control and drive unit Type 4190	12·5	- 18·8	- 235
10D/19248	Aerial selector unit Type 7003	17·0	- 19·0	- 323
10L/16204	Remote control unit Type 4189	2·5	- 19·0	- 48
	Total weight and moment A.R.I.5874 removable equipment	138·4	- 18·9	- 2,612
	A.1961			
10U/16596	Amplifier	6·3	- 21·9	- 138
	A.R.I.18011			
10Q/61	Indicator first pilot	1·4	- 29·5	- 41
10Q/61	Indicator second pilot	1·4	- 29·5	- 41
10L/263	Control unit Type 705	2·0	- 27·3	- 55
10D/17819	Receiver Type R1965	16·0	- 23·6	- 378
10D/17818	Receiver Type R1964	18·0	- 23·1	- 416
	Total weight and moment of A.R.I.18011 removable equipment	38·8	- 24·0	- 931

REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Item No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	A.R.I.5816			
10V16045	Waveform generator Type 72	21·5	- 18·5	- 398
10D/16876	Receiver Type R3673	21·5	- 18·5	- 398
10Q/16058	Indicator unit Type 26	18·5	- 19·0	- 352
	Total weight and moment of A.R.I.5816 removable equipment	61·5	- 18·7	- 1,148
	A.R.I.5800			
10D/18501	Radio head Type 1	65·0	+ 48·8	+ 3,172
10V/16057	Waveform generator	24·0	- 29·2	- 701
10Q/16073	Indicator Type 27	3·1	- 29·8	- 92
	Total weight and moment of A.R.I.5800 removable equipment	92·1	+ 25·8	+ 2,379

VARIABLE LOAD

12. Variable load is as follows:-

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	A.R.I.18051			
-	Container - aft of rear spar	29·5	32·5	959
-	Container - port and starboard	98·6	24·6	2,424
10AS/460	Stripper units 2 off	74	21·3	1,573
10AS/460	Stripper units 2 off	74	30·6	2,263
	Mountings, chutes and miscellaneous	15·3	24·6	374
	Control units and panel in cabin	15·75	- 20·2	- 318
	Total weight and moment of A.R.I.18051 equipment	307·15	23·7	7,275

VARIABLE LOAD (continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	T.4 Bombsight Installation			
9/4567	Computer	50·0	- 27·3	- 1,365
9/4566	Sighting head	15·0	- 29·0	- 435
9/4579	Amplifier	11·5	- 29·5	- 339
	Total weight and moment of T.4 bombsight equipment	76·5	- 28·0	- 2,139
	A.R.I.5848			
	Transmitter/receiver Type 279/APX 6	38·4	- 15·0	- 576
	Control unit Type R.160/34555/500	2·5	- 18·9	- 47
	Total weight and moment of A.R.I.5848 equipment	40·9	- 15·2	- 623
	Case A carriers and pintles (Blue Danube)	276·0	+ 11·9	+ 3,276
	Case B carriers and pintles (7,200 lb.store.)	295·0	+ 14·2	+ 4,201
	Case C carriers and pintles (6,000 lb. store)	473·0	+ 12·1	+ 5,728
	Case D carriers and pintles (7,500 lb. store)	473·0	+ 12·1	+ 5,728
	Case E carriers and pintles (Red Beard)	369·0	+ 12·1	+ 4,469
	Case F carriers and pintles (21 x 1,000 lb. bombs)	825·0	+ 13·4	+ 11,053
	Case G carriers and pintles (24 x 25 lb. smoke flashes)	1,050·0	+ 13·4	+ 14,039
	Case H carriers and pintles (24 x 100 lb. practice bombs)	1,050·0	+ 13·4	+ 14,039
	Aircraft destructors HE., No.1, Mk.1 (2 off)	+ 6·5	- 32·0	- 208
	Survival packs (5 off)	+ 170·0	- 33·9	- 5,766
	Oxygen - Walk round set Mk.4 (1 off and charge)	+ 8·0	- 23·2	- 186
	Bomb fuzing equipment	+ 108·0	- 1·9	- 205
	Misc. Appendix 'A' items - including binoculars, watches, navigational aid etc.	+ 47·1	- 22·5	- 1,067
	V.G. recorder IT 4.3.18	+ 4·2	- 19·8	- 83
	C. of G. Computer	+ 1·25	- 26·2	- 33
	Nitrogen charge - 16 bottles	94·0	+ 23·1	+ 2,171
	Nitrogen charge - 12 bottles	75·3	+ 23·4	+ 1,762

VARIABLE LOAD (continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	Pilot	+ 180·0	- 27·3	- 4,914
	Co-pilot	+ 180·0	- 27·3	- 4,914
	Air electronics officer	+ 180·0	- 21·6	- 3,888
	Navigators 2 off	+ 360·0	- 21·6	- 7,776
	Pilot's dinghy	+ 51·0	- 27·3	- 1,394
	Co-pilot's dinghy	+ 51·0	- 27·3	- 1,394
	Crew 1 dinghy	+ 43·7	- 21·7	- 947
	Crew 2 dinghy	+ 43·7	- 21·7	- 947
	Crew 3 dinghy	+ 43·7	- 21·7	- 947
	6th Crew member	+ 180·0	- 25·2	- 4,530
	Additional crew member's dinghy	+ 43·7	- 25·2	- 1,100

EXPENDABLE LOAD

13. Expendable load is as follows:-

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	Fuel			
	9370 gall. x 7.7 lb./gall.	72,149	12·195	879,857
	Bombs			
	Case A Blue Danube	10,225	+ 11·8	+ 120,382
	Case B 7,200 lb. store	7,200	+ 11·9	+ 85,968
	Case C 6,000 lb. store	3,175	+ 12·1	+ 38,285
	Case D 7,500 lb. store	7,500	+ 12·1	+ 90,438
	Case E Red Beard	1,680	+ 12·1	+ 20,339
	Case F 21 x 1,000 lb. bombs	21,000	+ 13·4	+ 280,499
	Case G 24 x 25 lb. smoke flashes	600	+ 13·4	+ 8,040
	Case H 24 x 100 lb. practice bombs	2,400	+ 13·4	+ 32,100
	Window			
	Case 1			
	10 AU/123 chaff Type 21 (3,696 packets)	689	24·42	16,825
	10 AU/123 chaff Type 21 (1,002 packets)	187	32·5	6,073
	Total weight case 1	876	26·14	22,898

EXPENDABLE LOAD (continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	Case 2			
	10 AU/124 chaff Type 22 (696 packets)	865	24·42	20,976
	10 AU/124 chaff Type 22 (352 packets)	219	32·5	7,104
	Total weight case 2	1,084	25·9	28,080
	Case 3			
	10 AU/125 rope Type 23 (696 packets)	680	24·42	16,606
	10 AU/125 rope Type 23 (352 packets)	156	32·5	5,070
	Total weight case 3	836	25·93	21,676
	Case 4			
	10 AU/123 chaff Type 21 (3,696 packets)	689	24·42	16,825
	10 AU/125 rope Type 23 (352 packets)	156	32·5	5,070
	Total weight case 4	845	25·91	21,895

FUEL LOADING DATA

14. Details of fuel tank capacities, weight and moment for varying fuel Specific Gravities are as follows:-

Tank No. P. & S.	Fuel S.G. 0.8 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,250	-11·027	10,000	-	110,270
2	1,890	- 3·0	15,120	-	45,360
3	1,260	13·316	10,080	134,225	-
4	1,240	19·055	9,920	189,026	-
5	1,020	21·937	8,160	179,005	-
6	1,470	25·616	11,760	301,243	-
7	1,100	28·538	8,800	251,133	-
-	-	-	-	1,054,632	155,630
Total	9,230	12·175	73,840	899,002	-

FUEL LOADING DATA (Continued)

Tank No. P. & S.	Fuel S.G. 0·78 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,270	-11·027	9,906	-	109,233
2	1,910	- 3·0	14,898	-	44,694
3	1,280	13·316	9,984	132,951	-
4	1,260	19·055	9,828	187,273	-
5	1,040	21·937	8,112	177,960	-
6	1,490	25·616	11,622	297,714	-
7	1,120	28·538	8,736	249,313	-
-	-	-	-	1,045,211	153,927
Total	9,370	12·195	73,086	891,284	-

Tank No. P. & S.	Fuel S.G. 0·77 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,270	-11·027	9,779	-	107,833
2	1,910	- 3·0	14,707	-	44,121
3	1,280	13·316	9,856	131,249	-
4	1,260	19·055	9,702	184,872	-
5	1,040	21·937	8,008	175,679	-
6	1,490	25·616	11,473	293,897	-
7	1,120	28·538	8,624	246,114	-
-	-	-	-	1,031,811	151,954
Total	9,370	12·195	72,149	879,857	-

Tank No. P. & S.	Fuel S.G. 0·76 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,270	-11·027	9,652	-	106,433
2	1,910	- 3·0	14,516	-	43,548
3	1,280	13·316	9,728	129,544	-
4	1,260	19·055	9,576	182,471	-
5	1,040	21·937	7,904	173,396	-
6	1,490	25·616	11,324	290,080	-
7	1,120	28·538	8,512	242,920	-
-	-	-	-	1,018,411	149,981
Total	9,370	-12·195	71,212	868,430	-

FUEL LOADING DATA (continued)

Tank No. P. & S.	Fuel S.G. 0.75 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,270	-11·027	9,525	-	105,032
2	1,910	- 3·0	14,325	-	42,975
3	1,280	13·316	9,600	127,840	-
4	1,260	19·055	9,450	180,070	-
5	1,040	21·937	7,800	171,115	-
6	1,490	25·616	11,175	286,263	-
7	1,120	28·538	8,400	239,723	-
-	-	-	-	1,005,011	148,007
Total	9,370	12·195	70,275	857,004	-

For design calculation use:-

Capacity (gall.)	Specific Gravity	Weight (lb.)	Mean Arm (ft.)	Moment (lb.ft.)
9,370	0·77	72,149	12·195	879,857

CREW LOADING DATA

15. The crew loading data is as follows:-

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Pilot	180	- 27·3	- 4,914
Co-pilot	180	- 27·3	- 4,914
Air electronics officer	180	- 21·6	- 3,888
Navigators - 2 Off	360	- 21·6	- 7,776
Total weight and moment - 5 Crew	900	- 23·88	- 21,492

CREW LOADING DATA (continued)

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Pilot's dinghy	51	- 27·3	- 1,394
Co-pilot's dinghy	51	- 27·3	- 1,394
Crew 1 dinghy	43·7	- 21·7	- 947
Crew 2 dinghy	43·7	- 21·7	- 947
Crew 3 dinghy	43·7	- 21·7	- 947
Total weight and moment - chutes and dinghies	233	- 24·15	- 5,626
Total weight and moment - 5 Crew with chutes and dinghies	1,133	- 23·93	- 27,118
6th Crew Member	180	- 25·16	- 4,530
Additional crew member's dinghy	43	- 25·16	- 1,082
Total weight and moment - 6th crew member and chute	223	- 25·16	- 5,612
Total weight and moment - 6 crew with chutes and dinghies	1,356	- 24·14	- 32,730

ENGINE C.G. DATA

16. To find $\bar{X}$ engine C.G. from front spar datum

$C = \cos 10^{\circ} \times A$
$= 0{\cdot}98481 \times A$
$\bar{X} = \text{C.G. of Trunnion} - C$
$= 164{\cdot}9841 - C$

Example:

A = C.G. of engine from trunnion = 5·5 in.
obtained from engine 'A.P.'

To find $\bar{X}$

$C = 0{\cdot}98481 \times 5{\cdot}5$
$= 5{\cdot}4165$
$X = 164{\cdot}9841 - 5{\cdot}4165$
$= 159{\cdot}676$ in. aft of datum

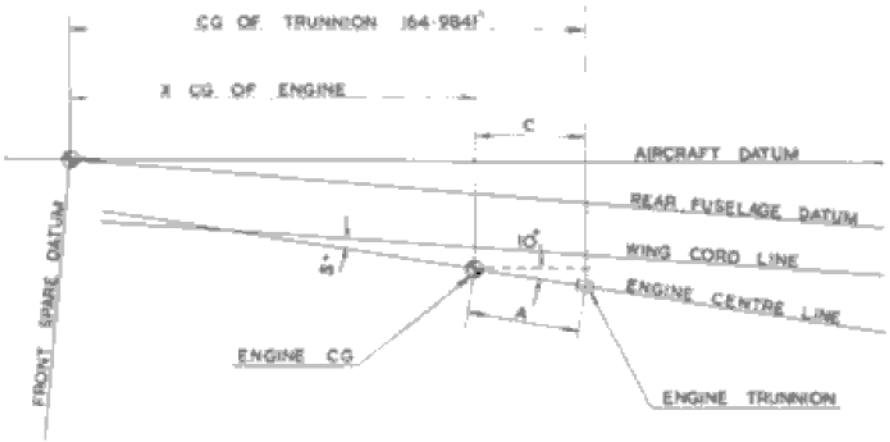

Fig.4. Engine C.G. data

TYPICAL LOADING CASES

17. Typical loading cases are as follows:-

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Case A - Blue Danube			
Current basic weight and moment - (obtained from record card)	84,630	11·548	977,314
Add:- Variable load			
Aircraft destructors H.E. No.1, Mk.1 (2 off)	6·5	- 32·0	- 208
Oxygen walk round set Mk.4 (1 off)	8	- 23·25	- 186
T.4 Bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069
A.R.I.5848 L.F.F. Mk.10 - removable	40·9	- 15·23	- 623
C. of G. computor	1·3	- 25·38	- 33
A.R.I.18051 window launching - removable	307·15	+ 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	276	11·869	3,276
Revised basic weight and moment	85,671·4	11·429	979,222
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149
Landing weight and moment no fuel or store	86,804·4	10·968	952,073
Add:- Expendable load			
Window Case 4	845	+ 25·91	21,895
Store	10,225	11·773	120,382
Landing weight and moment no fuel	97,874·4	11·181	1,094,350
Add:- Fuel	69,125·6	12·195	842,987
All up weight and moment	167,000	11·6	1,937,337
Case B - 1 x 7,200 lb. store			
Current basic weight and moment - (obtained from record card)	84,630	11·548	977,314
Add:- Variable load			
12L/203 Aircraft destructors H.E. No.1 Mk.1 (2 off)	6·5	- 32·0	- 208
Oxygen walk round set Mk.4 (1 off)	8	- 23·25	- 186
T.4 bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069

TYPICAL LOADING CASES (continued)

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
A.R.I.5848 I.F.F. Mk.10 - removable	40·9	- 15·23	- 623
C. of G. computor	1·3	- 25·38	- 33
A.R.I.18051 Window launching - removable	307·15	+ 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	295	14·24	4,201
Revised basic weight and moment	85,690·4	11·438	980,147
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149
Landing weight and moment no fuel or store	86,823·4	10·976	952,998
Add:- Expendable load			
Window Case 4	845	+ 25·91	21,895
Store	7,200	11·94	85,968
Landing weight and moment no fuel	94,868·4	11·182	1,060,861
Add:- Fuel	72,131·6	12·195	879,645
All up weight and moment	167,000	11·619	1,940,506
Case C - 1 x 6,000 lb. store			
Current basic weight and moment - (obtained from record card)	84,630	11·548	977,314
Add:- Variable load			
12L/203 Aircraft destructors H.E. No.1, Mk.1 (2 off)	6·5	- 32·0	- 208
Oxygen walk round set Mk.4 (1 off)	8	- 23·25	- 186
T.4 bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069
A.R.I.5848 I.F.F. Mk.10 - removable	40·9	- 15·23	- 623
C. of G computor	1·3	- 25·38	- 33
A.R.I.18051 window launching - removable	307·15	+ 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	473	12·106	5,726
Revised baxic weight and moment	85,868·4	11·432	981,672
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149

TYPICAL LOADING CASES (continued)

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Landing weight and moment no fuel or store	87,001·4	10·971	954,523
Add:- Expendable load			
Window Case 4	845	+ 25·91	21,895
Store	3,175	12·058	38,285
Landing weight and moment no fuel	91,021·4	11·147	1,014.703
Add:- Fuel	72,149	12·195	879,857
All up weight and moment	163,170	11·61	1,894,560
Case D - 1 x 7,500 lb. store			
Current basic weight and moment - (obtained from record card)	84,630	11·548	977,314
Add:- Variable load			
12L./203 Aircraft destructors H.E. No.1, Mk.1 (2 off)	6·5	- 32·0	208
Oxygen walk round set Mk.4 (1 off)	8	- 23·25	- 186
T.4 bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069
A.R.I.5848 I.F.F. Mk.10 - removable	40·9	- 15·23	- 623
C. of G. computor	1·3	- 25·38	- 33
A.R.I.18051 window launching - removable	307·15	+ 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	473	12·106	5,726
Revised basic weight and moment	85,868·4	11·432	981,672
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149
Landing weight and moment no fuel or store	87,001·4	10·971	954,523
Add:- Expendable load			
Window case 4	845	+ 25·91	21,895
Store	7,500	12·058	90,438
Landing weight and moment no fuel	95,346·4	11·189	1,066,856
Add:- Fuel	71,653·6	12·195	873,816
All up weight and moment	167,000	11·62	1,940,672

TYPICAL LOADING CASES (continued)

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Case E - Red Beard			
Current basic weight and moment - (obtained from record card)	84,630	- 11·548	977,314
Add:- Variable load			
Aircraft destructors H.E. No.1, Mk.1 (2 off)	6·5	- 32·0	- 208
Oxygen walk round set Mk.4 (1 off)	8	- 23·25	- 186
T.4 bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069
A.R.I.5848 I.F.F. Mk.10 - removable	40·9	- 15·23	- 683
C. of G. computor	1·3	- 25·38	- 33
A.R.I.18051 window launching - removable	307·15	+ 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	369	12·106	4,467
Revised basic weight and moment	85,764·4	11·431	980,413
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149
Landing weight and moment no fuel or store	86,897·4	10·969	953,264
Add:- Expendable load			
Window Case 4	845	+ 25·91	21,895
Store	1,680	12·106	20,339
Landing weight and moment no fuel	89,422·4	11·132	995,498
Add:- Fuel	72,149	12·195	879,857
All up weight and moment	161,571·4	11·606	1,875,355
Case F - 21 x 1,000 lb. bombs			
Current Basic Weight and Moment - (obtained from record card)	84,630	11·548	- 977,314
Add:- Variable load			
Aircraft destructors H.E. No.1, Mk.1 (2 off)	6·5	32·0	- 208
Oxygen walk round set Mk.4 (1 off)	8	23·25	- 186
T.4 bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069
A.R.I.5848 I.F.F. Mk.10 - removable	40·9	- 15·23	- 623
C. of G. computor	1·3	- 25·38	- 33
A.R.I.18051 window launching - removable	307·15	- 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	825	13·4	+ 11,053

TYPICAL LOADING CASES (continued)

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Revised basic weight and moment	86,220·4	+ 11·447	+ 986,999
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149
Landing weight and moment no fuel or store	87,353·4	10·988	959,850
Add:- Expendable load			
Window case 4	845	+ 25·91	21,895
Store	21,000	13·357	280,499
Landing weight and moment no fuel	109,198·4	11·559	1,262,244
Add:- Fuel	57,801·6	12·195	704,891
All up weight and moment	167,000	11·779	1,967,135
Case G - 24 x 25 lb. smoke flashes			
Current basic weight and moment - (obtained from record card)	84,630	11·548	- 977,314
Add:- Variable load			
Aircraft destructors H.E. No.1, Mk.1 (2 off)	6·5	- 32·0	- 208
Oxygen walk round set Mk.4 (1 off)	8	- 23·25	- 186
T.4 bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069
A.R.I.5848 I.F.F. Mk.10 - removable	40·9	- 15·23	- 623
C. of G. computor	1·3	- 25·38	- 33
A.R.I.18051 window launching - removable	307·15	+ 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	1,050	13·37	- 14,039
Revised basic weight and moment	86,445·4	11·452	989,985
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149
Landing weight and moment no fuel or store	87,578·4	10·993	962,836
Add:- Expendable load			
Window Case 4	845	+ 25·91	21,895
Store	600	13·2	8,040

TYPICAL LOADING CASES (continued)

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Landing weight and moment no fuel	89,023·4	- 11·15	992,771
Add:- Fuel	72,149	12·195	879,857
All up weight and moment	161,172·4	11·619	1,872,628
Case H - 24 x 100 lb. practice bombs			
Current basic weight and moment - (obtained from record card)	84,630	11·548	977,314
Add:- Variable load			
Aircraft destructors H.E. No.1, Mk.1 (2 off)	6·5	- 32·0	- 208
Oxygen walk round set Mk.4 (1 off)	8	- 23·25	- 186
T.4 bombsight installation - removable	76·5	- 27·96	- 2,139
Misc. Appendix 'A' items incl. binoculars etc.	47	- 22·74	- 1,069
A.R.I.5848 I.F.F. Mk.10 - removable	40·9	- 15·23	- 623
C. of G. computor	1·3	- 25·38	- 33
A.R.I.18051 window launching - removable	307·15	+ 28·85	+ 8,861
Bomb fuzing equipment	108	- 1·9	- 205
Survival packs	170	- 33·9	- 5,766
Carriers and pintles	1,050	13·37	14,039
Revised basic weight and moment	86,445·4	11·452	989,985
Add:- 5 crew complete with dinghies	1,133	- 23·96	- 27,149
Landing weight and moment no fuel or store	87,578·4	10·993	962,836
Add:- Expendable load			
Window Case 4	845	+ 25·91	21,895
Store	2,400	13·2	- 32,100
Landing weight and moment no fuel	90,823·4	11·19	1,016,831
Add:- Fuel	72,149	12·195	879,857
All up weight and moment	162,972·4	11·638	1,896,688

CALCULATIONS OF EXPENDABLE LOAD

18. This calculation is made on Case F (para.17) with 10,000 lb. of reserve fuel.

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Drop: Store 21 x 1,000 lb.	21,000	13·357	280,499
Window case	845	25·91	21,895
Use: Fuel less 10,000 reserve	47,865	12·195	583,709
Total weight and moment of expendable load	69,710	12·711	886,103

CALCULATION OF C.G. FOR LANDING

19. Case F leaving 10,000 lb. reserve fuel.

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
All-Up Weight	167,000	11·778	1,967,135
Remove para. 18 total	69,710	12·662	886,103
Landing weight and moment	97,290	11·11	1,081,032

Landing C.G. $= \frac{1,081,032}{97,290} = 11.11$ ft. (132·32 in.) aft of datum point.

EFFECT OF UNDERCARRIAGE RETRACTION

20. The moment effect of undercarriage retraction

= -19,640 lb.ft.

From para 17, Case F

Total moment = 1,967,135 lb.ft. (undercarriage down)

The C.G. position = 11·779 ft. (141·34 in.)

∴ Total moment (Undercarriage up) = 1,967,135 – 19,640 = 1,947,495 lb.ft.

The C.G. position (Undercarriage up) $= \frac{1,947,495}{167,000} = 11.66$ ft. (139·91 in.)

From the above calculations the effect of undercarriage retraction in Case D is a 1·43 in. C.G. shift forward.

Except in special cases where the C.G. position is on the forward limit the undercarriage retraction can be neglected.

LOADING NOTES ON BALLASTING

21.

1. General

For all production aircraft, if the H_2S Equipment on the scanner mounting is not fitted, the alternative loading of 570 lb. in the form of lead weights mounted in a wooden box must be fitted. (See drawing Z.8401 issued with Mod.116 for details).

2. Operation in Service

For operational flight loadings when all "Service Fit" items have been installed, it will not be necessary to use ballast. During the initial stages of Service flying, however, due to shortage of both "Contract Fit" and "Service Fit" items of equipment it may be necessary to carry ballast. To cover this condition Mod.116 was introduced calling up the following:-

Position	(ft.)	Drawing No.	Max. Capacity
D.1 ballast box	- 35·66	K.8401 - 1 off	810 lb. *
D.2 ballast box	- 25·17	SK.29556 - 2 off	500 lb. each

NOTE...
570 lb. of the 810 lb. maximum capacity is normally used as the alternative load to H_2S equipment.

3. D.1 ballast box

The Weight of the H_2S equipment plus amplidyne = 570 lb This can be replaced by weight of ballast box 90 lb. + lead weight 480 lb. For other missing equipment 40 lb. weights may be added to the ballast box to a minimum of 240 lb. Total 570 + 810 lb.

4. Ballast requirements

To enable the personnel in charge of load sheets, either at the firm or in service, to obtain the correct amount of ballast for each case, a graph has been prepared as shown on the following sheet. Arrangements should be made with the R.T.O. for the return of the ballast weights to the firm when the missing equipment has been installed in the aircraft.

NOTE...

Radomes fitted with 570 lb. weight (90 lb. box + 480 lb. lead to cover interchangeability of fitting. Extra ballast up to 810 lb. total can be refitted from inside.

Ballast

Case 1 - When to add ballast

It is assumed that the aircraft all up weight less ballast is known together with the C.G. position.

The safe C.G. range is from 10·742 ft. (128·90 in.) to 11·912 ft. (142·94 in.).

An A.U.W. less ballast of 152,666 lb. at a C.G. of 12·21 ft. has been selected.

The total C.G. movement required is 12·21 - 11·91 ft. = 3·6 in.

(1) D.1 ballast and box in lieu of H.2.S. scanner - read off D.1 ballast curve to obtain 268 lb./in. shift.

570 lb. gives a C.G. shift of $\frac{570}{268}$ = 2·13 in.

(2) D.1 extra ballast - To maximum (810 lb.)

240 lb. gives a C.G. shift of $\frac{240}{268}$ = 0·9 in.

The C.G. movement remaining = 3·6 - (2·13 + 0·9) = 0·57 in.

(3) Read off D.2 ballast curve to obtain 345 lb./in. shift.

Weight of D.2 ballast required is 345 x 0·57 = 197 lb.

say 5 x 40 lb. lead weights + 15 lb. box = 215 lb.

Case 2 - When to Remove Ballast

Landing weight - 5 crew, no fuel, no bomb, D.2 ballast only - 83,783 lb. at a C.G. of 10·74 ft. (128·88 in.).

The suggested maximum forward C.G. position undercarriage down is 134·2 in.

∴ The C.G. is required to move 134·2 - 128·88 = 5·32 in. aft.

Read off D.2 ballast curve to obtain 189 lb./in. shift.

∴ Weight of ballast to be removed = 189 x 5·32 = 1,005 lb.

i.e., All D.2 ballast and boxes.

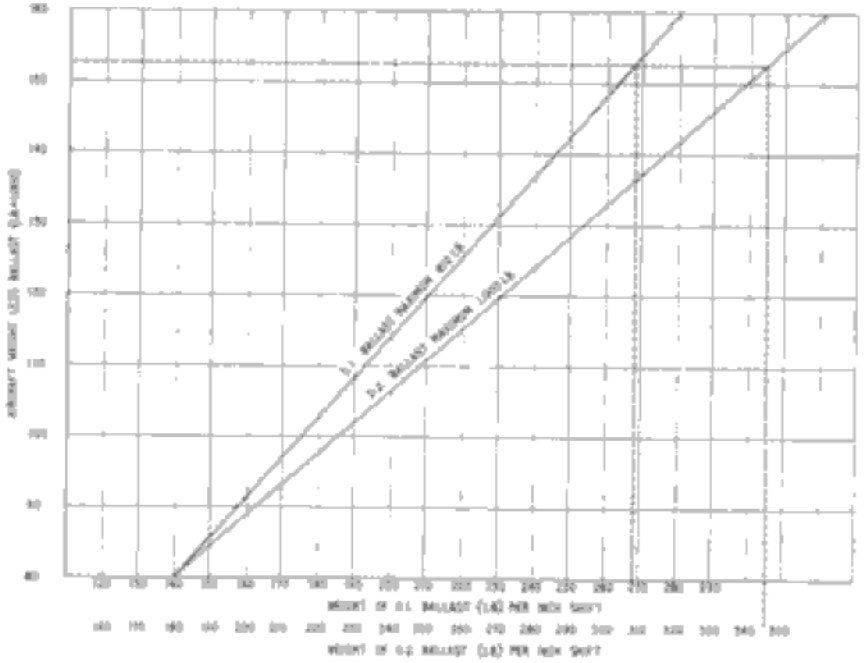

Fig.5. Ballast required for flight cases for aircraft having equipment shortages

BALLAST - LOADING EXAMPLES

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Case 1 - when to add ballast			
Current basic weight and moment - (No ballast and no N.B.S. removable)	80,000	+ 12·746	1,019,688
Add:-			
Crew - 5 off complete with dinghies	1,133	- 23·96	- 27,149
Fuel - 100 per cent - 9,370 gall.	72,149	12·195	879,857
All-up weight and moment - (Less D.1 and D.2 ballast)	153,282	12·215	1,872,396
Add:-			
D.1 ballast and box in lieu of H_2S scanner (480 + 90)	570	- 35·66	- 20,326
All-up weight and moment - (Less extra D.1 and D.2 ballast)	153,852	12·037	1,852,070
Add:-			
D.1 extra ballast - to maximum (810 lb.)	240	- 35·66	- 8,558
All-up weight and moment - (Less D.2 ballast)	154,092	- 11·963	1,843,512
Add:-			
D.2 ballast (5 x 40 lb.) + box (15 lb.)	215	- 25·17	- 5,412
All-up weight and moment undercarriage down	154,307	11·912	1,838,100
Case 2 - when to remove ballast			
Landing weight and moment	83,783	10·3	863,008
5 Crew, no Fuel, no Bombs, D.2 ballast only			
Remove:-			
All D.2 ballast (1,000 lb. + boxes 30 lb.)	- 1,030	- 25·17	25,925
Landing weight and moment - less ballast down	82,753	10·742	888,933

REMOVABLE MILITARY LOAD - BOMB BAY

Removable load	Case A 21 x 1,000 lb. H.E.	Case B 24 x 25 lb. smoke flash	Case C 24 x 100 lb. practice stores	Case D 1 x 10,225 lb. store	Case E 1 x 1,680 lb. target marker	Case F 1 x (6,200 + 1,000 lb.) store	Case G 1 x 6,000 lb. store	Case H store
Carriers	684	684 + 288*	684+288	160	343	177	-	-
Crutch assemblies	-	- -	-	90	Crutches 23) Fuzing units 6) Rear steady 48)	77	473	615
Pintles	78	78	78	26	26	26	-	-
Pneumatic pushers	-	-	-	-	-	65	-	-
Total (lb.)	762	1,050	1,050	276	369	345	473	615
Store	21,000	600	2,400	10,225	1,680	7,200	3,175	16,686
Total weight of stores, carriers, crutches and pintles (lb.)	21,762	1,650	3,450	10,501	2,049	7,545	3,648	17,301

NOTES . . .

Carrier weight = 228 lb.
Pintles, 2 off = 26
3 x 254 lb. = 762 lb.

** Adapter fitted to one normal carrier = 96 lb.*
Total for 3 carriers = 288 lb.

THE AIRCRAFT C.G. COMPUTER

23. The aircraft C.G. computer consists of a stock, slide and cursor. Two scales A and B are marked on the stock and two scales C and D on the slide. Scale A is a grid made up of three scales showing:-

(1) The C.G. position measured in feet from the aircraft front spar datum.

(2) The gross weight in lb.

(3) The C.G. limits.

Scale B is the Basic Moment scale and shows the aircraft moment in $\frac{\text{lb. ft.}}{10{,}000}$ about the computer datum. The graduated scale lines on the slide referred to as scales C and D represent various items of load and their lengths are determined by the value of their moments in lb. ft.

Computer Datum
A nominal C.G. position of 11·388 ft. aft of the front spar has been selected as the computer datum. This reduces the moments and gives a suitable scale to fit the computer dimensions.

Basic Moment
The Basic Moment is the aircraft moment converted to the computer datum and is obtained thus:-

$$\text{Basic Moment} = \frac{\text{Basic Weight} \times (\text{Arm in feet about F/S datum} - 11{,}388 \text{ ft.})}{10{,}000}$$

This gives the initial setting when using the C.G. Computer.

Instructions for use
(1) Set cursor hairline to Basic Moment.

(2) Move slide until the zero of selected items is below hairline.

(3) Move cursor in direction indicated by arrow until hairline is over quantity being loaded.

(4) Starting from the last setting of the cursor, repeat operations 2 and 3 for each item.

(5) The final position of the cursor hairline must be within the fore-and-aft limits as shown on grid on the inside face of the rule.

(6) The actual centre of gravity position (in feet aft of F/S datum) is obtained by removing slide and reading C.G. position under hairline against the appropriate weight line on grid.

(7) To obtain the C.G. position for landing, the instructions for items 2 and 3 will have to be reversed, i.e., for the C.G. position obtain in item 6, move slide until the quantity of the load to be expended is under hairline, move cursor until hairline is over zero, repeating the operations for all expendable items, the final landing C.G. position being obtained as in item 6.

Conclusion

The computer gives the summation of moments only, it does not give the Gross Weight or record the operations carried out. For this reason it is suggested that the user when computing an aircraft loading should first list all the items of load required with their associated weights.

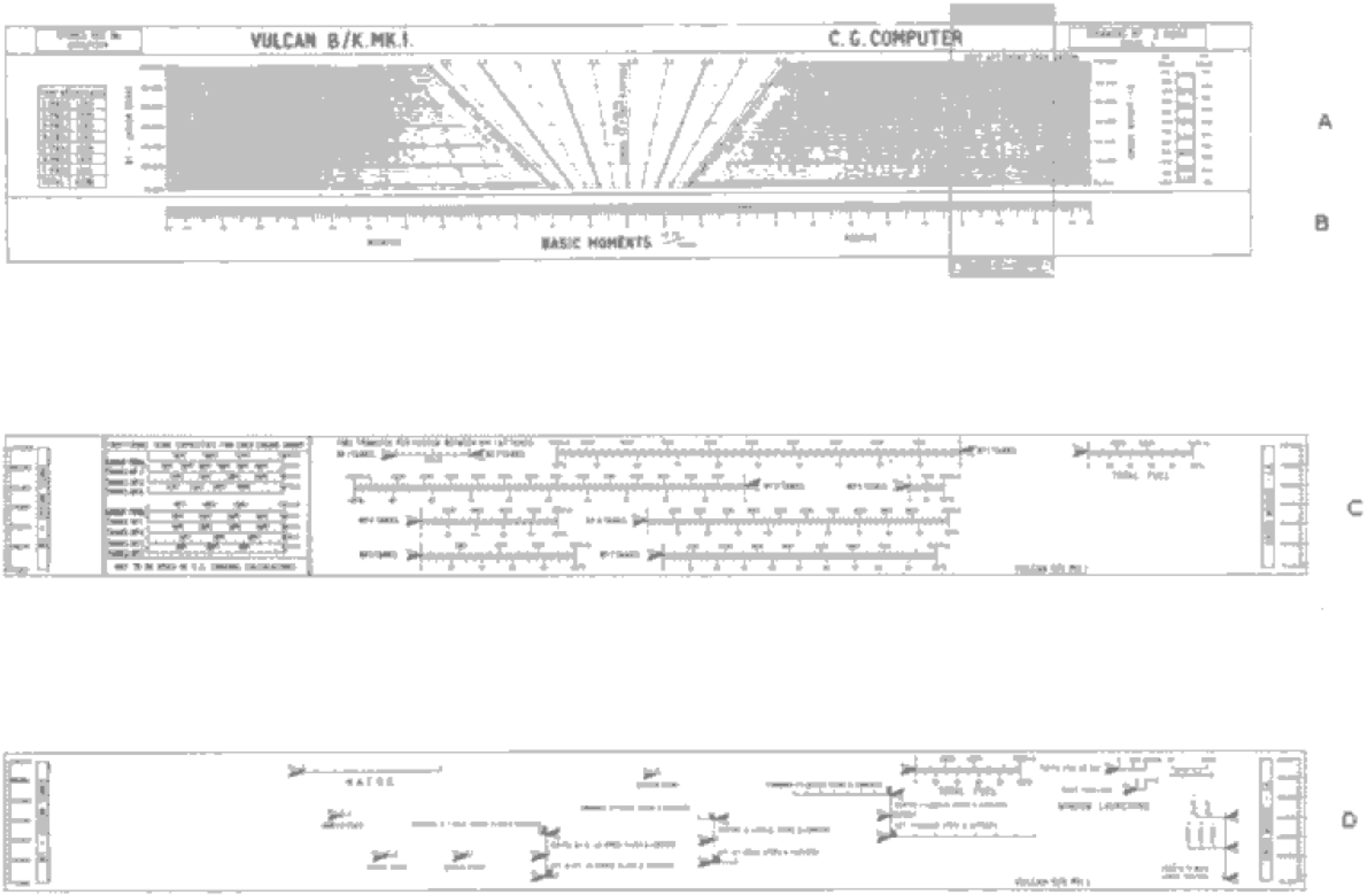

Fig.6. C.G. computer

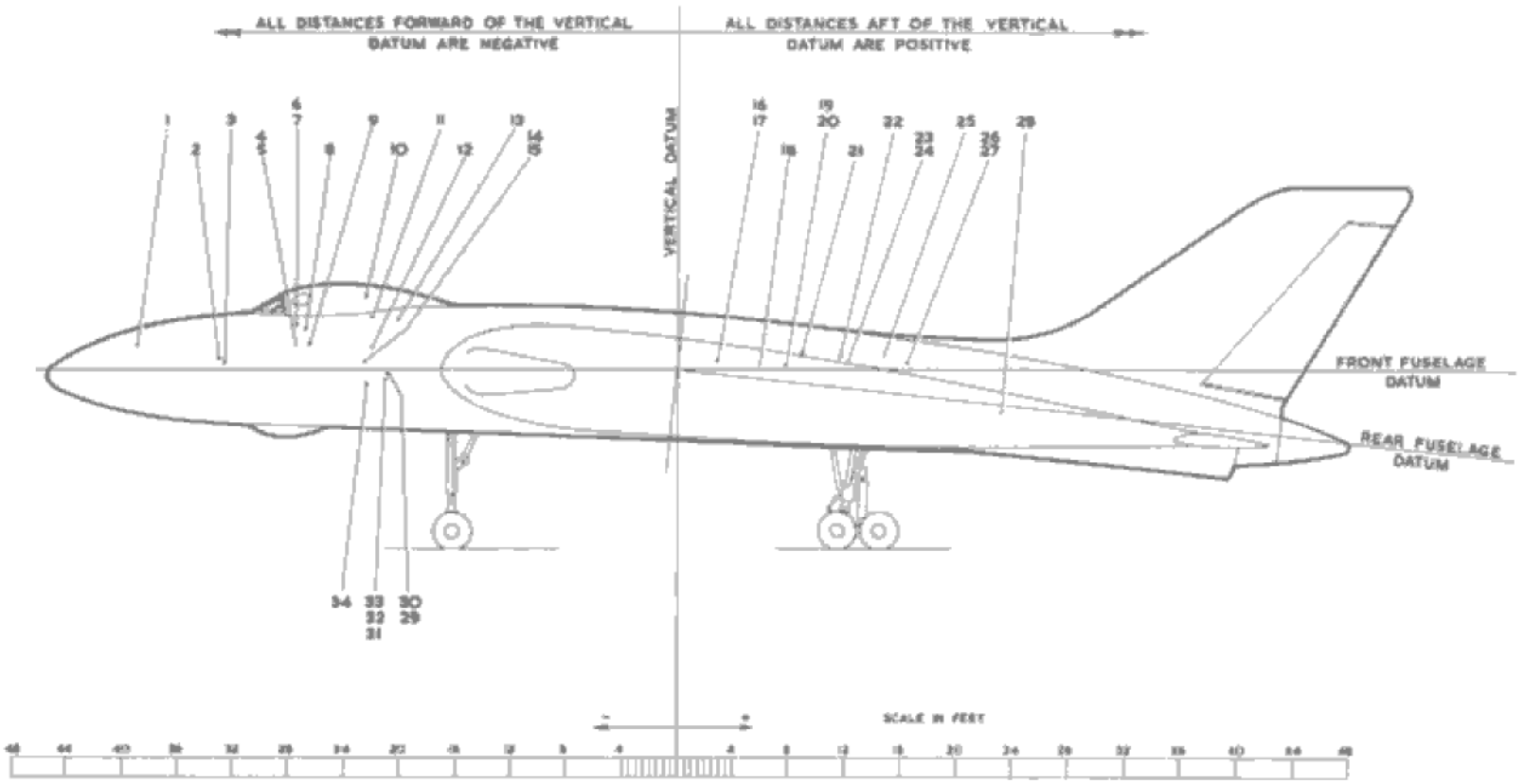

Fig. 7 Loading and C.G. diagram – general equipment

KEY TO FIG.7

Item No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
1.	Survival packs	100 00	- 33·92	- 3,392
2.	Gloves, first-aid kit	4·5	- 32·1	- 144
3.	Destructors	6·5	- 32·0	- 208
4.	Pilot's dinghy	32·2	- 27·5	- 886
5.	Co-pilot's dinghy	32·2	- 27·5	- 886
6.	Pilot	200·0	- 27·3	- 5,460
7.	Co-pilot	200·0	- 27·3	- 5,460
8.	Cartridge, seat-ejection	3·0	- 27·0	- 81
9.	First-aid kit, cabin	6·0	- 26·7	- 160
10.	Dinghy M.S.5	115·8	- 22·3	- 2,582
11.	Cartridge signal 1 in.	4·1	- 22·3	- 91
12.	Miscellaneous Appendix 'A' items	47·1	- 22·7	- 1,069
13.	Signal pistol	4·1	- 20·7	- 85
14.	Bottle oxygen system, walk round	6·0	- 23·2	- 139
15.	Charge oxygen, walk round	2·0	- 23·2	- 46
16.	Oxygen charge (forward bottle) port	14·0	+ 2·5	+ 35
17.	Oxygen charge (forward bottle) starboard	14·0	+ 2·5	+ 35
18.	Oxygen charge (rear bottle) port	7·0	+ 6·0	+ 42
19.	AT81913 Fwd. cable retraction winch	14·7	+ 4·06	+ 60
20.	AT82079 Mounting, forward snatch and fuzing unit	5·9	+ 4·06	+ 24
21.	AT81857/8 Forward crutches	9·5	+ 8·33	+ 79
22.	AT62778 Buffer stop assy.	13·2	+12·11	+ 160
23.	Carrier	160·0	+12·11	+1,938
24.	Pintles	26·0	+12·11	+ 315
25.	AT81855/6 Rear crutches	11·5	+14·79	+ 170
26.	AT8194 Aft. latch bolt bracket assembly	5·3	+14·79	+ 78
27.	AT62980 Aft. winches + mounting	27·8	+14·79	+ 411
	AT62992 Assy. attachment channels	+ 2·0	+20·75	+ 42
28.	Nitrogen charge (16 bottles)	94·0	+23·1	+2,171
	Nitrogen charge (12 bottles)	75·3	+23·4	+1,762
29.	Air Electronics Officer	200·0	-21·6	- 4,320
30.	Navigators - 2 off	400·0	- 21·6	- 8,640
31.	Crew 1 dinghy	23·0	- 21·7	- 499
32.	Crew 2 dinghy	23·0	- 21·7	- 499
33.	Crew 3 dinghy	23·0	- 21·7	- 499
34.	Periscopic sextant complete with case	11·5	- 23·0	- 265

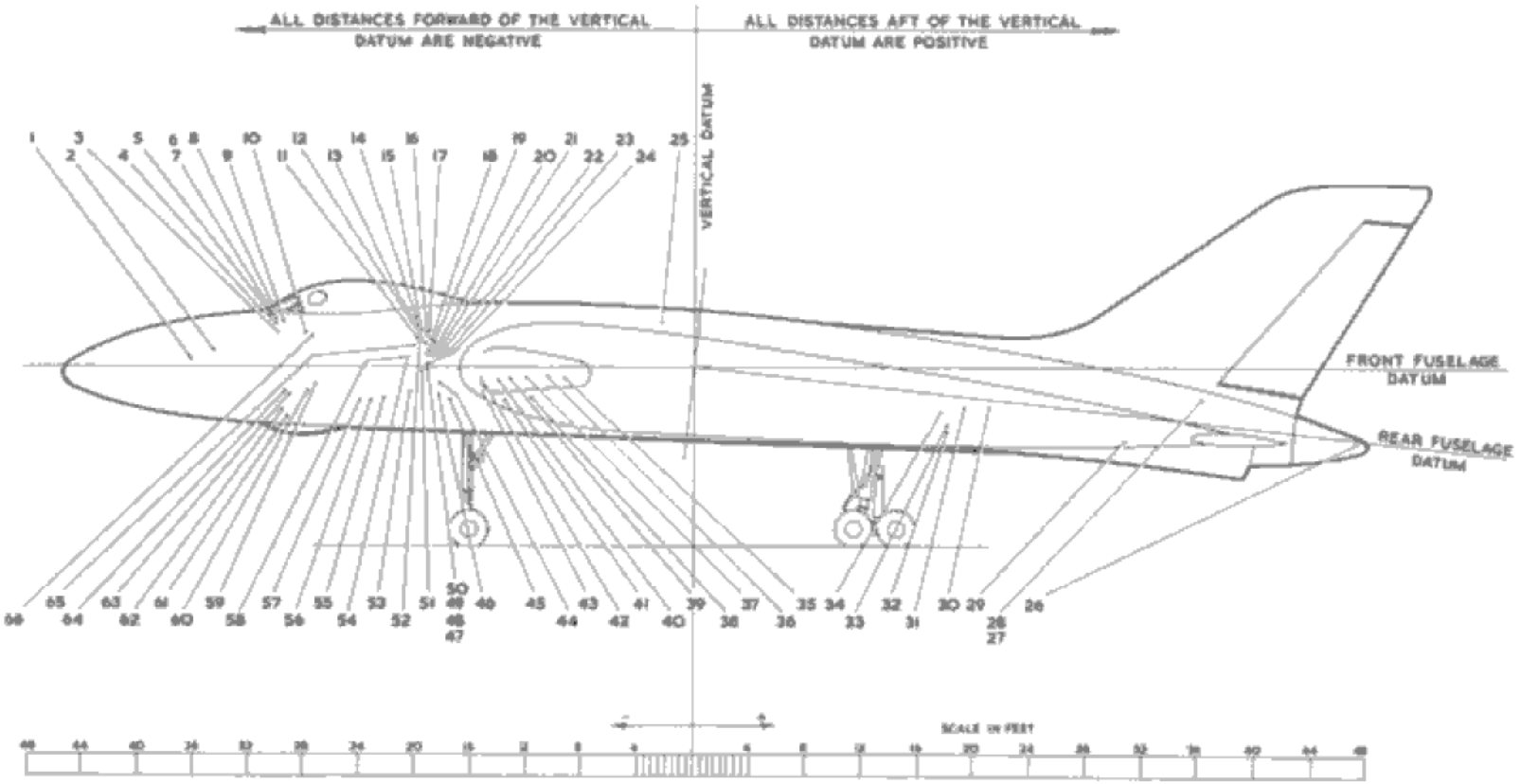

Fig.8 Loading and C.G. diagram - electrical, radio and radar equipment

KEY TO FIG.8

Item No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
1.	10B/16327 Scanner unit Type 121	489	- 35·67	+ 17,443
2.	5U/5748 Motor Generator - twin Amplidyne	39·5	- 34·08	- 1,346
3.	9D/8 Direction indicator	1·3	- 29·4	+ 38
4.	10Q/73 Radio altimeter, low level	4·9	- 29·7	- 146
5.	10Q/73 Radio altimeter, low level	4·9	- 29·7	- 146
6.	10Q/61 Indicator first Pilot's	1·4	- 29·5	- 41
7.	10Q/61 Indicator second Pilot's	1·4	- 29·5	- 41
8.	10Q/16073 Indicator (C.R.T.) Type 27	3·1	- 29·83	- 92
9.	9D/1111 Control unit	3·0	- 29·17	- 88
10.	10L/16043 Control unit Type 611	2·75	- 27·5	- 76
11.	14A/4260 Camera	9·0	- 19·67	- 177
12.	10L/16204 Remote control unit Type 4189	2·5	- 19·0	- 48
13.	10Q/88 Pulse altimeter indicator unit	10·0	- 19·5	- 195
14.	9D/10 Navigation panel	33·0	- 19·62	- 647
15.	Receiver controller Type 1274	2·8	- 19·2	- 54
16.	10Q/16058 Indicator unit Type 26	18·5	- 19·0	- 352
17.	10Q/B/6493 Indicator unit Type 301	51·0	- 18·75	- 956
18.	10LB/6366 Control unit Type 585	53·0	- 18·8	- 996
19.	10LB/6376 Control unit Type 595	10·0	- 18·75	- 188
20.	6B/541 G.P. indicator Mk.4	25·0	- 18·8	- 470
21.	I.F.F. control R160/3455/500	2·5	- 18·92	- 47
22.	10Q/16095 Control unit and indicator Type 101	21·0	- 18·8	- 395
23.	10L/293 Control unit Type 7216	16·1	- 19·0	- 306
24.	5UC/6010 Voltage regulator	10·8	- 19·0	- 205
25.	Receiver Type AD.7092D	15·7	- 2·3	- 36
26.	10D/18501 Radio head Type 1	65·0	+ 48·8	+ 3,172
27.	10D/17937 Transmitter receiver TR.1985	27·0	+ 36·2	+ 977
28.	10D/17938 Transmitter receiver TR.1986	27·0	+ 36·2	+ 977
29.	Stripper unit 10 AS.460	64·0	+ 30·6	+ 1,958
30.	Stripper unit 10 AS.460	64·0	+ 21·3	+ 1,363
31.	Tracking unit Type 100	48·0	+ 19·4	+ 931
32.	10B/16389 Aerial Type 501	40·0	+ 18·1	+ 724
33.	Waveguides, radio and radar equipment	1·1	+ 18·1	+ 20
34.	10Q/18843 Transmitter/receiver Type TR.3710	116·0	+ 17·5	+ 2,030
35.	10K/17035 Power unit Type 814	10·8	- 9·4	- 102
36.	10D/2585 Transmitter/receiver Type 1576	27·0	- 10·3	- 278
37.	10D/2597 Transmitter/receiver Type 1579	28·7	- 11·5	- 330

KEY TO FIG.8 (continued)

Item No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
38.	9D/2 Calculator Type 1 Mk.1	44·0	- 11·7	- 515
39.	10.VB/6250 Waveform generator Type 68	35·0	- 13·0	- 455
40.	10D/18640 Automatic calculator Mk.5	34·0	- 14·1	- 479
41.	9D/11 Power unit	55·0	- 13·3	- 732
42.	10B/8811 Power unit Type 729	39·0	- 15·2	- 593
43.	Transmitter/receiver Type R.T.82/APX-6	38·5	- 15·0	- 576
44.	10V/16045 Gee waveform generator Type 72	21·5	- 18·5	- 398
45.	9D/12 Resistance unit	4·0	- 17·3	- 69
46.	10D/16876 Gee receiver Type R.3673	21·5	- 18·5	- 398
47.	10D/19067 Power and radio unit Type 4192	36·0	- 18·8	- 677
48.	10D/19064 H.F. receiver	26·5	- 18·8	- 498
49.	10L/16205 Control and drive unit	12·5	- 18·8	- 235
50.	10D/19065 H.F. transmitter	17·0	- 18·8	- 320
51.	10D/19248 Aerial selector unit	17·0	- 19·0	- 323
52.	10L/16419 Control unit Type 4577	1·5	- 19·3	- 29
53.	10L/291 Control units	15·75	- 20·17	- 318
54.	10L/16060 Control unit Type 626	1·8	- 20·0	- 36
55.	10U/16596 I/C amplifier	6·3	- 21·9	- 138
56.	10D/17818 Receiver Type R.1964	18·0	- 23·1	- 416
57.	10L/16154 Control unit Type 903	6·5	- 19·7	- 128
58.	9D/1110 Calculator Type 7	20·0	- 20·8	- 416
59.	9D/4 Calculator Type 3 Mk.1	85·0	- 26·9	- 2,287
60.	9/4567 Computer	50·0	- 27·3	- 1,365
61.	9/4552 Sighting head	15·0	- 29·0	- 435
62.	9/4579 Amplifier	11·5	- 29·5	- 339
63.	9D/3 Calculator Type 2 Mk.1	60·0	- 29·0	- 1,740
64.	10V/16057 Waveform generator Type 76	24·0	- 29·2	- 701
65.	10D/17819 Receiver Type R.1965	16·0	- 23·6	- 378
66.	10L/263 Control unit Type 705	2·0	- 27·3	- 55