

Chapter 3 Loading and C.G. Data

LIST OF CONTENTS

	Para.
Introduction	1
Definition of C.G.	4
Datum point	5
Moment and moment arms	6
C.G. range	7
C.G. movement during flight	8

	Para.
Definition of basic weight	9
Movement of crew	10
Typical example	11
Standard operational cases	12
Removable equipment	13
Operating equipment	14

	Para.
Maximum weights	15
Overload landing weight	16
C.G. computer	17
Floor loading data	18
Unusable fuel	21
Modifications	22

ADDENDA

Addendum 1 - Incorporation of Phase 1
Addendum 2 - Incorporation of Phase 2

LIST OF ILLUSTRATIONS

	Fig.
Loading and C.G. diagram	1

	Fig.
Moment arms of bomb slips	2

	Fig.
Floor loading data	3

ADDENDA

ADDENDUM 1

	Fig.
Loading and C.G. diagram (Phase 1) ...	1

ADDENDUM 2

Loading and C.G. diagram (Phase 2)	1
Moment arms of bomb slips	2

Introduction

1. The data contained in this chapter is 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 the 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. Reference should be made to the "Basic weight and moment

record" form which will show the true basic weight and moment of the particular aircraft concerned.

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

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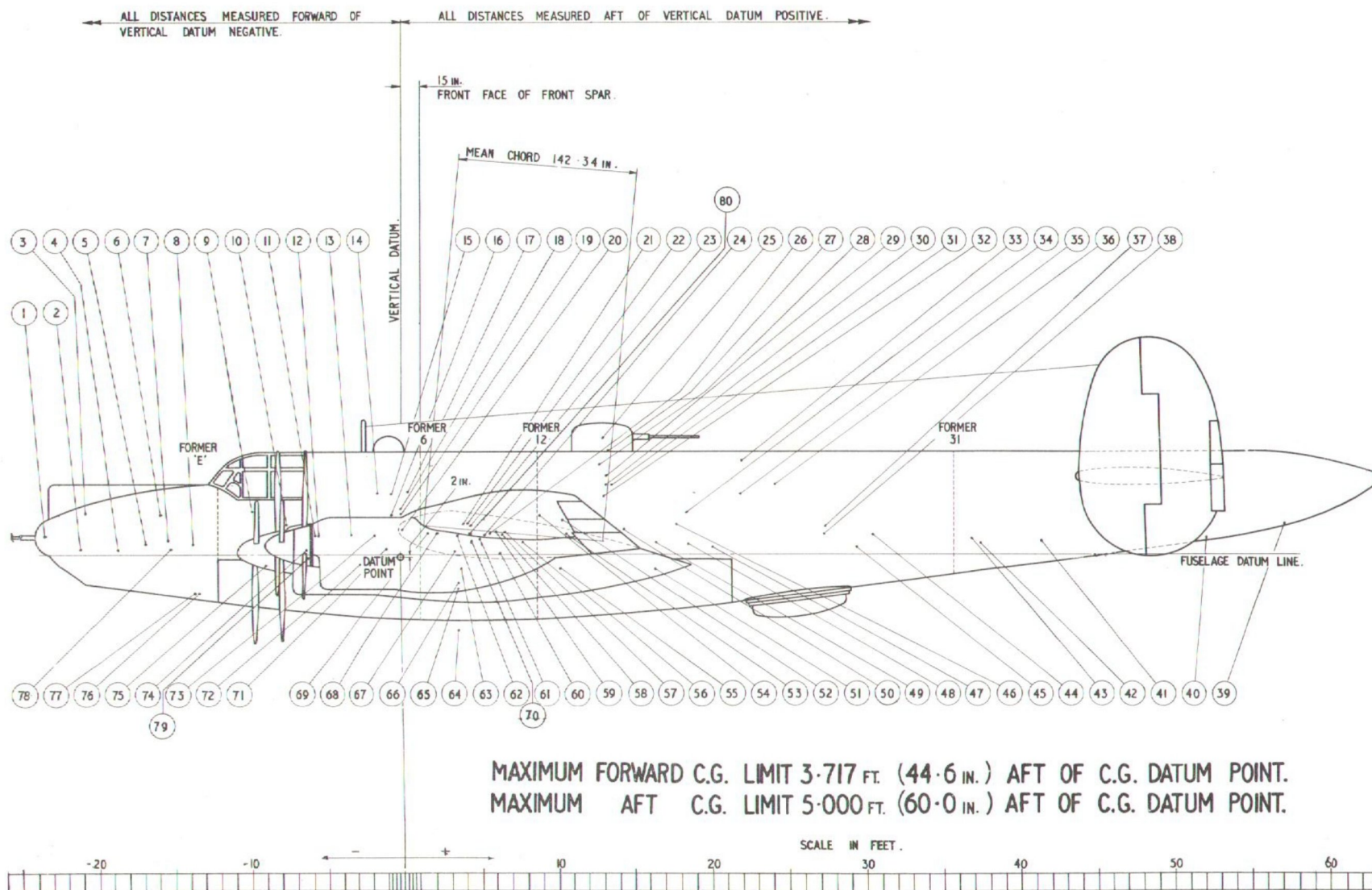


Fig.1. Loading & C.G. diagram

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DEFINITION OF THE 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. datum point (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 POINT

5. The datum point is arbitrarily located by the manufacturer, and on Shackleton aircraft is indicated on both port and starboard sides of the fuselage by a removable plug which is situated 1.25 ft. forward of the front face of the front spar and 2 inches below the fuselage datum line. The locations are provided for the suspension of a plumb line when determining the C.G. by weighing.

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 is positive. Therefore the resultant moment is negative. The moment arm of a load lying aft of the datum point is positive therefore the resultant moment is positive.

C.G. RANGE

7. The approved C.G. limits are as follows:- Maximum forward C.G. limit/44.6 in. (3.717 ft.) aft of datum point; maximum aft C.G. limit 60 in. (5.0 ft.) aft of C.G. datum point; and the C.G. must be

kept within this range at all times, including take-off and landing.

C.G. MOVEMENT DURING 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. The effect of retracting the undercarriage has been taken into consideration in establishing the safe C.G. range and may, therefore, be neglected.

DEFINITION OF BASIC WEIGHT

9. Basic weight is that weight which includes all basic equipment and unusable fuel and oil, to which it is only necessary to add the weight of variable, expendable and payload items in the various roles to arrive at the all-up weight. Complementary items of removable equipment will be found in the list of operating equipment and these must be added in conformity with the required loading of the aircraft (see para.14).

MOVEMENT OF CREW

10. Careful note must be made of the direction of movement, and also location of the crew stations which may be either forward or aft of the aircraft datum point, e.g., consider moving the starboard observer to the galley position, both these moments are positive and, as the moment at the galley position is less than the moment at the starboard observer's position, the smaller moment must be subtracted from the greater, which will result in the aircraft C.G. moving forward.

	lb. ft.
Moment at starboard observer's position	5,480
Moment at galley position	2,100
Difference	3,380

Similarly the opposite effect is incurred if we consider moving the air bomber to the rest bunk. The air bomber is forward of the aircraft datum point and has a negative moment. The rest bunk is aft of the aircraft datum point and has a positive moment; and, as the air bomber is moving aft, he passes the datum point and so the moment at the air bomber's position must be added to the moment at the rest bunk and the sum of these moments added to the aircraft moment in order to find the resultant C.G. of the aircraft.

	lb. ft.
Moment at air bomber's position	-3,700
Moment at rest bunk position	3,710
Total	7,410

TYPICAL EXAMPLE

11. The following calculation shows the method of computing the all up weight of the aircraft from the "Delivery" basic weight and moment, by use of the Basic Weight and Moment Record Sheet.

This is based on the Anti-submarine case, Role C.

1. Basic weight and moment record sheet

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 as the start of any loading calculation.

The initial entry shows the basic weight and moment obtained from the C.G. report of the particular aircraft and then proceeds to tabulate all equipment which falls into the category of service fit items and also any shortages that there may be.

This reduces the aircraft to the delivery condition, i.e., the basic weight and

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moment of the aircraft as delivered to the service and is termed "Delivery Basic Weight."

The "Basic Moment" quoted on these sheets is the commencement for all loadings when the C.G. Computer is used.

The following sheets act as a typical example of corrections to the Basic Weight and moment Record Sheet.

BASIC WEIGHT AND MOMENT RECORD

CONTINUOUS HISTORY OF CHANGES IN STRUCTURE OR EQUIPMENT AFFECTING WEIGHT AND MOMENT

AIRCRAFT TYPE SHACKLETON MK.2			SERIAL NUMBER XY 999			PAGE NUMBER 1		
Date	Number		Description of article or modification	Weight change		Running total basic aircraft		
	Added	Removed		+ Weight (lb.)	+ Moment (lb. ft.)	Weight (lb.)	Moment (lb. ft.)	Basic Index
1. 8. 59			Basic weight and moment from C.G. Report 123			52,486	243,756	24.38
		-	Signal pistol and cartridges	- 11	+ 61			
		-	Aircraft destructor	- 6	- 81			
		-	Electrical equipment	- 15	- 4			
		-	Flying and navigational instruments	- 45.5	- 5			
		-	Camera hand held	- 10	- 295			
		-	Camera F.24	- 42	- 2,405			
		-	Camera FX.91	- 42	- 2,195			
		-	Galley utensils	- 14.5	- 131			
		-	First aid outfit	- 11	- 222			
		-	Elsan charge	- 7	- 263			
		-	Autolycus	- 90	+ 622			
		-	I.F.F. A.R.I.5131	- 37	- 526			
		-	GEE A.R.I.5718	- 83	- 143			
		-	Rebecca A.R.I.5610	- 41	- 159			
		-	A.S.V. A.R.I.5729	- 267	- 4,417			
	-		De-icing fluid (32 gall)	+ 352	+ 2,746			
	-		De-icing fluid (23 gall)	+ 253	+ 1,973			
	-		De-icing fluid (7 gall)	+ 57	- 755			
	-		Oil (104 gall)	+ 936	+ 3,276			
			DELIVERY BASIC WEIGHT AND MOMENT			53,362	240,833	24.08
1. 9. 59	-	-	Oil (104 gall)	- 936	- 3,276			
		-	De-icing fluid (32 gall)	- 352	- 2,746			
		-	De-icing fluid (23 gall)	- 253	- 1,973			
		-	De-icing fluid (7 gall)	- 57	+ 755			
	-		Signal pistol and cartridges	+ 11	- 61			
			Basic moment = $\frac{\text{lb. ft.}}{10,000}$					

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BASIC WEIGHT AND MOMENT RECORD

CONTINUOUS HISTORY OF CHANGES IN STRUCTURE OR EQUIPMENT AFFECTING WEIGHT AND MOMENT

AIRCRAFT TYPE			SERIAL NUMBER				PAGE NUMBER			
SHACKLETON MK.2			XY 999				2			
Date	Number		Description of article or modification	Weight change				Running total basic aircraft		
	Added	Removed		Weight (lb.)	Moment (lb. ft.)	Weight (lb.)	Moment (lb. ft.)	Basic Index		
1. 9. 59	-		Aircraft destructor	+	6	+	81			
	-		Electrical equipment	+	15	+	4			
	-		Flying and navigational instruments	+	45.5	+	5			
	-		Camera hand held	+	10	+	295			
	-		Camera F.24	+	42	+	2,405			
	-		Camera FX.91	+	42	+	2,195			
	-		Galley utensils	+	14.5	+	131			
	-		First aid outfit	+	11	+	222			
	-		Autolycus	+	90	-	622			
	-		I.F.F. A.R.I.5131	+	37	+	526			
	-		GEE A.R.I.5718	+	83	+	143			
	-		Rebecca A.R.I.5610	+	41	+	159			
	-		A.S.V. A.R.I.5729	+	267	+	4,417			
	-		Elsan charge	+	7	+	263			
	MOD.748		Redesigned entrance door ladder	+	2	+	85			
	MOD.712		Inspection door on T/edge	+	1	+	1			
			CURRENT BASIC WEIGHT AND MOMENT					52,489	243,842	24.38
			Basic moment = $\frac{\text{lb. ft.}}{10,000}$							

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(2) Calculation of weight and moment of expendable item.

Nomenclature	Item No.	Weight (lb.)	Moment (lb.ft.)	
			Positive	Negative
Food and drinking water	54	170	1,530	-
Nitrogen charge	41	43	1,785	-
De-icing fluid (propeller)	56	352	2,746	-
De-icing fluid (wing and tail)	56	253	1,973	-
De-icing fluid (windscreen)	76	57	-	755
Illuminator flares (192)	46	258	4,592	-
Photoflashes 1.75 in. (24)	33	42	935	-
Flame floats (77)	35	265	5,830	-
Marine markers (10)	8	210	-	2,871
Marine markers (10)	5	210	-	3,518
Oil (104 gall.)	62	936	3,276	-
Bomb Bay				
Row 1 Sonobuoys (9)		720	-	6,887
Row 2 Sonobuoys (3)		240	-	1,024
Row 2 Marine markers (12)		252	-	1,075
Row 3 Depth charges Mk.X1 (3)		870	1,146	-
Row 3 Dealer 'B' (2)		1,360	5,220	-
Row 3 Depth charges Mk.X1 (3)		870	5,732	-
Row 4 Sonobuoys (9)		720	8,413	-
Row 5 Marine markers (12)		252	4,081	-
Row 5 Sonobuoys (3)		240	3,887	-
	-	-	51,146	16,130
Weight and moment of expendable items less fuel		8,320	35,016	

(3) Calculation of Gross Weight of Aircraft Excluding fuel:-

	(lb.)		(lb.ft.)
Corrected basic weight	52,489	Corrected basic moment	243,842
Operating equipment (Table 1)	2,748	Corresponding moment	10,837
Operating equipment (Table 2)	655	Corresponding moment	2,514
Expendable items	8,320	Corresponding moment	35,016
Gross weight excluding fuel	64,212		292,209

(4) Calculation of maximum weight of fuel:-

	Weight (lb.)
Maximum weight at which aircraft is to take off	89,000
Gross weight less fuel	64,212
Available weight for fuel	24,788

Fuel to be carried

Nomenclature	Item No.	Weight (lb.)	Moment (lb.ft.)	
			Positive	Negative
Fuel No.1 tanks (994 gall.)	61	7,157	35,907	-
Fuel No.2 tanks (1,082 gall.)	24	7,790	40,765	-

Nomenclature	Item No.	Weight (lb.)	Moment (lb.ft.)	
			Positive	Negative
Fuel No.3 tanks (594 gall.)	26	4,277	24,413	-
Fuel No.4 tanks (622 gall.)	60	4,479	27,640	-
Water/methanol (26 gall.)	59	234	1,493	-
Total maximum fuel	-	23,937	130,218	-

NOTE... Fuel weight taken at 7.2 lb./gall.

Water/methanol weight taken at 9 lb./gall.

(5) Calculation of Gross Weights:-

	(lb.)		(lb. ft.)
Gross weight excluding fuel	64,212	Corresponding moment	292,209
Maximum weight of fuel	23,937	Corresponding moment	130,218
Gross weight	88,149	Corresponding moment	422,427
C.G. of aircraft	=	Gross moment	
		Gross weight	
		422,427	
		88,149	
	=	4.795 ft. (57.54 inches) aft of the datum point.	

(6) Calculation of C.G. for landing (100 gall. fuel reserve)

Nomenclature	Item No.	Weight (lb.)	Moment (lb.ft.)	
			Positive	Negative
Fuel No.1 tanks (994 gall.)	61	7,157	35,907	-
Fuel No.2 tanks (1,082 gall.)	24	7,790	40,765	-
Fuel No.3 tanks (494 gall.)	26	3,557	20,303	-
Fuel No.4 tanks (622 gall.)	60	4,479	27,640	-
Expendable items (para.2)	-	8,320	35,016	-
Water/methanol (26 gall.)	59	234	1,493	-
Total expendable load	-	31,537	161,124	-

Movement of crew to Landing Stations

	Moment (lb.ft.)	
	Positive	Negative
Move stbd. observer to station aft of front spar	-	4,794
Move port observer to station aft of front spar	-	5,434
Move tactical navigator to station forward of rear spar.	1,325	-
Move radar operator to station forward of rear spar	-	25
	1,325	10,253
∴ Moment effect	=	8,928

Weight and C.G. for Landing

Landing weight = 88,149 - 31,537 = 56,612 lb.

Corresponding moment = 422,427 - 161,124 = 261,303 lb.ft.

Landing C.G. position = $\frac{261,303}{56,612}$

= 4.616 ft. (55.39 inches) aft of the datum point.

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STANDARD OPERATIONAL CASES

12.

Case 'A' Air sea rescue version

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Basic weight	-	52,489	-	243,842	-
Common operating equipment (Table 1)	-	2,748	-	10,837	-
Special operating equipment (Table 3)	-	240	-	1,738	-
Lifeboat airborne	64	4,200	3·838	16,120	-
Lindholme gear	51	308	16·589	5,109	-
Illuminator flares (48)	46	64	17·8	1,139	-
Photoflashes 1·75in. (12)	33	21	22·25	467	-
Flame floats (77)	35	265	22·0	5,830	-
Reconnaissance flares (10)	8	240	-13·67	-	3,281
Reconnaissance flares (2)	5	48	-16·75	-	804
Smoke floats (4)	5	46	-16·75	-	771
Photoflash 4·5in. (2)	5	58	-16·75	-	972
Marine markers (2)	5	42	-16·75	-	704
De-icing fluid (32 gall.)	56	352	7·8	2,746	-
De-icing fluid (23 gall.)	56	253	7·8	1,973	-
De-icing fluid windscreen (7 gall.)	76	57	-13·25	-	755
Nitrogen charge	41	43	41·5	1,785	-
Food and drinking water	54	170	9·0	1,530	-
Oil (104 gall.)	62	936	3·5	3,276	-
Fuel No.1 tanks (994 gall. max.)	61	7,157	5·017	35,907	-
Fuel No.2 tanks (1082 gall. max.)	24	7,790	5·233	40,765	-
Fuel No.3 tanks (594 gall. max.)	26	4,277	5·708	24,413	-
Fuel No.4 tanks (622 gall. max.)	60	4,479	6·171	27,640	-
Water methanol (26 gall. max.)	59	234	6·38	1,493	-
	-	-	-	426,610	7,287
All-up weight	-	86,517	-	419,323	-

The C.G. is 4·85 ft. (58·2 in.) aft of the aircraft datum

Case 'B' Long range reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Basic weight	-	52,489	-	243,842	-
Common operating equipment (Table 1)	-	2,748	-	10,837	-
Special operating equipment (Table 4)	-	1,070	-	1,048	-
Oxygen charge	75	56	-8·912	-	499
Reconnaissance flares (12 Bomb bay)	51	288	16·589	4,778	-
Photoflashes 4·5 in. (6 Bomb bay)	51	174	16·589	2,886	-
Illuminator flares (192)	46	258	17·8	4,592	-
Flame floats (77)	35	265	22·0	5,830	-
Reconnaissance flares (8)	5	192	-16·75	-	3,216
Marine markers (8)	8	168	-13·67	-	2,297
De-icing fluid (32 gall.)	56	352	7·8	2,746	-
De-icing fluid (23 gall.)	56	253	7·8	1,973	-
De-icing fluid windscreen (7 gall.)	76	57	-13·25	-	755
Nitrogen charge	41	43	41·5	1,785	-
Food & drinking water	54	170	9·0	1,530	-
Oil (104 gall.)	62	936	3·5	3,276	-
Photoflashes 1·75 in. (24)	33	42	22·25	935	-
Fuel No.1 tanks (994 gall. max.)	61	7,157	5·017	35,907	-
Fuel No.2 tanks (1082 gall. max.)	24	7,790	5·233	40,765	-
Fuel No.3 tanks (594 gall. max.)	26	4,277	5·708	24,413	-
Fuel No.4 tanks (622 gall. max.)	60	4,479	6·171	27,640	-
Fuel auxiliary tank (400 gall. max.)	66	2,880	3·838	11,053	-
Water methanol (26 gall. max.)	59	234	6·38	1,493	-
	-	-	-	427,329	6,767
All-up weight	-	86,378	-	420,562	-

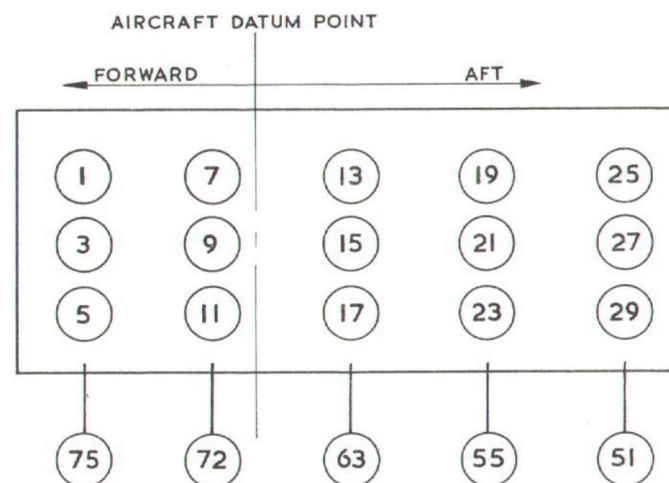
The C.G. is 4·87 ft. (58·44 in.) aft of the aircraft datum

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Case 'C' Anti-underwater reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Basic weight	-	52,489	-	243,842	-
Common operating equipment (Table 1)	-	2,748	-	10,837	-
Special operating equipment (Table 2)	-	655	-	2,514	-
Illuminator flares (192)	46	258	17.8	4,592	-
Photoflashes 1.75 in. (24)	33	42	22.25	935	-
Flame floats (77)	35	265	22.0	5,830	-
Marine markers (10)	8	210	-13.67	-	2,871
Marine markers (10)	5	210	-16.71	-	3,518
Food and drinking water	54	170	9.0	1,530	-
Nitrogen charge	41	43	41.5	1,785	-
De-icing fluid (32 gall.)	56	352	7.8	2,746	-
De-icing fluid (23 gall.)	56	253	7.8	1,973	-
De-icing fluid (windscreen) (7 gall.)	76	57	-13.25	-	755
Row No.1 sonobouys (9)	-	720	-9.565	-	6,887
Row No.2 sonobouys (3)	-	240	-4.267	-	1,024
Row No.2 Marine markers (12)	-	252	-4.267	-	1,075
Row No.3 Depth charges Mk.X1 (3)	-	870	1.317	1,146	-
Row No.3 Dealer 'B' (2)	-	1,360	3.838	5,220	-
Row No.3 Depth charges Mk.X1 (3)	-	870	6.588	5,732	-
Row No.4 sonobouys (9)	-	720	11.685	8,413	-
Row No.5 Marine markers (12)	-	252	16.195	4,081	-
Row No.5 sonobouys (3)	-	240	16.195	3,887	-
Oil (104 gall.)	62	936	3.5	3,276	-
Fuel No.1 tanks (994 gall. max.)	61	7,157	5.017	35,907	-
Fuel No.2 tanks (1082 gall. max.)	24	7,790	5.233	40,765	-
Fuel No.3 tanks (594 gall. max.)	26	4,277	5.708	24,413	-
Fuel No.4 tanks (622 gall. max.)	60	4,479	6.171	27,640	-
Water methanol (26 gall. max.)	59	234	6.38	1,493	-
	-	-	-	438,557	16,130
All-up weight	-	88,149	-	422,427	-

The C.G. is 4.792 ft. (57.4 in.) aft of the aircraft datum.



No. 1 to 6	- 8.912 ft.	front row 75
No. 7 to 12	- 2.537 ft.	second row 72
No.13 to 18	- 3.838 ft.	third row 63
No.19 to 24	10.214 ft.	fourth row 55
No.25 to 30	16.589 ft.	fifth row 51

Fig.2. Moment arms of bomb slips

In this case, all the stores carried in the bomb bay with the exception of the Dealer 'B' are fitted on special carriers attached to the appropriate slips. The centres of gravity of these stores do not coincide with the slip positions (reference should be made to Section 7 of this publication) and are as shown below:-

	ft.
Row 1 Sonobouys	- 9.565
Row 2 Sonobouys	- 4.267
Row 2 Marine markers	- 4.267
Row 3 Depth charges	1.317
Row 3 Dealer 'B'	3.838
Row 3 Depth charges	6.588
Row 4 Sonobouys	11.685
Row 5 Marine markers	16.195
Row 5 Sonobouys	16.195

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Case 'D' Bomber (15,000 lb.)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Basic weight	-	52,489	-	243,842	-
Common operating equipment (Table 1)	-	2,748	-	10,837	-
Carriers A.V.152 (3)	75	57	- 8.912	-	508
Carriers A.V.152 (3)	72	57	- 2.537	-	145
Carriers A.V.152 (3)	63	57	3.838	219	-
Adapter No.4 A.V.122 (1)	63	18	3.838	69	-
Carriers A.V.152 (3)	55	57	10.214	582	-
Carriers A.V.152 (3)	51	57	16.589	946	-
Bombs 3 x 1,000 lb.	75	3,000	- 8.912	-	26,736
Bombs 3 x 1,000 lb.	72	3,000	- 2.537	-	7,611
Bombs 3 x 1,000 lb.	63	3,000	3.838	11,514	-
Bombs 3 x 1,000 lb.	55	3,000	10.214	30,642	-
Bombs 3 x 1,000 lb.	51	3,000	16.589	49,767	-
Oil (104 gall.)	62	936	3.5	3,276	-
Fuel No.1 tanks (262 gall.)	61	1,889	5.017	9,477	-
Fuel No.2 tanks (923 gall.)	24	6,645	5.233	34,773	-
Fuel No.3 tanks (594 gall.) max.	26	4,277	5.708	24,413	-
Fuel No.4 tanks (622 gall.) max.	60	4,479	6.171	27,640	-
Water methanol (26 gall.)	59	234	6.38	1,493	-
	-	-	-	449,490	35,000

All-up weight - 89,000 - 414,490 -

The C.G. position is 4.66 ft. (55.92 in.) aft of the aircraft datum.

NOTE...

This loading is subject to all-up weight and fuel drill restrictions.

REMOVABLE EQUIPMENT

13. The basic weight of the aircraft includes the following items of removable equipment.

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Signal pistol and cartridges	74	11	-5.5	-	61
Aircraft destructor	31	6	13.5	81	-
Electrical equipment	18	15	-	4	-
Flying and navigational equipment	19	45.5	-	5	-

REMOVABLE EQUIPMENT (continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Camera hand held (allowance)	45	10	29.5	295	-
Camera F.24	39	42	57.25	2,405	-
Camera FX.91	40	42	52.25	2,195	-
Galley utensils	54	14.5	9.0	131	-
First aid outfit	47	11	20.15	222	-
Elsan charge	42	7	37.5	263	-
A.1134A amplifier	23	52	4.385	228	-
T.1154/R.1155	10	141.5	-7.5	-	1,058
A.R.I.5284 A.Y.F.	17	18.5	0.5	9	-
A.R.I.5131 I.F.F.	50	37	14.36	526	-
A.R.I.5718 GEE	69	83	1.73	143	-
A.R.I.5267 Loran	14	61.5	-1.672	-	103
A.R.I.5610 Rebecca	21	41	3.939	159	-
A.R.I.5729 A.S.V.	49	267	16.54	4,417	-
A.R.I.5428 Radio compass	22	30	4.0	120	-
A.R.I.5490 V.H.F.	71	50	-1.0	-	50
Autolycus	79	90	-6.91	-	622

OPERATIONAL EQUIPMENT

TABLE 1

14. List of operating equipment common to all roles (A)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Dinghies Type 'SS' (10)	70	200	4.375	875	-
Dinghies Type M.S.9 (2)	53	360	10.7	3,852	-
Bomb sight (L.L.)	2	33	-21.0	-	693
Armament electrics	78	14	-15.25	-	214
A.R.I.5487 Sonobuoy 1B	15	101	1.2	121	-
Parachute and harnesses (10)	80	240	4.02	965	-
1st pilot	9	180	-9.7	-	1,746
2nd pilot	9	180	-9.7	-	1,746
Flight engineer	11	180	-5.8	-	1,044
Wireless operator	12	180	-5.6	-	1,008
Navigator	13	180	-3.25	-	585
Tactical navigator	20	180	0.0	-	-
Radar operator	57	180	6.75	1,215	-
Sonobuoy operator	68	180	2.25	405	-
Starboard observer	38	180	27.4	4,932	-
Port observer	44	180	30.6	5,508	-
Total Table 1	-	-	-	17,873	7,036
	-	2,748	-	10,837	-

RESTRICTED

TABLE 2

List of operating equipment for anti-underwater reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
A.V.164 Carrier (3)	-	207	-5.725	-	1,185
A.V.168 Carrier (3)	-	207	13.401	2,774	-
A.V.169 Carrier (1)	63	85	3.838	326	-
A.V.163 Carrier (2)	63	42	3.838	161	-
A.V.193 Adapter (8)	-	96	3.838	369	-
A.V.122 Adapter (1)	63	18	3.838	69	-
	-	-	-	3,699	1,185
Total	-	655	3.838	2,514	-

TABLE 3

List of operating equipment for air-sea rescue

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Suspension and release unit	63	72	3.838	276	-
Quintuple carrier	51	91	16.589	1,510	-
Portable oxygen sets (10)	16	77	-0.627	-	-
	-	-	-	1,786	48
Total	-	240	-	1,738	-

TABLE 4

List of operating equipment for long range reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Oxygen crate	75	393	-8.912	-	3,502
Portable oxygen bottles (10)	16	77	-0.627	-	48
Carriers and Adapters (3 sets)	51	180	16.589	2,986	-
Auxiliary fuel tank and carrier	63	420	3.838	1,612	-
	-	-	-	4,598	3,550
Total	-	1,070	-	1,048	-

RESTRICTED

TABLE 5

List of disposable loads

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)		Role		
				Positive	Negative			
Fuselage								
Illuminator flares (192)	46	258	17.8	4,592	-	-	B	C
Illuminator flares (48)	46	64	17.8	1,139	-	A	-	-
Photoflashes 1.75 in.(12)	33	21	22.25	467	-	A	-	-
Photoflashes 1.75 in.(24)	33	42	22.25	935	-	-	B	C
Flame floats (77)	35	265	22.0	5,830	-	A	B	C
Reconnaissance flares (10)	8	240	-13.67	-	3,281	A	-	-
Reconnaissance flares (2)	5	48	-16.75	-	804	A	-	-
Reconnaissance flares (8)	5	192	-16.75	-	3,216	-	B	-
Smoke floats (4)	5	46	-16.75	-	771	A	-	-
Photoflashes 4.5 in. (2)	5	58	-16.75	-	972	A	-	-
Marine markers (2)	5	42	-16.75	-	704	A	-	-
Marine markers (8)	8	168	-13.67	-	2,297	-	B	-
Marine markers (10)	8	210	-13.67	-	2,871	-	-	C
Marine markers (10)	5	210	-16.75	-	3,518	-	-	C
Food and drinking water	54	170	9.0	1,530	-	A	B	C
Nitrogen charge	41	43	41.5	1,785	-	A	B	C
De-icing fluid (32 gall.)	56	352	7.8	2,746	-	A	B	C
De-icing fluid (23 gall.)	56	253	7.8	1,973	-	A	B	C
De-icing fluid (7 gall.)	76	57	-13.25	-	755	A	B	C
Pyrotechnic stowage	36	-	24.2	-	-	-	-	-
Bomb bay								
Lifeboat airborne	64	4,200	3.838	16,120	-	A	-	-
Lindholme gear (1 set)	51	308	16.589	5,109	-	A	-	-
Reconnaissance flares (12)	51	288	16.589	4,778	-	-	B	-
Photoflashes 4.5 in. (6)	51	174	16.589	2,886	-	-	B	-
Oxygen charge	75	56	-8.912	-	499	-	B	-
Sonobuoys T.1946 (9)	-	720	-9.565	-	6,887	-	-	C
Marine markers No.4 Mk.1	-	252	-4.267	-	1,075	-	-	C
Sonobuoys T.1946 (3)	-	240	-4.267	-	1,024	-	-	C
Depth charges Mk.XI (3)	-	870	1.317	1,146	-	-	-	C
Dealer 'B' (2)	-	1,360	3.838	5,220	-	-	-	C
Depth charges Mk.XI (3)	-	870	6.588	5,732	-	-	-	C
Sonobuoys T.1946 (9)	-	720	11.685	8,413	-	-	-	C
Marine markers No.4 Mk.1 (12)	-	252	16.195	4,081	-	-	-	C
Sonobuoys T.1946 (3)	-	240	16.195	3,887	-	-	-	C

Case 'A' Air sea rescue version

Case 'B' Long range reconnaissance version

Case 'C' Anti-underwater version

RESTRICTED

TABLE 5 List of disposable loads (continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
<i>Fuel and oil</i>					
No.1 tanks (994 gall.)	61	7,157	5.017	35,907	-
No.2 tanks (1082 gall.)	24	7,790	5.233	40,765	-
No.3 tanks (594 gall.)	26	4,277	5.708	24,413	-
No.4 tanks (622 gall.)	60	4,479	6.171	27,640	-
Oil (104 gall.)	62	936	3.5	3,276	-
Water methanol (26 gall.)	59	234	6.38	1,493	-

(B) Alternative items and crew positions not included in tables

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Expendable part of front gun ammunition	77	210	-13.4	-	2,820
Front guns	1	173	-23.5	-	4,066
Front gun ammunition (600 rds.)	6	375	-15.88	-	5,955
Mid-upper turret	29	735	13.3	9,776	-
Blanking cover					
M/U turret	27	33	13.3	439	-
Mid-upper guns	25	240	13.0	3,120	-
Mid-upper gun ammunition (700 rds.) 20 mm.	32	437.5	13.0	5,688	-
Expendable part of mid-upper gun ammunition	30	245	13.2	3,259	-
Front gunner	3	180	20.75	-	3,735
Mid-upper gunner	28	180	12.8	2,304	-
Crew member at air bomber's station	4	180	-18.75	-	3,375
Crew member at toilet	43	180	38.0	6,840	-
Crew member at rest bunk upper	34	180	18.55	3,339	-
Crew member at rest bunk lower	48	180	18.55	3,339	-
Crew member at galley	52	180	10.5	1,890	-
Crew member at flare chute fwd.	7	180	-15.25	-	2,745
Crew member at flare chute aft.	37	180	27.5	4,950	-
Crew member at Capt. nav. Station	73	180	- 1.75	-	315
Crew member at crash station forward of front spar	20	180	-	-	-

Alternative items and crew positions not included in tables (continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Crew member at crash station forward of rear spar	58	180	6.625	1,193	-
Crew member at crash station aft of front spar	67	180	3.429	617	-
Freight carrier and bomb bay container	-	130	-	-	-

NOTE...

When calculating C.G. movement in flight, the total weight of ammunition is not expended (see alternative items). It must be borne in mind that the expendable part of the total weight is subtracted from the weight of the aircraft. For the mid-upper turret ammunition, having a positive arm, the resultant moment is negative and must be subtracted from the aircraft moment. For the forward gun ammunition, having a negative moment arm, the resultant moment is positive and must be added to the aircraft moment.

MAXIMUM WEIGHTS

15. The maximum take-off and landing weights are as follows:-

Maximum all-up weight = 89,000 lb.

Provided that the following restrictions are observed:-

(1) Normal accelerations not to exceed 2g. and manoeuvres, during the early stages of flight, are limited to gentle turns. Turbulent air conditions to be avoided.

(2) Manoeuvres appropriate to the long range reconnaissance role may be performed after the weight has been reduced to 82,000 lb.

(3) Fuel to be consumed from the inboard tanks first.

Landing weight = 72,000 lb.

OVERLOAD LANDING WEIGHT

16. The aircraft are now cleared to land at weights not exceeding 77,000 lb. when dictated by operational necessity and provided that extra care is taken when landing at weights above 72,000 lb. At these higher weights the reserve factors on the main alighting gear and engine mountings become marginal; the new limitations should, therefore, be regarded as an "Overload" case.

RESTRICTED

C.G. COMPUTER

17. A C.G. computer (Ref.No.26FP/5284) has been designed for this aircraft. The instructions for use are appended herewith:-

- (1) Set cursor hairline to basic moment (* see note below).
- (2) Move slide until zero of selected item is under hairline.
- (3) Move cursor in direction indicated by arrow until hairline is over quantity being loaded.
- (4) Starting from last setting of cursor, repeat operations 2 and 3 for each item or compartment.

- (5) The final position of the cursor hairline must be within the fore-and-aft limits as shown on scale on the inside face of the rule.
- (6) The actual C.G. position (in feet aft of the aircraft datum) may be obtained by removing slide and reading C.G. position under hairline against the appropriate weight line on scale.
- (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 hairline over zero, repeating the operation for all expendable items. The final landing C.G. position being obtained as in item 6.

NOTE...

$$\text{The basic moment} = \frac{\text{Basic weight} \times \text{arm (in feet) about a/c datum}}{10,000}$$

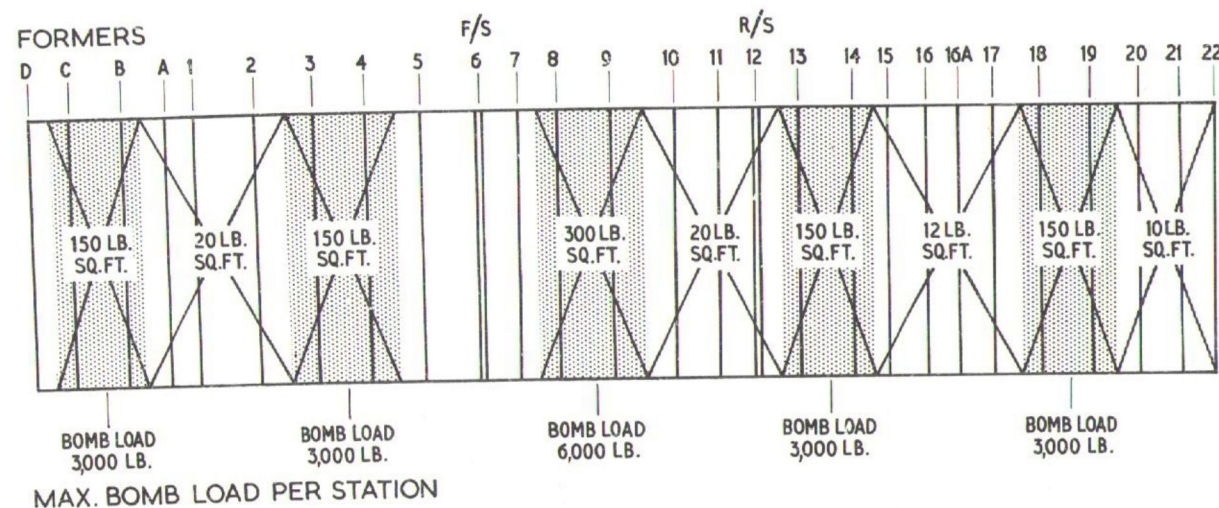


Fig.3. Floor loading data

RESTRICTED

FLOOR LOADING DATA (fig. 3)

18. Data on additional floor loading when carrying spares and ground equipment for special flights is given in the illustration.

19. On the shaded areas, which are areas over bomb supporting formers, the loading shown represents floor loading with no bomb load. When full bomb load is carried, the additional floor load is nil with linear variation when only a portion of the full bomb load is carried. The total floor loading should not exceed the full bomb load, i.e., 15,000 lb. (refer to Case 'D', para.20), distributed to suit C.G. conditions. All loadings assume that the load is distributed over at least

two floor beams.

20. The placing of loading planks longitudinally across and over the low dimensional floor areas from one bomb supporting former to another will enable heavier loads to be transported, attention always being paid, however, to bomb loading in the same area and C.G. requirements.

UNUSABLE FUEL

21. After defuelling, the aircraft must be rigged with the aircraft horizontal datum level, and the tanks drained in accordance with the instructions contained in Sect.4, Chap.2 of this Book. The

weight and moment of the fuel to bring to Basic Weight are:-

Weight of fuel	57 lb.
Moment	+305 lb.ft.

MODIFICATIONS

22. 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 should be ascertained if further modifications have been added, if so the Basic Weight and Index should be raised on the Record Card, R.A.F. Form No.4908.

Addendum I

INCORPORATION OF PHASE I

Fig. 1 (overleaf) shows the location of items of removable military load when Phase 1 has been incorporated in the aircraft. The facing key details the new equipment and gives weights, arms and moments. Items shown on the illustration but not quoted in the Key (a typical service load) are the same as those detailed in the various tables in the preceding Chapter 3.

RESTRICTED

SUBSEQUENT TO PHASE I RADIO AND RADAR INSTALLATION

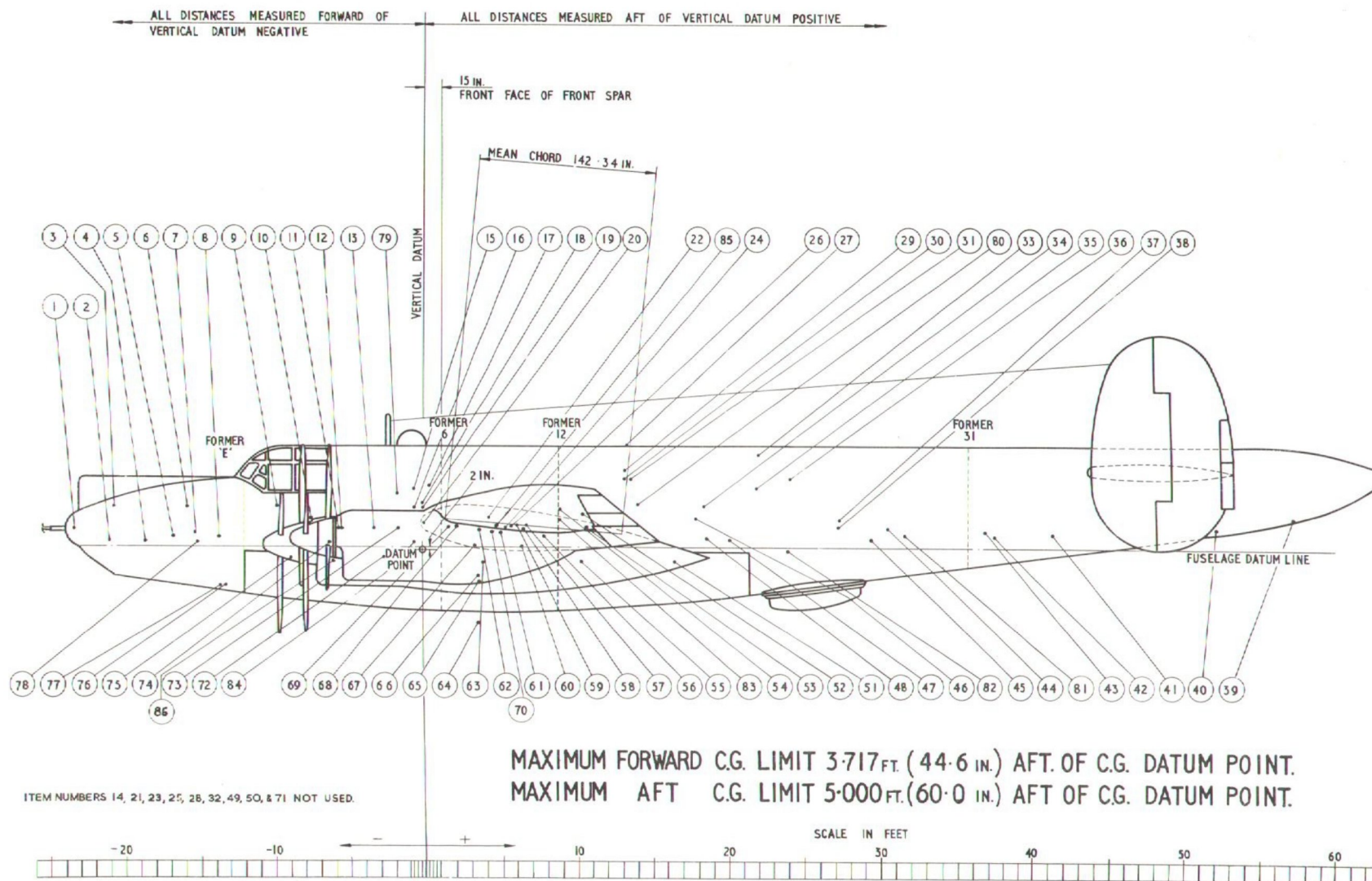


Fig. I. Loading & C.G. diagram - Phase I

RESTRICTED

KEY TO FIG.1

Phase 1 - Removable equipment

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb. ft.)	
				Positive	Negative
Signal pistol and cartridges	74	11	- 5.5	-	61
Aircraft destructors	31	6	13.5	81	-
Electrical equipment	18	15	-	4	-
Flying & navigational instruments	19	63.6	-	11	-
Camera - hand held (allowance)	45	10	29.5	295	-
Camera F.24	39	42	57.25	2,405	-
Camera FX.91	40	42	52.25	2,195	-
Galley utensils	54	14.5	9.0	131	-
First aid outfit	47	11	20.15	222	-
Elsan charge	42	7	37.5	263	-
A.1961 amplifier	83	12.5	8.8	110	-
T.1154/R.1155	10	141.5	- 7.5	-	1,058
A.R.I.5284 A.Y.F.	17	18.5	0.5	9	-
A.R.I.5848 I.F.F.10 & coder	80	51	13.58	696	-
A.R.I.5718 GEE	69	83	1.73	143	-
A.R.I.5771 Loran	79	34	- 2.0	-	68
A.R.I.5490 V.H.F.	84	50	- 0.72	-	36
A.R.I.5428 Radio compass	22	30	4.0	120	-
A.R.I.5885 Blue silk	81	161	31.17	5,018	-
A.R.I.5878 A.S.V. Mk.21	82	350	23.62	8,284	-
Autolycus	86	90	- 6.91	-	622

RESTRICTED

Addendum 2

INCORPORATION OF PHASE 2

Fig.1 (overleaf) shows the location of items of load when Phase 2 has been incorporated in the aircraft. The accompanying keys detail the weights, arms and moments of items of removable equipment. Items shown on the illustration but not quoted in the keys are the same as those detailed in Chapter 3. Fig.2 shows the moment arms of bomb slips when Phase 2 is incorporated.

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SUBSEQUENT TO PHASE 2 RADIO AND RADAR INSTALLATION

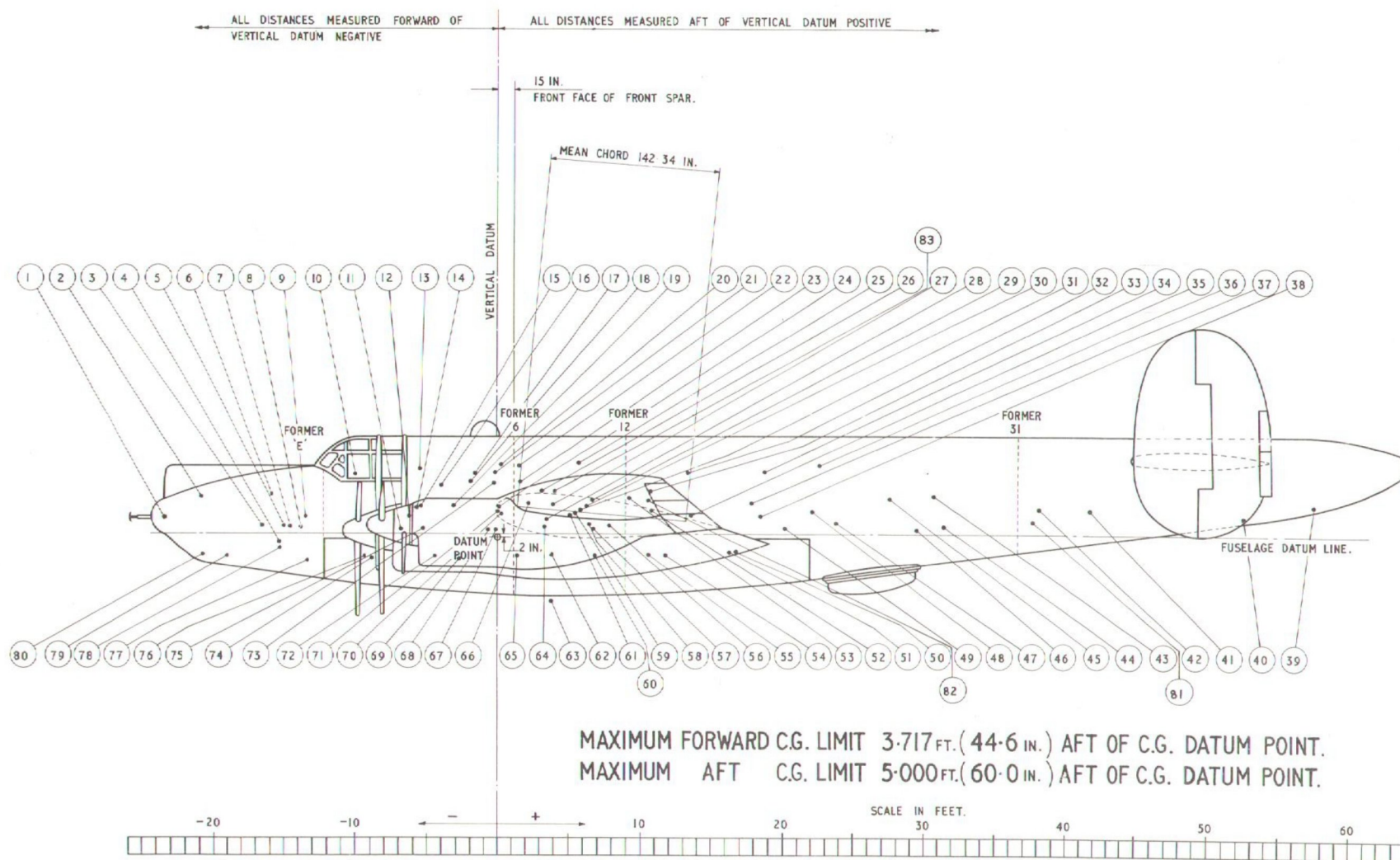


FIG. I. LOADING AND C.G. DIAGRAM
RESTRICTED

STANDARD OPERATIONAL CASES

Case 'A' Air sea rescue version					
Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Basic weight	-	53,940	4.8	258,770	-
Common operating equipment (Table 1)	-	2,647	-	10,716	-
Special operating equipment (Table 3)	-	240	-	1,738	-
Lifeboat airborne	63	4,200	3.838	16,120	-
Lindholme gear	50	308	16.589	5,109	-
Illuminator flares (48)	37	64	17.8	1,139	-
Photoflashes 1.75 in. (12)	36	21	22.25	467	-
Flame floats (77)	48	265	22.0	5,830	-
Reconnaissance flares (10)	8	240	-13.67	-	3,281
Reconnaissance flares (2)	3	48	-16.75	-	804
Smoke floats (4)	3	46	-16.75	-	771
Photoflash 4.5 in. (2)	3	58	-16.75	-	972
Marine markers (2)	3	42	-16.75	-	704
De-icing fluid (32 gall.)	56	352	7.8	2,746	-
De-icing fluid (23 gall.)	56	253	7.8	1,973	-
De-icing fluid wind-screen (7 gall.)	77	57	-13.25	-	755
Nitrogen charge	41	43	41.5	1,785	-
Food and drinking water	53	170	9.0	1,530	-
Oil (104 gall.)	28	936	3.5	3,276	-
Fuel No.1 tank (994 gall.)	61	7,157	5.017	35,907	-
Fuel No.2 tank (1,082 gall.)	59	7,790	5.233	40,765	-
Fuel No.3 tank (594 gall.)	31	4,277	5.708	24,413	-
Fuel No.4 tank (622 gall.)	30	4,479	6.171	27,640	-
Water methanol (26 gall.)	58	234	6.38	1,493	-
	-	-	-	441,417	7,287
All-up weight	-	87,867	-	434,130	-

The C.G. is 4.94 ft. (59.28 in.) aft of the aircraft datum.

Case 'B' Long range reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Basic weight	-	53,940	4.8	258,770	-
Common operating equipment (Table 1)	-	2,647	-	10,716	-

Case 'B' Long range reconnaissance (continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Special operating equipment (Table 4)	-	1,070	-	1,048	-
Oxygen charge	74	56	-8.912	-	499
Reconnaissance flares bomb bay (12)	50	288	16.589	4,778	-
Photoflashes 4.5 in. bomb bay (6)	50	174	16.589	2,886	-
Illuminator flares (192)	37	258	17.8	4,592	-
Flame floats (77)	48	265	22.0	5,830	-
Reconnaissance flares (8)	3	192	-16.75	-	3,216
Marine markers (8)	8	168	-13.67	-	2,297
Photoflashes 1.75 in. (24)	36	42	22.25	935	-
De-icing fluid (32 gall.)	56	352	7.8	2,746	-
De-icing fluid (23 gall.)	56	253	7.8	1,973	-
De-icing fluid wind-screen (7 gall.)	77	57	-13.25	-	755
Nitrogen charge	41	43	41.5	1,785	-
Food and drinking water	53	107	9.0	1,530	-
Oil (104 gall.)	28	936	3.5	3,276	-
Fuel No.1 tank (994 gall.)	61	7,157	5.017	35,907	-
Fuel No.2 tank (1,082 gall.)	59	7,790	5.233	40,765	-
Fuel No.3 tank (594 gall.)	31	4,277	5.708	24,413	-
Fuel No.4 tank (622 gall.)	30	4,479	6.171	27,640	-
Auxiliary tank (400 gall.)	62	2,880	3.838	11,053	-
Water methanol (26 gall.)	58	234	6.38	1,493	-
	-	-	-	442,136	6,767
	-	87,728	-	435,369	-

The C.G. is 4.963 ft. (59.56 in.) aft of the aircraft datum.

Case 'C' Anti-underwater reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Basic weight	-	53,940	4.8	258,770	-
Common operating equipment (Table 1)	-	2,647	-	10,716	-
Special operating equipment (Table 2)	-	655	-	2,514	-
Illuminator flares (192)	37	258	17.8	4,592	-
Photoflashes 1.75 in. (24)	36	42	22.25	935	-
Flame floats (77)	48	265	22.0	5,830	-
Marine markers (10)	8	210	-13.67	-	2,871
Marine markers (10)	3	210	-16.75	-	3,518
Food and drinking water	53	170	9.0	1,530	-

RESTRICTED

Case 'C' Anti underwater reconnaissance (continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Nitrogen charge	41	43	41.5	1,785	-
De-icing fluid (32 gall.)	56	352	7.8	2,746	-
De-icing fluid (23 gall.)	56	253	7.8	1,973	-
De-icing fluid wind-screen (7 gall.)	77	57	-13.25	-	755
Row No.1 Sonobuoys (9)	76	720	- 9.565	-	6,887
Row No.2 Sonobuoys (3)	72	240	- 4.267	-	1,024
Row No.2 Marine markers (12)	72	252	- 4.267	-	1,075
Row No.3 Depth charge Mk. XI (3)	65	870	1.317	1,146	-
Row No.3 Dealer 'B' (2)	62	1,360	3.838	5,220	-
Row No.3 Depth charge Mk. XI (3)	60	870	6.588	5,732	-
Row No.4 Sonobuoys (9)	54	720	11.685	8,413	-
Row No.5 Marine markers (12)	51	252	16.195	4,081	-
Row No.5 Sonobuoys (3)	51	240	16.195	3,887	-
Oil (104 gall.)	28	936	3.5	3,276	-
Fuel No.1 tank (925 gall.)	61	6,658	5.017	33,403	-
Fuel No.2 tank (1082 gall.)	59	7,790	5.233	40,765	-
Fuel No.3 tank (594 gall.)	31	4,277	5.708	24,413	-
Fuel No.4 tank (622 gall.)	30	4,479	6.171	27,640	-
Water methanol (26 gall.)	58	234	6.38	1,493	-
	-	-	-	450,860	16,130
All-up weight	-	89,000	-	434,730	-

The C.G. is 4.885 ft. (58.62 in.) aft of the aircraft datum

In this case, all the stores carried in the bomb bay with the exception of the Dealer 'B', are fitted on special carriers attached to the appropriate slips. The centres of gravity of these stores do not coincide with slip positions, (reference should be made to Sect.7, Book 2 of this publication) and are as follows:-

Row 1	Sonobuoys	-9.565 ft.
Row 2	Sonobuoys	-4.267 ft.
Row 2	Marine markers	-4.267 ft.
Row 3	Depth charges (forward end of carrier)	1.317 ft.
Row 3	Dealer 'B'	3.838 ft.
Row 3	Depth charges (aft end of carrier)	6.588 ft.
Row 4	Sonobuoys	11.685 ft.
Row 5	Marine markers	16.195 ft.
Row 5	Sonobuoys	16.195 ft.

REMOVABLE EQUIPMENT

The basic weight of the aircraft includes the following items of removable equipment.

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Aircraft destructor	32	6	13.5	81	-
Signal pistol and cartridges	13	11	-5.5	-	61
Electrical equipment	71	15	0.266	4	-
Flying and navigational inst.	70	64	0.17	11	-
Camera F.60 (allowance)	46	10	29.5	295	-
Camera F.24	39	42	57.25	2,405	-
Camera FX.91	40	42	52.25	2,195	-
Galley utensils	53	14.5	9.0	131	-
First aid outfits (4)	49	11.5	20.15	222	-
A.R.I.18089 (I/C.)	75	12.5	-5.4	-	68
A.R.I.5284 (A.Y.F.)	20	18.5	0.5	9	-
A.R.I.5848 (IFF 10 and coder)	35	51.24	13.58	696	-
A.R.I.5718 (GEE)	22	82.875	1.56	129	-
A.R.I.5771 (Loran)	18	34.31	-2.0	-	69
A.R.I.5490 (V.H.F.)	68	50.0	-0.72	-	36
A.R.I.5428 (Radio compass)	16	30.0	-4.0	-	120
A.R.I.5885 (Blue silk)	44	161.0	31.17	5,018	-
A.R.I.5878 (A.S.V. Mk.21)	47	350.0	23.62	8,284	-
A.R.I.5876 (SARAH)	23	49.0	1.55	76	-
A.R.I.18108/1 (Sonobuoy IC.)	26	106.0	3.2	192	-
A.R.I.18103 (S.B.Indicator)					
A.R.I.18157 (Metering switch)	12	4.0	-6.25	-	25
A.R.I.18101/1 (S.B.Homer)	21	14.0	-0.143	-	2
A.R.I.18124/1 (U.H.F.)	7	51.5	-14.7	-	758
A.R.I.5874 (S.T.R.18B)	25	67.5	5.96	402	-
A.R.I.18107/2 (Tacan)	5	58.0	-15.0	-	870
Autolycus	11	90.0	-6.91	-	622
A.R.I.18144 'Orange Harvest'	82				
'S' Band	239		10.71	2,561	-
'C' Band	234		10.75	2,516	-
'X' Band	229		10.79	2,471	-
Elsan charge	81	7	37.5	263	-

RESTRICTED

OPERATING EQUIPMENT

TABLE 1

List of operating equipment common to all roles

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Dinghies Type 'SS' (10)	27	200	4.375	875	-
Dinghies Type M.S.9	52	360	10.7	3,852	-
Bomb sight (L.L.)	80	33	-21.0	-	693
Armament electrics	4	14	-15.25	-	214
Parachute and Harnesses (10)	83	240	4.02	965	-
1st pilot	10	180	-9.7	-	1,746
2nd pilot	10	180	-9.7	-	1,746
Flight engineer	14	180	-5.8	-	1,044
Wireless operator	15	180	-5.6	-	1,008
Navigator	19	180	-3.25	-	585
Tactical navigator	24	180	0	0	0
Radar operator	29	180	6.75	1,215	-
Sonobuoy operator	66	180	2.25	405	-
Starboard observer	45	180	27.4	4,932	-
Port observer	43	180	30.6	5,508	-
	-	-	-	17,752	7,036
Total	-	2,647	-	10,716	-

TABLE 2

List of operating equipment for anti-underwater reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
A.V.164 carrier (3)	-	207	-5.725	-	1,185
A.V.168 carrier (3)	-	207	13.401	2,774	-
A.V.169 carrier (1)	62	85	3.838	326	-
A.V.163 carrier (2)	62	42	3.838	161	-
A.V.193 adapter (8)	-	96	3.838	369	-
A.V.122 adapter (1)	67	18	3.838	69	-
	-	-	-	3,699	1,185
Total:	-	655	3.838	2,514	-

TABLE 3

List of operating equipment for air-sea rescue

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Suspension and release unit	62	72	3.838	276	-
Quintuple carrier	50	91	16.589	1,510	-
Portable oxygen sets (10)	73	77	-0.627	-	48
	-	-	-	1,786	48
Total:	-	240	-	1,738	-

TABLE 4

List of operating equipment for long range reconnaissance

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Oxygen crate	74	393	-8.912	-	3,502
Portable oxygen sets (10)	73	77	-0.627	-	48
Carriers and adapters (3 sets)	50	180	16.589	2,986	-
Auxiliary fuel tank and carrier	62	420	3.838	1,612	-
	-	-	-	4,598	3,550
Total:	-	1,070	-	1,048	-

RESTRICTED

TABLE 5
List of disposable loads

	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)		Role
				Positive	Negative	
<i>Fuselage</i>						
Illuminator flares (192)	37	258	17.8	4,592	-	- B C
Illuminator flares (48)	37	64	17.8	1,139	-	A - -
Photoflash 1.75 in. (12)	36	21	22.25	417	-	A - -
Photoflash 1.75 in. (24)	36	42	22.25	935	-	- B C
Flame floats (77)	48	265	22.0	5,830	-	A B C
Reconnaissance flares (10)	8	240	-13.67	-	3,281	A - -
Reconnaissance flares (2)	3	48	-16.75	-	804	A - -
Reconnaissance flares (8)	3	192	-16.75	-	3,216	- B -
Smoke floats (4)	3	46	-16.75	-	771	A - -
Photoflash 4.5 in. (2)	3	58	-16.75	-	972	A - -
Marine markers (2)	3	42	-16.75	-	704	A - -
Marine markers (8)	8	168	-13.67	-	2,297	- B -
Marine markers (10)	8	210	-13.67	-	2,871	- - C
Marine markers (10)	3	210	-16.75	-	3,518	- - C
Food and drinking water	53	170	9.0	1,530	-	A B C
Nitrogen charge	41	43	41.5	1,785	-	A B C
De-icing fluid (32 gall.)	56	352	7.8	2,746	-	A B C
De-icing fluid (23 gall.)	56	253	7.8	1,973	-	A B C
De-icing fluid (7 gall.)	77	57	-13.25	-	755	A B C
<i>Bomb Bay</i>						
Lifeboat airborne (when carried)	63	4,200	3.838	16,120	-	A - -
Lindholme gear (1 set)	50	308	16.589	5,109	-	A - -
Reconnaissance flares (12)	50	288	16.589	4,778	-	- B -
Photoflash 4.5 in. (6)	50	174	16.589	2,886	-	- B -
Oxygen charge	74	56	-8.912	-	499	- B -
Sonobuoys T.1946 (9)	76	720	-9.565	-	6,887	- - C
Marine markers No.4, Mk.1 (12)	72	252	-4.267	-	1,075	- - C
Sonobuoys T.1946 (3)	72	240	-4.267	-	1,024	- - C
Depth charges Mk.X1 (3)	65	870	1.317	1,146	-	- - C
Dealer 'B' (2)	62	1,360	3.838	5,220	-	- - C
Depth charges Mk.X1 (3)	60	870	6.588	5,732	-	- - C
Sonobuoys T.1946 (9)	54	720	11.685	8,413	-	- - C
Marine markers No.4, Mk.1 (12)	51	252	16.195	4,081	-	- - C
Sonobuoys T.1946 (3)	51	240	16.195	3,887	-	- - C

Role A Air-sea rescue version
Role B Long range reconnaissance version
Role C Anti-underwater version

RESTRICTED

TABLE 5 List of disposable load (continued)

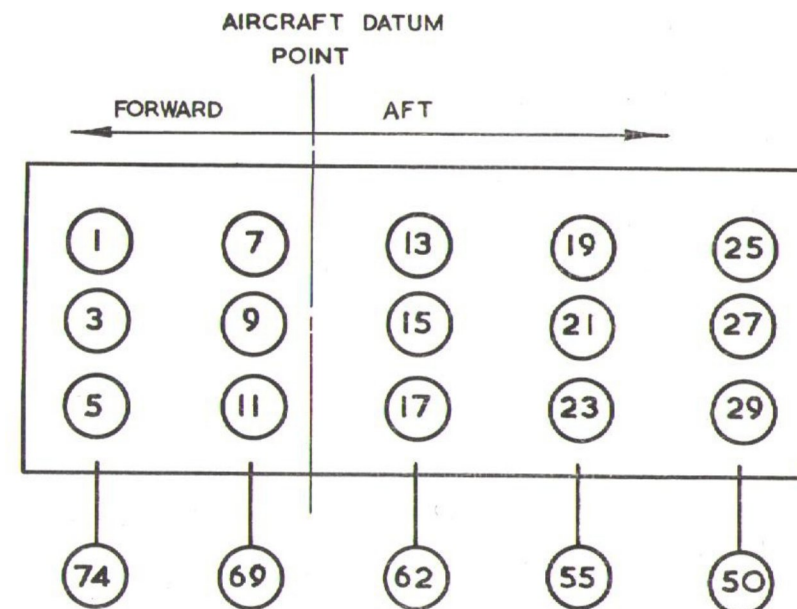
Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
No.1 tanks (994 gall.)	61	7,157	5.017	35,907	-
No.2 tanks (1,082 gall.)	59	7,790	5.233	40,765	-
No.3 tanks (594 gall.)	31	4,277	5.708	24,413	-
No.4 tanks (622 gall.)	30	4,479	6.171	27,640	-
Overload tank (400 gall.)	62	2,880	3.838	11,053	-
Water/methanol (26 gall.)	58	234	6.38	1,493	-
Oil (104 gall.)	28	936	3.5	3,276	-

(B) Alternative items and crew positions not included on tables

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
Front guns	1	173	-23.5	-	4,066
Front gun ammunition (600 rds.)	6	375	-15.88	-	5,955
Expendable part of front gun ammunition	9	210	-18.75	-	3,700
Front gunner	2	180	-20.75	-	3,735
Crew member at air bombers station	79	180	-18.75	-	3,375
Crew member at toilet	42	180	38.0	6,840	-
Crew member at galley	33	180	10.5	1,890	-
Crew member at rest bunk, upper	34	180	18.55	3,399	-
Crew member at rest bunk, lower	38	180	18.55	3,399	-
Crew member at flare chute, forward	78	180	-15.25	-	2,745
Crew member at captain nav. station	17	180	-1.75	-	315
Crew member at crash station forward of front spar	67	180	0	-	-
Crew member at crash station forward of rear spar	57	180	6.625	1,193	-
Crew member at crash station aft of front spar	64	180	3.429	617	-
Freight carrier and bomb bay container	-	130	-	-	-

WEIGHT AND C.G. BREAKDOWN FOR REMOVABLE ITEMS

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
7B/982 Signal pistol	-	2.75	-6.4	-	18
Cartridges	-	8.25	-5.2	-	43
Total Signal pistol and cartridges	13	11.0	-5.5	-	61



No. 1 to 6 - 8.912 ft.
 No. 7 to 12 - 2.537 ft.
 No.13 to 18 3.838 ft.
 No.19 to 24 10.214 ft.
 No.25 to 30 16.589 ft.

Fig.2. Moment arms of bomb slips

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
5A/2334 Lamp signalling	-	2.25	-11.6	-	26
Torches (20)	-	6.0	2.35	14	-
Cells dry (40)	-	6.75	2.35	16	-
	-	-	-	30	26
Total Electrical equipment	71	15.0	0.266	4	-
Clocks (4)	-	2.0	-10.0	-	20
Watches (5)	-	2.0	-10.0	-	20
6E/320 Binoculars (4)	-	8.0	25.0	200	-
6B/1673 Compass (1)	-	4.6	-3.0	-	14
6B/399 Astro compass	-	2.2	-3.0	-	7
6B/400 Standards	-	1.8	-3.0	-	5

RESTRICTED

WEIGHT AND C.G. BREAKDOWN FOR REMOVABLE ITEMS (Continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
6B/2649 G.P.I. Mk.4A	-	25.0	-4.0	-	100
6B/633 Amplifier	-	2.0	-3.6	-	7
Sextants	-	16.0	-1.0	-	16
				200	189
Total Flying and navigational instruments	70	63.6	-	11	-
Dinghy Type 'SS' (2)	-	40.0	-14.5	-	580
Dinghy Type 'SS' (2)	-	40.0	-8.25	-	330
Dinghy Type 'SS' (1)	-	20.0	-2.5	-	50
Dinghy Type 'SS' (1)	-	20.0	-1.0	-	20
Dinghy Type 'SS' (1)	-	20.0	8.75	175	-
Dinghy Type 'SS' (1)	-	20.0	17.0	340	-
Dinghy Type 'SS' (2)	-	40.0	33.75	1,340	-
				1,855	980
Total Dinghies Type 'SS' (10)	27	200.0	4.375	875	-
Parachute and harness (2)	-	48.0	-16.0	-	768
Parachute and harness (1)	-	24.0	-14.5	-	348
Parachute and harness (1)	-	24.0	-5.3	-	127
Parachute and harness (1)	-	24.0	-4.0	-	96
Parachute and harness (2)	-	48.0	4.25	204	-
Parachute and harness (1)	-	24.0	18.5	444	-
Parachute and harness (1)	-	24.0	33.75	810	-
Parachute and harness (1)	-	24.0	35.25	846	-
				2,304	1,339
Total Parachutes and harness	83	240.0	4.02	965	-
10U/16596 Amplifier (1)	-	6.25	-5.1	-	32
10U/16596 Amplifier (1)	-	6.25	-5.7	-	36
Total A.R.I.18089 I/C	75	12.5	-5.4	-	68
110DB/25 Trans/rec. RT-7/APN-1		18.5	0.5	9	-
Total A.R.I.5284 (A.Y.F.)	20	18.5	0.5	9	-
16K/1660 - 036290932					
Coder unit	-	10.44	13.5	141	-
10AJ/646 Mtg. for coder unit	-	0.8	13.5	11	-

WEIGHT AND C.G. BREAKDOWN FOR REMOVABLE ITEMS (Continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
16K/1660 - 36290585					
Control unit	-	1.1	-8.0	-	9
16K/1660 - 083670097					
Trans/receiver	-	38.4	14.5	557	-
10F/17424 Switch unit	-	0.5	-8.0	-	4
				709	13
Total A.R.I.5848 (I.F.F.10 and coder)	35	51.24	13.58	696	-
10DB/8477 Trans/receiver R.3645	-	28.375	-3.25	-	92
10QB/6382 Indicator	-	38.5	4.25	164	-
R.F. Units	-	14.5	3.5	51	-
Ring adapter and visor	-	1.5	4.25	6	-
				221	92
Total A.R.I.5718 (Gee)	22	82.875	1.56	129	-
110QB/71 Rec./indicator	-	33.75	-2.0	-	68
110AB/380 Visor	-	0.56	-2.0	-	1
Total A.R.I.5771 (Loran)	18	34.31	-2.0	-	69
10D/17693 T.R.1934	-	25.0	-0.3	-	8
10D/17694 T.R.1935	-	25.0	-1.1	-	28
Total A.R.I.5490 (V.H.F.)	68	50.0	-0.72	-	36
10D/16797 Receiver	-	30.0	-4.0	-	120
Total A.R.I.5428 (Radio Compass)	16	30.0	-4.0	-	120
10D/19653 Trans/receiver	-	85.0	36.25	3,081	-
10K/18356 Power Unit	-	70.0	28.0	1,960	-
10Q/16248 Amplifier	-				
10Q/16247 Discriminator	-				
10Q/16246 Indicator electrical	-	6.0	-3.75	-	23
				5,041	23
Total A.R.I.5885	44	161.0	-	5,018	-
10L/16401 Control unit	-	7.0	5.6	39	-
6W/12 Gyroscopic unit	-	8.0	27.25	218	-
10Q/16266 Indicator unit	-	41.5	4.25	176	-
10D/20213 Modulator	-	44.0	28.25	1,243	-
10D/18939 Power unit	-	39.5	29.0	1,146	-
10B/17724 Scanner	-	114.0	25.75	2,936	-
10D/20214 Trans/receiver	-	56.0	27.25	1,526	-
10V/16278 Waveform generator	-	40.0	25.0	1,000	-
Total A.R.I.5878 (A.S.V. Mk.21)	47	350.0	23.62	8,284	-

RESTRICTED

WEIGHT AND C.G. BREAKDOWN FOR REMOVABLE ITEMS (continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
10D/19540 Receiver	-	10.0	2.75	28	-
Batteries, Modulators, etc.	-	39.0	1.22	48	-
Total Sarah	23	49.0	1.55	76	-
Power unit X.1929 (1)	-	12.0	-0.584	-	14
Amplifier unit X.11144(1)	-	5.5	1.75	10	-
Receiver A and B X.950 (1)	-	35.0	2.29	80	-
Junction box X.9429 (1)	-	1.5	2.58	4	-
Filter X.1707 (1)	-	3.0	2.5	7	-
Indicator unit X.1928 (1)	-	45.0	2.0	98	-
Control unit X.9468 (1)	-	4.0	2.0	8	-
	-	-	-	206	14
Total A.R.I.18108/1 sonobuoy I.C. and A.R.I.18103 S.B. indicator	26	106.0	3.2	192	-
Filter X.1707 (2)	-	6.0	2.5	15	-
Comparator X.7968 (1)	-	6.0	-2.5	-	15
Control unit X.11141 (1)	-	2.0	-1.0	-	2
	-	-	-	15	17
Total A.R.I.18101/1	21	14.0	-0.143	-	2
Switch unit X.11145 (1)	-	1.0	-10.0	-	10
J.B. Homing X.11143 (1)	-	1.0	-3.0	-	3
Indicator electric (2)	-	2.0	-6.0	-	12
Total (Metering switch) A.R.I.18157	12	4.0	-6.25	-	25
Trans/receiver ARC.52/T.R.5	-	48.5	-15.0	-	728
Control unit C1607/ARC52	-	3.0	-10.0	-	30
Total A.R.I.18124/1 (U.H.F.)	7	51.5	-14.7	-	758
10D/19065 Transmitter T.4188	-	16.0	7.12	114	-
10K/16207 Control unit T.4243	-	17.5	5.7	89	-
10K/19067 Power and radio unit T.4192	-	34.0	5.86	199	-
Total A.R.I.5874 (S.T.R.18B)	25	67.5	5.96	402	-
Trans/receiver Type TR.9171	-	58.0	-15.0	-	870
Total A.R.I.18107/2	5	58.0	-15.0	-	870

WEIGHT AND C.G. BREAKDOWN FOR REMOVABLE ITEMS (Continued)

Nomenclature	Item No.	Weight (lb.)	Arm (ft.)	Moment (lb.ft.)	
				Positive	Negative
6B/2590 Detection unit	-	36.0	-14.5	-	522
6B/2648 Electrometer	-	20.0	2.5	50	-
6B/2591 Recorder IR/375	-	24.0	1.25	30	-
12Z/16	-	10.0	-18.0	-	180
				80	720
Total Autolycus	11	90.0	-6.91	-	622
10B/19427 Aerial "S" Band X.11030	-	55.0	9.0	495	-
or Aerial "C" Band X.11031	-	50.0	9.0	450	-
or Aerial "X" Band X.11032	-	45.0	9.0	405	-
Amplifier X.13049	-	4.25	12.5	53	-
10U/16881 Amplifier A.7450	-	10.5	11.9	125	-
10D/21799 Junction box X.11711	-	4.5	12.8	58	-
10L/16140 Control unit X.7449	-	0.7	4.3	3	-
10L/16504 Control unit X.9103	-	5.31	3.8	20	-
10L/16721 Control unit X.9987	-	3.25	4.3	14	-
10D/19908 Coupling unit X.9212	-	0.5	10.0	5	-
10P/16186 Filter unit X.7496	-	15.75	12.25	193	-
10Q/16460 Indicator X.9984	-	13.25	3.8	50	-
10D/19898 Mixer unit X.9098	-	8.0	10.2	82	-
10D/19897 Mixer unit X.9099	-	6.31	8.4	53	-
10B/17507 Aerial and mixer unit	-	4.0	10.2	40	-
10V/16237 Oscillator unit 9100	-	29.125	15.6	454	-
or					
10V/16236 Oscillator unit 9101	-	28.875	-	-	-
or					
10V/16235 Oscillator unit 9102	-	29.125	-	-	-
10K/21154 Power Unit X.9986	-	10.75	4.3	46	-
10K/17941 Power Unit X.7495	-	19.375	13.62	264	-
10K/18273 Power unit X.7824	-	16.75	13.1	219	-
10D/21800 Receiver X.9982	-	31.25	12.33	385	-
Visor X.11774	-	0.5	4.2	2	-
Total A.R.I.18144 (Orange Harvest)	82				
"S" Band		239.07	10.71	2,561	-
"C" Band		234.07	10.75	2,516	-
"X" Band		229.07	10.79	2,471	-

