Chapter 3

LOADING AND C.G. DATA

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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 the 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 C.G. is calculated with the aircraft in rigging position, i.e., the C.G. datum line horizontal.

3. 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.

DEFINITION OF THE C.G.

4. The C.G. is defined by its distance in feet, measured along the C.G. datum line from a reference point known as the C.G. datum point. This distance is

called the Moment Arm of the C.G. and is determined from the following expression:-

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

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

LOADING AND REFERENCE DATUMS (fig.1)

C.G. datum line

5. The line along which all longitudinal moment arms are measured is the front fuselage datum and makes an angle of 5 degrees with the rear fuselage datum.

C.G. datum point

6. The intersection of the front fuselage datum and the front spar datum.

Weighing reference point

7. Located on both port and starboard sides of the front fuselage by a removable plug which is situated 31·208 ft. (374·5 in.) forward of the C.G. datum point and 1·25 in. above the front fuselage datum. These locations are provided for the suspension of a plumb line when determining the C.G. by weighing the aircraft on platform scales.

Trim or computer datum

8. The slide rule computer datum is 12·453 ft. (149·43 in.) aft of the C.G. datum point. This is the middle of the C.G. range and only used for calculating the Index Unit for the initial setting on the C.G. computer (para.35).

MOMENT AND MOMENT ARMS

9. The moment of an item is the product of its weight (lb.) and its moment arm (ft.) measured along the C.G. Datum Line from the C.G. Datum Point. The Moment Arm of a load lying forward of the C.G. 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 C.G. Datum Point is positive and, therefore, the resultant moment is positive.

WEIGHT AND C.G. LIMITATIONS

Maximum all up and landing weights

10. Aircraft prior to production set no.41:-

Maximum permissible A.U.W.180,000 lb.

Plus modification no.
1302
1309
1321 Maximum permissible
1334 A.U.W. 190,000 lb.

Plus modification no.
1456
1587 Maximum A.U.W.
1627 204,000 lb.

Maximum Permissible All Up Weight 204,000 lb.

Maximum Permissible Landing Weight 204,000 lb. (Overload case)

Maximum Normal Landing Weight 140,000 lb.

C.G. Range (See Fig.2)

11. The approved C.G. limits are as follows:-

Maximum Forward Limit 11.833 ft (142.0 in.) aft of the C.G. Datum Point.	Up to 195,000 lb.
Maximum Aft Limit 13.075 ft. (156.89 in.) aft of the C.G. Datum Point.	
Maximum Forward Limit 12.333 ft. (148 in.) Aft of The C.G. Datum point	Over 195.000 lb.
Maximum Aft Limit 12.608 ft. (151.3 in) Aft of The C.G. Datum Point.	

The C.G. must be kept within these ranges at all times, including take off and landing.

C.G. MOVEMENT DURING FLIGHT

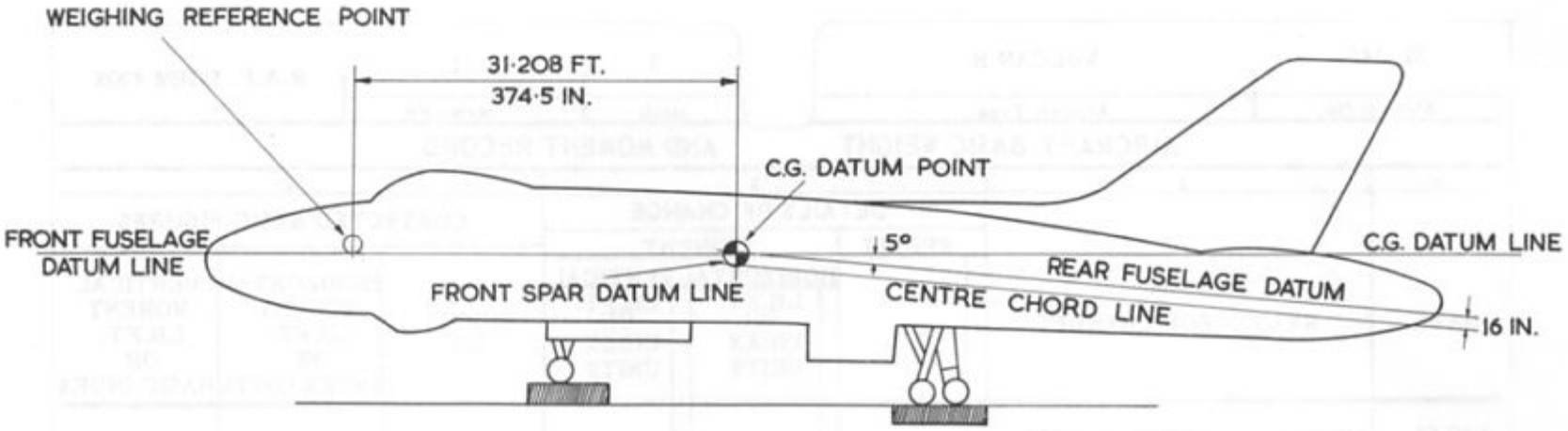
12. A loading which gives a satisfactory C.G. for take-off may be so affected by expenditure of fuel, etc., that the C.G. passes beyond its limit. The possibility of this occurrence must always be considered (para.28). The effect of retracting the undercarriage has been taken into consideration in establishing the safe C.G. range and may, therefore, be neglected.

AIRCRAFT BASIC WEIGHT

13. The Basic Weight of an aircraft is by definition, the weight of the basic structure of the aircraft together with the weight of that non-expendable equipment that is common to all the roles for which the aircraft has been designed. It includes the weight of unusable fuel, oil and other fluids, (i.e., the weight of fluids trapped in the systems after draining through the normal drain points) and the weight of the full coolant, hydraulic and pneumatic systems.

BASIC WEIGHT AND MOMENT RECORD CARD

14. This card 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 to be used at the start of any loading calculation and shows the appropriate C.G. computer index unit to be used for C.G. checks in flight. The initial entry is the basic weight and moment of the aircraft with normal "service fit" equipment, obtained from the C.G. report supplied with the aircraft upon delivery to the "Service."



AIRCRAFT IN THE RIGGING POSITION i.e. C.G. DATUM LINE HORIZONTAL

Fig.1. Loading and reference datums

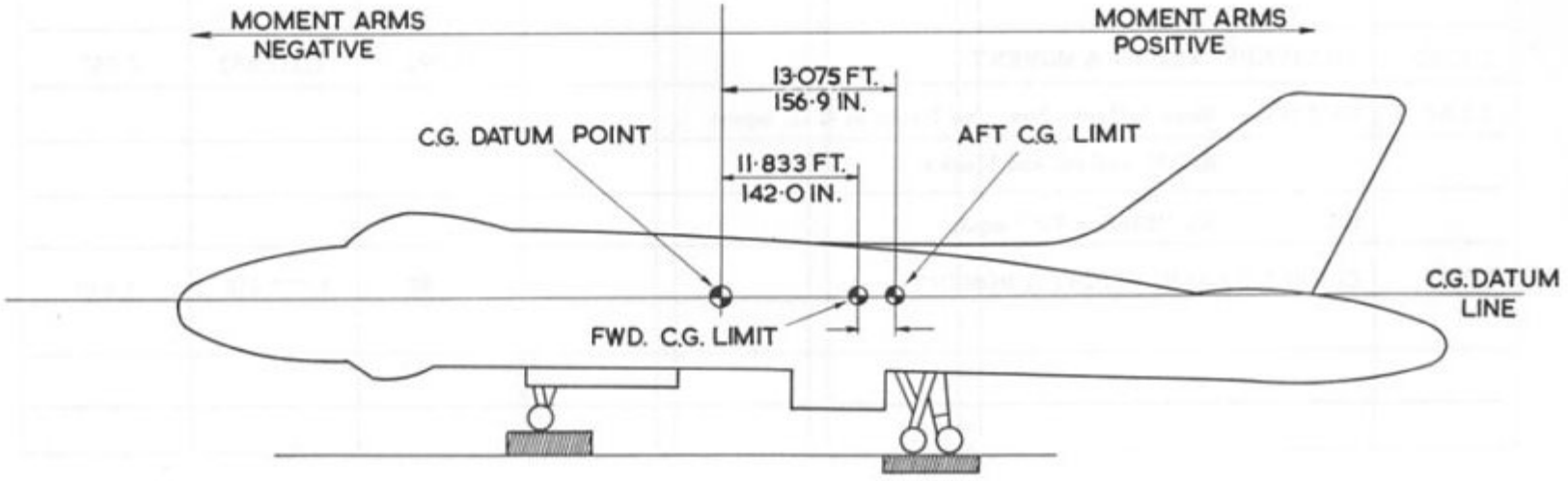


Fig.2. C.G. range

XL.446	VULCAN B	2	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
2.12.62	FROM C.G. REPORT NO.1216						
CURRENT BASIC WT. & MOMENT					100,757	1,272,916	1.819
	REMOVE:- 'Service fit' equip. as listed in C.G. report						
	ADD:- Nose ballast + box 576 lb.						
	E.C.M. ballast Stn. 7 & 8; 490 lb. and Stn. 9; 245 lb. + blanks						
2.12.62	'DELIVERY' WEIGHT & MOMENT				98,391	1,232,852	0.757
2.1.63	REMOVE:- Nose ballast + box as listed in C.G. report						
	E.C.M. ballast and blanks						
	FIT:- All "Service Fit" equip.						
2.1.63	CURRENT BASIC WEIGHT & MOMENT				100,757	1,272,916	1.819

Fig.3. R.A.F. Form 4908

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT

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

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	A.R.I.5874			
10D/19065	Transmitter S.T.18 Type 4188	17·0	-18·8	- 320
10D/19064	Receiver Type 4187	26·5	-18·8	- 499
10K/19067	Power and radio unit Type 4192	36·0	-18·8	- 678
5UC/6010	Voltage regulator	10·8	-19·0	- 204
10L/16205	Control and drive unit Type 4190	17·0	-18·8	- 320
10D/19248	Aerial selector unit Type 7003	12·5	-19·0	- 238
	Total weight and moment A.R.I.5874 removable equipment	119·8	-18·9	-2,259
	A.R.I.18107/3			
10D/22927	Transmitter receiver	53·0	-10.2	-539
10D/22524	Coupling unit	5·0	- 9·0	- 45
	Total weight and moment A.R.I.18107/3 removable equipment	58·0	-10·07	-584
	A.R.I.18089			
10U/16596	Amplifier Type A.1961	6·25	-17·9	- 112
10U/16596	Amplifier Type A.1961	6·25	-21·9	- 137
	Total weight and moment A.R.I.18089 equipment	12·5	-19·9	- 249
	A.R.I.5928			
10B/19090	Scanner unit Type 121 } With Connectors			
10D/19023	Frame assy. 4032A } 280 lb.			
10U/16761	Amplifier A.3703 40 lb.			
10D/18638	Modulator Type 2 50 lb.	489·0	-35·7	-17,441
10AD/3379	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	64·3	-18·8	-1,206
14A/4260	Camera	12·3	-19·7	- 242
10L/16060	Control unit Type 626	1·8	-20·0	- 36
10LB/6376	Control unit Type 595	10·0	-18·8	- 188
19L/16154	Control unit Type 903	6·5	-19·7	- 128
10DB/8811	Power unit Type 729	33·0	-15·2	- 503
10VB/6250	Waveform generator Type 68	37·8	-13·0	- 491
10D/20968	Automatic calculator Type 5A	41·3	-14·1	- 582

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
9D/1141	Navigation panel	36·0	-19·7	- 708
9D/756	Wind monitor unit	10·0	-18·8	- 188
9D/2	Calculator Type 1, Mk.1	50·0	-11·7	- 583
9D/1373	Calculator Type 2, Mk.2	60·0	-29·1	-1,745
9D/1140	Calculator Type 3, Mk.2	95·0	-26·9	-2,557
10LB/6366	Control unit Type 585	55·0	-18·8	-1,036
9D/11	Power unit	55·0	-13·3	- 729
9D/12	Resistance unit	4·0	-17·3	- 69
10L/11643	Control unit Type 12558	8·2	-20·7	- 170
9D/1566	Variable air speed unit	0·8	-21·0	- 17
9D/1400	Forward throw indicator	1·0	-19·0	- 19
9D/757	Indicator unit	1·5	-19·3	- 29
9D/1372	Bombing indicator	0·6	-30·0	- 18
10L/16495	Control unit Type 12580	2·8	-21·8	- 61
	Total weight and moment A.R.I.5928 removable equipment	1,075·9	-26·7	-28,746
	A.R.I.18011			
10L/263	Control unit Type 705	2·0	-22·0	- 44
10D/17819	Receiver Type R.1965 (Glide Path)	16·0	-23·6	- 378
10D/17818	Receiver Type R.1964 (Localiser Marker)	18·0	-23·1	- 416
	Total weight and moment A.R.I.18011 removable equipment	36·0	-23·3	- 838
	A.R.I.23143/1			
10L/9455739	Control unit	3·2	-22·0	- 70
10D/9711781	Transmitter receiver	50·0	-10·33	-517
	Total weight and moment A.P.I.23143/1 removable equipment	53·2	-11·033	-587
	A.R.I.5378			
10D/2585	Trans/receiver Type 1576	27·0	-10·3	- 278
10K/17035	Power unit Type 814	10·8	- 9·4	- 101
10F/17565	Control unit Type 7231	2·0	-28·0	- 56
	Total weight and moment A.R.I.5378 removable equipment	39·8	-11·0	- 435
	A.R.I.18090			
10Q/93	Pulse altimeter indicator Type 7921	10·0	-19·5	- 195
10D/19806	Transmitter receiver Type 7923	28·7	-11·6	- 332
	Total weight and moment A.R.I.18090 removable equipment	38·7	-13·6	- 527

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	A.R.I.23023			
10D/19598	Receiver Type AD.7092D	15·7	- 2·4	- 37
10L/16073	Control unit Type 1274	2·8	- 21·1	- 59
	Total weight and moment A.R.I.23023 removable equipment	18·5	- 5·2	- 96
	A.R.I.5851			
10D/18843	Transmitter receiver Type TR.3710	116·0	17·5	2,030
10Q/16094	Tracking unit Type 100	48·0	19·4	932
10B/19515	Aerial Type 501A	40·0	18·1	723
10B/17373	Waveguides Type T.529	1·1	18·2	20
10Q/16095	Control unit and indicator Type 101	21·0	- 18·8	- 394
6B/541	G.P. indicator Mk.4 alternative items	25·0	- 18·8	- 471
9CA/101	G.P. indicator Mk.6	80·0	- 18·7	- 1,493
	Total weight and moment A.R.I.5851 removable equipment with G.P.1 Mk.4.	251·1	11·3	2,840
	Total weight and moment A.R.I.5851 removable equipment with G.P.1 Mk.6	306·1	5·9	1,818
	A.R.I.18124			
10D/5821	Transmitter/receiver Type 4	48·5	8·0	- 388
10L/5821	Control unit Type C/1607/ARC.52	2·76	- 27·9	- 77
	Total weight and moment A.R.I.18124 removable equipment	51·26	- 9·1	- 465
	A.R.I.23063			
10L/16716	Control unit Type 16051	1·5	- 19·3	- 29
10D/21774	Receiver Type 16048 - nose-wheel bay) alternative	11·0	- 10·2	- 112
10D/21774	Receiver Type 16048 - nose positions	11·0	- 33·5	- 369
	Total weight and moment A.R.I.23063 removable equipment (pre-Mod.1365).	12·5	- 11·3	- 141
	Total weight and moment A.R.I.23063 removable equipment (post Mod.1365).	12·5	- 31·8	- 398
	A.R.I.23061			
10D/21794	Transmitter/receiver Type 16098	12·0	- 4·3	- 51
10U/17445	Amplifier Type 16089	4·0	- 6·8	- 27
	Total weight and moment A.R.I.23061 removable equipment	16·0	- 4·9	- 78

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	E.C.M. equipment (including tail warning installation)			
	A.R.I.5919			
10D/20974	Radar head c/w heat exchanger Type 6934	146·0	53·4	7,799
10Q/16420	Indicator unit (nav's. station) Type 6935	13·5	- 18·7	- 253
10J/214	Control unit	4·5	- 19·3	- 87
	Total weight and moment A.R.I.5919 removable equipment	164·0	45·5	7,459

◀ *NOTE...*
When Mod.2017 is embodied the A.R.I.5919 is deleted and replaced by A.R.I.5952

	A.R.I.5952			
5841-99-954-7738	Radar head	152·0	53·41	8,119
5841-99-954-7737	Indicator/control unit	18·5	- 19·00	- 352
	Total A.R.I.5952 installation	170·5	45·50	7,766 ▶

	A.R.I.18074			
10D/20533	Transmitter and P.U. T.7810 with base mounting T.4367	160·9	43·4	6,986
10L/16351	Control unit Type 7812	1·3	- 20·0	- 26
	Total weight and moment A.R.I.18074 removable equipment	162·2	42·9	6,960

◀ *NOTE...*
When Mod.2024 is embodied A.R.I.18074 is deleted and replaced by A.R.I.18146

	A.R.I.18146			
5895-99-913-1187	Transmitter radio	120·0	35·83	4,300
5895-99-945-2035	Power supply set	250·0	43·40	10,850
5895-99-946-5122	Receiver radar	41·0	39·83	1,633
5895-99-946-5358	Control frequency selector	25·0	39·83	996
5895-99-947-3004	Blanker interference	7·5	35·83	269
5841-99-952-9685	Switch Don-Lan	0·5	39·20	20
10L/946/5125	Control unit Type 13044	5·0	- 19·30	- 97
	Total A.R.I.18146 installation	449·0	- 40·02	17,970 ▶

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

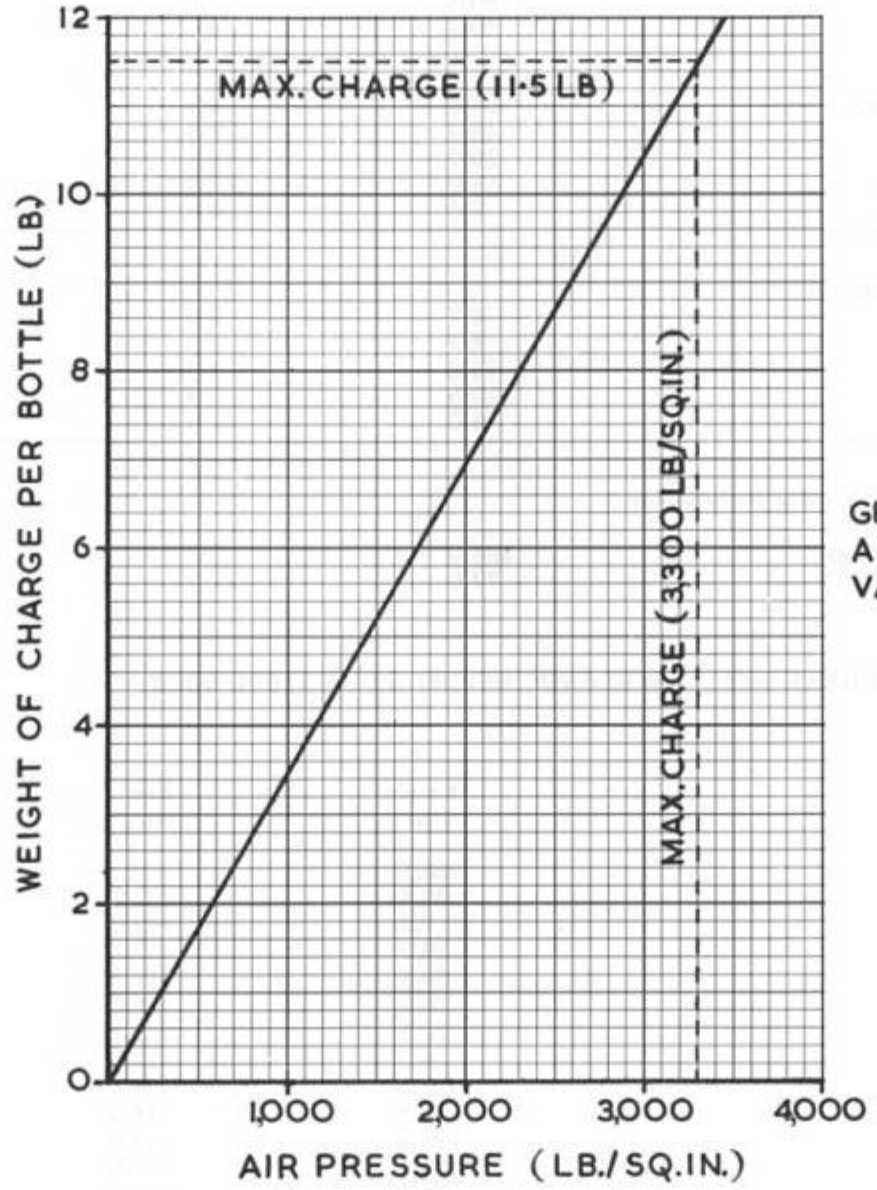
Ref.No.	Description	Weight (lb)	Arm (ft)	Moment (lb ft)
▶	BALLAST (In lieu of A.R.I.18075, post Mod.2501)			
10ZZ/470411	Ballast	156.3	45.6	7,127
10ZZ/470411	Ballast	156.3	45.6	7,127
	Total weight and moment removable BALLAST equipment	312.6	45.6	14,254 ◀
	A.R.I.18228/1			
–	Control unit, Type 17172	1.5	-19.25	– 29
–	Indicator, Type 17171	5.5	-19.04	– 125
–	Power unit, Type 17203	8.8	38.83	342
–	Receiver radio, Type 17170	15.0	39.00	585
	Total weight and moment A.R.I.18228/1 removable equipment	30.8	25.75	793
	A.R.I.18105 (Post Mod.2304)			
10D/20750	Blanking unit, Type 9777	6.4	-39.5	– 253
10D/20567	Receiver, Type R.9561	12.0	-39.5	– 474
10D/20567	Receiver, Type R.9561	12.0	-39.5	– 474
	Total weight and moment A.R.I.18105 (Post Mod.2304) removable equipment	30.4	-39.5	– 1,201
	A.R.I.18076			
10K/19874	No.1 Power unit T.9421 with base mounting	244.7	47.5	11,619
10K/19874	No.2 Power unit T.9421 with base mounting	244.7	47.5	11,619
10K/19874	No.3 Power unit T.9421 with base mounting	244.7	49.5	12,117
10D/20525	No.1 Transmitter T.9420 with base mounting T.4367	219.0	41.4	9,072
10D/20525	No.2 Transmitter T.9420 with base mounting T.4367	219.0	41.4	9,072
10D/20525	No.3 Transmitter T.9420 with base mounting T.4367	217.0	43.4	9,421
10L/16346	Control unit Type 9422	5.0	-19.6	– 98
	Total weight and moment A.R.I.18076 removable equipment	1,394.1	45.1	62.822

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Ref.No.	Description	Weight (lb)	Arm (ft)	Moment (lb ft)
	A.R.I.5959			
AN/APN/170	Radar pod	85.0	-43.59	- 3,705
	Total A.R.I.5959 installation	85.0	-43.59	- 3,705
	Oxygen charge (* denotes alternative systems)			
	System No.1			
	Total (10 bottles in power compartment) *	70.0	33.5	2,347
	System No.2 Mod.668			
	4 bottles (in power compartment)	28.0	35.0	980
	6 bottles (in bomb bay)	42.0	6.2	259
	Total (10 bottles) *	70.0	17.7	1,239
	System No.3 Mod.897			
	4 bottles (in power compartment)	28.0	35.0	980
	6 bottles (in bomb bay)	42.0	6.2	259
	2 bottles (in bomb bay)	14.0	15.8	221
	Total (12 bottles) *	84.0	17.4	1,460
	Other component weights			
	Dinghy Type M.S.5	115.8	-22.33	- 2,586
7B/1484	Signal pistol 1½ in, Mk.1.	4.1	-20.7	- 85
	Signal pistol cartridges 12 off	4.1	-22.3	- 91
12K/1314	Ejector seat cartridges Set No.3 Mk.3	3.0	-26.8	- 80
	First aid outfit cabin	6.0	-26.7	- 160
	Gloves and first aid kit – nose section	4.5	-32.1	- 144
	Windscreen anti-icing fluid 12 gallon	97.8	-32.2	- 3,146
	Periscope sextant Mk.2 C/W case 1 off	11.5	-23.0	- 265
	Entrance ladder	28.0	-21.4	- 600
	Hand fire extinguishers in cabin – 5 off	27.5	-24.8	- 683

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (continued)

Ref.No.	Description	Weight (lb)	Arm (ft)	Moment (lb ft)
5J/3364	Battery	76.5	– 7.8	– 593
5UB/6431	Amplidyne	32.5	–34.1	– 1,108
	Tail parachute	200.0	48.5	9,693
	Rapid engine start – air charge (8 bottles) Refer to fig.3A	92.0	21.2	1,950
	Rapid engine start – air charge (10 bottles)	115.0	21.2	2,438
	E.C.M. cooling:-			
	Pack – vapour cycle cooling	109.5	49.6	5,429
	Coolant (glycol and freon) (7.4 gallons)	89.5	45.9	4,105
▶	Heading reference system Mk.2:-			
	Gyro reference unit, Type B	31.0	–25.17	– 780
	Electronic unit, Type A	27.0	–25.17	– 680
	Control unit	5.0	–19.17	– 96
	Heading repeater unit, Type B	28.0	–28.25	– 791
	Mounting tray	.75	–28.25	– 21
	Junction box	6.0	–18.67	– 112
	Total H.R.S. Mk.2 equipment	97.75	–25.37	– 2,480 ◀



GRAPH SHOWING WEIGHT OF AIR CHARGE PER BOTTLE AT VARYING PRESSURES

Fig.3A. Rapid engine starting air bottles

V.2.1A. 1653

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT.(continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	Auto-pilot equipment:-			
6T/201	Gyro units Type A (112 EAP Smiths)	18·5	- 30·3	- 560
6T/1617	Locking unit (155 EAP Smiths)	40·0	- 29·8	- 1,190
6T/1615	Servo control (130 EAP Smiths)	20·0	- 28·4	- 567
6T/1616	Platform control (148 EAP Smiths)	15·0	- 29·2	- 438
6T/1614	Pressure unit (143 EAP Smiths)	5·4	- 30·6	- 165
	Auto landing installation (auto-throttle):-			
6T/1951	Amplifier (fwd.)	8·7	0·8	7
6T/1951	Amplifier (aft)	8·7	2·3	20
6T/1952	Integrator unit	18·5	1·2	22
6T/1688	Control unit	16·5	1·9	31
6T/1953	Junction box	6·0	1·5	9
	NOTE... *See also Radio Alt. Mk.7 and leader cable installation .*			
	Unusable fuel to bring to 'Basic Weight'	154·0	7·75	1,193
	A.A.P.P. fuel tank 10 gall. at S.G. 0·77	77·0	21·6	1,663

V.2.1A. 1654

LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE)

◀ 15(a).

Ref.No.	Description	Weight (lb)	Arm (ft.)	Moment (lb.ft.)
	Hydraulics - hoisting	266.5	+14.3	+ 3,819
	A.L.S.U. fairing mounting	38.8	+22.0	+ 852
	A.L.S.U. fusing unit mounting	7.3	+22.0	+ 161
	A.L.S.U. hot air supply - port	19.9	+17.5	+ 349
	A.L.S.U. hot air supply - stbd	19.9	+17.5	+ 349
	Remote control panel	15.6	+15.8	+ 247
	Refrigeration pack	223.5	+ 3.9	+ 833
	Store heating	28.5	+17.6	+ 502
	Pneumatics	22.0	+13.5	+ 296
	Mechanical jettison	40.9	+14.2	+ 582
	Hydraulics - general	179.2	+ 1.6	+ 293
	Hydraulics - fin gap doors	61.7	+17.5	+ 1,078
	Hydraulics - umbilical	28.9	+17.3	+ 500
	Carrier beam	314.7	+14.3	+ 4,488
	Hinge brackets	22.5	+14.3	+ 321

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15(a) LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE) (Continued)

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	Door support struts	50.6	+12.1	+ 610
	Door support structure	2.4	+14.6	+ 35
	Fairings and attachments	5.1	- 5.5	- 28
	Rear crutching beam	137.1	+19.9	+ 2,733
	Fairing door - port	458.3	+14.7	+ 6,726
	Fairing door - stbd	545.6	+14.6	+ 7,963
	Mechanical shut-off for refrigeration	5.0	+14.8	+ 74
	Horizontal struts	6.0	+17.7	+ 106
	Removable fairings	22.5	+32.3	+ 726
	Inertia navigator control unit	13.5	- 18.8	- 254
	Inertia navigator monitoring unit	12.0	- 18.8	- 226
	Adapter box monitoring	22.0	- 18.5	- 407
	Shock absorbers and fairings	10.1	- 1.2	- 12
	Electrics including panels 85P, 86P, 92P, 93P, 95P, & 97P.	113.2	+ 8.1	+ 918
	Cables	98.0	+14.6	+ 1,429
	No.4 Butt connector	18.0	+ 5.8	+ 105
	Total Blue Steel removable equiment	2,809.3	+12.518	+35,168

A.R.I.5928

10B/19090	Scanner Unit Type 121	With connectors			
10D/19023	Frame Assy. 4032A	280 lb.			
10U/16761	Amplifier A.3703	40 lb.			
10D/18638	Modulator Type 2	50 lb.	489.0	- 35.7	- 17,441
10AD/3379	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		64.3	- 18.8	- 1,206
14A/4260	Camera		12.3	- 19.7	- 242
10L/16060	Control Unit Type 626		1.8	- 20.0	- 36
10LB/6376	Control Unit Type 595		10.0	- 18.8	- 188
19L/16154	Control Unit Type 903		6.5	- 19.7	- 128
10DB/8811	Power Unit Type 729		33.0	- 15.2	- 503
10VB/6250	Waveform Generator Type 68		37.8	- 13.0	- 491
10D/20968	Automatic Calculator Type 5A		41.3	- 14.1	- 581
9D/1141	Navigation Panel		36.0	- 19.7	- 708
9D/756	Wind Monitor Unit		10.0	- 18.8	- 188
9D/2	Calculator Type 1 Mk.1		50.0	- 11.7	- 583
9D/1373	Calculator Type 2 Mk.2		60.0	- 29.1	- 1.745
9D/1140	Calculator Type 3 Mk.2		95.0	- 26.9	- 2,557
10LB/6366	Control Unit Type 585		55.0	- 18.8	- 1,036
9D/11	Power Unit		55.0	- 13.3	- 729
9D/12	Resistance Unit		4.0	- 17.3	- 69
10L/11643	Control Unit Type 12558		8.2	- 20.7	- 170
9D/1566	Variable air speed unit		0.8	- 21.0	- 17

15(a) LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE) (Continued)

Ref.No.	Description	Weight (lb)	Arm (ft.)	Moment (lb.ft.)
9D/1400	Forward throw indicator	1.0	- 19.0	- 19
9D/757	Indicator unit	1.5	- 19.3	- 29
9D/1372	Bombing Indicator	0.6	- 30.0	- 18
10L/16495	Control Unit Type 12580	2.8	- 21.8	- 61
	Total weight and moment - A.R.I. 5928	1075.9	- 26.7	- 28,746
	A.R.I.18107/3			
10D/22927	Trans/Receiver	53.0	- 10.2	- 539
10D/22524	Coupling Unit	5.0	- 9.0	- 45
	Total weight and moment A.R.I.18107/3	58.0	- 10.07	- 584
	A.R.I.23143/1			
10L/9455739	Control Unit	3.2	- 22.0	- 70
10D/9711781	Trans/Receiver	50.0	- 10.33	- 517
	Total weight and moment A.R.I. 23143/1	53.2	- 11.033	- 587
	A.R.I. 5874			
10D/19065	Transmitter S.T.18 Type 4188	17.0	- 18.8	- 320
10D/19064	Receiver Type 4187	26.5	- 18.8	- 499
10K/19067	Power and Radio Unit Type 4192	36.0	- 18.8	- 678
5UC/6010	Voltage Regulator	10.8	- 19.0	- 204
10L/16205	Control and Drive Unit Type 4190	17.0	- 18.8	- 320
10D/19248	Aerial Selector Unit Type 7003	12.5	- 19.0	- 238
	Total weight and moment A.R.I. 5874	119.8	- 18.9	- 2,259
	A.R.I. 18089			
10U/16596	Amplifier Type A.1961	6.25	- 17.9	- 112
10U/16596	Amplifier Type A.1961	6.25	- 21.9	- 137
	Total weight and moment A.R.I.18089	12.5	- 19.9	- 249
	A.R.I. 18011			
10L/263	Control Unit Type 705	2.0	- 22.0	- 44
10D/17819	Receiver Type R.1965 (Glide Path)	16.0	- 23.6	- 378
10D/17818	Receiver Type R.1964 (Localiser Marker)	18.0	- 23.1	- 416
	Total weight and moment A.R.I. 18011	36.0	- 23.3	- 838

15(a) LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE) (Continued)

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	A.R.I. 5378			
10D/2585	Trans/Receiver Type 1576	27.0	- 10.3	- 278
10K/17035	Power Unit Type 814	10.8	- 9.4	- 101
10F/17565	Control Unit Type 7231	2.0	- 28.0	- 56
	Total weight and moment A.R.I. 5378	39.8	- 11.0	- 435
	A.R.I. 18090			
10Q/93	Pulse Altimeter Indicator Type 7921	10.0	- 19.5	- 195
10D/19806	Transmitter Receiver Type 7923	28.7	- 11.6	- 332
	Total weight and moment A.R.I. 18090	38.7	- 13.6	- 527
	A.R.I. 23023			
10D/19598	Receiver Type AD. 7092 D	15.7	- 2.4	- 37
10L/16073	Control Unit Type 1274	2.8	- 21.6	- 59
	Total weight and moment A.R.I. 23023	18.5	- 5.2	- 96
	A.R.I. 5851			
10D/18843	Transmitter Receiver Type TR3710	116.0	+ 17.5	+ 2,030
10Q/16094	Tracking Unit Type 100	48.0	+ 19.4	+ 932
10B/19515	Aerial Type 501A	40.0	+ 18.1	+ 723
10B/17373	Waveguides Type 529	1.1	+ 18.2	+ 20
10Q/16095	Control Unit and Indicator Type 101	21.0	- 18.8	- 394
6B/541	G.P. Indicator Mk.4 Alternatives	25.0	- 18.8	- 471
9CA/101	G.P. Indicator Mk.6	80.0	- 18.7	- 1,493
	Total weight and moment A.R.I. 5851 with G.P.I. Mk.4	251.1	+ 11.3	+ 2,840
	Total weight and moment A.R.I. 5851 with G.P.I. Mk.6	306.1	+ 5.9	+ 1.818
	A.R.I. 18124			
10D/5821	Transmitter Receiver Type 4	48.5	- 8.0	- 388
10L/5821	Control Unit Type C/1607/ARC52	2.76	- 27.9	- 77
	Total weight and moment A.R.I. 18124	51.26	- 9.1	- 465

V.2.1A. 1657

15(a) LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE) (Continued)

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	A.R.I. 23063			
10L/16716	Control Unit Type 16051	1.5	- 19.3	- 29
10D/21774	Receiver Type 16048 - Nosewheel Bay	11.0	- 10.2	- 112
10D/21774	Receiver Type 16048 - Nose (Alt. Position)	11.0	- 33.5	- 369
	Total weight and moment A.R.I. 23063 prior to Mod 1365	12.5	- 11.3	- 141
	Total weight and moment A.R.I. 23063 subsequent to Mod.1365	12.5	- 31.8	- 398
	A.R.I. 23061			
10D/21794	Transmitter Receiver Type 16098	12.0	- 4.3	- 51
10U/17445	Amplifier Type 16089	4.0	- 6.8	- 27
	Total weight and moment A.R.I. 23061	16.0	- 4.9	- 78
	A.R.I. 5959			
AN/APN/170	Radar Pod	85.0	- 43.59	- 3,705
	Total weight and moment A.R.I. 5959	85.0	- 43.59	- 3,705
	E.C.M. Equipment (Including Tail Warning Installation)			
	A.R.I. 5919			
10D/20974	Radar head c/w heat exchanger Type 6934	146.0	+ 53.4	+ 7,799
10Q/16420	Indicator Unit (Nav's station) Type 6935	13.5	- 18.7	- 253
10J/214	Control Unit			
	Total weight and moment A.R.I. 5919 removable	164.0	+ 45.5	+ 7,459
	A.R.I.18074			
10D/20533	Transmitter and P.U. T.7810 with base mounting T.4367	160.9	+ 43.4	+ 6,986
10L/16351	Control Unit Type 7812	1.3	- 20.0	- 26
	Total weight and moment A.R.I. 18074 removable	162.2	+ 42.9	+ 6,960
	A.R.I.18075			
10D/20530	No.1 Transmitter Type 9454 with P.U. and base mounting T.4367	164.3	+ 45 6	+ 7,492
10D/20530	No. 2 Transmitter Type 9454 with P.U. and base mounting T.4367	164.3	+ 45.6	+ 7,492
10L/16349	Control Unit Type 9456	2.2	- 19.5	- 43
	Total weight and moment A.R.I. 18075 removable	330.8	+ 45.2	+ 14,941

15(a) LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE) (Continued)

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	A.R.I.18105			
10D/20570	Blanking Unit Type 9777	6.4	+ 51.6	+ 330
10D/21506	Blanking Unit Type 11871	6.4	- 39.5	- 253
10D/20567	Receiver Type R.9561	12.0	+ 51.6	+ 619
10D/20567	Receiver Type R.9561	12.0	+ 51.6	+ 619
10D/20567	Receiver Type R.9561	12.0	- 39.5	- 474
10D/20567	Receiver Type R.9561	12.0	- 39.5	- 474
10J/214	Control Unit Type 9562	4.5	- 19.6	- 88
	Total weight and moment A.R.I. 18105 removable	65.3	+ 4.3	+ 279
	A.R.I. 18076			
10K/19874	No.1 Power Unit T.9421 with base mounting	244.7	+ 47.5	+ 11,619
10K/19874	No.2 Power Unit T.9421 with base mounting	244.7	+ 47.5	+ 11,619
10K/19874	No.3 Power Unit T.9421 with base mounting	244.7	+ 49.5	+ 12,117
10D/20525	No.1 Transmitter T.9420 with base mounting T.4367	219.0	+ 41.4	+ 9,072
10D/20525	No.2 Transmitter T.9420 with base mounting T.4367	219.0	+ 41.4	+ 9,072
10D/20525	No.3 Transmitter T.9420 with base mounting T.4367	217.0	+ 43.4	+ 9,421
10L/16346	Control Unit Type 9422	5.0	- 19.6	- 98
	Total weight and moment A.R.I. 18076 removable	1,394.1	+ 45.1	+ 62,822
	Total weight and moment E.C.M. removable equipment	2,116.4	+ 43.7	+ 92,461
	OXYGEN CHARGE (* denotes alternative systems)			
System No.1	TOTAL (10 Bottles) (in Power Compartment) *	70.0	+ 33.5	+ 2,347
	4 Bottles (in Power Compartment)	28.0	+ 35.0	+ 980
	6 Bottles (in Bomb Bay)	42.0	+ 6.2	+ 259
System No.2 Mod.668	TOTAL (10 Bottles) *	70.0	+ 17.7	+ 1,239
	4 Bottles (in Power Compartment)	28.0	+ 35.0	+ 980
	6 Bottles (in Bomb Bay)	42.0	+ 6.2	+ 259
	2 Bottles (in Bomb Bay)	14.0	+ 14.0	+ 221
System No.3 Mod.897	TOTAL (12 Bottles) *	84.0	+ 17.4	+ 1,460

15(a) LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE) (Continued)

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	OTHER COMPONENT WEIGHTS			
	Life raft Type M.S.5	115.8	- 22.33	- 2,586
7B/1484	Signal Pistol 1½" Mk.1	4.1	- 20.7	- 85
	Signal Pistol Cartridges 12 off	4.1	- 22.3	- 91
2K/1314	Ejector Seat Cartridges Set No.3 Mk.3	3.0	- 26.8	- 80
	First Aid Outfit Cabin	6.0	- 26.7	- 160
	Gloves and First Aid Kit - D.1	4.5	- 32.1	- 144
	Windscreen Anti-icing Fluid 12 gall.	97.8	- 32.2	- 3,146
	Periscopic Sextant Mk.2 C/W Case 1 off	11.5	- 23.0	- 265
	Entrance Ladder	28.0	- 21.4	- 600
	Hand Fire Extinguishers in cabin - 5 off	27.5	- 24.8	- 683
	Battery 5J 3364	76.5	- 7.8	- 593
5UB/6431	Amplidyne	32.5	- 34.1	- 1,108
	Tail Parachute	200.0	+ 48.5	+ 9,693
	3300 P.S.I.			
	Rapid Engine Start - Air Charge (8 bottles)	92.0	+ 21.2	+ 1,950
	Rapid Engine Start - Air Charge (10 bottles)	115.0	+ 21.2	+ 2,438
	E.C.M. Cooling			
	Pack- Vapour Cycle Cooling	109.5	+ 49.6	+ 5,429
	Coolant (Glycol & Freon) (7.4 gallons)	89.5	+ 45.9	+ 4,105
	AUTO-PILOT EQUIPMENT			
6T201	Gyro Units Type A. (112 EAP Smiths)	18.5	- 30.3	- 560
6T1617	Locking Unit (155 EAP Smiths)	40.0	- 29.8	- 1,190
6T1615	Servo Control (130 EAP Smiths)	20.0	- 28.4	- 567
6T1616	Platform Control (148 EAP Smiths)	15.0	- 29.2	- 438
6T1614	Pressure Unit (143 EAP Smiths)	5.4	- 30.6	- 165
	AUTO LANDING INSTALLATION (AUTO-THROTTLE)			
6T1951	Amplifier (Fwd.)	8.7	+ 0.8	+ 7
6T1951	Amplifier (Aft)	8.7	+ 2.3	+ 20
6T1952	Integrator Unit	18.5	+ 1.2	+ 22
6T1688	Control Unit	16.5	+ 1.9	+ 31
6T1953	Junction Box	6.0	+ 1.5	+ 9
	(NOTE . . . *See also Radio Alt. Mk.7 & Leader Cable Installation.)*			
	Unusable fuel to bring to 'Basic Weight'	154.0	+ 7.75	+ 1,193
	A.A.P.P. Fuel tank 10 galls @ S.G. .77	77.0	+ 21.6	+ 1,663

V.2.1A. 1660

15(a) LIST OF REMOVABLE EQUIPMENT INCLUDED IN BASIC WEIGHT (BLUE STEEL ROLE) (Continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	Equipment to be removed in order to prepare aircraft for Blue Steel			
D.8729	Bomb doors	1,426.0	14.5	20,654
A.8986	Bomb door jacks	92.0	14.9	1,369
	Bomb door seals	47.2	6.5	305
D10520	Tank bay fairing	27.3	- 3.3	- 91
8/D10981	Access panel	24.5	30.5	747
D9201	Bomb door linkage	10.0	0.3	3
30/D9046	Levers - forward	32.0	0.3	11
30/D9046	Levers - aft	32.0	29.2	933
AT62150	Universal couplings	5.0	13.4	67
Z.7723	Diffuser (with duct and channel assemblies)	3.7	16.5	61
FDFA3010	Inching control	2.9	18.3	53
Z.7691	Injector body	9.4	17.7	166
7/D8839	Special bolts	7.0	0.6	4
7/D9046	Special bolts	2.5	0.4	1
17/D9046	Pins	8.8	29.2	257
V.9301	Panel	0.9	- 29.0	- 26
	Miscellaneous:- Hydraulic and pneumatic) pipes deleted) nuts, bolts etc.)	15.0	14.8	222
	Total bomb doors etc.	1,746.2		24,736

Total weight and moment effect of conversion from standard aircraft to Blue Steel

Add Blue Steel removable	2,809		35,168
Delete bomb doors etc.	1,746		-24,736
Weight and moment effect	1,063		10,432

VARIABLE LOAD

16. Variable load is as follows:-

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	BOMB GEAR			
	Case A			
	Blue Steel equipment - see separate list			

VARIABLE LOAD (continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	Case B			
	6,000 lb. store			
	Carrier and pintles	473·0	12·1	5,726
	Case C			
	Red Beard			
	Carrier and pintles	369·0	12·1	4,467
	Case D			
	21 x 1000 lb. stores			
	Fwd. carriers and pintles	275·0	4·463	1,227
	Centre carriers and pintles	275·0	13·405	3,686
	Aft carriers and pintles	275·0	22·327	6,140
	Total weight and moment of carriers and pintles	825·0	13·4	11,053
	Case E			
	24 x 25 lb. smoke flashes			
	Carriers and pintles	1,050	13·4	14,042
	Case F			
	24 x 100 lb. practice bombs			
	Carriers and pintles	1,050	13·4	14,042
	Aircraft destructors H.E. No.1, Mk.1(2 off)	6·5	-32·0	- 208
	Survival packs (5 off)	170·0	-33·9	- 5,766
	Bomb fuzing equipment including B/Panel 9P	51·5	- 3·8	- 197
	Misc. appendix 'A' items - includes binoculars, watches, navigational aids, etc.	47·1	-22·5	- 1,067
	V.G. recorder IT. 4.3.18	4·2	-19·8	- 83
26DC/8929	C.G. computer (Z 9969)	1·25	-26·2	- 33
IT3-15-61	R.A.E. recorder	35 0	-22·2	- 777
9C/102	Ground speed resolver	47·0	-29·3	- 1,379
	T.4 bombsight installation - removable equipment			
9/4482	Computer	50·0	-27·3	- 1,365
9/4566	Sighting head	15·0	-29·3	- 439
9/4579	Amplifier	11·5	-26·8	- 308
	Total weight and moment T.4 bombsight removable equipment	76·5	-27·6	- 2,112
	A.R.I.18051 window launching removable equipment			
26DC/4362	Main containers port and starboard	93·0	24·5	2,280
26DC/9850	Secondary containers port and starboard	29·6	24·5	724

VARIABLE LOAD (continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Z9871	Secondary containers stripper units (2 off)	74·0	23·4	1,733
Z9871	Sub. Assembly for containers	10·6	23·3	248
Z10031	Assembly of main containers	1·7	24·4	42
Z10031	Main container stripper units (2 off)	74·0	21·3	1,579
Z8277	Installation of W.L. units	9·4	24·2	227
10L/291	Control units and panel	15·8	-19·7	- 311
	Total weight and moment of A.R.I.18051 removable equipment	308·1	21·2	6,522
	A.R.I.5848 removable equipment			
10D/20334	Trans/rec. Type T.R.4535	38·4	-15·0	- 574
10K/1660/036290932	S.I.F. coder KY.95.A/APX-25	10·4	-14·2	- 148
16K/1660/036290584	Control unit Type C1158/APX-6A	1·4	-18·9	- 26
16K/1660/036290585	S.I.F. control unit C1128/APX-25	1·2	-19·2	- 23
	Total weight and moment of A.R.I.5848 removable equipment	51·4	-15·0	- 771
	Blue Steel removable equipment			
Q2260	Hydraulics - hoisting	266·5	14·3	3,819
D11952	A.L.S.U. fairing mounting	38·8	22·0	852
	A.L.S.U. fuzing unit mounting	7·3	22·0	161
	A.L.S.U. hot air supply - port	19·9	17·5	349
	A.L.S.U. hot air supply - starboard	19·9	17·5	349
	Remote control panel	15·6	15·8	247
Z9955	Refrigeration pack	223·5	3·9	833
Z10050	Store heating	28·5	17·6	502
Q2302	Pneumatics	22·0	13·5	296
	Mechanical jettison	40·9	14·2	582
Q2422	Hydraulics - general	179·2	1·6	293
Q2263	Hydraulics - fin gap doors	61·7	17·5	1,078
Q2276	Hydraulics - umbilical	28·9	17·3	500
D11230	Carrier beam	314·7	14·3	4,488
1/Z10005	Hinge brackets	22·5	14·3	321
	Door support struts	50·6	12·1	610
	Door support structure	2·4	14·6	35
	Fairings and attachments	5·1	- 5·5	- 28
	Rear crutching beam	137·1	19·9	2,733
D11220	Fairing door - port	458·3	14·7	6,726
	Fairing door - starboard	545·6	14·6	7,963
	Mechanical shut-off for refrigeration	5·0	14·8	74
	Horizontal struts	6·0	17·7	106
D10827	Removable fairings	22·5	32·3	726

VARIABLE LOAD (continued)

Ref. No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
9C/103	Inertia navigator control unit	13·5	-18·8	- 254
9C/104	Inertia navigator monitoring unit	12·0	-18·8	- 226
R/AI AO2/35430	Adapter box monitoring	22·0	-18·5	- 407
	Shock absorbers and fairings	10·1	- 1·2	- 12
	Electrics including panels 85P, 86P, 92P, 93P and 97P.	113·2	8·1	918
	Cables	98·0	14·6	1,429
	No.4 butt connector	18·0	5·8	105
	Total Blue Steel removable equipment	2,809·3	12·518	35,168
	Freight pannier			
27H/3346	Freight pannier (empty)	446	9·0	4,014
26DC/6177	Freight pannier suspension	273	9·0	2,457
	Pannier case			
26DC/6177	Suspension	273	9·0	2,457
27H/3346	Freight pannier (full)	4,000	9·0	36,000
	Total	4,273	9·0	38,457
	Mod.630 Special flight containers			
	7,000 lb. M.C. case			
	Type 'A' container (power compartment)	181·0	32·7	5,920
Z.9815	Type 'A' container cradle	19·3	32·6	630
	Type 'C' container (bomb bay)	123·0	13·5	1,661
Z.10046	Type 'C' container cradle	18·7	13·5	252
	Total	342·0	24·7	8,463
	Red Beard case			
	Type 'A' container (power compartment)	181·0	32·7	5,920
Z.9815	Type 'A' container cradle	19·3	32·6	630
	Type 'B' container (bomb bay)	115·0	13·5	1,552
Z.9827	Type 'B' container cradle	11·4	13·5	154
	Total	326·7	25·3	8,256

FUEL LOADING DATA

18. 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	1,220	-11·027	9,760		107,618
2	1,870	- 3·0	14,960	-	44,880
3	1,260	13·316	10,080	134,234	-
4	1,260	19·055	10,080	192,077	-
5	1,030	21·937	8,240	180,771	-
6	1,490	25·616	11,920	305,350	-
7	1,130	28·538	9,040	257,991	-
Total	9,260	12·391	74,080	917,925	-

Tank No. P. & S.	Fuel S.G. 0·78 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,240	-11·027	9,672	-	106,651
2	1,890	- 3·0	14,742	-	44,226
3	1,280	13·316	9,984	132,950	-
4	1,280	19·055	9,984	190,245	-
5	1,050	21·936	8,190	179,668	-
6	1,510	25·616	11,778	301,707	-
7	1,150	28·538	8,970	255,988	-
Total	9,400	12·407	73,320	909,681	-

Tank No. P. & S.	Fuel S.G. 0·77 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,240	-11·027	9,548	-	105,281
2	1,890	- 3·0	14,553	-	43,659
3	1,280	13·316	9,856	129,542	-
4	1,280	19·055	9,856	185,367	-
5	1,050	21·936	8,085	175,061	-
6	1,510	25·616	11,627	293,971	-
7	1,150	28·538	8,855	249,424	-
Total	9,400	12·407	72,380	898,019	-

EXPENDABLE LOAD

17. Items of expendable load are as follows:-

Ref.No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)
	Bombs			
	Case A Blue Steel	15,750	14·02	220,815
	Case B 7,000 lb. M.C.	7,200	11·9	85,968
	Case C 6,000 lb. store	3,175	12·1	38,285
	Case D Red Beard	1,680	12·1	20,339
	Case E 21 x 1,000 lb. H.E. stores	21,000	13·4	280,499
	Case F 24 x 25 lb. smoke flashes	600	13·4	8,040
	Case G 24 x 100 lb. practice bombs	2,400	13·4	32,100
	Window			
	Case 1			
10 AU/123	Window Type 21 (primary containers 3,744 packets)	698	24·4	17,043
10 AU/123	Window Type 21 (secondary containers 936 packets)	175	24·3	4,244
	Total	873	24·4	21,287
	Case 2			
10 AU/124	Window Type 22 (primary containers 1,440 packets)	894	24·4	21,829
10 AU/124	Window Type 22 (secondary containers 360 packets)	224	24·3	5,432
	Total	1,118	24·4	27,261
	Case 3			
10 AU/125	Window Type 23 (primary containers 1,920 packets)	851	24·4	20,779
10 AU/125	Window Type 23 (secondary containers 480 packets)	213	24·3	5,165
	Total	1,064	24·4	25,944
	Case 4			
10 AU/130	Window Type 28 (primary containers 2,592 packets)	806	24·4	19,680
10 AU/130	Window Type 28 (secondary containers 648 packets)	202	24·3	4,899
	Total	1,008	24·4	24,579

FUEL LOADING DATA

18. 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	1,220	-11·027	9,760		107,618
2	1,870	- 3·0	14,960	-	44,880
3	1,260	13·316	10,080	134,234	-
4	1,260	19·055	10,080	192,077	-
5	1,030	21·937	8,240	180,771	-
6	1,490	25·616	11,920	305,350	-
7	1,130	28·538	9,040	257,991	-
Total	9,260	12·391	74,080	917,925	-

Tank No. P. & S.	Fuel S.G. 0·78 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,240	-11·027	9,672	-	106,651
2	1,890	- 3·0	14,742	-	44,226
3	1,280	13·316	9,984	132,950	-
4	1,280	19·055	9,984	190,245	-
5	1,050	21·936	8,190	179,668	-
6	1,510	25·616	11,778	301,707	-
7	1,150	28·538	8,970	255,988	-
Total	9,400	12·407	73,320	909,681	-

Tank No. P. & S.	Fuel S.G. 0·77 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,240	-11·027	9,548	-	105,281
2	1,890	- 3·0	14,553	-	43,659
3	1,280	13·316	9,856	129,542	-
4	1,280	19·055	9,856	185,367	-
5	1,050	21·936	8,085	175,061	-
6	1,510	25·616	11,627	293,971	-
7	1,150	28·538	8,855	249,424	-
Total	9,400	12·407	72,380	898,019	-

Tank No. P. & S.	Fuel S.G. 0·76 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,240	-11·027	9,424	-	103,917
2	1,890	- 3·0	14,364	-	43,092
3	1,280	13·316	9,728	129,542	-
4	1,280	19·055	9,728	185,367	-
5	1,050	21·936	7,980	175,061	-
6	1,510	25·616	11,476	293,971	-
7	1,150	28·538	8,740	249,424	-
Total	9,400	12·407	71,440	886,356	-

Tank No. P. & S.	Fuel S.G. 0·75 Gall.	Arm (ft.)	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
1	1,240	-11·027	9,300	-	102,550
2	1,890	- 3·0	14,175	-	42,525
3	1,280	13·316	9,600	127,838	-
4	1,280	19·055	9,600	182,928	-
5	1,050	21·936	7,875	172,758	-
6	1,510	25·616	11,325	290,103	-
7	1,150	28·538	8,625	246,142	-
Total	9,400	12·407	70,500	874,694	-

FUEL TRANSFER

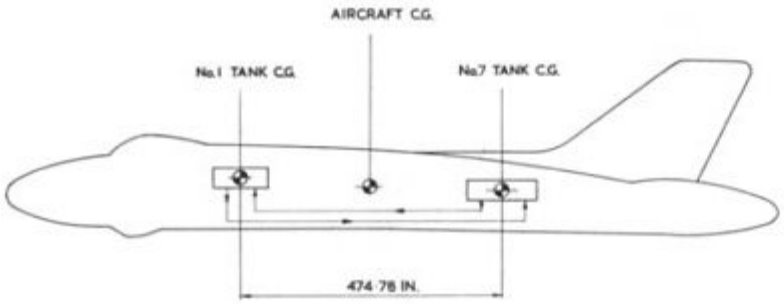


Fig.4. Fuel transfer

19. To calculate the amount of fuel to be transferred between No.1 and 7 tanks to trim the aircraft proceed as follows:-

$$\frac{\text{All up weight x C.G. shift required}}{474{\cdot}78} = \text{Weight of fuel to be transferred.}$$

e.g., $\frac{145{,}000 \times 1}{474{\cdot}78} = 305$ lb.

i.e., To move the aircraft C.G. forward or aft by one inch at an All Up Weight of 145,000 lb. a total weight of 305 lb. fuel must be transferred.

BOMB BAY FUEL SYSTEM

20. Items of the bomb bay fuel system removable equipment introduced by Mod.527 and 528 are as follows:-

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Blue Steel case (Tank 'A' aft +Tank 'E')			
P3390 Tank 'A' (aft position)	596·0	8·8	5,265
P3375 Tank 'E'	654·0	24·3	15,914
Fire extinguisher bottles	170·0	6·8	1,162
Total removable Blue Steel case	1,420·0	15·7	22,341
Fuel - Tank 'A' - 718 Gall.(S.G.0·77)	5,529·0	8·8	48,840
Fuel - Tank 'E' - 721 Gall.(S.G.0·77)	5,552·0	24·3	135,099
Total fuel 1,439 Gall.	11,081·0	16·6	183,939
6,000 lb. Store and Red Beard cases (Tank 'A' Fwd. +Tank 'E')			
P3390 Tank 'A' (fwd. position)	596·0	4·33	2,583
P3375 Tank 'E'	654·0	24·3	15,914
Fire extinguisher bottles	170·0	6·8	162
Total removable 6,000 lb. store and Red Beard	1,420·0	13·8	19,659
Fuel - Tank 'A' - 718 Gall.(S.G.0·77)	5,529·0	4·33	23,959
Fuel - Tank 'E' - 721 Gall.(S.G.0·77)	5,552·0	24·3	135,099
Total fuel 1,439 Gall.	11,081·0	14·4	159,058
7,000 lb. M.C. Case (Tank 'A' Fwd.)			
P3390 Tank 'A' (fwd. position)	596·0	4·33	2,583
Fire extinguisher bottles	170·0	6.8	1,162
Total removable 7,000 lb. M.C.	766·0	4·9	3,745
Total fuel - tank 'A' 718 Gall.	5,529·0	4·33	23,959

Cylindrical tanks

20A. Items of the bomb bay fuel system introduced by Mod.2013 and 2014 are as follows:-

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Cylindrical tank (fwd.)	1,010	5·2	5,233
Cylindrical tank (aft)	1,010	24·6	24,829
Fire extinguishers etc.	170	6·8	1,162
Total removable items	2,190	14:3	31,224

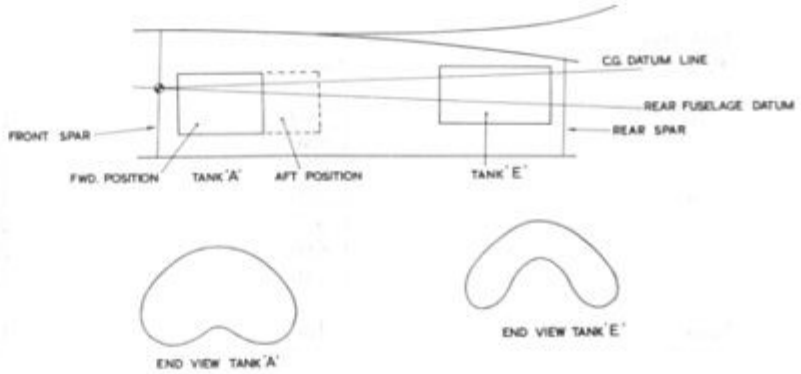


Fig.5. Bomb bay fuel tanks

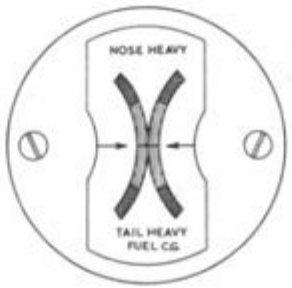


Fig.6. Fuel C.G. indicator

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
Fuel - fwd. tank 1,008·75 gall.	7,767	5·2	40,130
Fuel - aft tank 1,008·75 gall.	7,767	24·6	190,936
Total fuel 2,017·5 gall. (S.G.0·77)	15,534	14·9	231,066

FUEL C.G. INDICATOR

21. This instrument is mainly for use during flight refuelling, to aid the pilot to keep the aircraft in longitudinal trim. It shows any variation in the mean fuel C.G. due to uneven distribution. The gauge is calibrated about the mean C.G. of the fuel and is connected to the tank contents transmitters via a computor box which takes into consideration the moment arm of each tank. The limit of each green sector represents 30,000 lb. ft. out of balance moments, giving a total of 60,000 lb. ft. for the aircraft. When fuel is correctly distributed the needles are in the middle of the green sector, i.e., number of out of balance moments zero.

NOTE...

1. *This instrument does not give the aircraft C.G. position.*
2. *Does not include the bomb bay fuel system.*

UNUSABLE FUEL

22. Unusable fuel is the fuel remaining after the contents gauges register zero. This fuel is included in the Basic Weight and must be added to the weighed weight of the aircraft.

The weight and moment of fuel to bring to 'Basic Weight'

Weight	154 lb.
Moment Arm	7·75 ft. (93 in.)
Moment	1,193 lb.ft.

NOTE...

Although all the fuel indicated on the fuel contents gauges is usable the recommended minimum for final landing is 8,000 lb. total, because of the wide distribution of fuel between tanks and the possibility of uncovering pumps while manoeuvring the aircraft.

CREW LOADING DATA

23. Details of crew loading are as follows:-

Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
1st and 2nd pilot	360	-27·3	- 9,828
3 crew members	540	-21·6	-11,664
Total weight and moment - 5 crew	900		-21,492
Safety equipment			
1st and 2nd pilot's chutes and dinghies	102	-27·3	- 2,785
3 crew member's chutes and dinghies	131	-21·7	- 2,843
Total weight and moment of chutes and dinghies	233		- 5,628
Total weight and moment - 5 crew with chutes etc.	1,133		-27,120
6th crew member	180	-25·2	- 4,536
6th crew member's chute and dinghy	43	-25·2	- 1,084
Total weight and moment - 6 crew with chutes etc.	1,356		-32,740

ENGINE C.G. DATA

24. To find X engine C.G. from aircraft C.G. datum point

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

Example:

A = C.G. of engine from trunnion = 5·5 in. obtained from engine Air Publication

To find X:

$C = 0{\cdot}98481 \times 5{\cdot}5 \text{ in.}$
$= 5{\cdot}4165 \text{ in.}$
$X = 164{\cdot}9841 - 5{\cdot}4165 \text{ in.}$
$= 159{\cdot}5676 \text{ in. aft of aircraft C.G. datum point}$

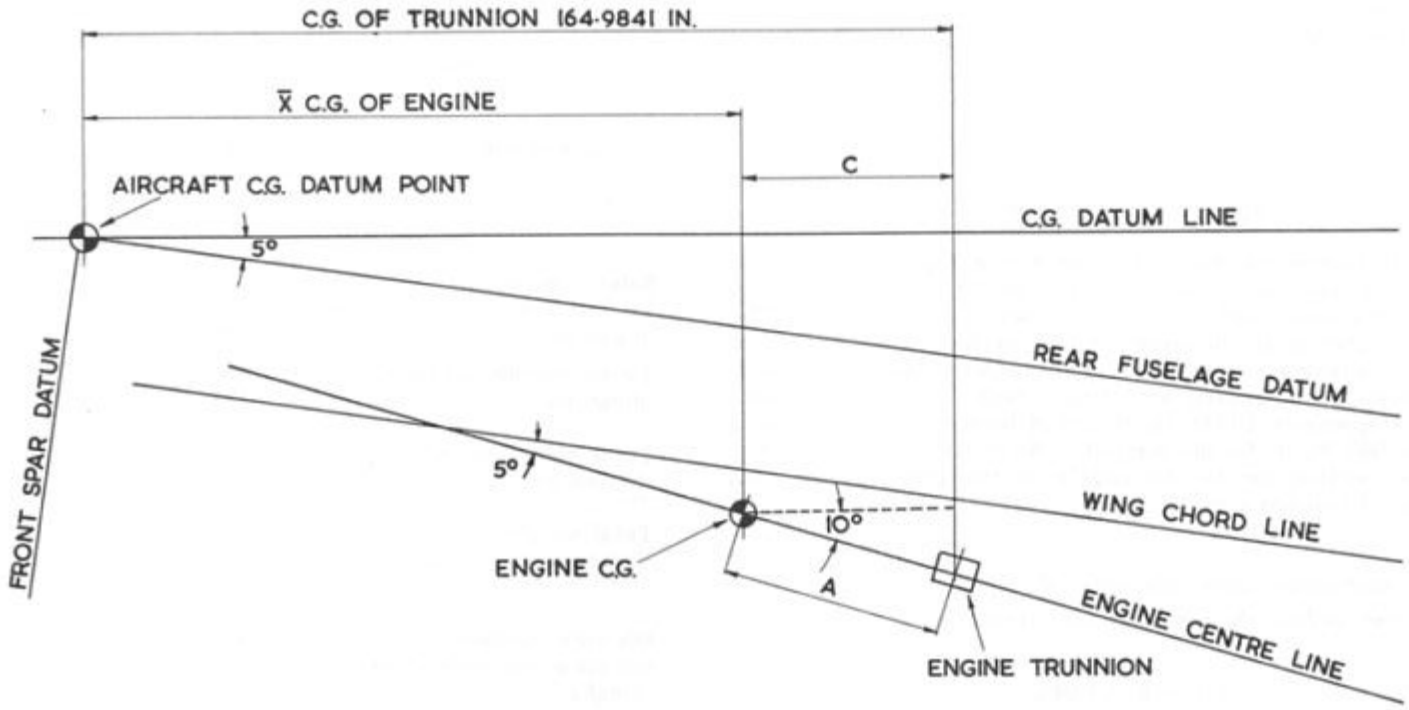


Fig.7. Engine C.G.

TYPICAL LOADING CALCULATIONS

25. Case A, Blue Steel with bomb bay fuel

Description	Weight (lb.)	Moment (lb.ft.) Positive	Moment (lb.ft.) Negative
Current basic weight and moment (Obtained from Record Sheet - Form 4908)	100,757	1,272,916	-
Convert to Blue Steel	1,063	10,432	-
Add - Bomb bay fuel system removable equipment	1,420	22,341	-
	103,240	1,305,689	-
Add - operational equipment			
Aircraft destructors	6·5	-	208
Bomb fuzing	51·5	-	197

Description	Weight (lb.)	Moment (lb. ft.) Positive	Moment (lb. ft.) Negative
Miscellaneous Appendix 'A' items	47·1	-	1,067
Window launching - removable	308·1	6,522	-
I.F.F. Mk.10	51·4	-	771
T.4 bombsight - removable	76·5	-	2,112
V.G. recorder	4·2	-	83
C.G. computer	1·3	-	33
Survival packs	170·0	-	5,766
Crew 5 off c/w chutes and dinghies	1,133·0	-	27,120
		1,312,211	37,357
Weight and moment less disposable load	105,090	1,274,854	Index Unit -3·384
Add disposable load			
Store	15,750	220,815	-
Window (case 1)	873	21,287	-
Fuel 100% 9,400 gall. at 7·7 lb./gall.	72,380	898,019	-
Bomb bay fuel tank A - 718 gall. Bomb bay fuel tank E - 721 gall.	11,081	183,939	-
All up weight and moment	205,174	2,598,914	Index Unit 4·37

C.G. position = $\frac{2,597,133}{205,215}$ =12.655 ft.= 151·9 in. aft of datum point

26. Case B,7,000 lb. M.C.

Current basic weight and moment	100,757	1,272,916	
(Obtained from Record Sheet - Form 4908)			
Add - operational equipment			
Carriers and pintles	295·0	4,201	-
Aircraft destructors H.E. Mk.1 (2 off)	6·5	-	208
Bomb fuzing	51·5	-	197
Miscellaneous Appendix 'A' including binoculars, watches navigational aids etc.	47·1	-	1,067
Window Launching - removable equipment	308·1	6,522	-
I.F.F. Mk.10 - removable equipment	51·4	-	771
T.4 bombsight - removable equipment	76·5	-	2,112
V.G. recorder IT/4.3.18	4·2	-	83
C.G. computer	1·25	-	33

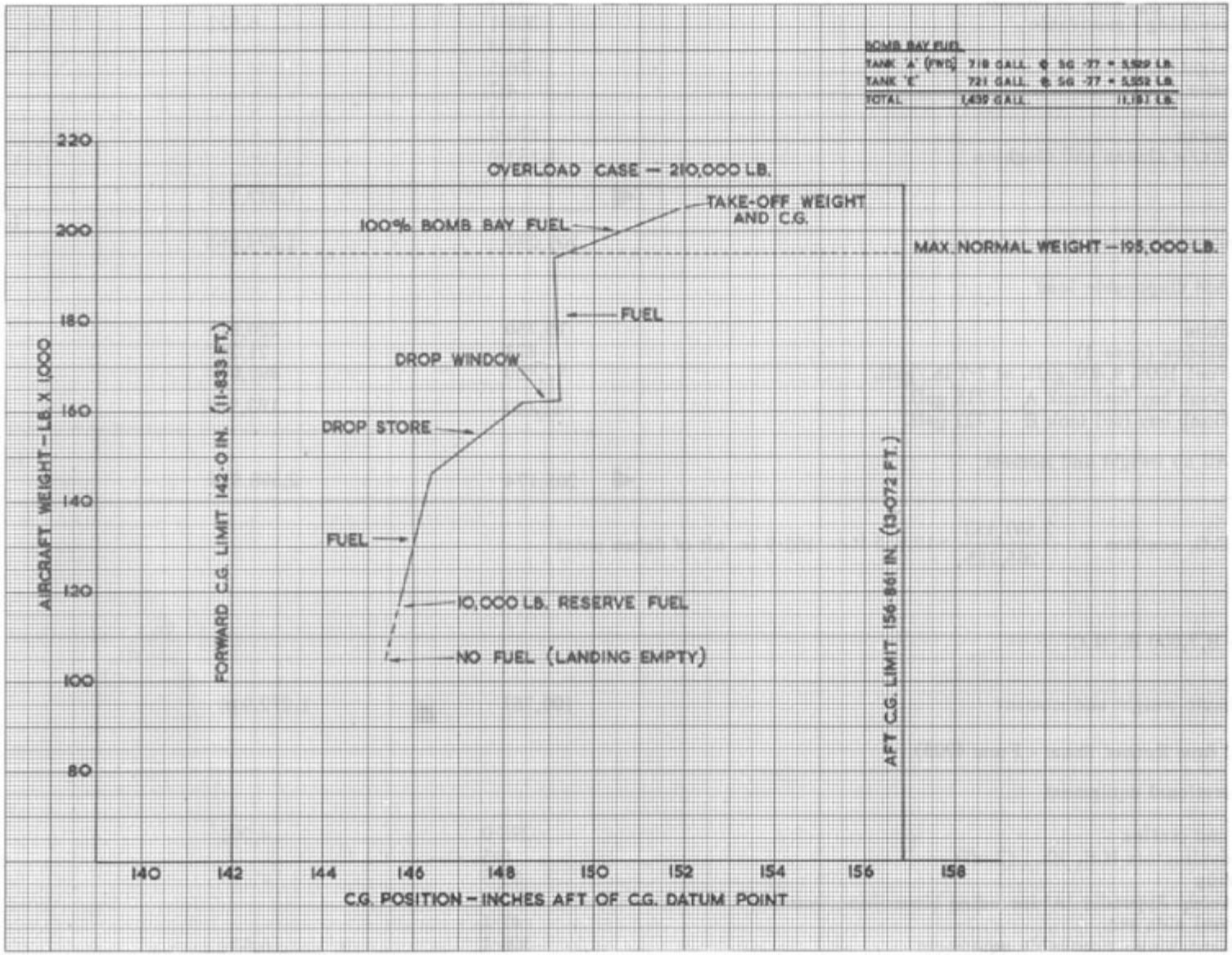


Fig.8. C.G. movement during flight - Blue Steel case

TYPICAL LOADING CALCULATION (continued)

Description	Weight (lb.)	Moment (lb. ft.) Positive	Moment (lb. ft.) Negative
Survival packs	170·0	-	5,766
Crew (5 off) c/w chutes and dinghies	1,133·0	-	27,120
		1,283,639	37,357
Weight and moment less disposable load	102,902	1,246,282	Index Unit -3·519
Add - disposable load			
Store (7,000 lb. M.C.)	7,200	85,968	-
Window (case 1)	873	21,287	-
Fuel 100% 9,400 gall. at 7·7 lb./gall.	72,380	898,019	-
A.U.W. and Moment	183,355	2,251,556	Index Unit -3·172

C.G. position = $\frac{2,251,556}{183,355}$ = 12·279 ft. = 147·3 in. aft of datum point

CALCULATION OF EXPENDABLE LOAD - 7,000 LB. M.C.

27. Case B - 7,000 lb. M.C.

Description	Weight (lb.)	Moment (lb. ft.) Positive	Moment (lb. ft.) Negative
Drop:-			
Window	873	21,287	-
Store	7,200	85,968	-
Use:-			
Fuel less 10,000 lb. reserve	62,380	773,949	-
Oxygen 12 bottles	84	1,460	-
Windscreen anti-icing fluid (12 gall.)	97·8	-	3,146
		882,664	3,146
Total weight and moment of expendable load	70,635	879,518	-

CALCULATION OF C.G. FOR LANDING - 7,000 LB. M.C.

28. Case B - 7,000 lb. M.C.

Landing weight = 183,355 − 70,635 = 112,720 lb.

Moment = 2,251,556 − 879,518 = 1,372,038 lb. ft.

Landing C.G. = $\frac{1,372,038}{112,720}$ = 12·172 ft. (146·1 in.) Aft of C.G. datum point

EFFECT OF UNDERCARRIAGE RETRACTION

29. The moment effect of undercarriage retraction = -18,570 lb.ft.

Example:-

◀ Case B - 7,000 lb. M.C. (para.28) ▶

Weight 112,720 lb., C.G. 12·172 ft. (146·1 in.)

Moment	1,372,038 lb. ft. (undercarriage down)
Change in moment due to undercarriage retraction	- 18,570 lb. ft.
Moment	1,353,468 lb. ft. (undercarriage up)

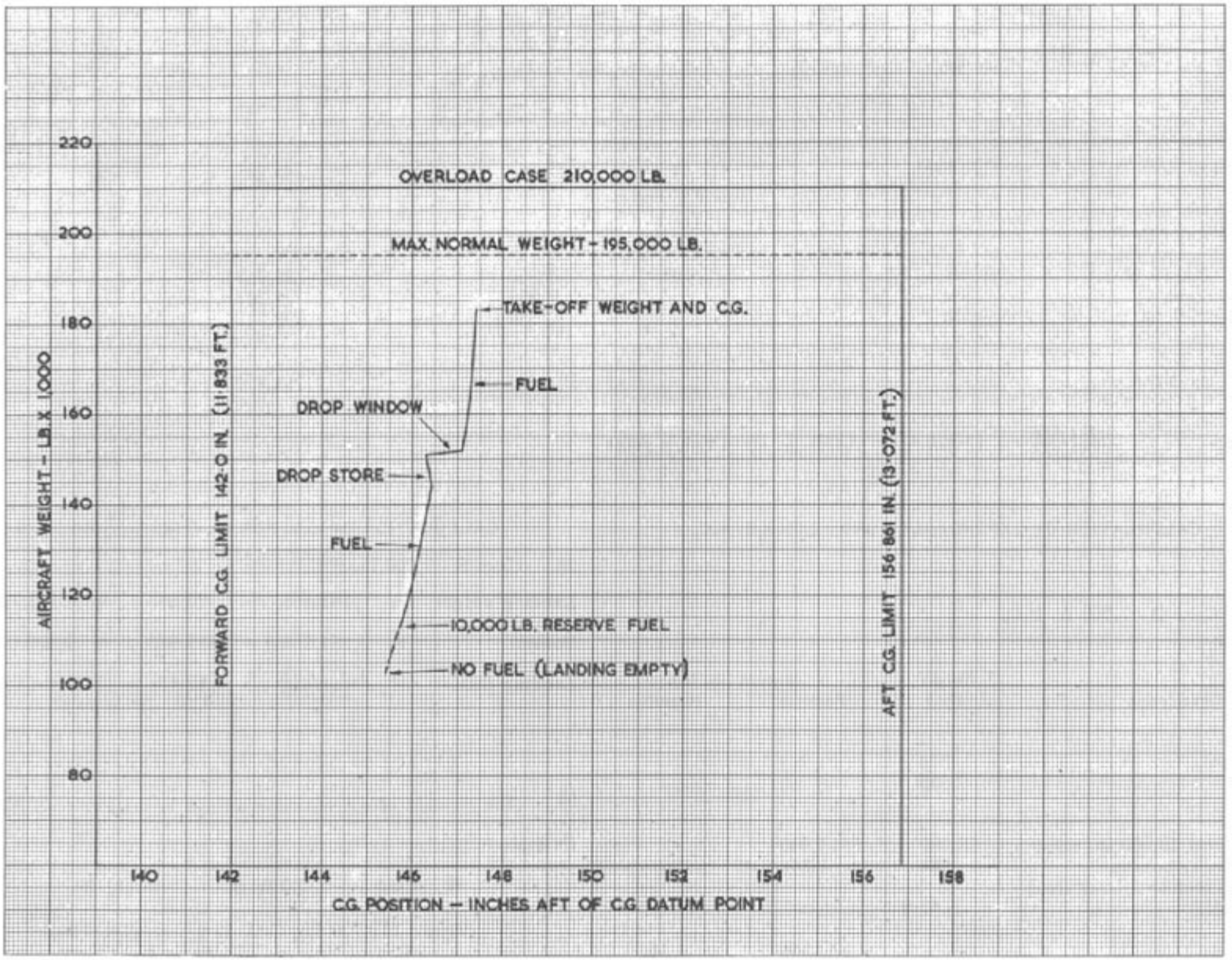


Fig.9. C.G. movement during flight - 7,000 lb. M.C. case

C.G. position (undercarriage up) = $\frac{1\,353\,468}{112\,720}$ = 12.0 ft. (144 in.)

The C.G. shift due to undercarriage retraction at a weight of 112 720 lb. is 2.1 in. forward, at the A.U.W. of 183 355 lb. this effect is reduced to 1.2 in.

NOTE . . .
All C.G.'s moments and limits in this chapter are quoted with the undercarriage down.

BALLAST

30. Ballasting of this aircraft in the operational condition is unnecessary. Provision has been made however to fit ballast to compensate for substantial equipment shortages. Ballasting positions are situated in the nose and the E.C.M. rear fuselage.

Nose Ballast
Ballast is fitted in the nose as replacement weight for the H_2S scanner. This consists of a box 90 lb. and 12 ballast weights of approximately 40 lb.each.

12 x 40 = 480 + Box 90 = 570 lb.
Moment arm = –35.66 ft. (–428 in.)

Maximum capacity of Ballast box = 18 Weights.

Maximum weight = 18 x 40 = 720 + Box 90 = 810 lb.

Maximum permissible weight to be fitted at this station = 810 lb.

E.C.M. Ballast
Introduced by Mod.949 E.C.M. Ballasting is in two parts. Part A used for 'Delivery' loading to the Service and Part B for replacement of E.C.M. sets, when all other 'Service Fit' equipment is fitted.

As the aircraft C.G. in the fully equipped condition approaches the forward C.G. limit (fig.8) due to modifications it becomes more important to replace equipment removed in the rear fuselage by ballast weights.

E.C.M. BALLAST

31.

Station No.	Description	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)
	Part A, E.C.M. delivery ballast			
1 and 2	Socket plate Ref.No.26DC/9664 (2 off)	30.0	41.4	1 243
3	Socket plate Ref.No.26DC/9664	15.0	43.4	651
4	Socket plate Ref.No.26DC/9665	15.0	43.4	651
5 and 6	Socket plate Ref.No.26DC/9666 (2 off)	30.0	45.6	1 368
	Transportation plate Part No.1/Z10109	2.5	52.0	130
	Total socket plates	92.5	43.7	4 043
7 and 8	Ballast plates Ref.No.26DC/9860 (2 off)	480.0	47.5	22 792
9	Ballast plate Ref.No.26DC/9860	240.0	49.5	11 884
	Total ballast	720.0	48.2	34 676
	Total delivery ballast and socket plates	812.3	47.7	38 719
	Part B, E.C.M. additional ballast			
1 and 2	Ballast plate Part No.29/Z9980 (2 off)	480.0	41.4	19 884
3 and 4	Ballast plate Part No.29/Z9980 (2 off)	480.0	43.4	20 840
5 and 6	Ballast plate Part No.29/Z9980 (2 off)	480.0	45.6	21 880
	Total additional ballast	1 440.0	43.5	62 604

WEIGHING PROCEDURE

32. The aircraft should be checked for any deviation in equipment from that defined as included in the Basic Weight (para.13, 15 and 16). Defuelling is carried out in the normal manner as laid down in Section 4, Chapter 2 of this book to unusable fuel level (i.e., contents gauge zero). The aircraft is then rigged so that the C.G. datum line is horizontal. This can be done by either using a clinometer set at 5^{o} in the main undercarriage bay or by using a star plate and plumb line in the cabin (Sect.2, Chap.4). The remaining fuel in each tank must then be drained via each fuel tank drain valve by depressing the spring loaded base of the valve. The aircraft external surfaces must be dry, the wheel brakes off when on platform scales, and the hanger doors closed.

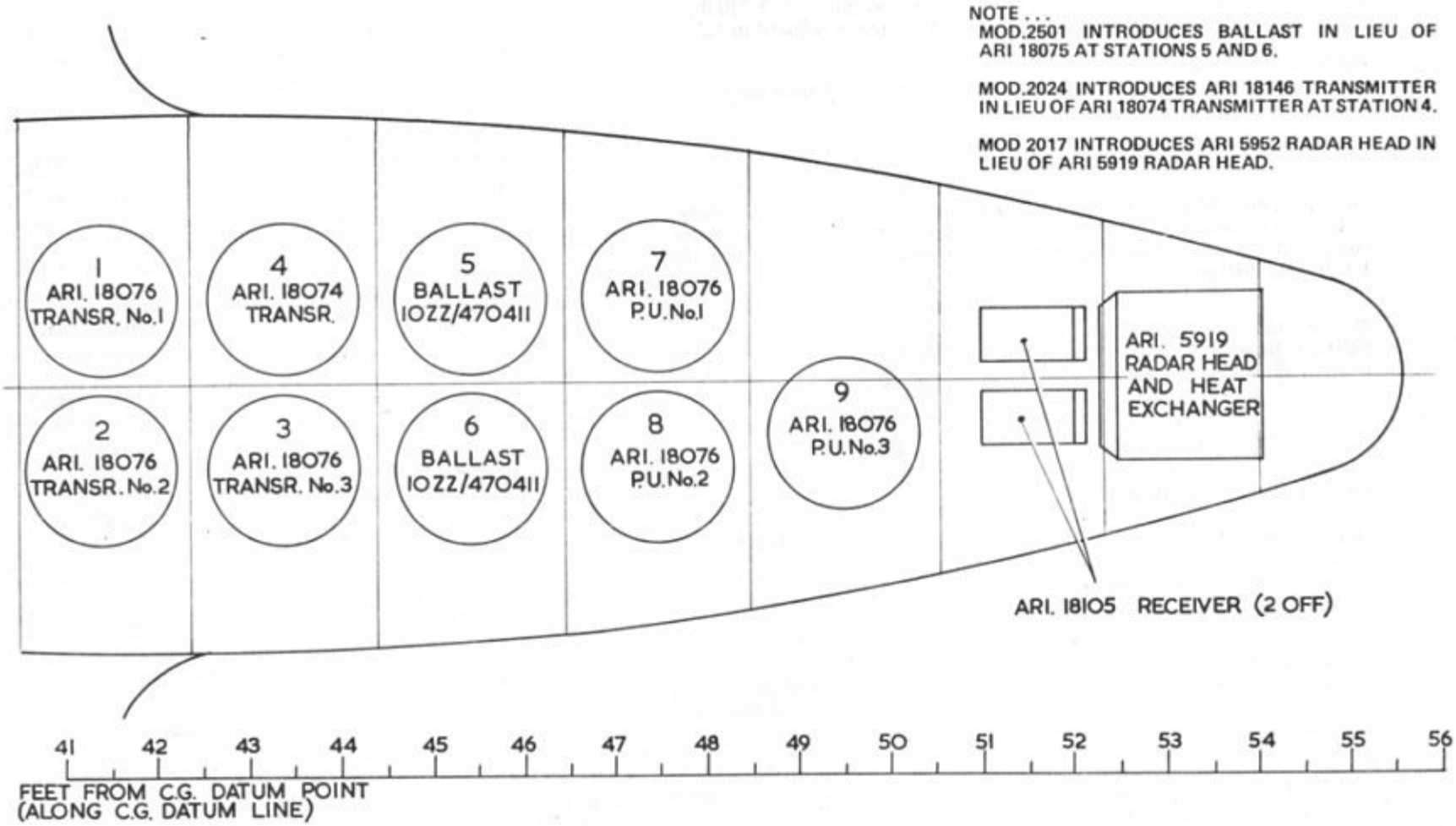


Fig. 10 E.C.M. equipment and ballast in rear fuselage

► *Mod. 2501* ◄

A1359

Weighing on platform scales

Measurements

N (ft.) - Weighing reference point to nose wheel centre

L (ft.) - Nose wheel centre to bogie centre line.

Calculations

To determine the aircraft centre of gravity in relation to the C.G. datum point (dimension X)

Take moments about the weighing reference point

$$(W + w) \times M = (w \times N) + W(N + L)$$

$$\therefore \quad M = \frac{(w \times N) + W(N + L)}{(W + w)}$$

$$X = M - 31{\cdot}208 \text{ ft.}$$

Example

W = 95,787 lb. L = 30·14 ft.
w = 5,611 lb. N = 15·35 ft.

W + w = 101,398 lb. N + L = 45·49 ft.

$$\therefore \quad M = \frac{(5{,}611 \times 15{\cdot}35) + (95{,}787 \times 45{\cdot}49)}{101{,}398} = 43{\cdot}822 \text{ ft.}$$

$$x = 43{\cdot}822 - 31{\cdot}208 = 12{\cdot}614 \text{ ft.}$$

Weight = 101,398 lb.

Moment arm X = 12·614 ft. (aft of C.G. datum point).

Moment (W x X) = 1,279,034 lb. ft.

Weighing on hydrostatic units

Calculations

To determine the aircraft centre of gravity in relation to the C.G. datum point (dimension X)

Take moment about the C.G. datum point

$$(R.1 + R.2)X = (R.2 \times 28{\cdot}5) - (R.1 \times 0{\cdot}55)$$

$$X = \frac{(R.2 \times 28{\cdot}5) - (R.1 \times 0{\cdot}55) \text{ ft.}}{(R.1 + R.2)}$$

Example

R.1 = 55,449 lb.
R.2 = 45,949 lb.

R.1 + R.2 = 101,398 lb.

$$X = \frac{(45{,}949 \times 28{\cdot}5) - (55{,}449 \times 0{\cdot}55)}{101{,}398} = 12{\cdot}614 \text{ ft.}$$

Weight = 101,398 lb.

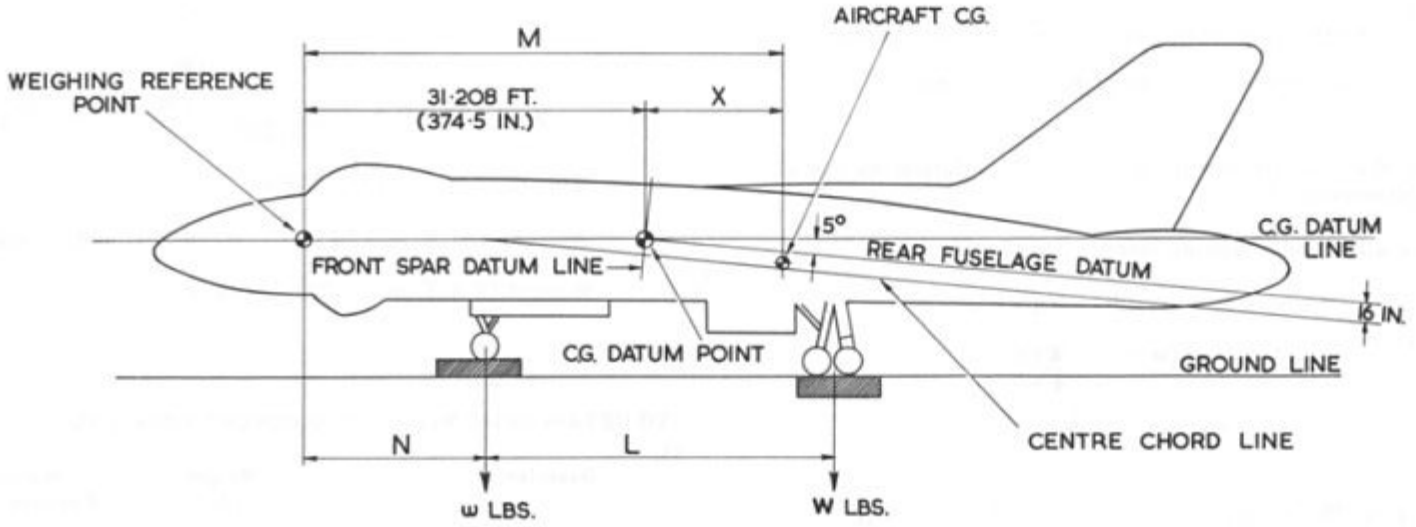
Moment arm X = 12·614 ft. (aft of C.G. datum point)

Moment (W x X) = 1,279,034 lb. ft.

TO OBTAIN BASIC WEIGHT AND MOMENT FROM A SERVICE WEIGHING

33.

Description	Weight (lb.)	Moment (lb. ft.) Positive	Moment (lb. ft.) Negative
EXAMPLE			
Aircraft as weighed	101,398	1,279,034	-
Remove:- Equip. not included in the Basic Weight			
7,000 lb. M.C. carrier and pintles	- 295	-	4,201
Aircraft destructors 2 off	- 6·5	208	-
Bomb fuzing	- 51·5	197	-
Window launching - removable equipment	- 308·1	-	6,522
I.F.F. Mk.10 removable equipment	- 51·4	771	-
T.4 bombsight - removable equipment	- 76·5	2,112	-
V.G. recorder IT/4.3.18	- 4·2	83	-
C.G. computer	- 1·25	33	-
Add:-			
Unusable fuel inc. in basic weight	154	1,193	
		1,283,631	10,723
Aircraft basic weight and moment	100,757	1,272,908	-



(◀ *Weighing reference point distance changed* ▶)

Fig. 11. Weighing on platform scales

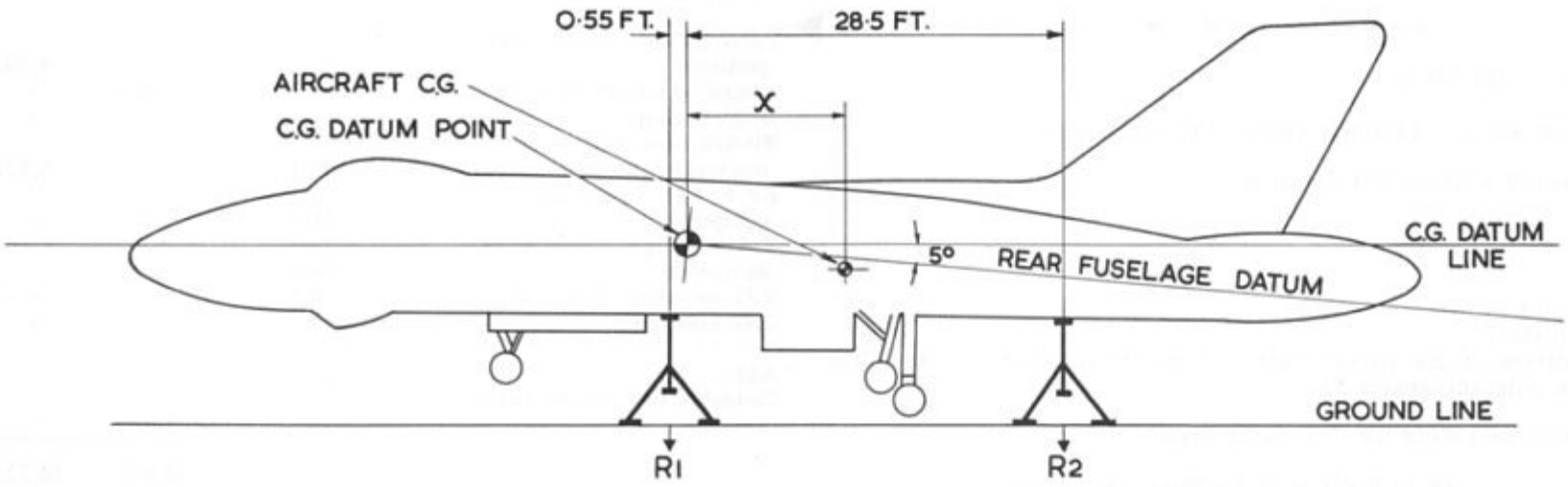


Fig. 12. Weighing on hydrostatic units

34.

REMOVABLE MILITARY LOAD - BOMB BAY

Removable Load	Case A Blue Steel 1 x 15,750 lb.	Case B 7,000 lb. MC. 1 x (6,200 + 1,000 lb.) store	Case C 6,000 lb. store	Case D Red Beard 1 x 1,680 lb. target marker	Case E 21 x 1,000 lb. H.E. stores	Case F 24 x 25 lb. smoke flashes	Case G 24 x 100 lb. practice bomb
Operational equipment							
Carriers		192		343	684	684 + 288* = 972	684 + 288* = 972
Crutch assemblies	2,850 (para.16)	Crutches 23 Fuzing units 6 77 Rear steady 48	473				
Pintles		26		26	78	78	78
Total	2,850	295	473	369	† 762	1,050	1,050
Disposable load							
Store	15,750	7,200	3,175	1,680	21,000	600	2,400
Total weight of stores carriers crutches and pintles	18,600	7,495	3,648	2,049	21,762	1,650	3,450

† Carrier Weight = 228 lb.
Pintles (2 off) = 26 lb.

3 x 254 = 762 lb.

* Adapters fitted to one normal carrier = 96 lb. (4 off)

Total for 3 carriers = 288 lb.

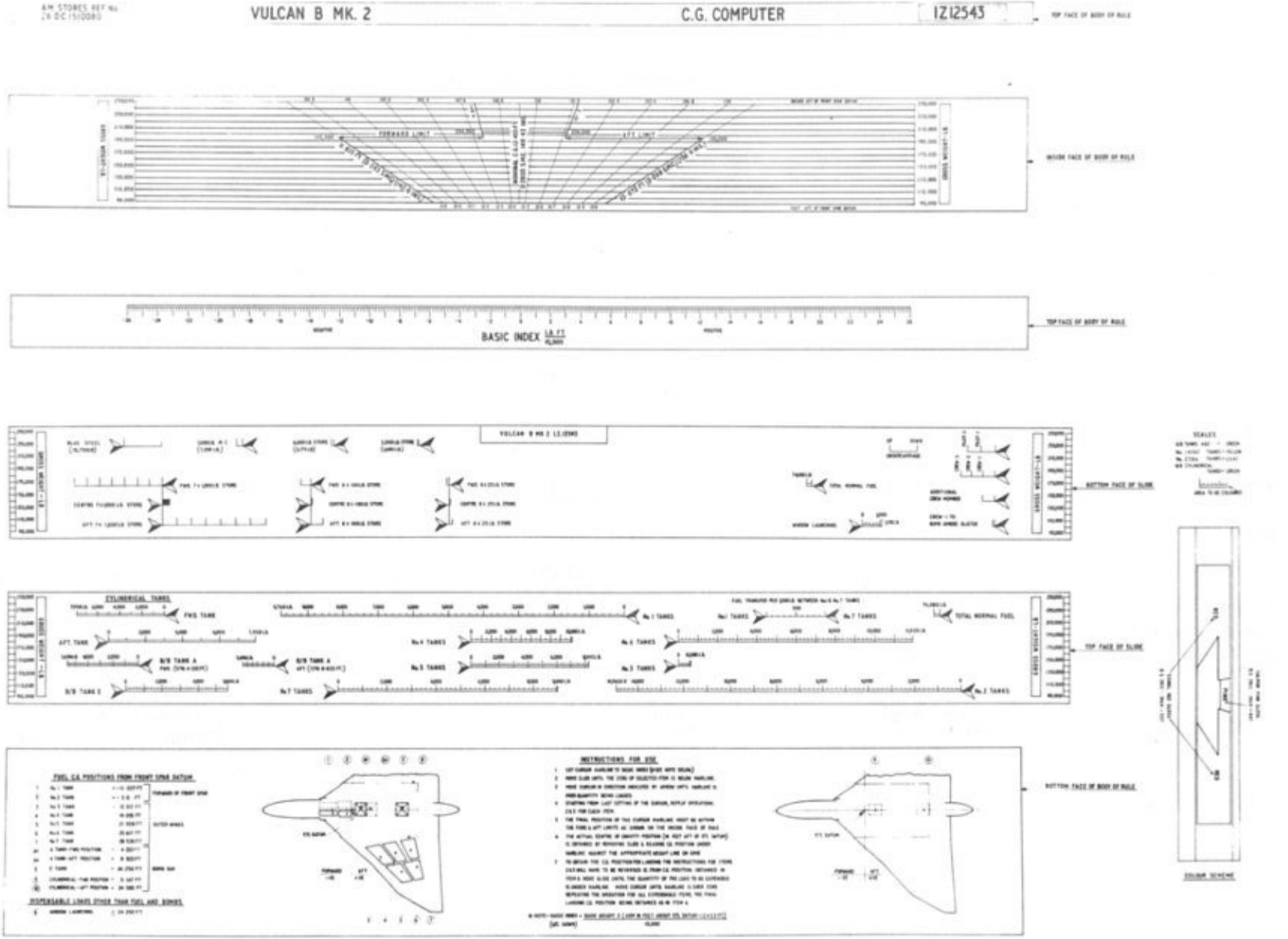


Fig. 13 The aircraft C.G. computer
◄ *Mod. 2337* ►

THE AIRCRAFT C.G. COMPUTER

35. 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 (fig.13). Scale A is a grid made up of three scales showing:-

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

(2) The Gross Weight in lb.

(3) The C.G. limits.

Scale B is the Basic Index 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 the moment in lb.ft. about the computer datum.

Trim or computer datum

A nominal C.G. position 12·453 ft. aft of the aircraft C.G. datum point has been selected as the computer datum, i.e., centre of C.G. range. This reduces the moment and gives a suitable scale to fit the computer dimensions.

Basic index

The basic index is the aircraft moment converted to the computer datum and is obtained thus:-

$$\text{Basic index} = \frac{\text{Basic weight} \times (\text{arm in feet about C.G. datum point} - 12{\cdot}453 \text{ ft.})}{10{,}000}$$

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

Instructions for Use

(1) Set cursor hairline to basic index.

(2) Move slide until the zero of selected item 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 front spar 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., from the C.G. position obtained 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.

MODIFICATIONS

36. When an aircraft is weighed by the manufacturer its Basic Weight and Index are quoted together with the modifications that are embodied at the time of weighing. Before a particular aircraft Basic Weight is used, it must be ascertained if further modifications have been added. If so, the Basic Weight and Index must be raised on the Record Card, R.A.F. Form 4908.

KEY TO FIG.14

Item No.	Ref. No.	Description	Weight (lb.)	$\bar{x}$ arm (ft.)	W$\bar{x}$ Moment (lb. ft.)
1	-	Survival packs - 5 off	170·0	- 33·9	- 5,766
2	10D/21774	Receiver Type 16048 - nose position	11·0	- 33·5	- 369
3	-	Cooling for ground speed resolver	11·9	- 30·9	- 367
4	9C 102	Ground speed resolver	47·0	- 29·3	- 1,379
5	-	Windscreen de-icing fluid 12 gall.	97·8	- 32·2	- 3,146
6	9D/1372	Bombing indicator	0·6	- 30·0	- 18
7	10F/17565	Control unit Type 7231	2·0	- 28·0	- 56
8	-	First aid outfit in cabin	6·0	- 26·7	- 160
9	12D/1256	Ejector seat cartridges set No.3, Mk.1	3·0	- 26·8	- 80
10	26DC/8929	C.G. computor	1·25	- 26·2	- 33
11	10L/16495	Control unit Type 12580	2·8	- 21·8	- 61
12	10L/11643	Control unit Type 12558	8·2	- 20·7	- 170
13	10L/263	Control unit Type 705	2·0	- 22·0	- 44
14	-	Signal pistol cartridges 12 off	4·1	- 22·3	- 91
15	-	Dinghy, Type M.S.5	115·8	- 22·3	- 2,586
16	9D/1566	Variable air speed unit	0·8	- 21·0	- 17
17	10L/16074	Control unit Type 1274	2·8	- 21·1	- 59
18	7B/1784	Signal pistol 1·5 in. Mk.2	4·1	- 20·7	- 85
19	10L/16060	Control unit Type 626	1·8	- 20·0	- 36
20	10L/16351	Control unit Type 7812	1·3	- 20·0	- 26
21	-	V.G. recorder IT. 4.3.18	4·2	- 19·8	- 83
22	14A/4260	Camera	12·3	- 19·7	- 242
23	9D/1141	Navigation panel	36·0	- 19·7	- 708
24	10Q/93	Pulse altimeter indicator Type 7921	10·0	- 19·5	- 195
25	9D/757	Indicator unit	1·5	- 19·3	- 29
26	10L/16716	Control unit Type 16051	1·5	- 19·3	- 29
27	9D/1400	Forward throw indicator	1·0	- 19·0	- 19
28	10L/291	Control units and panel	15·8	- 19·7	- 311
29	9D/756	Wind monitor unit	10·0	- 18·8	- 188
30	-	-	-	-	-
31	-	- ▶ ◀	-	-	-
32	-	-	-	-	-
33	10QB/6493	Indicator unit Type 301	64·3	- 18·8	- 1,206
34	10Q/16420	Indicator unit Type 6935 (Nav's station)	13·5	- 18·7	- 253
35	10U/16596	Amplifier Type A.1961	6·25	- 17·9	- 112
36	16K/1660/036290584	Control unit Type C.1158/APX.6A	1·4	- 18·9	- 26
37	16K/1660/036290585	S.I.F. control unit C1128/APK-25	1·2	- 19·2	- 23
38	10LB/6366	Control unit Type 585	55·0	- 18·8	- 1,036
39	10LB/6376	Control unit Type 595	10·0	- 18·8	- 188
40	10Q/16095	Control unit and indicator Type 101	21·0	- 18·8	- 394
41	9CA/101	G.P. indicator Mk.6	80·0	- 18·7	- 1,493
42	6B/541	G.P. indicator Mk.4	25·0	- 18·8	- 471
43	R/AI/A02/31415	Adapter box monitoring	22·0	- 18·5	- 407
44	10DB/8811	Power unit Type 729	33·0	- 15·2	- 503

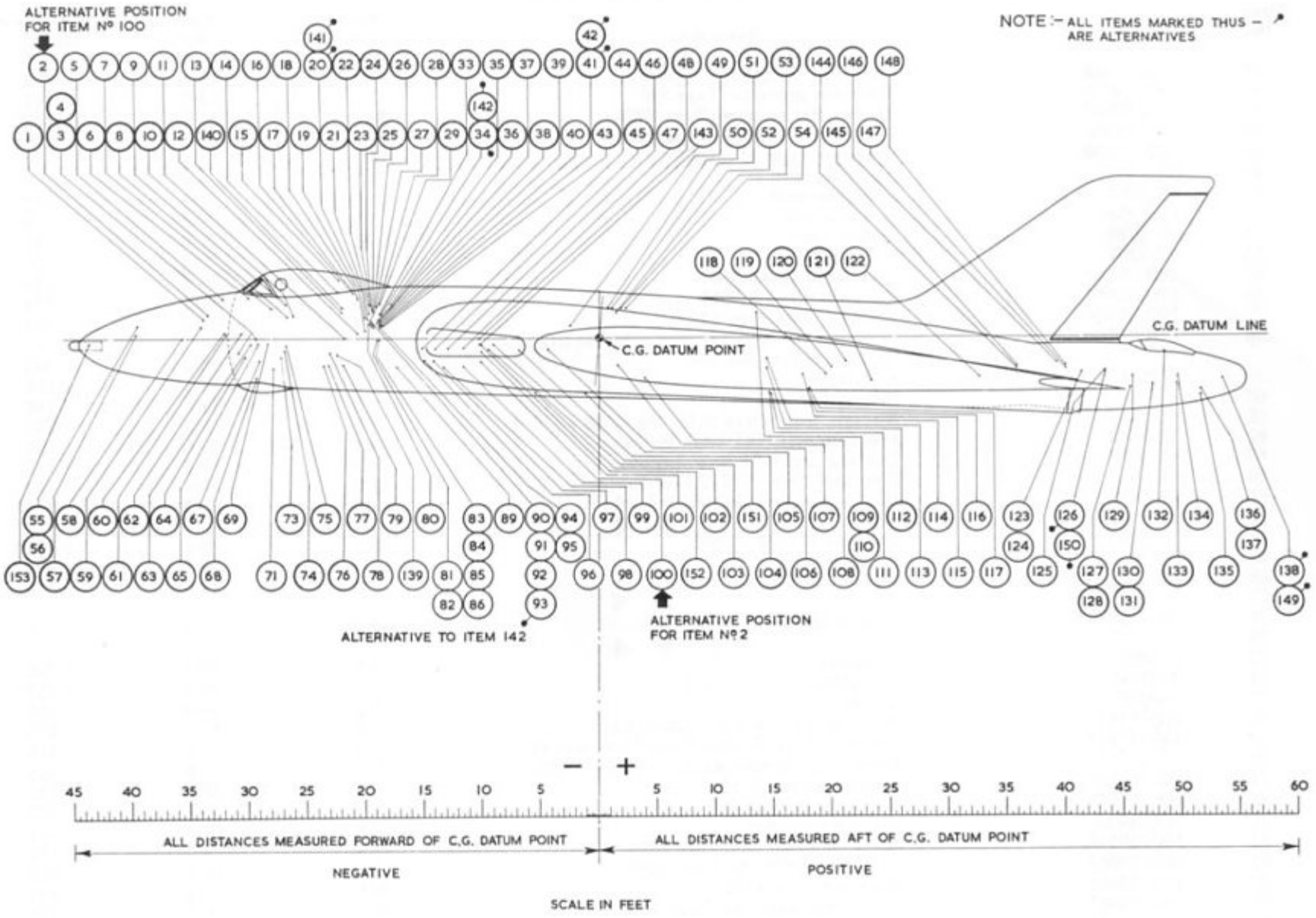


Fig. 14. Loading and C.G. diagram – electrical, radio and radar removable equipment

(◂ Mod. 2017 2024 and 2057 ▸)

RESTRICTED

KEY TO FIG.14 (continued)

Item No.	Ref. No.	Description	Weight (lb.)	x̄ arm (ft.)	Wx̄ Moment (lb. ft.)
45	10D/20968	Automatic calculator Type 5A	41·3	- 14·1	- 582
46	10VB/6250	Waveform generator Type 68	37·8	- 13·0	- 491
47	10D/19806	Transmitter receiver Type 7923	28·7	- 11·6	- 332
48	10D/2585	Transmitter receiver Type 1576	27·0	- 10·3	- 278
49	10D/19598	Receiver Type AD.7092D	15·7	- 2·4	- 37
50	6T.1951	Amplifier (fwd.)	8·7	0·8	7
51	6T.1952	Integrator unit	18·5	1·2	22
52	6T.1953	Junction box	6·0	1·5	9
53	6T.1688	Control unit	16·5	1·9	31
54	6T.1951	Amplifier (rear)	8·7	2·3	20
55	10D/20567	Receiver Type R.9561	12·0	- 39·5	- 474
56	10D/20567	Receiver Type R.9561	12·0	- 39·5	- 474
57	10D/21506	Blanking unit Type 11871	6·4	- 39·6	- 253
58	10B/19090	Scanner unit Type 121 including amplifier modulator gyro unit etc.	489·0	- 35·7	-17,441
59	5UB/6431	Amplidyne	32·5	- 34·1	- 1,108
60	-	Gloves and first aid kit	4·5	- 32·1	- 144
61		Aircraft destructors H.E., No.1, Mk.1 (2 off)	6·5	- 32·0	- 208
62	6T.1614	Pressure unit (143 EAP Smiths)	5·4	- 30·6	- 165
63	6T.1617	Locking unit (155 EAP Smiths)	40·0	- 29·8	- 1,190
64	6T.201	Gyro unit Type A (112 EAP Smiths)	18·5	- 30·3	- 560
65	6T.1616	Platform control (148 EAP Smiths)	15·0	- 29·2	- 438
66	-	- ▶ ◀	-	-	-
67	9D/1373	Calculator Type 2, Mk.2	60·0	- 29·1	- 1,745
68	9/4566	Sighting head	15·0	- 29·3	- 439
69	6T.1615	Servo-control (130 EAP Smiths)	20·0	- 28·4	- 567
70	-	- ▶ ◀	-	-	-
71	10L/5821	Control unit Type C/1607/ARC52	2·76	- 27·9	- 77
72	-	- ▶ ◀	-	-	-
73	9/4482	Computor	50·0	- 27·3	- 1,365
74	9D/1140	Calculator Type 3, Mk.2	95·0	- 26·9	- 2,557
75	9/4579	Amplifier	11·5	- 26·8	- 308
76	10D/17819	Receiver Type R.1965 (Glide path)	16·0	- 23·6	- 378
77	10D/17818	Receiver Type R.1964 (Localiser marker)	18·0	- 23·1	- 416
78	-	Periscopic sextant Mk.2 c/w case (1 off)	11·5	- 23·0	- 265
79	10U/16596	Amplifier Type A 1961	6·25	- 21·9	- 137
80	19L/16154	Control unit Type 903	6·5	- 19·7	- 128
81	5UC/6010	Voltage regulator	10·8	- 19·0	- 204
82	10D/19248	Aerial selector unit Type 7003	12·5	- 19·0	- 238
83	10D/19065	Transmitter S.T. 18 Type 4188	17·0	- 18·8	- 320
84	10D/19064	Receiver Type 4187	26·5	- 18·8	- 499
85	10K/19067	Power and radio unit Type 4192	36·0	- 18·8	- 678
86	10L/16205	Control and drive unit Type 4190	17·0	- 18·8	- 320
87	-	- ▶ ◀	-	-	-
88	-	-	-	-	-
89	9D/12	Resistance unit	4·0	- 17·3	- 69

KEY TO FIG.14 (continued)

Item No.	Ref. No.	Description	Weight (lb.)	$\bar{x}$ arm (ft.)	Wx Moment (lb.ft.)
90	10L/16349	Control unit Type 9456	2·2	- 19·5	- 43
91	10L/16346	Control unit Type 9422	5·0	- 19·6	- 98
92	10J/214	Control unit Type 9562	4·5	- 19·6	- 88
93	10J/214	Control unit	4·5	- 19·3	- 87
94	9C/103	Inertia navigator control unit	13·5	- 18·8	- 254
95	9C/104	Inertia navigator monitoring unit	12·0	- 18·8	- 226
96	10D/20334	Transmitter receiver T.R. 4535	38·4	- 15·0	- 574
97	10K/1660/036290932	S.I.F. coder KY.95.A/APX-25	10·4	- 14·2	- 148
98	9D/11	Power unit	55·0	- 13·3	- 729
99	9D/2	Calculator Type 1 Mk.1	50·0	- 11·7	- 583
100	10D/21774	Receiver Type 16048 - nose-wheel bay position	11·0	- 10·2	- 112
101	10D/5821	Transmitter receiver Type 4	48·5	- 10·2	- 497
102	-	Fairings and attachments (Blue Steel)	5·1	- 5·5	- 28
103	10K/17035	Power unit Type 814	10·8	- 9·4	- 101
104	10U/17445	Amplifier Type 16089	4·0	- 6·8	- 27
105	-	Shock absorbers and fairings	10·1	- 1·2	- 12
106	10D/21794	Transmitter receiver Type 16098	12·0	- 4·3	- 51
107	-	Hydraulics general (Blue Steel)	179·2	1·6	239
108	-	Refrigeration pack (Blue Steel)	205·3	3·9	798
109	-	Type 'E' special flight container	115·0	13·5	1,552
110	-	Type 'C' special flight container	123·0	13·5	1,661
111	-	Fairing door - stbd. (Blue Steel)	546·6	14·6	7,963
112	-	Fairing door - port (Blue Steel)	458·3	14·7	6,726
113	-	Carrier beam (Blue Steel)	314·7	14·3	4,488
114	-	Hydraulic - hoisting (Blue Steel)	266·5	14·3	3,819
115	10D/18843	Transmitter receiver Type T.R.3710	116·0	17·5	2,030
116	10B/19515	Aerial Type 501A	40·0	18·1	723
117	10B/17373	Waveguides Type T.529	1·1	18·2	20
118	10Q/16094	Tracking unit Type 100	48·0	19·4	932
119	-	Rear crutching bean (Blue Steel)	137·1	19·9	2,733
120	-	Rapid engine start - air charge	83·6	21·2	1,770
121	-	Window launching installation	292·3	23·4	6,833
122	-	Type "A" special flight container	181·0	32·7	5,920
123	10D/20525	No.1 transmitter T.9420 with base mounting T.4367	219.0	41·4	9,072
124	10D/20525	No.2 transmitter T.9420 with base mounting T.4367	219·0	41·4	9,072
125	10D/20525	No.3 transmitter T.9420 with base mounting T.4367	217·0	43·4	9,421
126	10D/20533	Transmitter and power unit T.7810 with base mounting T.4367	160·9	43·4	6,986
127	10D/20530	No.1 transmitter T.9454 with P.U. and base mounting T.4367	164·3	45·6	7,492
128	10D/20530	No.2 transmitter T.9454 with P.U. and base mounting T.4367	164·3	45·6	7,492
129	-	Coolant glycol and freon (7·4 gallons)	89·5	45·9	4,105
130	10K/19874	No.1 power unit T.9421 with base mounting	244·7	47·5	11,619

KEY TO FIG.14 (continued)

Item No.	Ref. No.	Description	Weight (lb.)	$\bar{x}$ arm (ft.)	$W\bar{x}$ Moment (lb. ft.)
131	10K/19874	No.2 power unit T.9421 with base mounting	244·7	47·5	11,619
132	-	Tail parachute	200·0	48·5	9,693
133	10K/19874	No.3 power unit T.9421 with base mounting	244·7	49·5	12,117
134	-	Pack - vapour cycle cooling	109·5	49·6	5,429
135	10D/20570	Blanking unit Type 9777	6·4	51·6	330
136	10D/20567	Receiver Type R.9561	12·0	51·6	619
137	10D/20567	Receiver Type R.9561	12·0	51·6	619
138	10D/20974	Radar head c/w heat exchanger Type 6934	146·0	53·4	7,799
139	1T3-15-61	R.A.E. recorder	35·0	22·2	777
140	10L/9455739	PTR.175 control unit	3·2	- 22·00	- 70
141	10L/9465125	Control unit Type 103044	5·0	- 19·30	- 97
142	5841-99-954-7737	Indicator/control unit	18·5	- 19·00	- 352
143	10D/9711781	PTR.175 transmitter/receiver	50·0	- 10·33	- 517
144	5895-99-913-1187	'X' band transmitter/receiver	120·0	35·83	4,300
145	5895-99-947-3004	Blanker interference	7·5	35·83	269
146	5841-99-952-9685	Switch Don-Lan	0·5	39·20	20
147	5895-99-948-5358	Control frequency selection	25·0	39·83	996
148	5895-99-946-5122	Receiver radar	41·0	39·83	1,633
149	5841-99-954-7738	Radar head	152·0	53·41	8,119
150	5895-99-945-2035	Power supply set	250·0	43·40	10,850
151	10D/22524	Tacan coupling unit	5·0	- 9·00	- 45
152	10D/22927	Tacan transmitter/receiver	53·0	- 10·20	- 539
153	AN/APN/170	Radar pod	85·0	- 43·59	- 3,705