

AVRO 698

WITH VERTICAL TIER STOWAGE OF 1,000 LB. BOMBS.CONTENTS.

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AVRO 698WITH VERTICAL TIER STOWAGE OF 1,000 LB. BOMBS.INTRODUCTION.

The AVRO 698 to specification B.35/46 is designed to carry a bomb load of 10,000 lb for still air ranges of 3350 to 5000 nautical miles. It has been recognised for some time that an alternative mission would be the carriage of greatly increased bomb loads for short ranges, and in January 1951 a proposal was made for the carriage of either 53 x 1000 lb bombs or four 10,000 lb bombs. (See Appendix 2 of the AVRO 698 brochure, Issue 4, I.P.B. 32). Two wing nacelles were fitted, each of which carried either thirteen 1,000 lb bombs or one 10,000 lb bomb. The remaining 27 x 1,000 lb bombs or two 10,000 lb bombs were carried in the bomb bay. Preliminary wind tunnel work on this scheme has been carried out, and it was intended to fit these nacelles to the second prototype aircraft.

The conventional method of carrying 1,000 lb bombs does not, however, utilise fully either the space available in the bomb bay and nacelles, or the exceptional load carrying capacity of the delta wing aircraft. The method proposed by the Royal Aircraft Establishment of arranging the bombs in vertical tiers opens up the possibility of carrying greatly increased numbers of 1000 lb. bombs in the same volume, and therefore without loss of performance. Advantages are also gained in respect of better bomb dropping characteristics.

This brochure describes the proposed application of Vertical Tier Stowage to the AVRO 698. In the standard case 83 x 1000 lb. bombs are carried. These are disposed in roughly equal numbers in the bomb bay and in the nacelles so that a satisfactory ground pattern is obtained by dropping groups consisting of two bombs from the fuselage and one from each nacelle. A possible development of up to 93 bombs has been considered, with 49 bombs in the fuselage, but this gives an excess number of bombs in the fuselage relative to wing nacelles.

It has been assumed that the still air range with 83,000 lb bombs will be from 1200 to 1800 nautical miles, giving radii of action from 500 to 750 nautical miles. It would also be possible to carry thirty-nine bombs in the fuselage only, for still air ranges of, say, 3350 nautical miles

Particular attention has been paid throughout to the achievement of a simple straightforward installation which will give the maximum ease of ground handling and loading. The aircraft is loaded in its normal attitude on the ground and does not require the use of pits or ramps etc. or special bomb transporters. The bombs in their containers are lifted into the bomb bay or nacelles by the standard method developed for the AVRO698, namely by a pair of hydraulic jacks.

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AVRO 698WITH VERTICAL TIER STOWAGE OF 1,000 LB. BOMBS.1. General.

The general features of Vertical Tier Stowage are by now well known. The bombs are held in containers which are divided into a number of cells with vertical walls. Two or more bombs are stowed in each cell and are separately crutched. When a bomb is released it slides down the cell, being constrained from fore and aft movement by two trunnions, and from rotation by the fins.

At the present stage no standard scheme for crutching and releasing the individual bombs has been adopted. A scheme is proposed in Section 4 of this brochure which differs in some respects from the scheme under development at R.A.E., and is considered to have some advantages.

In the application of vertical tier stowage to the Avro 698, it is proposed to use both the existing bomb bay and the wing nacelles. Thirty-nine 1,000 lb. bombs are carried in the bomb bay and twenty-two 1,000 lb. bombs in each of the two nacelles, making a total of 83 x 1,000 lb. bombs (See Page 23). The standard aircraft is provided with fittings for wing nacelles, and the modifications to provide for vertical tier stowage comprise the provision of fittings to carry the bomb containers, some strengthening of the structure, and gear for operating the container doors and releasing the bombs. There is no interference with the carriage of any of the present standard loads. The fixed fittings for the tier stowage incur a slight weight penalty in the normal long-range case, but by careful design this has been kept to a minimum.

Throughout the design every attempt has been made to keep the construction simple, consistent with the overriding requirement of lightness. For example, although each aircraft carries nine separate containers, there are only three different designs of these. Each type of container, of course, includes a large number of common features, such as the crutching and release mechanisms, the main structural members, and the bomb doors and their operating mechanism. The method of loading the aircraft is described fully in Section 4. It is emphasised that the aircraft can be fully loaded while standing on its wheels on any hard and reasonably flat surface and without the use of any specialised gear.

The effect on structural strength and weight is considered in Sections 6 and 7. The effect on performance is shown in Section 8.

2. Installation of Fuselage Containers.

The arrangement of the 39 bombs in three identical containers is shown on page 24. Each container has three tiers of 3 bombs and two tiers of 2 bombs. To install these containers it is necessary to remove the existing bomb doors. The containers are shaped to clear the existing structure in the roof of the bomb bay and are hung

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All the containers for both the fuselage bomb bay and the wing nacelles can be loaded with the aircraft standing on its wheels on any piece of level hard ground. The standard aerodrome bomb transporter is used to carry the completely loaded containers to the aircraft and the containers have been designed so that they can be passed under the aircraft and loaded without the need for any special arrangements.

The loading of the fuselage containers is shown on pages 29 and 30. The containers are all brought into position under the bomb bay from the rear of the aircraft with the bomb trolley in the low position. When the trolley is below the appropriate position in the bomb bay it is raised to the high position and a pair of hydraulic loading jacks inserted between the container and the attachment points in the bomb bay roof. (This, of course, follows the standard AVRO 698 practice for loading bombs etc.). The jacks are then retracted, lifting the container into position and the wedges are inserted to retain it in place. The loading jacks and the bomb trolley are then removed and the process repeated with the other two containers.

The method of bringing the bomb containers up to the wing nacelles is shown on page 31. The loading arrangements are similar to those adapted for the fuselage containers.

5. Proposed arrangement for Stacking the Bombs in the Container.

At the present time a method of crutching and releasing bombs in vertical tier stowage is undergoing development at the Royal Aircraft Establishment. A proposed alternative is, however, described in this brochure and is shown on page 32. This method allows the bombs to be loaded through the top of the container by means of a crane (See page 33).

The bomb is held between one release point $2\frac{1}{2}$ " aft of the bomb C.G. and at 45° to the vertical, and two crutching points respectively 9" forward and 11" aft of the bomb C.G. and diagonally opposite to the release point. The release mechanism is actuated by a Vickers No.1. release unit and after release the pad and link arms retract completely into the wall of the container. The crutching arms are mechanically coupled by a torque tube and are controlled by compression links, enabling them to take up either of two positions, namely crutching the bomb or completely retracted within the casing.

The Vickers No.1. Unit is a standard developed unit and can be removed for servicing or replacement leaving the release mechanism in situ. The crutching and release mechanisms can also be removed for servicing.

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The bombs are loaded in the following manner, the bottom bomb in each row is, of course, loaded first. The appropriate release is cocked by rotating the torque shaft by means of the handle provided. The bomb is then lowered into the container until it rests on the release pad. The clutch on the shaft which connects the two crutches is then rotated to cock the crutches, and the square on the concentric shaft is then rotated until both crutching pads are held tightly against the bomb. The process is now repeated with the second bomb in the row, and so on.

When the bomb is dropped, the lower release mechanism retracts into the container structure, thus permitting free passage for the bomb. The upper pair of crutches remain in position until they are moved away when the next bomb is dropped.

6. The effect of increased bomb load on structural strength.

The basic AVRO 698 aircraft is now designed to carry a bomb load of 10,000 lb. for 5,000 nautical miles still air range or a load of 53,000 lb. (26,000 lb. of which is in wing nacelles) for 1,200 nautical miles. The all-up-weight for both these cases is in the region of 150,000 lb., and at this weight the aircraft will meet the full required strength factors.

The effect of increasing the bomb load to 83,000 lb. (Case A) is best considered separately for three conditions, namely, take-off, flight and landing. As regards landing it is not proposed that the aircraft should land with bombs on, and there is, therefore, no reduction in safety factors, in fact, the maximum normal landing weight at 109,000 lb. would permit landing with 12,000 lb. bombs and half the fuel for a range of 1200 nautical miles.

A examination of the structural strength of the aircraft has been made for the take-off and flight cases, and the results are given in the table on pages 20 and 21. For each component of structure the required factor in the governing case is shown, together with the factor achieved and the weight penalty to meet the full factor.

For the flight case, full factors are obtained provided that the bomb dropping is sequenced so that the bomb load in the wings never falls much below that in the fuselage. This is partly because the weight of the nacelles and contents is a relief load on the inner part of the wing and partly because the design of some parts of the wing is determined by considerations of stiffness rather than of strength. There is also a slight relief due to reduction of fuel in the fuselage.

The normal sequence of dropping bombs will involve groups of four bombs made up of two bombs from the fuselage and one from each nacelle, and this will automatically meet the above condition. Thus the structural requirements for

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flight will impose no restriction on the operational use of the aircraft.

The take-off strength requirements for Case A are not met in full, low factors being shown for braked taxiing, turning and swinging on the ground at take-off weight and for landing at take-off weight. It is not proposed to strengthen the undercarriage and its attachment structure to meet these cases since the braked taxiing, turning and swinging can be cleared by using care when handling the aircraft on the ground - and in particular by reducing taxiing to a minimum by loading the aircraft near the take-off point.

It should also be remembered that by reason of the high runway loading factor the aircraft will be operating from good quality airfields.

In Case B where the aircraft carries 39,000 lb. of bombs in the fuselage, but no wing nacelles for a range of 3350 nautical miles, the required and realised factors are shown in detail on page 22 together with the weight penalties incurred if the specified factors are to be achieved. It will be seen that the specified factors in flight will not be obtained on the wing spar booms, the transport rib and boom and part of the bomb bay skin and stringers, the minimum realised factor being 2.46 against a required 3.0. Unless it is regarded as an important operational case it is not proposed to strengthen the aircraft to meet these flight cases as this would involve a further weight penalty of approximately 220 lb.

The take-off weight with this load for a range of 3350 still air miles is 164,870 lb. and again the take-off strength requirements cannot be fully met. From the table on page 22 it will be seen that the minimum realised factor is 1.78 against a required factor of 2.25. However, the realised factors are higher than those for the 83,000 lb. bombs case and it is considered that reduced factors could be accepted.

7. Weight and C.G. data.

The weight data given in this brochure is based on the weight estimated for production aircraft, the latter meeting full strength factors at a take-off weight of 154,000 lb., and capable of either the 10,000 lb bomb - 5000 nautical miles or the 53,000 lb. bombs - 1200 nautical miles.

The fixed weight penalty that must be carried on all aircraft fitted for vertical tier stowage is detailed on page 18 and amounts to 540 lb. The corresponding weight breakdowns for the present production aircraft and the modified aircraft are given on page 15 for the case where the aircraft is carrying a 10,000 lb. bomb load for the range of 5,000 nautical miles. It will be noted that the additional fuel required brings the total increase of take-off weight to 840 lb.

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The conversion of the aircraft from the 10,000 lb. case to the 83,000 lb. case will involve removal of the main bomb doors and fitting the wing nacelles, the bomb containers and their operating mechanism.

The weight of these items is detailed on page 19 and the corresponding weight breakdown for the whole aircraft is shown on page 16. The corresponding figures for the case where 39,000 lb. is carried in the bomb bay without wing nacelles is shown on page 17.

It should be noted that no account has been taken of any reduction in the operational equipment carried, and some savings in this respect might be possible.

The wing nacelles have been positioned so that the C.G. position remains within suitable limits throughout the flight. The estimated C.G. positions given in the following table may be compared with the design C.G. limits of 0.279 to 0.309 Standard Mean Chord.

CASE.	<u>Standard Long Range.</u>	<u>Vertical Tier Stowage.</u>	
		A.	B.
Bomb Load (lb.)	10,000	83,000	39,000
Range (N.M's)	5,000	1,200	3,350
C.G. At Take-off.	0.289	0.286	0.303
Position Less:- Bombs & $\frac{1}{2}$ Fuel	0.285	0.285	0.289
(SMC) Less:- Bombs & All Fuel.	0.279	0.283	0.286

8. Performance.

A complete drag analysis for the aircraft without nacelles has been given on pages 45, 46 and 47 of the AVRO 698 Brochure I.P.B. 32 Issue 4. The drag of the nacelles is estimated to be 13% of the profile drag of the aircraft without nacelles.

Performance has been estimated for the aircraft with four Bristol Olympus (B.O.L. 3 rating) engines with a take-off thrust of 12,000 lb. The power curves of the engine appear on page 49 of the Avro 698 Brochure I.P.B. 32 Issue 4.

Typical flight plans for the aircraft carrying 83 x 1,000 lb. M.C. or L.C. bombs, to targets at distances of 500, 600, 700 and 750 nautical miles are given on page 34 and for the aircraft carrying 39,000 lb. bombs to a target at a distance of 1500 nautical miles on page 35.

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fixed fittings is 540 lb. (See page 18) and to maintain the range with this increased weight an additional 300 lb. of fuel is required. The total weight penalty is, therefore, 840 lb. at take-off and entails a loss of height at the target of 150 ft.

In the above it has been assumed either that the wing nacelles are always carried when tier stowage is used in the fuselage or that the reduced factors detailed in the table on pages 20 and 21 can be accepted.

If it is desired to meet the full specified structure factors when carrying 39,000 lb. bombs in the bomb bay and no wing nacelles there is a further increase of fixed weight of 285 lb., making a total increase of fixed weight of 825 lb. and an increase of take-off weight of 1,280 lb. and a loss of height at the target of 230 ft.

10. Development programme on vertical tier stowage.

In view of the urgent necessity of obtaining the earliest possible testing of vertical tier stowage in flight, A.V.Roe have in hand the design and construction of a vertical tier stowage container to fit the bomb bay of the Canberra. This will carry eight 1000 lb. bombs and the design will be based on the scheme for crutching and releasing the bombs shown on page 32 of this brochure. A number of items such as the crutching and release mechanism and the bomb doors and their operating mechanism will be common to the installation on the AVRO 698.

Considerable wind tunnel testing has been carried out on the bomb bay and wing nacelles of the AVRO 698 in the AVRO 9 ft. x 7 ft. wind tunnel, and the results of these tests have been communicated to the Ministry of Supply. The fuselage bomb bay has shown the smallest drag and least disturbance to the 10,000 lb. bomb on release yet measured in this country. The disturbance to 1000 lb. bombs when dropped from conventional stowage is also small, and it is expected that even better results will be obtained from vertical tier stowage since the bomb bay is thereby split up into fifteen separate cells. Tests on the bomb bay arrangement shown on page 24 will be made during the next month. (April 1952).

As regards the wing nacelles, tests in the High Speed Tunnel at R.A.E. have proved that the adverse effect of wing nacelles on the drag rise Mach number is small, and that this type is much superior to other configurations e.g. those mounted on struts below the wing. It will be noted that the shape of the nacelles follows the latest R.A.E. recommendations (Tech.Note Aero.2136).

Low speed tunnel tests in the AVRO wind tunnel with a nacelle substantially similar to that shown on page 28 (See AVRO Report No. WT/698/32) have shown satisfactory

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Comparative weight breakdowns for the standard aircraft
and the aircraft modified for vertical tier stowage.

	Standard Weight(lb.)	Modified Weight(lb.)	Penalty (lb.)
* Mainplane	22,175	22,275	+100
* Fuselage.	8,688	8,788	+100
Tail unit	1,965	1,965	
Landing gear.	5,221	5,221	
TOTAL STRUCTURE	38,049	38,249.	
Engines (dry)	14,620	14,620	
Mountings	150	150	
Starter systems	232	232	
Engine controls	390	390	
Air intakes	435	435	
Jet pipes	1,160	1,160	
Miscellaneous	221	221	
Oil in engines.	260	260	
TOTAL POWER PLANTS	17,468	17,468	
Fuel tanks	798	798	
Fuel system	893	893	
Residual fuel	-	-	
TOTAL FUEL SUPPLY UNIT	1,691	1,691	
Flying controls inc. power controls,	1,722	1,722	
Hydraulics	905	905	
Pneumatics	66	66	
* Electrics	3,670	3,870	+200
TOTAL FIXED POWER SERVICES	6,363	6,563	
De-icing (thermal)	389	389	
Fire extinguishers	654	654	
Nitrogen	1,074	1,074	
Fixed armaments.	-	-	
TOTAL FIXED PROTECTION	2,117	2,117	
Furnishings	550	550	
Soundproofing & bomb bay lagging	314	314	
Bomb bay heating	191	191	
Cabin heating & pressurisation	615	615	
Oxygen system	295	295	
* Bomb gear	294	434	+140
Pyrotechnics	70	70	
Instruments	469	469	
Radio & radar	2,543	2,543	
Photographic	54	54	
Emergency equipment	205	205	
Miscellaneous appendix 'A' items	85	85	
Contingency	227	227	
TOTAL FIXED EQUIPMENT.	5,912	6,052	
TARE WEIGHT	71,600	72,140	+540
Bomb containers.	-	-	
Crew (five)	1,000	1,000	
BASIC OPERATIONAL WEIGHT	72,600	73,140	+540
Bombs	10,000	10,000	
Photoflash	250	250	
WEIGHT LESS:- FUEL	82,850	83,390	+540
Fuel (5,000 n.m.)	68,150	68,450	+300
ALL-UP WEIGHT	151,000	151,840	+840

Items marked thus * are detailed on page 18.

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AVRO 698 - WITH VERTICAL TIER STOWAGE OF 1,000 LB. BOMBS.

Aircraft modified for vertical tier stowage.

Weight breakdowns for the 10,000 lb & 83,000 lb. bomb cases.

	10,000 lb. bomb - 5,000 n.m. range. Weight (lb.)	83,000 lb. bombs - 1,200 n.m. range. Weight (lb.)	Change (lb.)
* Mainplane	22,275	22,275	
* Fuselage	8,788	7,538	-1,250
Tail unit	1,965	1,965	
Landing gear	5,221	5,221	
TOTAL STRUCTURE	38,249	36,999	-1,250
Engines (dry)	14,620	14,620	
Mountings	150	150	
Starter systems	232	232	
Engine controls	390	390	
Air intakes	435	435	
Jet pipes	1,160	1,160	
Miscellaneous	221	221	
Oil in engines	260	260	
TOTAL POWER PLANTS	17,468	17,468	
Fuel tanks	798	798	
Fuel system	893	893	
Residual fuel	-	-	
TOTAL FUEL SUPPLY UNIT	1,691	1,691	
Flying controls inc. power controls	1,722	1,722	
Hydraulics	905	905	
Pneumatics	66	66	
Electrics	3,870	3,870	
TOTAL FIXED POWER SERVICES	6,563	6,563	
De-icing (thermal)	389	389	
Pipe extinguishers	654	654	
Nitrogen	1,074	1,074	
Fixed armaments	-	-	
TOTAL FIXED PROTECTION	2,117	2,117	
Furnishings	550	550	
Soundproofing & bomb bay lagging	314	314	
Bomb bay heating	191	191	
Cabin heating & pressurisation	615	615	
Oxygen system	295	295	
Bomb gear	434	434	
Pyrotechnics	70	70	
Instruments	469	469	
Radio & radar	2,543	2,543	
Photographic	54	54	
Emergency equipment	205	205	
Miscellaneous appendix 'A' items.	85	85	
Contingency	227	227	
TOTAL FIXED EQUIPMENT	6,052	6,052	
TARE WEIGHT	72,140	70,890	-1,250
* Bomb containers & wing nacelles	-	14,725	+14,725
Crew (five)	1,000	1,000	
BASIC OPERATIONAL WEIGHT	73,140	86,615	+13,475
Bombs	10,000	83,000	+73,000
Photoflash	250	250	
WEIGHT LESS:- FUEL	83,390	169,865	+86,475
Fuel	68,450	22,835	-45,615
ALL-UP WEIGHT	151,840	192,700	+40,860

Items marked * are detailed on page 19.

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Aircraft modified for vertical tier stowage.

Weight breakdowns for the 10,000 lb. and 39,000 lb. (fuselage) cases.

	10,000 lb. bombs - 5,000 n.m. range. Weight(lb.)	39,000 lb. bombs - 3,350 n.m. range. Weight(lb.)	Change (lb.)
* Mainplane	22,275	22,275	
* Fuselage	8,788	7,538	-1,250
Tail unit	1,965	1,965	
Landing gear	5,221	5,221	
TOTAL STRUCTURE	38,249	36,999	-1,250
Engines (dry)	14,620	14,620	
Mountings	150	150	
Starter systems	232	232	
Engine controls	390	390	
Air intakes	435	435	
Jet pipes	1,160	1,160	
Miscellaneous	221	221	
Oil in engines.	260	260	
TOTAL POWER PLANTS.	17,468	17,468	
Fuel tanks	798	798	
Fuel system	893	893	
Residual fuel	-	-	
TOTAL FUEL SUPPLY UNIT	1,691	1,691	
Flying controls inc. power controls	1,722	1,722	
Hydraulics	905	905	
Pneumatics	66	66	
Electrics	3,870	3,870	
TOTAL FIXED POWER SERVICES	6,563	6,563	
De-icing (thermal)	389	389	
Fire extinguishers	654	654	
Nitrogen	1,074	1,074	
Fixed armaments	-	-	
TOTAL FIXED PROTECTION	2,117	2,117	
Furnishings	550	550	
Soundproofing and bomb bay lagging	314	314	
Bomb bay heating	191	191	
Cabin heating & pressurisation	615	615	
Oxygen system	295	295	
Bomb gear	434	434	
Pyrotechnics	70	70	
Instruments	469	469	
Radio & radar	2,543	2,543	
Photographic	54	54	
Emergency equipment	205	205	
Miscellaneous appendix 'A' items	85	85	
Contingency	227	227	
TOTAL FIXED EQUIPMENT	6,052	6,052	
TARE WEIGHT	72,140	70,890	-1,250
* Bomb containers	-	5,475	+5,475
Crew (five)	1,000	1,000	
BASIC OPERATIONAL WEIGHT	73,140	77,365	+4,225
Bombs	10,000	39,000	+29,000
Photoflash	250	250	
WEIGHT LESS:- FUEL	83,390	116,615	+33,225
Fuel	68,450	48,255	-20,195
ALL-UP WEIGHT.	151,840	164,870	+13,030

Items marked * detailed on page 19.

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AVRO 698WITH VERTICAL TIER STOWAGE OF 1,000 LB BOMBS.DETAILS OF CONVERSION TO VERTICAL TIER STOWAGE OF BOMBS IN FUSELAGE BOMB BAY AND WING NACELLES.

Item	Weight (lb.)
<u>Fuselage.</u>	
Existing main bomb doors deleted	- 1,250
<u>Bomb Containers.</u>	
Wing nacelles	+ 3,000
Container (13 x 1,000 lb.) = 1,605 lb x 3 =	+ 4,815
Doors & Mechanism = 195 lb x 3 =	+ 585
Container (9 x 1,000 lb.) = 1,111 lb x 4 =	+ 4,444
Doors & Mechanism = 139 lb. x 4 =	+ 556
Container (4 x 1,000 lb.) = 480 lb. x 2 =	+ 960
Doors & Mechanism = 70 lb. x 2 =	+ 140
Actuators = 25 lb x 9 =	+ 225
TOTAL	<u>+13,475</u>

DETAILS OF CONVERSION TO VERTICAL TIER STOWAGE OF BOMBS IN FUSELAGE.

Item	Weight (lb.)
<u>Fuselage</u>	
Existing main bomb doors deleted	- 1,250
<u>Bomb Containers.</u>	
Container (13 x 1,000 lb.) = 1,605 lb. x 3 =	+ 4,815
Doors & Mechanism = 195 lb. x 3 =	+ 585
Actuators = 25 lb. x 3 =	+ 75
TOTAL	<u>+ 4,225.</u>

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CASE A (contd). ITEM.	GOVERNING CASE.	SPECIFIED FACTOR REQUIRED.	REALISED FACTOR		WEIGHT PENALTY TO ACHIEVE SPECIFIED FACTOR.		
			TAKE-OFF	AT HALF * RANGE, WING BOMBS GONE.	TAKE-OFF	AT HALF RANGE, WING BOMBS GONE. *	
<u>Transport rib.</u>							
Top boom	Turning and swinging on ground	1.5	1.4	-	15	-	
Bottom boom	-do-	1.5	1.3	-	45	-	
Webs	-do-	1.5	1.25	-	112	-	
Web stiffeners	-do-	1.5	1.25	-	39	-	
<u>Bomb bay</u>							
Rib web	Landing at take-off weight, high drag	2.35	1.52	-	30	-	
Skin and stringers	Flight case A (low speed pull-out)	3.0	-	2.8 *	-	26 *	
<u>Undercarriage structure</u>							
Nose undercarriage vertical beams.	Landing at take-off weight, high drag.	2.32	1.94	-	21	-	
Main undercarriage side load beam.	Turning and swinging on ground.	1.5	1.22	-	10	-	
<p>* NOTE: This table shows the effect of retaining the fuselage bombs after dropping the wing bombs. For the normal case where wing and fuselage bombs are dropped simultaneously, the realised factors are never less than those required and no increase of structural strength has therefore been assumed.</p>							

AVRO 698 WITH VERTICAL TIER STORAGE OF 1000 LB BOMBS.
 Effect on Structural Strength

CASE A (contd).

ISSUE NO	1					
DATE	3/52					

TAKE-OFF WEIGHT 164,870 LB.

LOAD: 39,000 lbs Bombs + Containers in Fuselage + Wing Fittings.

50,000 lbs. Fuel.

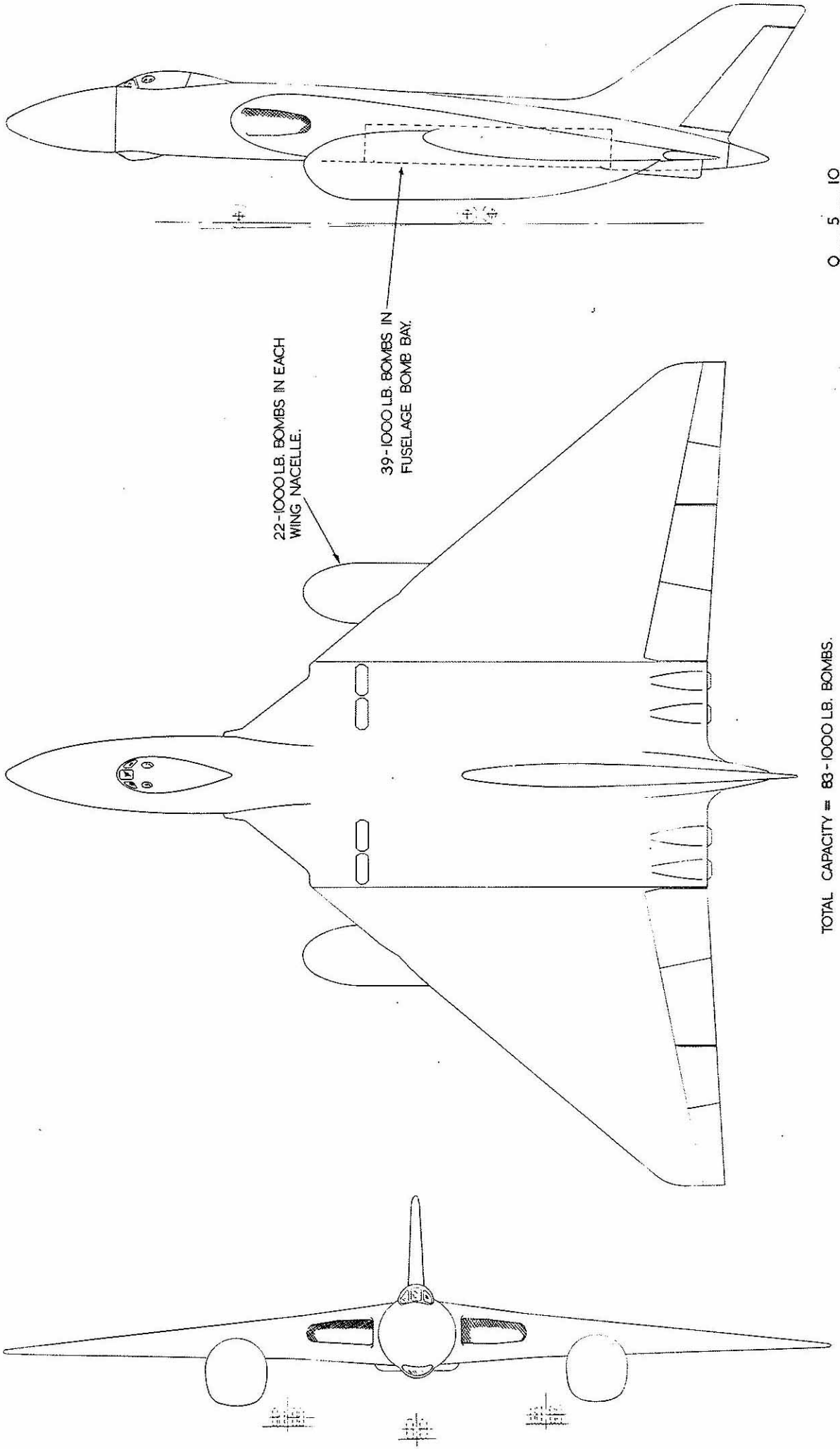
CASE B

ITEM.		SPECIFIED FACTOR REQUIRED.	REALISED FACTOR		WEIGHT PENALTY TO ACHIEVE SPECIFIED FACTOR.	
			TAKE-OFF.	FLIGHT.	TAKE-OFF.	FLIGHT.
<u>Outer wing.</u>						
Front spar bottom boom	Flight case A (low speed pull-out)	3.0	-	2.65	-	9
Front spar web	Braked taxiing at take-off weight	2.25	1.78	-	33	-
<u>Centre section</u>						
Front spar booms	Flight case A (low speed pull-out)	3.0	-	2.46	-	68
Rear spar top boom	-do-	3.0	-	2.50	-	87
Rear spar bottom boom	-do-	3.0	-	2.87	-	9
Front spar web	Landing at take-off weight	3.12	3.06	-	14	-
<u>Transport rib</u>						
Bottom boom	Flight case A (low speed pull-out)	3.0	-	2.50	-	23
<u>Bomb rib</u>						
Rib web	Landing at take-off weight with high drag.	2.35	2.18	-	6	-
Skin and stringers	Flight case A (low speed pull-out)	3.0	-	2.80	-	24
<u>Undercarriage structure</u>						
Nose undercarriage vertical beams.	Landing at take-off weight (high drag)	2.35	2.20	-	6	-
Main undercarriage side load beam.	Turning and swinging on ground.	1.50	1.40	-	6	-

AVRO 698 WITH VERTICAL TIER STORAGE OF 1000 LB. BOMBS.
Effect on Structural Strength.

CASE B.

A.V. ROE & CO LTD

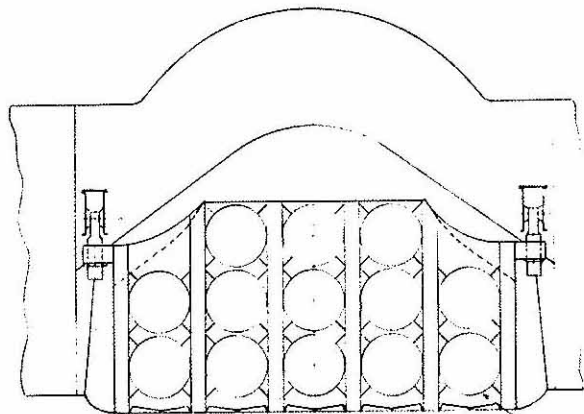
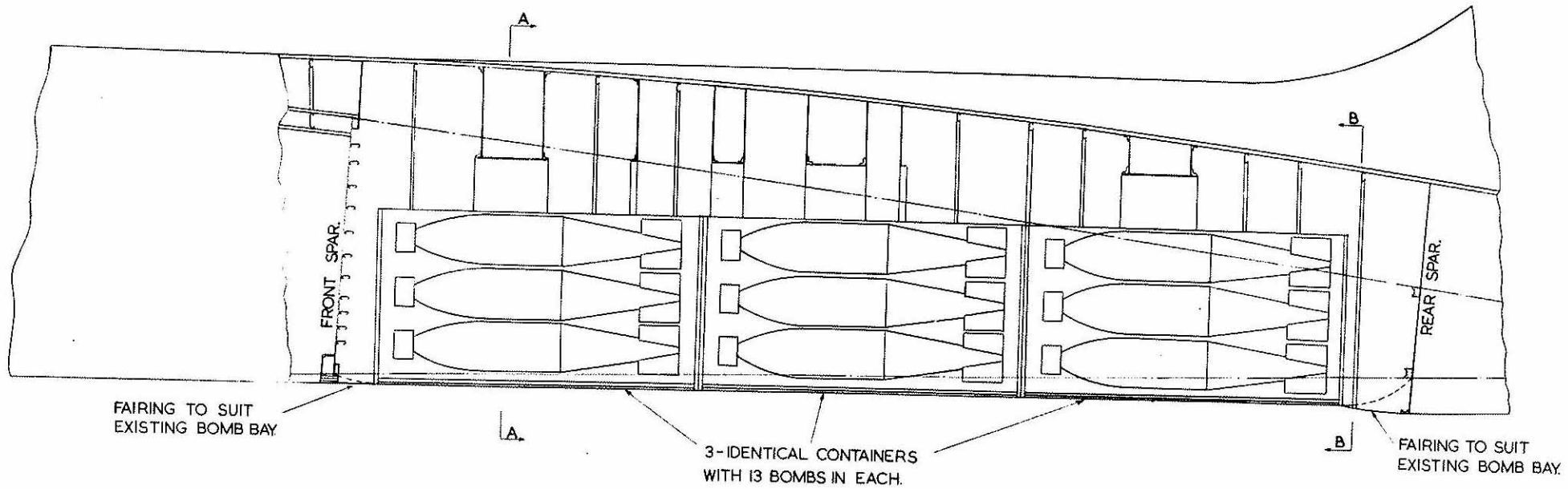


TOTAL CAPACITY = 83-1000 LB. BOMBS.

AVRO 698

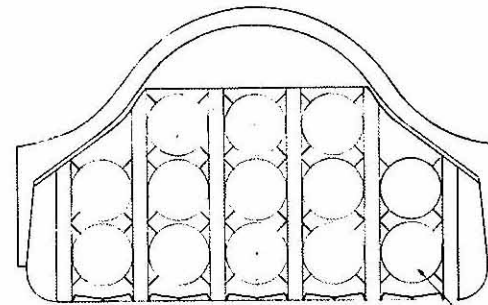
GENERAL ARRANGMENT (VERTICAL TIER STOWAGE)

SPECIFICATION B.35/46.



SECTION A-A.

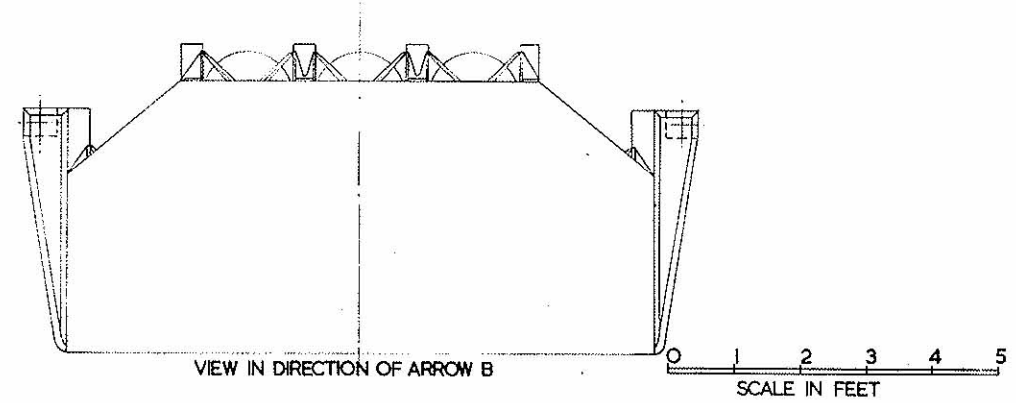
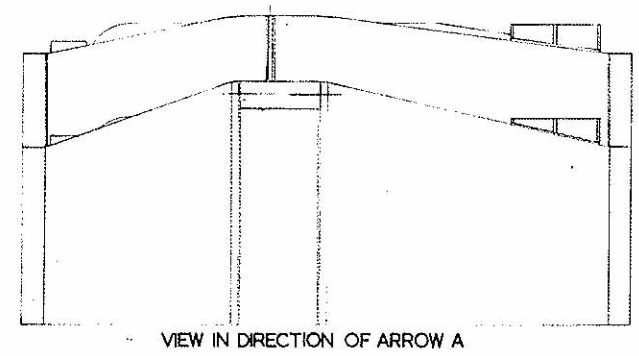
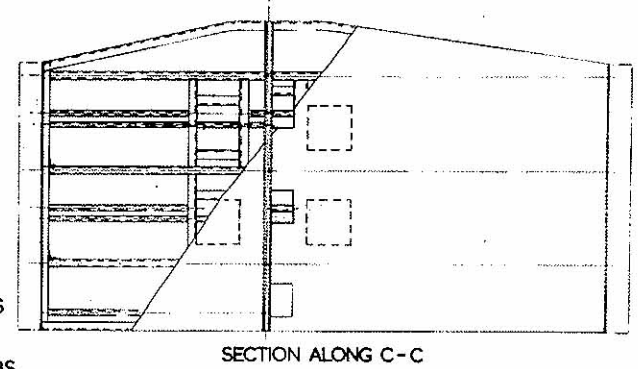
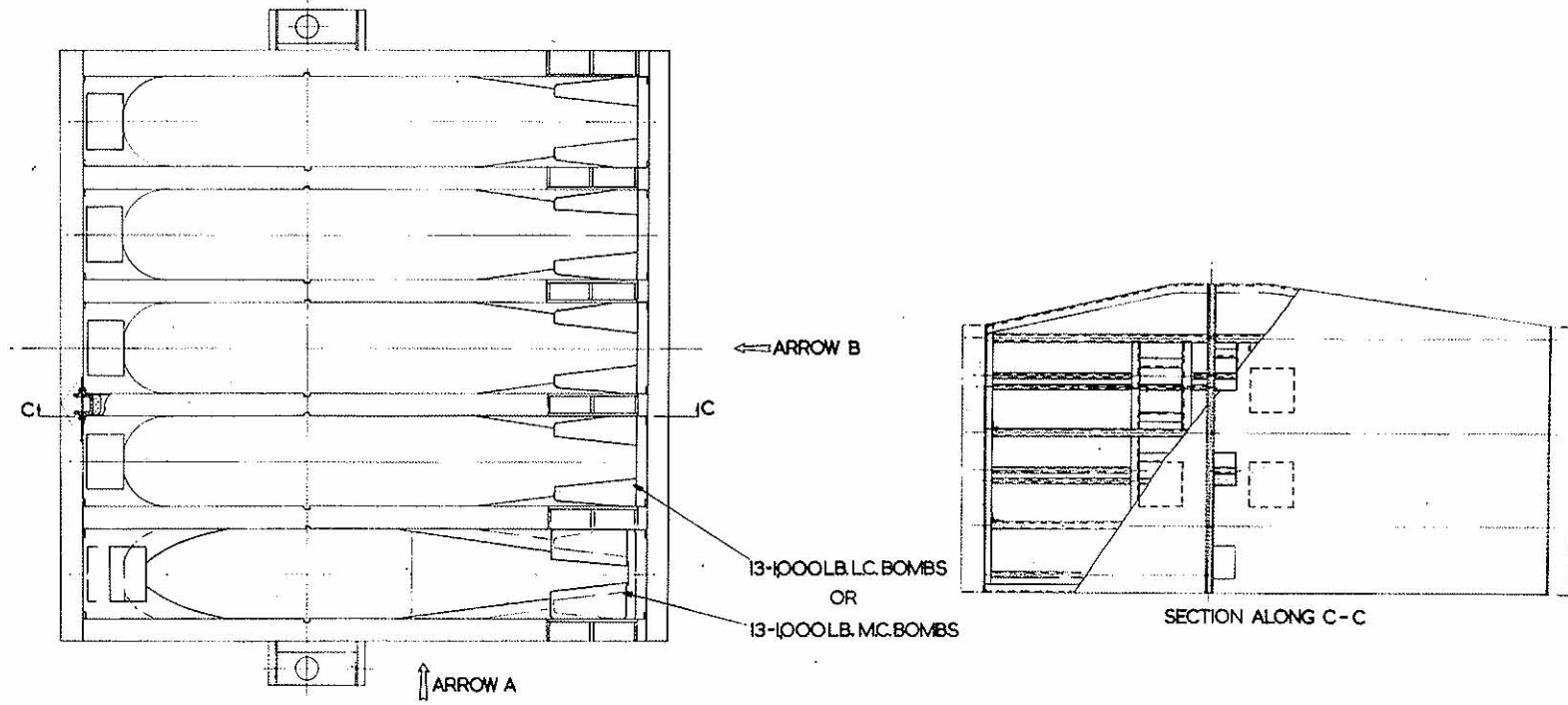
13-BOMBS IN CONTAINER



SECTION B-B.

13-BOMBS IN CONTAINER

0 1 2 3 4 5
SCALE IN FEET



L.P.D. 371

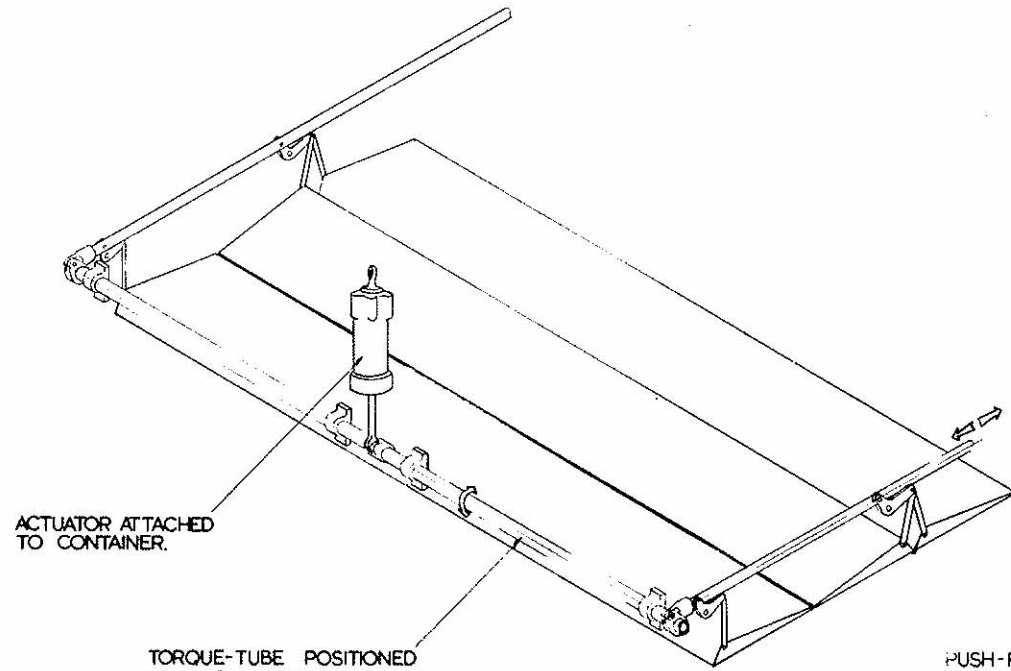
AVRO 698

CONTAINER FOR 13 - 1,000 LB. BOMBS (VERTICAL TIER STORAGE)

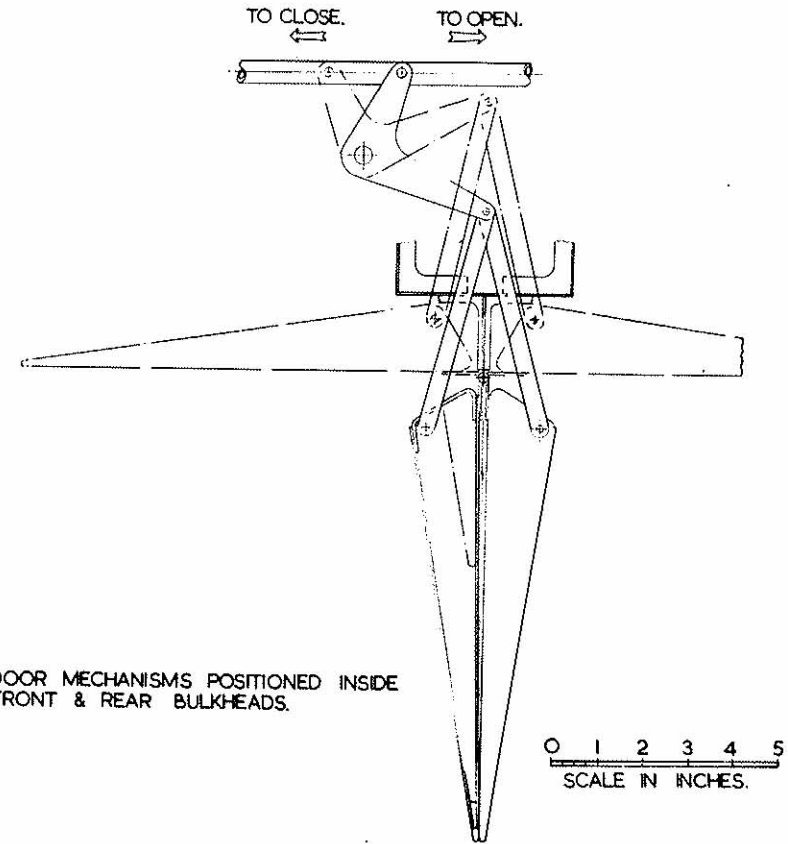
SPECIFICATION B 35/46

SECRET

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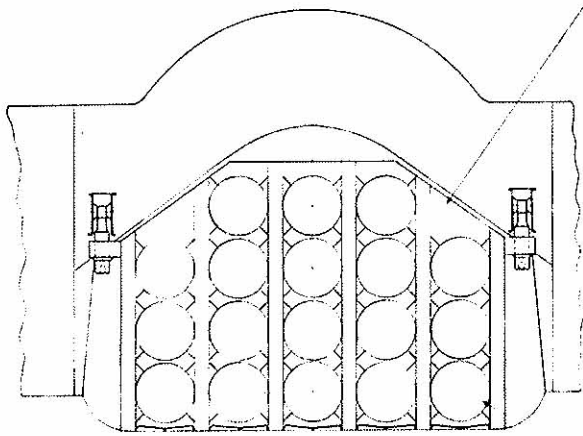
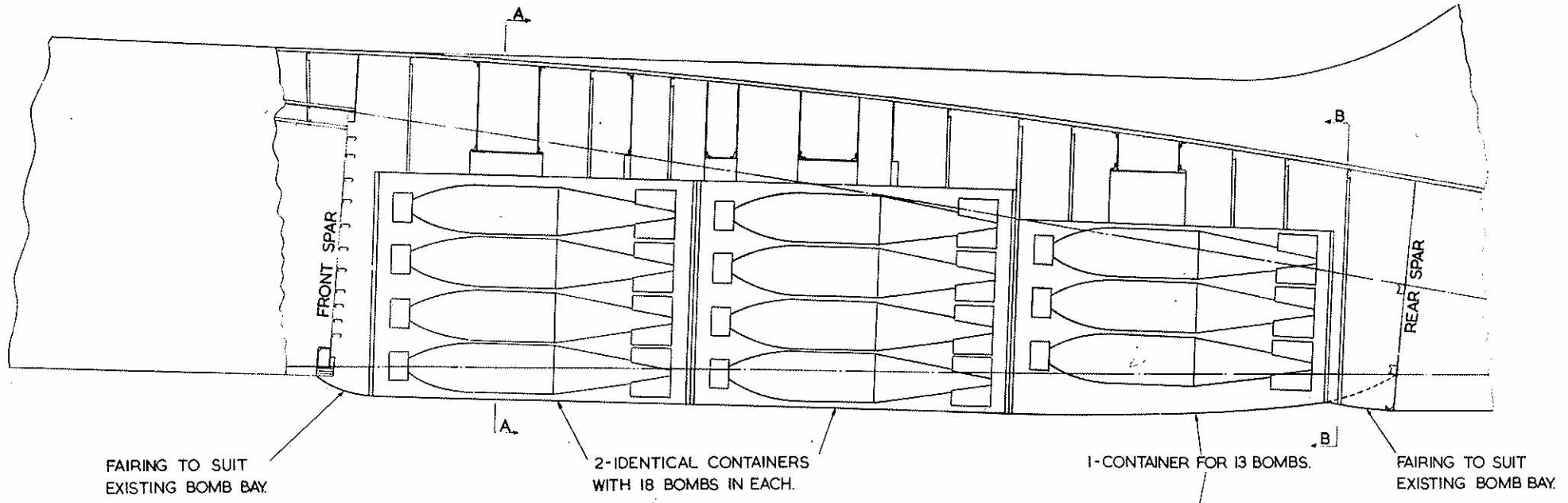
SCRAP VIEW OF BOMB CELL DOORS (NOT TO SCALE.)



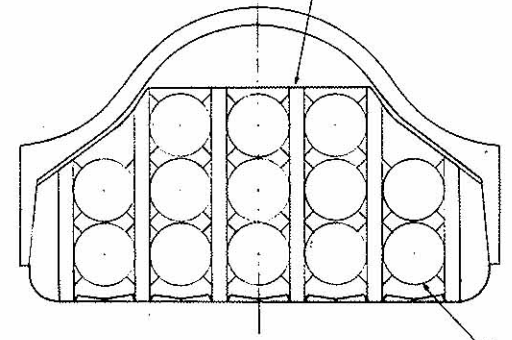
AVRO 698

BOMB CELL DOOR MECHANISMS (VERTICAL TIER STOWAGE.)

SPECIFICATION B 35/46.



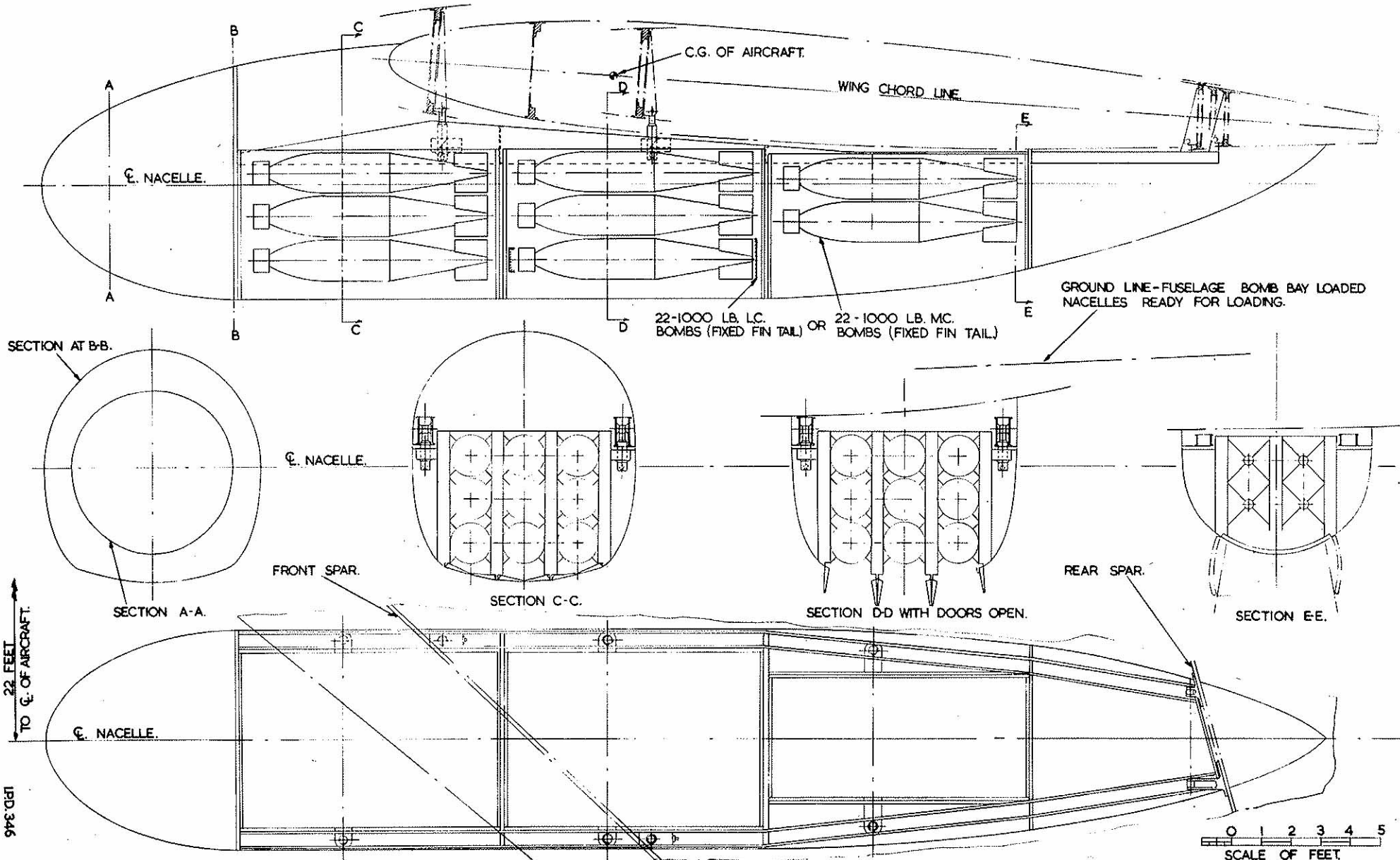
SECTION A-A



SECTION B-B



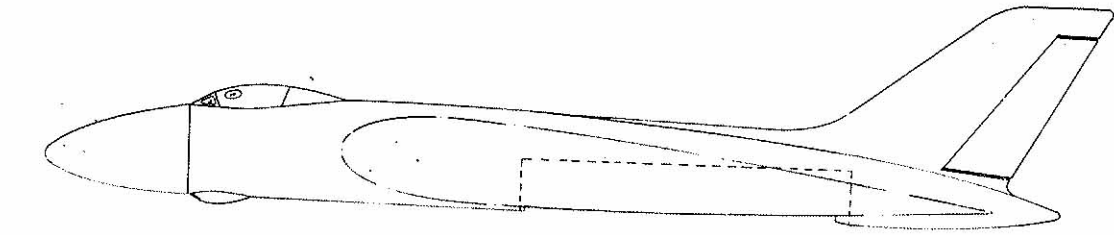
LPD 348



AVRO 698

ARRANGEMENT OF 22-1000 LB. BOMBS IN NACELLE (VERTICAL TIER STORAGE)

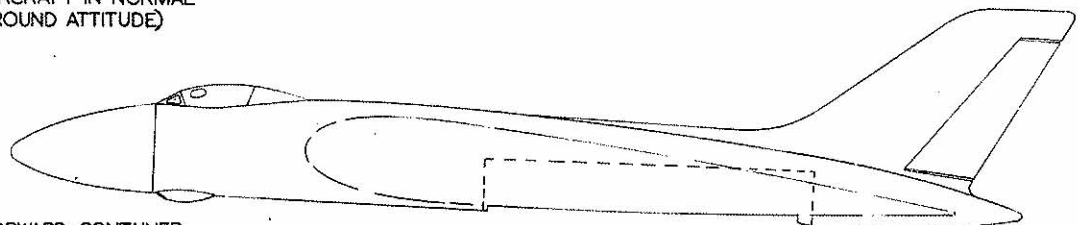
SPECIFICATION B35/46.



AIRCRAFT READY FOR LOADING.
(AIRCRAFT IN NORMAL GROUND ATTITUDE)



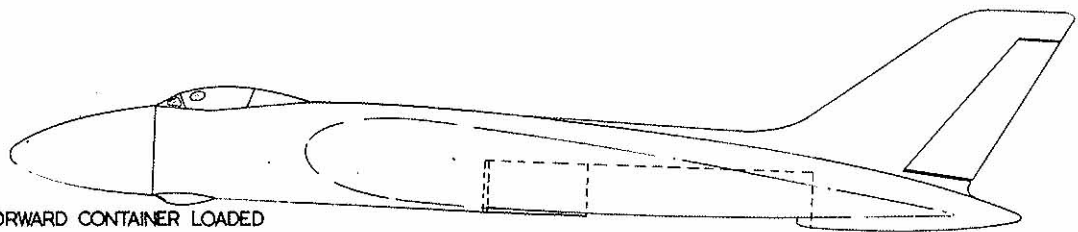
GROUND LINE



FORWARD CONTAINER IN POSITION FOR HOISTING.



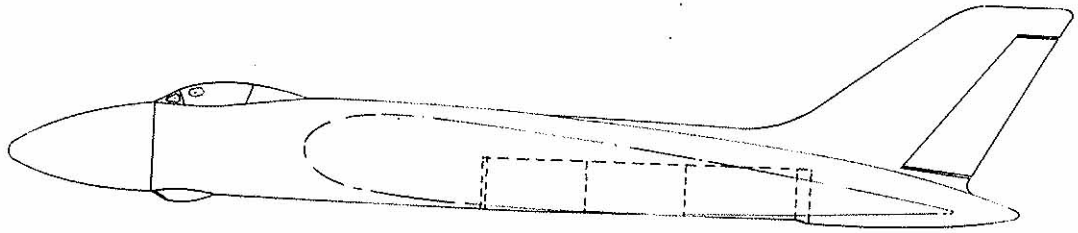
GROUND LINE



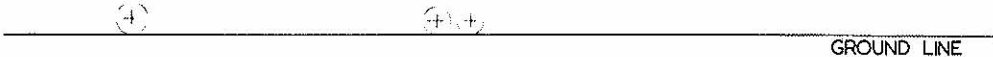
FORWARD CONTAINER LOADED
CENTRE CONTAINER BEING BROUGHT IN POSITION.



GROUND LINE



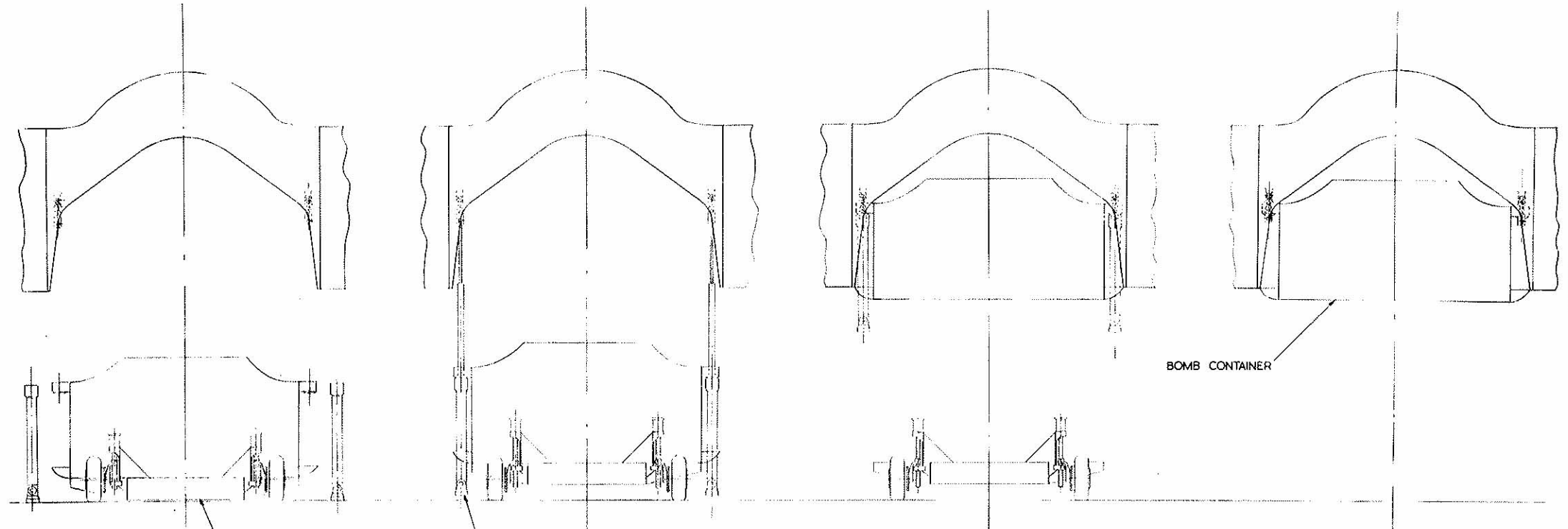
AIRCRAFT LOADED.



GROUND LINE



SCALE IN FEET



BOMB TRANSPORTER
IN LOW POSITION

HYDRAULIC LOADING JACKS
ATTACHED TO AIRCRAFT AND CONTAINER

JACKS RETRACTED RAISING
CONTAINER INTO POSITION

WEDGES INSERTED TO HOLD CONTAINER
JACKS AND TRANSPORTER REMOVED

BOMB CONTAINER

0 1 2 3 4 5
SCALE IN FEET

AVRO 698

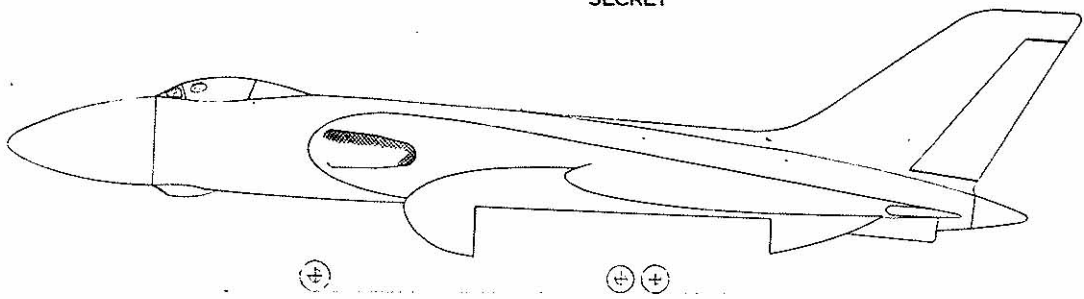
ARRANGEMENT OF LOADING FUSELAGE BOMB BAY(VERTICAL TIER STOWAGE)

SPECIFICATION B35/46

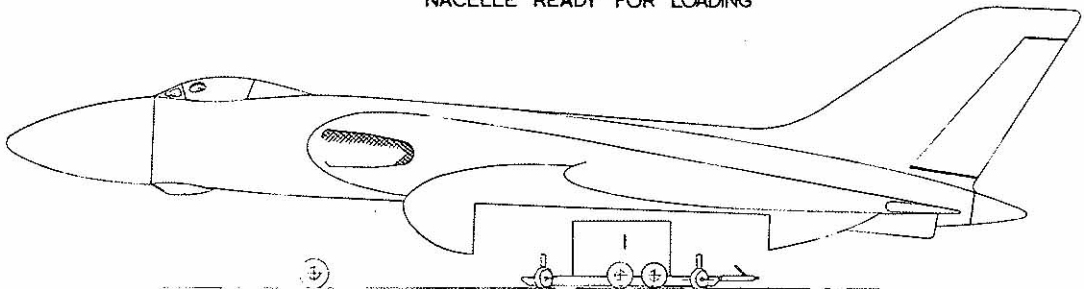
SECRET

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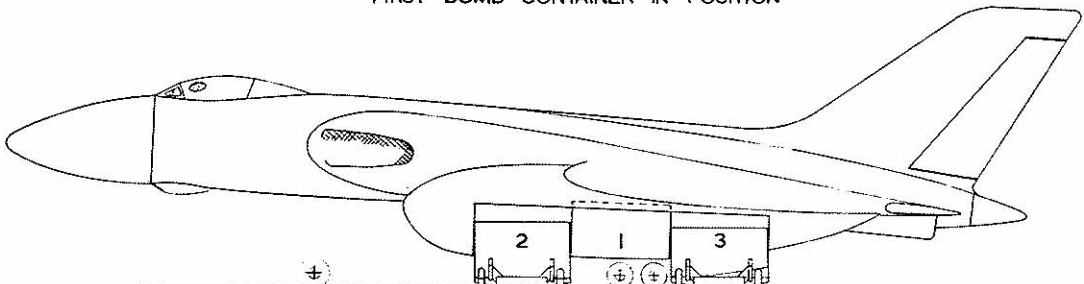
LRD 358 SH1 2



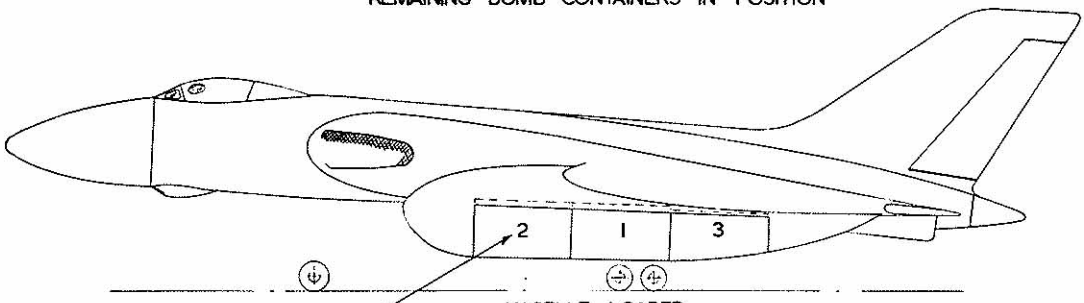
NACELLE READY FOR LOADING



FIRST BOMB CONTAINER IN POSITION



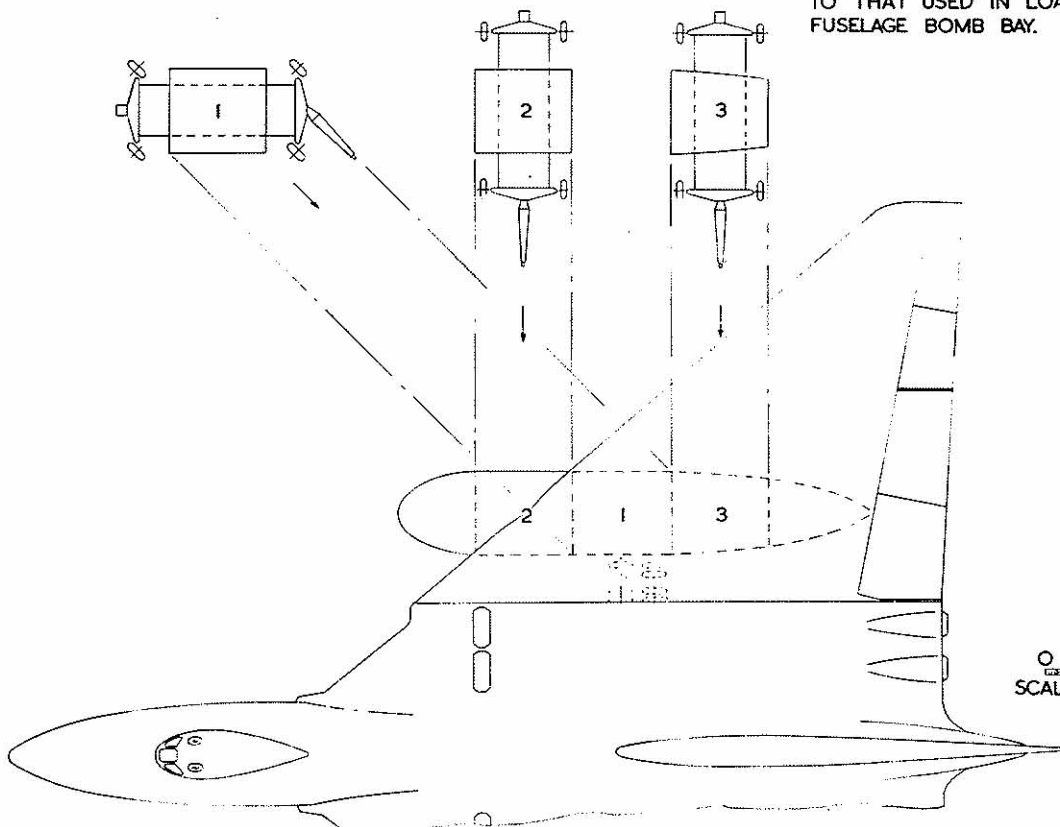
REMAINING BOMB CONTAINERS IN POSITION



NACELLE LOADED

ORDER OF LOADING BOMB CONTAINERS

WHEN IN POSITION CONTAINERS ARE LIFTED BY A SIMILAR METHOD TO THAT USED IN LOADING THE FUSELAGE BOMB BAY.



0 5 10
SCALE IN FEET

ARRANGEMENT OF LOADING WING NACELLES (VERTICAL TIER STOWAGE)

192 365

RELEASE UNIT OPERATION.

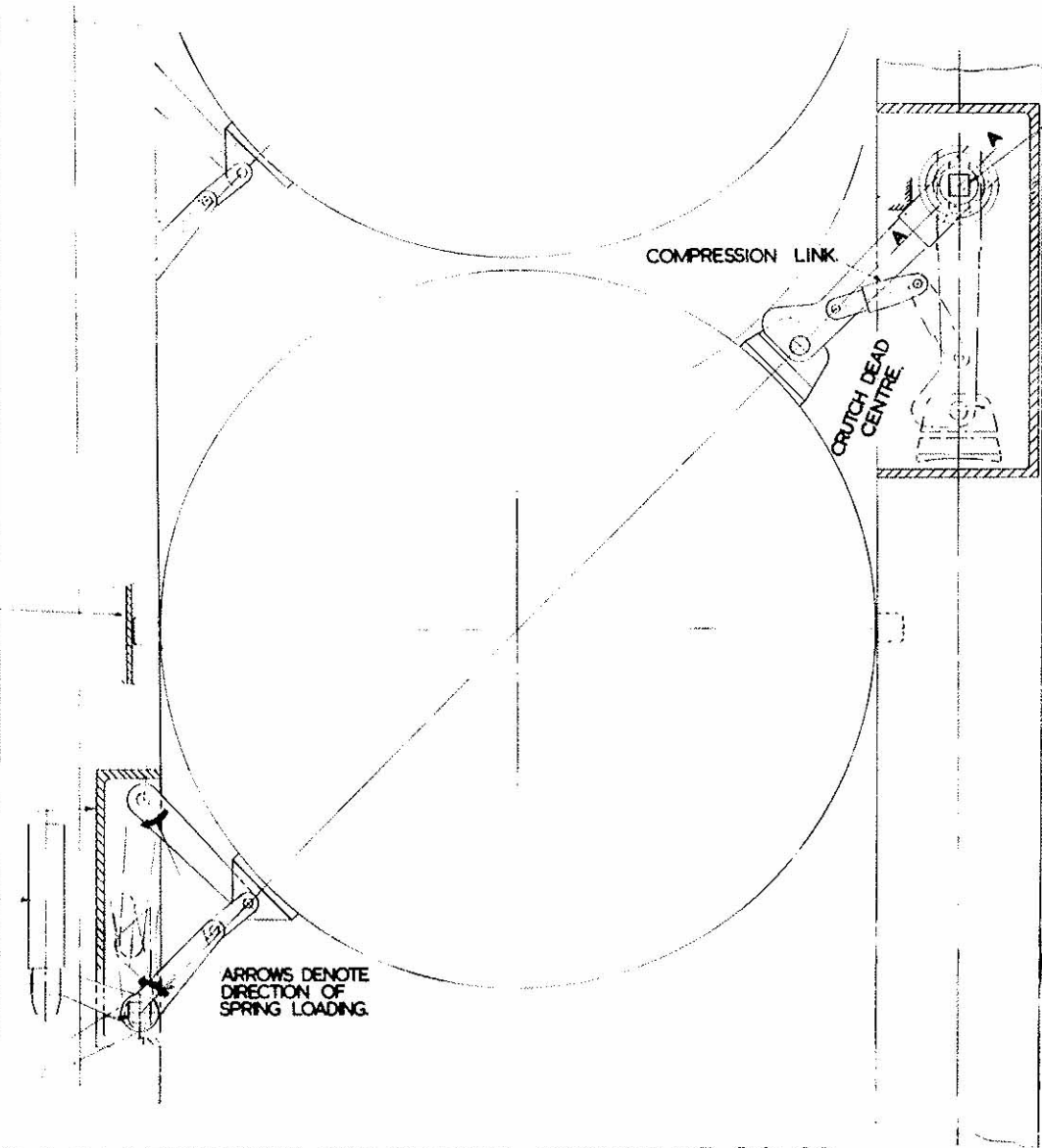
INSERT HANDLE TO COCK.
WHEN VICKERS UNIT OPERATES
THE WEIGHT OF THE BOMB
ACTING ON THE OFFSET LINKAGE
OF THE LOWER STRUT TOGETHER
WITH THE SPRING LOADING
RETRACTS & RETAINS THE RELEASE
UNTIL IT IS RE-COCKED.

BOMB RELEASE
MECHANISM POSITIONED
25" AFT OF BOMB
C.O.F.G. (REMOVABLE
COMPLETE IN CASING.)

VICKERS NO 1 UNIT.

SQUARE ON HANDLE ENGAGES
HERE TO COCK RELEASE.

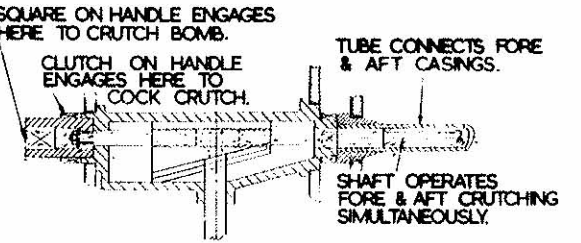
GUIDE FOR TRUNNION POSITIONED
ONE ON EACH SIDE ON BOMB C.O.F.G.



SQUARE ON HANDLE ENGAGES
HERE TO CRUTCH BOMB.

CLUTCH ON HANDLE
ENGAGES HERE TO
COCK CRUTCH.

TUBE CONNECTS FORE
& AFT CASINGS.



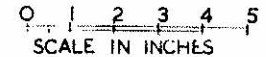
SHAFT OPERATES
FORE & AFT CRUTCHING
SIMULTANEOUSLY.

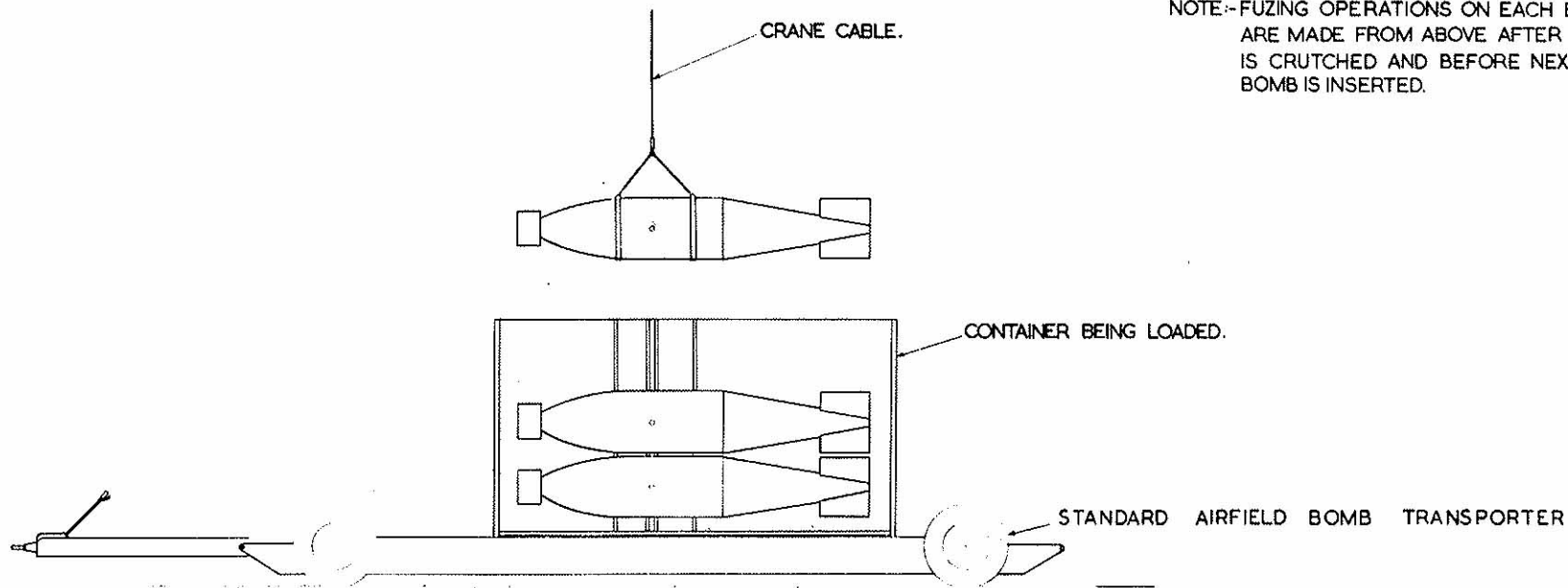
**DETAIL OF CRUTCHING MECHANISM.
SCRAP VIEW ON A-A**

RETRACTABLE CRUTCHING ARMS POSITIONED
9" FORWARD & 11" AFT OF BOMB C. OF G.

CRUTCH OPERATION.

INSERT HANDLE, COCK - THEN CRUTCH.
WHEN BOMB IS RELEASED CRUTCH REMAINS
IN EXTENDED POSITION UNTIL THE NEXT
BOMB IS RELEASED. THE BOMB THEN
KNOCKS THE CRUTCH OVER ITS DEAD
CENTRE. THE COMPRESSION LINK SNAPS
HOME THE CRUTCH & RETAINS IT IN THE
RETRACTED POSITION UNTIL IT IS RE-COCKED.





NOTE:-FUZING OPERATIONS ON EACH BOMB
ARE MADE FROM ABOVE AFTER IT
IS CRUTCHED AND BEFORE NEXT
BOMB IS INSERTED.

0 1 2 3 4 5
SCALE IN FEET

SECRET.

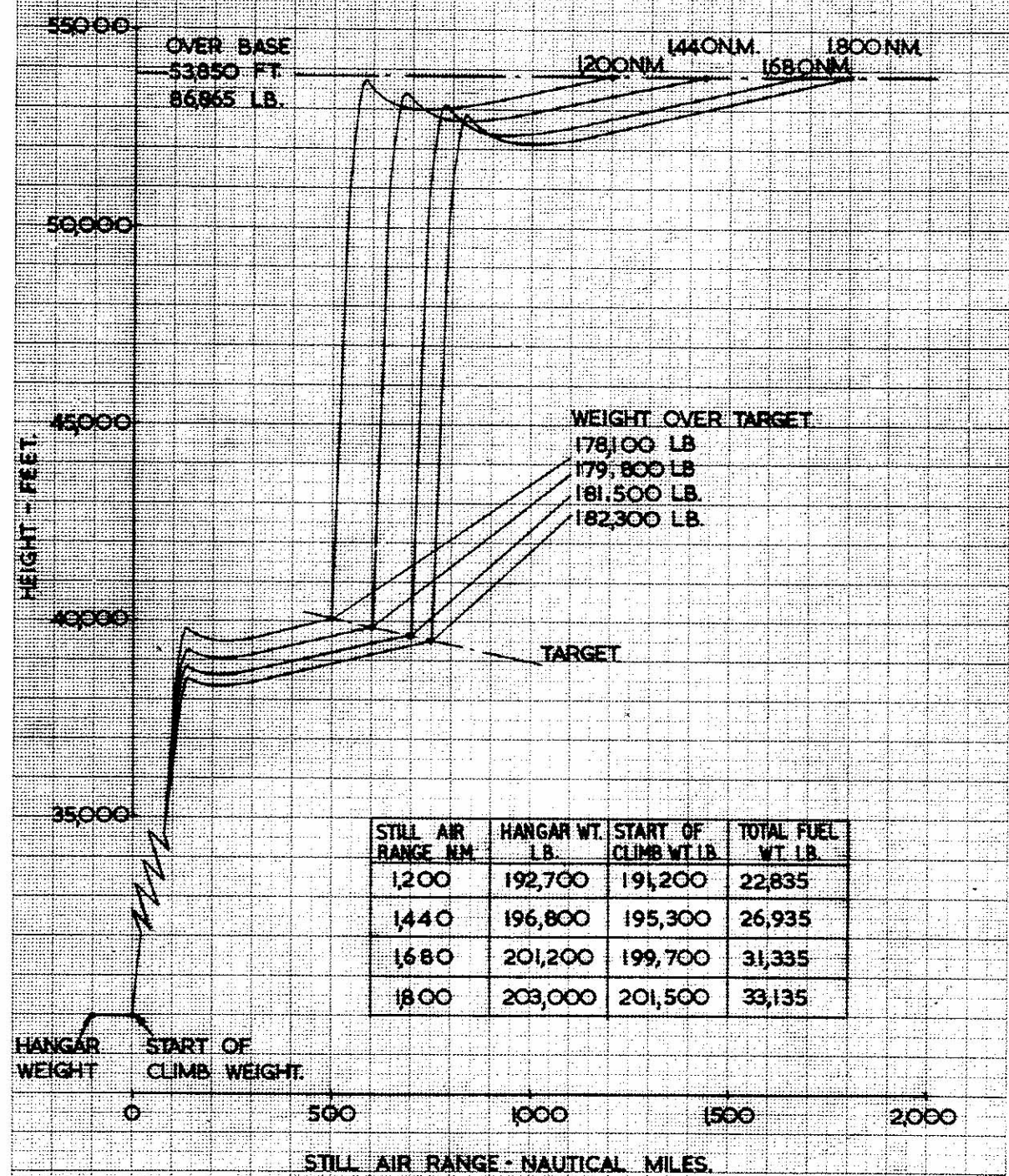
FLIGHT PLANS.

ICAN. STANDARD ATMOSPHERE.

FOUR BRISTOL OLYMPUS (B.O.L.3. RATING) ENGINES.

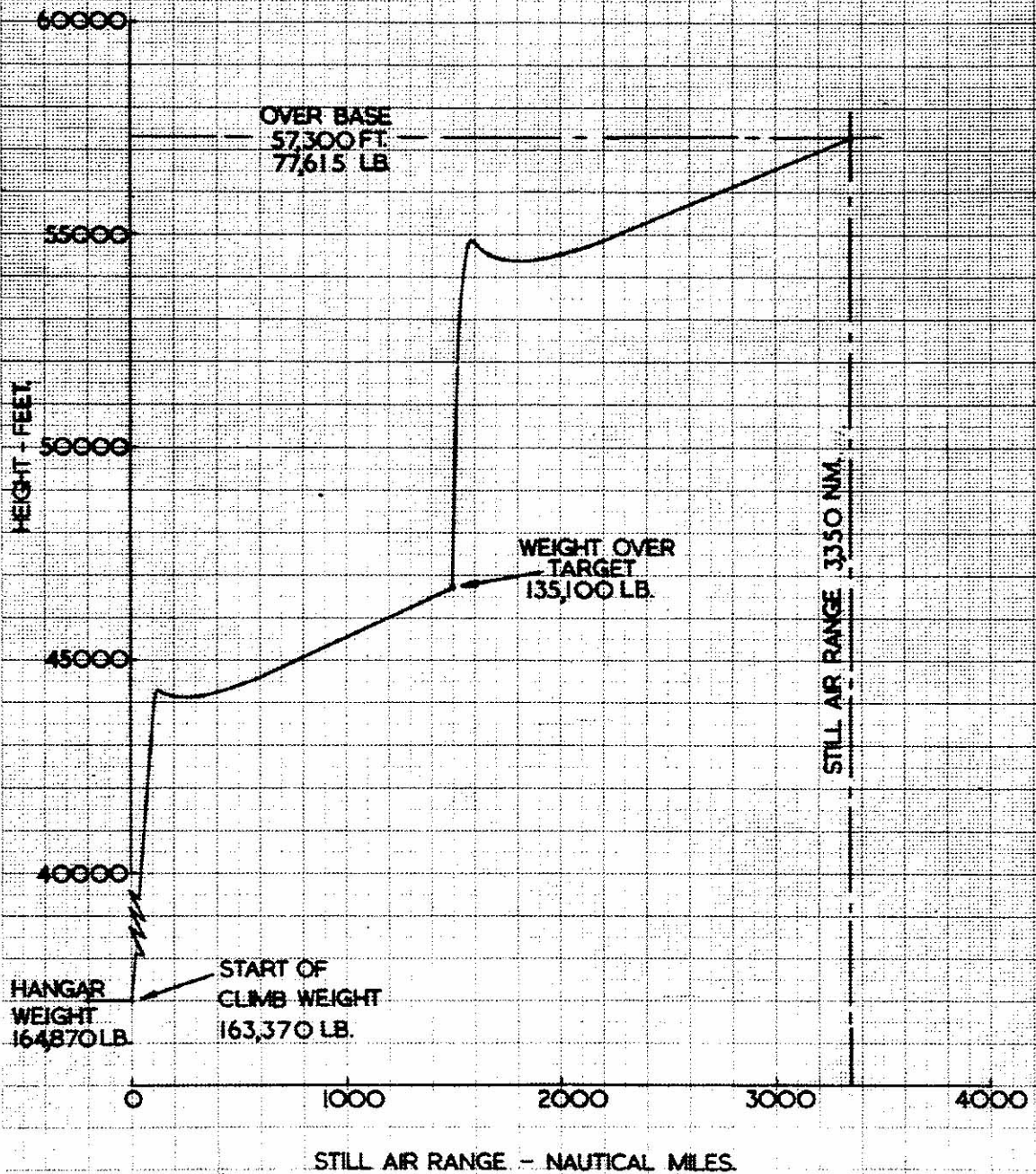
STILL AIR RANGE * DISTANCE TO TARGET & RETURN PLUS 20% ALLOWANCE.

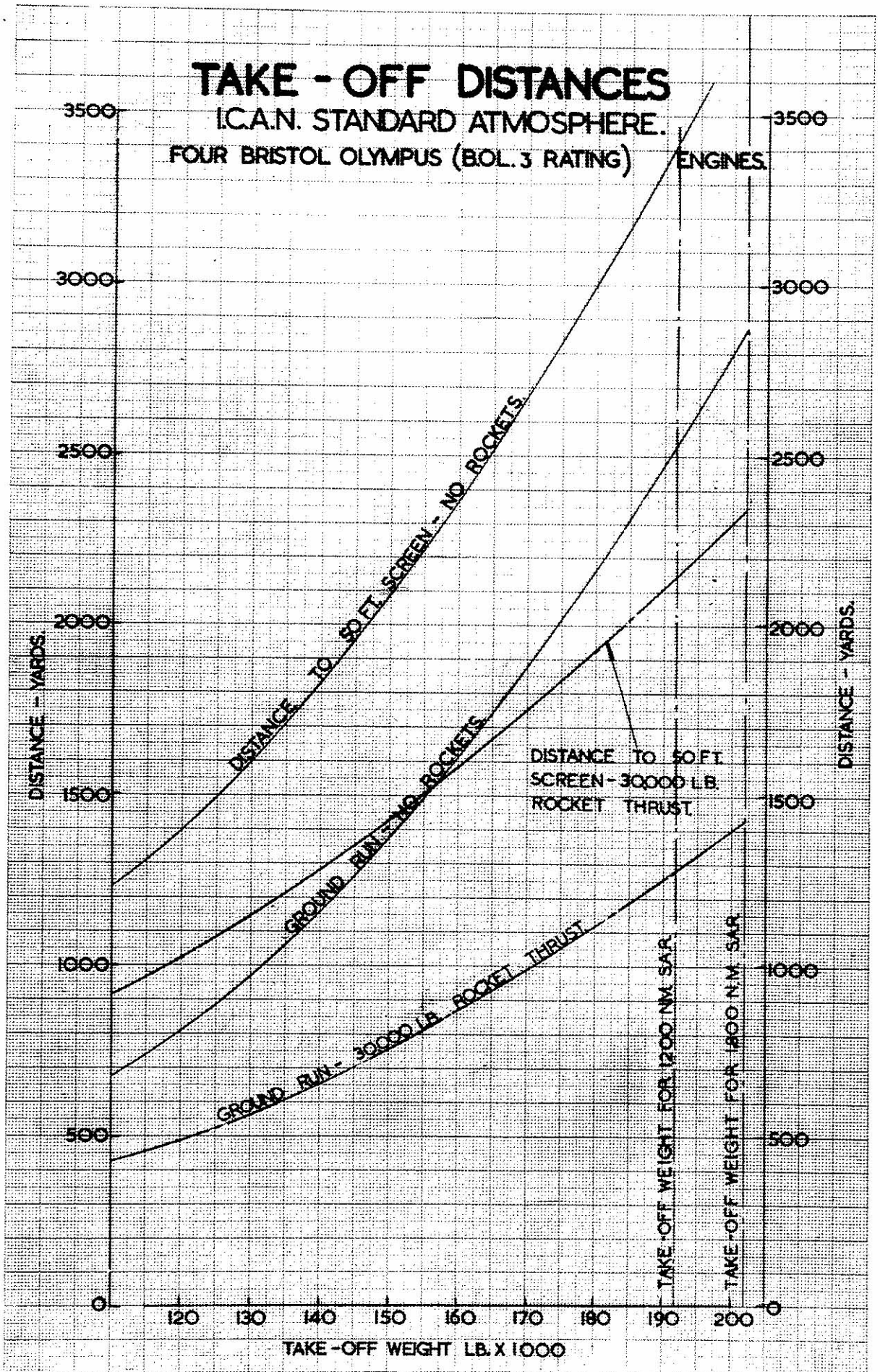
83x1000 LB BOMBS IN FUSELAGE AND WING NACELLES.

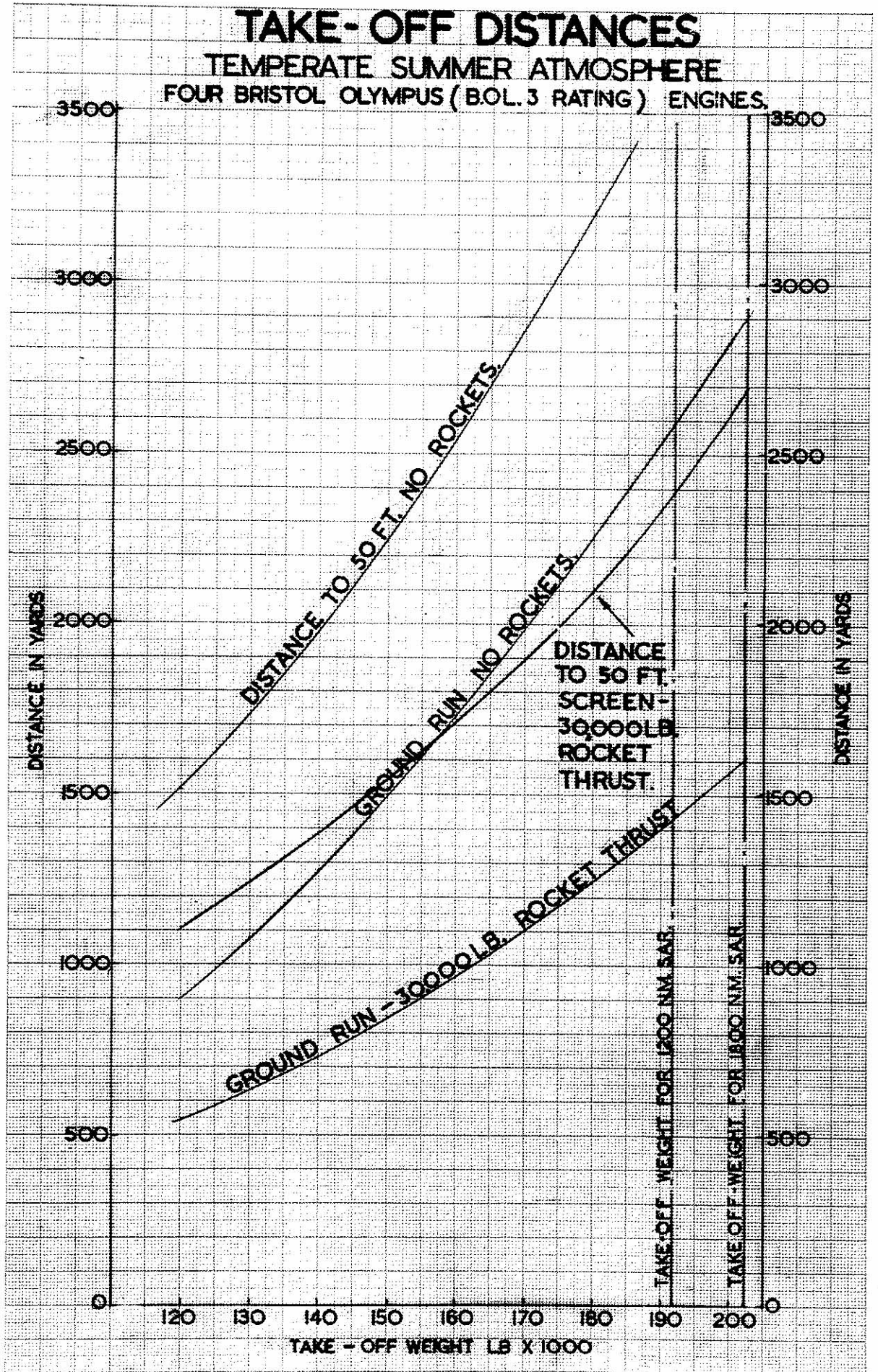


FLIGHT PLAN.

ICAN. STANDARD ATMOSPHERE.
FOUR BRISTOL OLYMPUS (B.O.L. 3 RATING) ENGINES.
39 x 1,000 LB. BOMBS IN FUSELAGE.



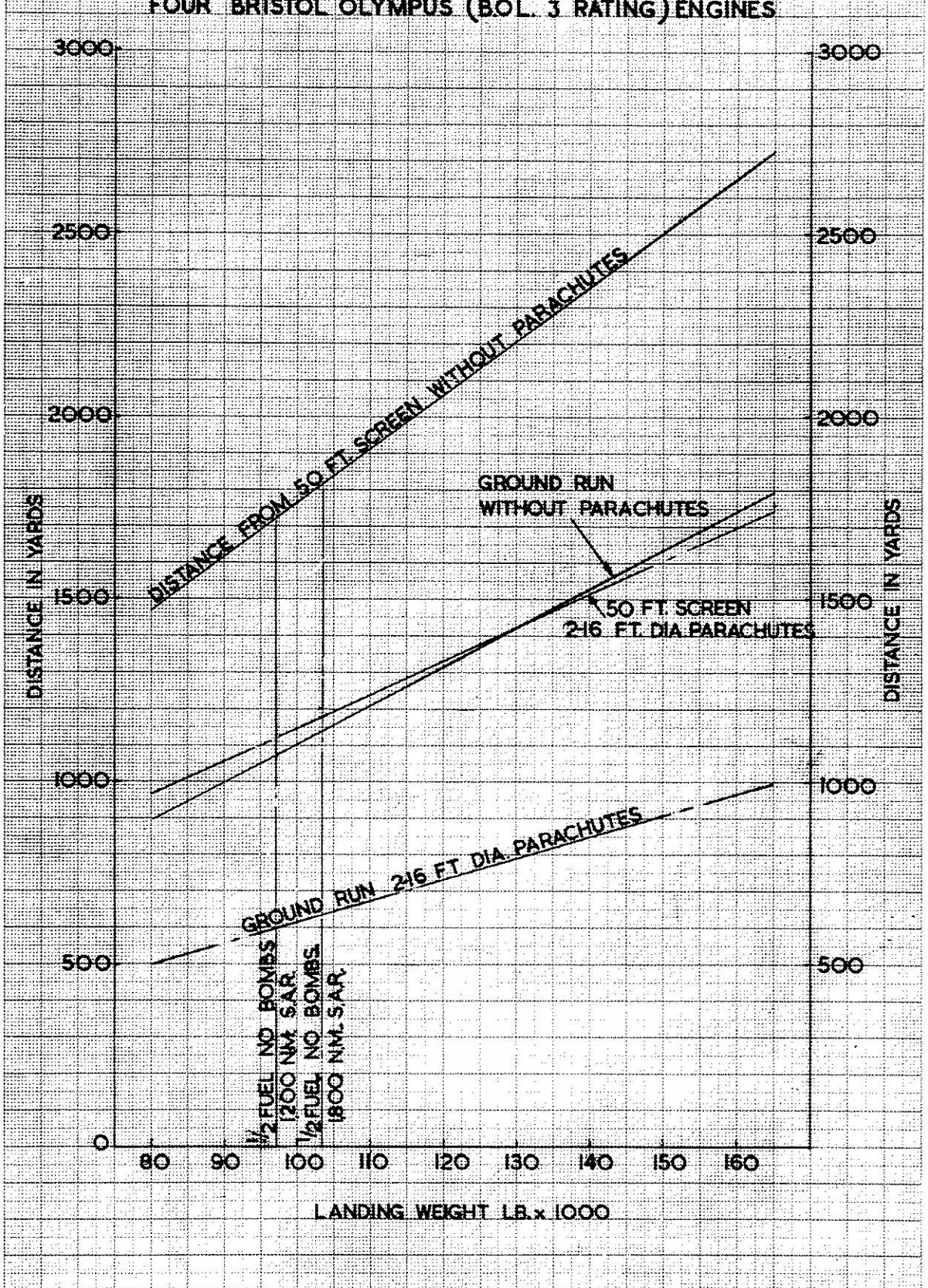




LANDING DISTANCES

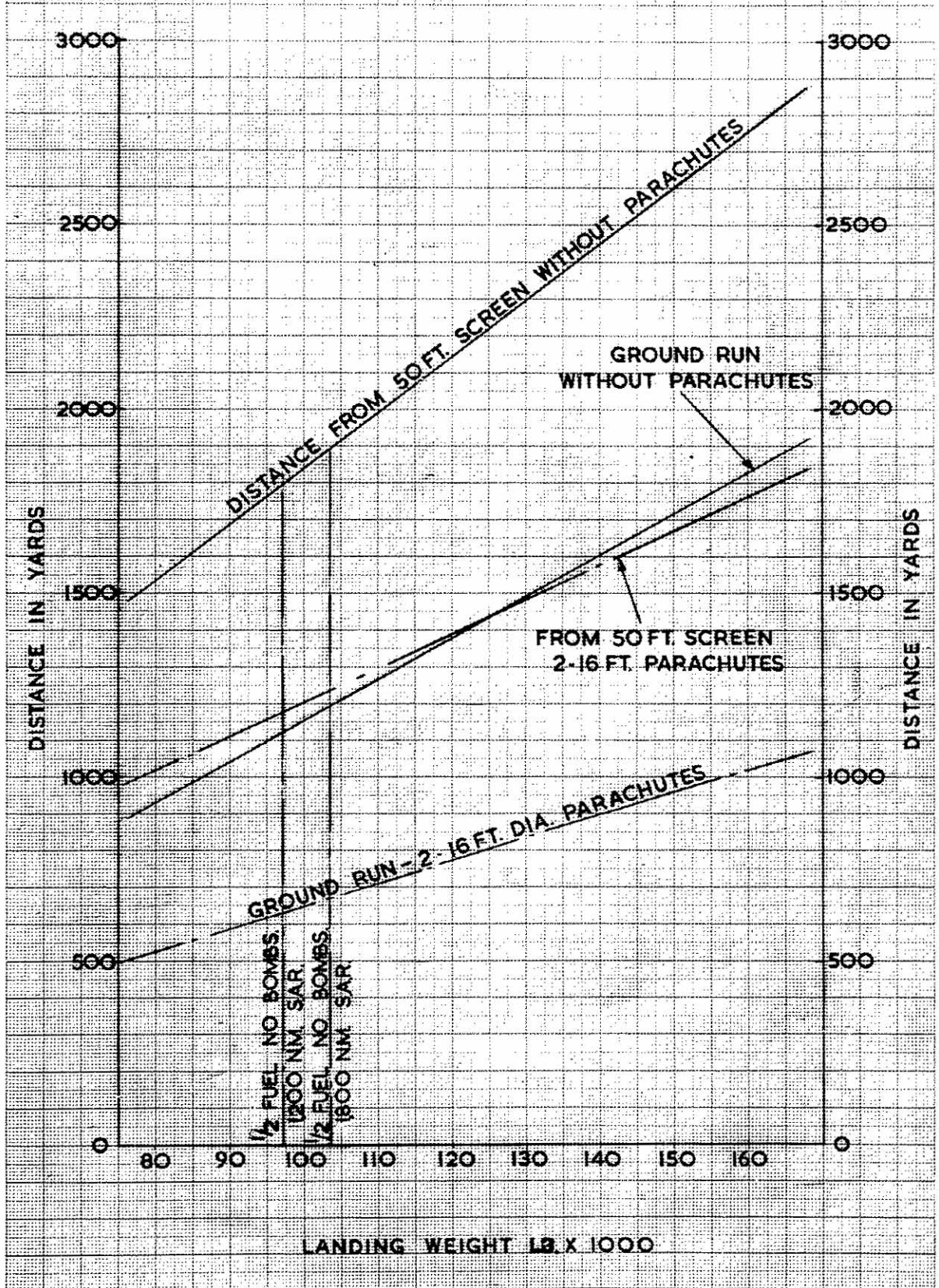
I.C.A.N. STANDARD ATMOSPHERE

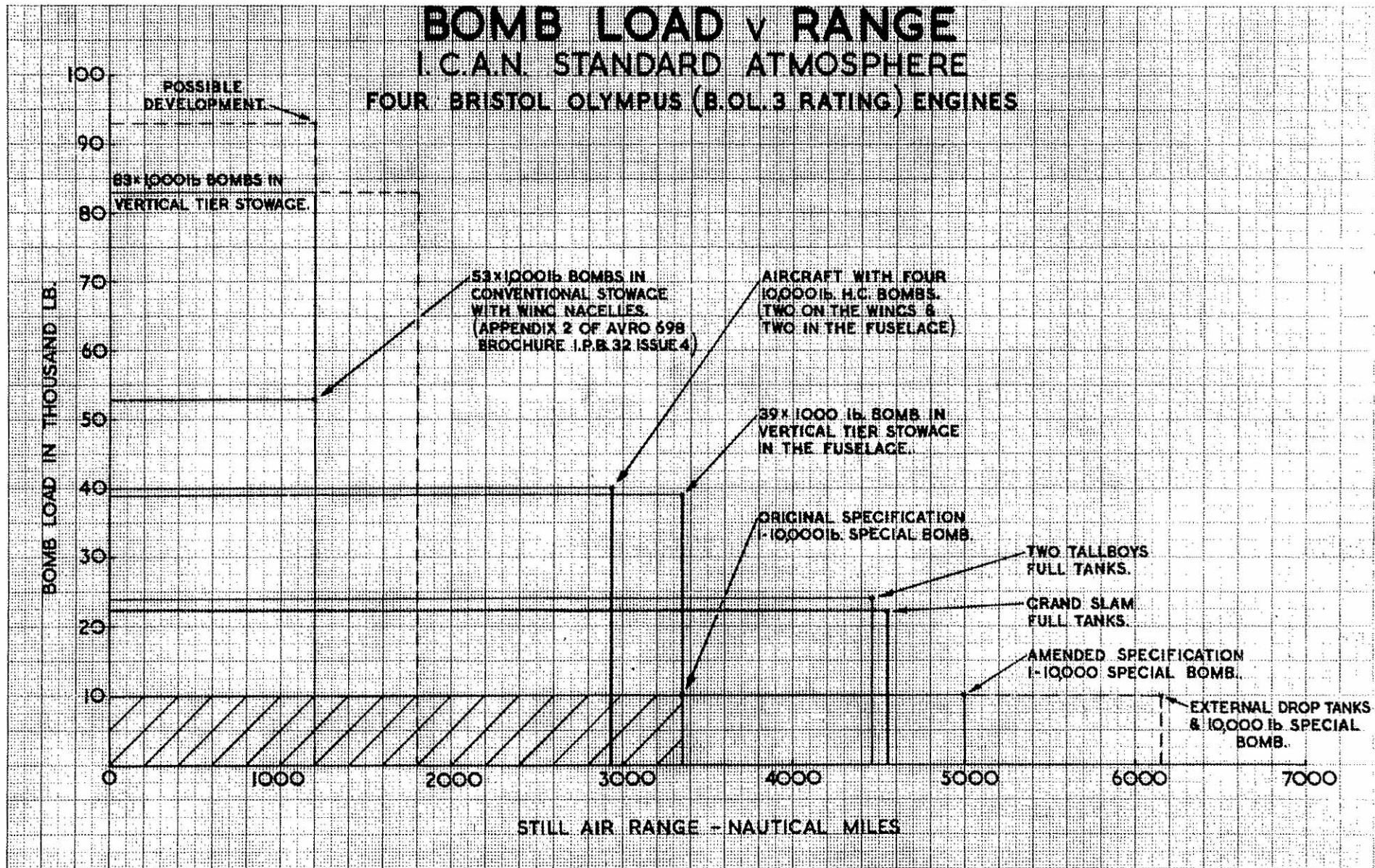
FOUR BRISTOL OLYMPUS (BOL. 3 RATING) ENGINES



LANDING DISTANCES

TEMPERATE SUMMER ATMOSPHERE
 FOUR BRISTOL OLYMPUS (B. OL. 3. RATING) ENGINES





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