

HAWKER SIDDELEY AVIATION LIMITED

AVRO VULCAN B.1A

TANKER CONVERSION

PRELIMINARY STUDY



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TANKER CONVERSION

CONTENTS

	Page
SUMMARY	1
DESCRIPTION	
1. General	2
2. Installation of Mk. 17 P.U. and Bomb Bay Tank	2
3. Installation of Mk. 20A Package Units on Outer Wings	3
4. Fuel System	4
5. Electrical System	9
6. Structure	11
7. Radio and Radar Installations	14
8. Weight & C.G. Data	15
9. Performance	16
10. Development and Production Time Scale	16

LIST OF ILLUSTRATIONS

	Figure
General Arrangement of Aircraft	1
G.A. of B.B. Tank and Mk. 17 P.U.	2
Mounting of Mk. 20A P.U.'s at 77'.0 Centres	3
Mounting of Mk. 20A P.U.'s at 87'.0 Centres	4
Electrics - Main Generating System	5
Electrical Loading	5a
Diagram of Fuel System	6
Diagram of Venting and Methyl-Bromide System	7
C.G. Envelope	8
Weight Summary	8a
Endurance with Lightening Aircraft	9
Endurance with T.S.R.2 Aircraft	10
Take-off Distance	11
Overall Production Programme	12

SUMMARY

A preliminary study has been made into the conversion of the Vulcan B.1A aircraft into the Tanker Role to meet the requirements of S.O.P. Ref. C148798/62/ORI, and this brochure details our assessment to date.

This shows that the current requirements can be met. It is possible to refuel in flight any of the aircraft fitted with inflight re-fuelling receiver equipment at present in service in the R.A.F. or under development for future service.

Depending on the type of receiver aircraft, fuel can be transferred at a maximum rate of 150 g. p. m. from each of the Mk. 20A wing pod units simultaneously, or 500 g. p. m. from the Mk.17 unit in the rear of the Bomb Bay, at altitudes from 8,000' - 40,000' and speeds from 180KTS - 310KTS. E.A.S.

The Bomb Bay fuel tank holds 4,000 galls. of fuel. This together with a feed from the main aircraft fuel system enables 5,000 galls. to be transferred in 10 mins. and with a recovery time of 16 mins. max. a further transfer of 5,000 galls. may be made.

No modifications are required to meet the increased all up weight of 200,000 lb. other than the fitting of stronger tyres to the main undercarriage as at present used on the Vulcan B. 2.

TANKER CONVERSION

DESCRIPTION

1. GENERAL

1.1 The General Arrangement of the aircraft is shown in Fig. 1.

The basic configuration of the aircraft is to the present B. 1A. standard fitted with four Bristol Olympus 104 engines of 13,500 lb. thrust each, less E.C.M. equipment and with additional Radio and Navigational aids.

1.2. In order to accommodate a tank of the required capacity and the Mk. 17 Package Unit, the bomb doors are removed. The under-surface of the aircraft is formed by the false bottom of the tank, a forward fairing, and an aft fairing which also forms a stowage for the drogue.

1.3 An allowance of 2,000 lb. has been made for aircraft spares. It is anticipated that spare wheels and tyres can be carried in the E.C.M. Bay and aircraft spares and/or spare drogues in the areas vacated by the "Window" containers.

2. INSTALLATION OF MK. 17 P. U. AND BOMB BAY TANK

2.1 The General Arrangement is shown in Fig. 2

The tank holds 4,000 galls. of fuel excluding air space. It is of conventional aluminium alloy construction and of true circular cross section. This gives the most economical shape for pressurisation, manufacture, testing and installation and the best weight capacity ratio. Unlike the present A and E Bomb bay tanks for the Mk. 2, the shape is not dictated by the carriage of stores.

TANKER CONVERSION

2.2 The false bottom of the tank protects the tank proper from damage by stones etc., thrown up by the wheels, provides space for the fuel pump sumps and delivery pipes and provides some protection in the event of a wheels up landing.

2.3 Fairings hinged to the false bottom complete the under-surface. These may be swung fully down to give access to the bomb bay for routine servicing, and when in the closed position provide a working platform.

2.4 The tank is secured by wide steel straps and crutched to a predetermined load against fixed pads by suitably torque-loading the turnbuckles. Fore and aft loads are taken by longitudinal struts which attach to diffusion members on the tank.

2.5 The under surface is completed by a forward fairing, and an aft fairing which also forms the stowage for the Mk.17 Package Unit drogue.

2.6 The Mk. 17 unit is mounted in a sub-frame which is attached to strong points on the bomb arches. Two hydraulic jacks enable the unit to swing down to the transfer position.

2.7 This uncovers an air scoop and the drogue is ejected rearwards by air pressure.

3. INSTALLATION OF MK. 20A PACKAGE UNITS ON OUTER WINGS

3.1 Two alternative positions are shown on Fig. 1, 3 and 4 for the mounting of the Mk. 20A Package Units near the wing tips. The inboard position ref: Fig. 3 (77 ft. centres) gives complete ground clearance during the landing and take-off including the remote case of a landing with fully compressed shock absorbers, flat tyres and a 2° roll, on touch down.

TANKER CONVERSION

3.2 The outboard position ref: Fig. 4. (87 ft. centres) shows complete ground clearance for all cases except the 2° roll condition.

3.3 To determine the optimum position the effect of wing tips turbulence and downwash on the receiver aircraft must be considered. It is recommended that some flight testing will be necessary to establish this. Very preliminary estimates indicate that either position will be satisfactory.

3.4 Some wind tunnel tests will also be required to establish their angular location relative to wing chord, to determine the minimum drag position.

4. FUEL SYSTEM

Three Package Units are installed in the aircraft as follows:-

4.1 For the 500 g. p. m. Receiver a Mk. 17 Package Unit is fitted in the Bomb Bay, and for the 150 g. p. m. Receiver aircraft a Mk. 20A podded Package Unit is underslung from each wing tip.

4.2 During normal contacts 150 g. p. m. Receiver aircraft will make contact with the drogue on the wing tip Package Unit, but in the event of a failure of one of these units, one of the Receiver aircraft will be able to obtain fuel from the Bomb Bay Package Unit.

4.3 The facilities provide for refuelling in flight over an altitude band of 8,000 to 40,000 ft. at speeds varying from 180 knots to 310 knots E.A.S. The maximum contact time of each Receiver aircraft has been assumed to be ten minutes, and the capacity has also been provided to enable the tanker to make subsequent contacts after break away periods of sixteen minutes.

TANKER CONVERSION

4.4 In the event of an abortive mission the contents of the refuelling tank in the Bomb Bay can be supplied to the engines of the tanker. Provision is also made to off load the contents of the Bomb Bay tank through the Bomb Bay Package Unit.

4.5 Facilities are also provided to transfer the fuel from the wing Package Unit back to the Bomb Bay tank in the event of a failed unit or an abortive sortie.

4.6 Description of the System

4.6.1 Bomb Bay Tank

A 4,000 gallon cylindrical tank which serves as a fuel reservoir to supply each of the Package Units is installed in the tanker bomb bay. The tank is also interconnected with the main aircraft fuel system through the aircraft cross feed piping for replenishment in flight, and to the normal aircraft refuelling system for replenishment on the ground.

4.6.2 Ten 112V. SPE. 3506 Fuel Pumps are installed in the tank, and these are interconnected in banks of five to a main 4" O/D gallery pipe on each side of the Bomb Bay. Non-return valves are fitted in each pump supply line to prevent fuel being re-circulated back into the tank in the event of a pump failure.

4.6.3 A fuel contents gauge system is installed in the tank, and to prevent over filling during ground refuelling a high level cut-off float switch interconnected electrically with the tank refuelling valve is fitted. A 2% air space is provided in the tank to allow for thermal expansion of the fuel under high ambient temperature conditions on the ground.

4.6.4 To prevent the Package Unit fuel pump from cavitating during transfer a minimum pressure of 7 p. s. i. g. is required, and this

TANKER CONVERSION

is achieved by supplementing the pressure from the Booster Pumps with pressurisation in the tank. A tank pressure of 3 p. s. i. g. is required, and this is obtained from engine tapped air by means of a simplified tank pressurisation system, employing a pressure reducing valve fitted between the engine and the tank, and combined inward/outward vent valves at the vent pipe outlets.

The size of the vent pipe has been designed to ensure that overspilling of fuel from the vent during ground refuelling, due to a faulty fuel level cut off switch will not overpressurise the tank.

4.7 Piping to Package Units

4.7.1 The piping from the bomb bay tanks is taken along each side of the Bomb Bay, through the rear spar then run along the aft side of the Rear Spar to each of the wing tip Package Units.

4.7.2 The gallery pipes in the Bomb Bay are 4" O/D and the galleries are interconnected at the aft end of the tank. A tapping from the interconnecting pipe is taken direct to the Bomb Bay Package Unit.

4.7.3 The piping to the wing tip Package Unit is sub-divided into two 2 $\frac{1}{2}$ " O/D pipes at the rear spar to enable the piping to be taken clear of the Jet Pipe Tunnels and minimise the amount of structural alterations to the trailing edge ribs. The trailing edge piping is then terminated in a 3" O/D pipe at the wing tip where it enters the Package Unit via an electrically operated Refuel/Defuel valve.

4.7.4 Electrically operated isolation cocks are installed in the Bomb Bay piping to enable the wing tip and Bomb Bay Package Units to be selected or isolated when required.

4.8 Existing Aircraft Fuel System

4.8.1 To ensure that the Bomb Bay tanks can be fully re-

TANKER CONVERSION

plenished in sixteen minutes from the main fuel tanks, the existing SPE. 808 Booster Pumps will be replaced with SPE. 1206 pumps which are physically interchangeable. Although these pumps have a higher performance than the existing pumps, the pressure losses in the system will have to be reduced by increasing the existing 2" O/D piping from the undercarriage bay to the engines to 2½" O/D and the aircraft cross feed pipe in the Bomb Bay to 3" O/D.

4.8.2 The Bomb Bay gallery pipes are interconnected to the main aircraft cross feed piping, and also to the main ground refuelling piping. Suitable refuelling valves and isolation cocks are fitted to select the service required.

4.9 Wing Tip Package Unit

4.9.1 The Mk. 20A Package Unit is a self contained podded unit, complete with a 150 gallon reservoir tank, Hose Reel and pumps.

A ram air turbine provides the motive power through a suitable gearbox to drive the fuel pumps and the hydraulic pump for the hose reel motor.

4.9.2 To prevent cavitation of the main fuel pump a pressure of 7 p.s.i.g. is required at the pump inlet, and this is provided by a separate air bottle system housed in the wing tip. The pressurisation system also enables the fuel in the Package Unit reservoir to be transferred back to the Bomb Bay tank in the event of an abortive sortie.

4.10 Bomb Bay Package Unit

The Mk. 17 Package Unit is fitted with an air turbine fuel pump and the supply for this is provided by the bleed air from four engines. A suitable tapping already exists in the Bomb Bay system ducting, and piping from this point to the Package Unit will be fitted.

TANKER CONVERSION

The bleed air flow for the turbine air pump can be obtained from three engines assuming an engine failure.

4.11 Fire Protection

4.11.1 A fire protection system is provided for the Bomb Bay Tank. This consists of a Graviner Firewire Detector running the complete length of the Bomb Bay on either side of the tank. The latest Triple F.D. system is installed to eliminate spurious false warnings.

4.11.2 A suppressant system with spray pipes on each bomb bay rib is installed with two 12 lb. Methyl Bromide bottles for each side. This system is similar to that existing on the Mk.2 Vulcan aircraft, and has satisfactorily cleared discharge and concentration checks.

4.12. General

A general layout of the fuel system is shown diagrammatically in Fig.6 and the venting, tank pressurisation and fire protection of the Bomb Bay tank is shown in Fig. 7.

4.13. Function of system

4.13.1. Since each wing tip Package Unit will be supplying fuel at 150 g.p.m. for ten minutes then at the end of this period 3,000 gallons will have been taken from the Bomb Bay Tank. This leaves 1,000 gallons in the tank, and replenishment of this tank during contact is not required.

4.14. Bomb bay package unit

4.14.1. When the Bomb Bay Package Unit is delivering 500 g.p.m. for ten minutes, the demand will be necessary to replenish the Bomb Bay Tank during contact.

4.14.2. This will be accomplished by the aircraft fuel system

TANKER CONVERSION

booster pumps described in para. 4.8.1. These pumps can deliver fuel in excess of engine requirements, and provide a surplus flow greater than 250 g. p. m. which is sufficient to fill the Bomb Bay Tank in sixteen minutes.

5. ELECTRICAL SYSTEM

5.1. The main generating system on Vulcan B.Mk. 1A in its present configuration of 4 - 22.5 Kw. 112V D.C. generators, (two running in parallel, and two running individually) is capable of providing the additional load imposed during a tanker refuelling role. The additional load comprises 1 - 200 amp. (22.5 Kw.) load for Bomb Bay hose unit motor connected to No. 1 and 2 generator bus-bars, and 10 - 8.5 amp. (0.95 Kw.) fuel pump loads equally divided between No.3 and No.4 generators. A minor increase in aircraft fuel pump load attributed to the introduction of larger capacity fuel pumps, comprises a further 14 amps. (1.57 Kw.). The above distribution is illustrated in mimic diagram form in Fig. 5.

5.2. Electrical loading

Together with the above load distribution the total aircraft load may be broken down as shown in Fig. 5a, with the maximum load on any generator not exceeding 21 Kw. or 22 Kw. in an emergency. In the event of a single generator failure load shedding is necessary, the loads to be shed will depend upon the particular failure. After the first generator failure the tanker may continue its refuelling role after the loads have been re-adjusted.

5.3. In general the two load shedding conditions to be considered are:-

TANKER CONVERSION

5.3.1. No. 1 or No. 2 generator failed

The loads to be shed are No.1 - 112V/28V D.C. Rotary Transformer and No.1 - 112V/115V Inverter. The remaining generator, i.e., No.1 or No.2 must be run isolated to feed the refuelling hose motor only, and No.3 and No.4 generators paralleled to feed the remaining aircraft load.

5.3.2. No. 3 or No. 4 generator failed

The loads to be shed are standby rudder motor, No. 3 and No.4 Inverters and two 112V/28V D.C. Rotary Transformers. The shedding of the above loads will be made automatic with the provision for manual override.

5.4. The theoretical load values detailed in Fig.5a, have in practice been found to be some 15% high, this is due in part to cable voltage drop reducing the load and loads being quoted on maximum tolerance. This is therefore a rather pessimistic view of the loading for a tanker refuelling aircraft.

5.5. Electrical installation

An additional contactor and fuse distribution panel will be necessary in addition to the standard control and operating panel as fitted at the rear crews station. This could be a removable fittings panel, alternatively the aircraft's main distribution panels could be modified to supply the additional fuse-ways and the fuel pump contactors mounted separately.

5.6. Main generating system - modification state

5.6.1. Two modifications applicable to the main generating system should be considered in the light of this new role. These are briefly described along with their considered importance.

TANKER CONVERSION

5.6.2. Mod.874 - Introduction of the type 120 voltage Regulator in lieu of type 91 and the addition of a voltage regulator amplifier.

This is considered a necessary requirement to provide a more stable voltage generating system, especially during the heavy transient load switchings. To date several aircraft have been brought up to this standard by C. W. P.

5.6.3. Mod.1620 - Improvement to the electrical generating system protection circuits.

It is considered desirable to embody the improved protection associated with this mod, and also to re-arrange the distribution panels, thus providing additional spare fuses to cater for the 10 fuel pumps and pump motor for the winch on 112 volt side.

5.6.4. In general the main generating system will in its present form, with only minor changes lend itself to fulfill this role.

6. STRUCTURE

No additional structural modifications are envisaged to meet the proposed A.U.W. of 200,000 lb. with the exception of a change to the Main Undercarriage tyres. Some reduction in the reserve factors in the ground manoeuvre and taxi cases will however, result. These are shown at para. 6.4.1.

6.1. Permissible normal accelerations

The permissible 'g' in symmetric flight manoeuvre is shown in the following table for cases with wing refuelling pods. The aircraft weight shown is, in all cases appropriate to full Bomb Bay fuel.

TANKER CONVERSION

A. U. W.	% of Normal fuel	Design Permissible 'g'
200,000	100	2.05
180,000	72	2.16
160,000	44	2.29
140,000	16	2.42

6.1.1. Transfer of tanker fuel from the Bomb Bay tanks will improve the above permissible accelerations, e. g., transfer of 20,000 lb. will increase 'g' by .5g. Permissible 'g' for the Service will be approximately 75% of the "Design" 'g'.

6.1.2. Flight with the wing refuelling pods removed but with full Bomb Bay tanks and Bomb Bay refuelling unit will give a lower permissible 'g' as follows:-

A. U. W.	% of Normal Fuel	Design Permissible 'g'
196,248	100	1.90
180,000	77	1.98
160,000	49.5	2.08
140,000	21.5	2.20

6.1.3. Here again the transfer of say 20,000 lb. of Bomb Bay tank fuel, will reduce the weight by 20,000 lb. and increase the permissible 'g' by .4g. Permissible 'g' for the Service will be approximately 75% of the "Design" 'g'.

TANKER CONVERSION

6.2. Permissible vertical gust velocities

A. U. W.	Permissible gust velocity - ft. /sec.	
	with pods	without pods
200,000	53.7	35.5
180,000	43.7	30.2
160,000	38.7	27.3
140,000	37.8	26.6

6.2.1. The effect of transfer of say 20,000 lb. of tanker fuel from the Bomb Bay tanks will reduce the aircraft weight by 20,000 lb. and increase the permissible gust speeds by approximately 11 ft. /sec.

6.3. Landing and take-off

The Vulcan B. Mk. 1/1A main and nose undercarriage units and support structures has been stressed to meet full factors (1.5) at a take-off weight of 162,000 lbs.

6.3.1. Re-land after take-off at this weight is cleared to a rate of vertical descent of 8.8 ft. /sec. For normal landings the weight is 109,350 lbs. and the associated rate of descent is 11 ft. /sec.

6.3.2. At a take-off weight of 200,000 lbs. it is not considered that a normal take-off will be critical from structural aspects. Should it be necessary to re-land immediately after take-off then the permissible rate of descent should be not greater than 8 ft. /sec.

6.4. Ground manoeuvre and taxi cases

An ultimate factor of 1.5 is achieved at a weight of 162,000 lb. Any increase in weight above this figure reduces the ultimate or safety factor to less than 1.5.

TANKER CONVERSION

6.4.1. At a weight of 200,000 lb. the following reserve factors and ultimate factors are obtained.

Manoeuvre Case	R. F.	or Ultimate Factor
Towing	.825	1.24
Swing on T. O.	.840	1.26
Braked taxi	.900	1.36

6.4.2. It is recommended that caution is exercised when taxiing or manoeuvring on the ground at a weight of 200,000 lb.

6.5. Jacking

It is recommended that jacking for wheel changes etc., should only be carried out at reduced weights, i. e., by draining off required quantity of fuel.

6.6. Wheels and tyres

The existing tyre DC/DF.0023 will not be suitable at weights in excess of 185,700 lb. To meet a weight of 200,000 lb. it will be necessary to fit Vulcan Mk.2 tyres (DF.0095/7; DC.0024/T) for which the required tyre pressure is 262 lb./sq. in.

6.7. Load classification

At a tyre pressure of 262 lb./sq. in. corresponding to a weight of 200,000 lb. the LCN is 92.

7. RADIO AND RADAR INSTALLATIONS

In addition to the existing navigational equipment N.B.S. Mk.1A - A. R. I. 5928, Green Satin Mk.2, and Tacan A. R. I.18107/13 the following new equipment will be fitted.

TANKER CONVERSION

- 7.1. A Twin installation of the Plessey P.T.R.175 combined U. H. F. /V. H. F. system will replace the existing twin V.H.F. and single U.H.F. systems now fitted in the aircraft. This will require an additional V. H. F. aerial.
- 7.2. A Collins U. H. F. /DF. type DF301, ADF installation will be fitted. The flush mounting circular aerial assembly will be mounted in the fairing under No. 2 tank bay.
- 7.3. A Vertical slotted Mast aerial will supply by means of a waveguide the approaching aircraft's forward Radar Beacon to a TRANSPONDER which will be operated by means of a remote control unit.
- 7.4. Navigators U. H. F. R. T. facility will be provided.
- 7.5. It is probable that owing to the change in services available the existing Inter-comm. system will be replaced by one giving more scope.
- 7.6. The column 9, H2S units may have 'FISHPOOL' modifications to the waveform generator type 68B and type 301 Indicator.

8. WEIGHT C. G. DATA

The basic operational weight less E.C.M. of 86,871 lb. has been assumed. This gives a total fuel content of 13,574 galls. 104,525 lb. all of which it is theoretically possible to transfer. This results in a maximum A. U. W. of 200,000 lb. Fig. 8 (a) shows details of the weight breakdown.

- 8.2. The C.G. plot is shown in Fig. 8 and it will be seen that this is at all times within the existing C.G. Envelope.

TANKER CONVERSION

9. PERFORMANCE

9.1. The take-off distance to clear 50 ft. under L. S. A. conditions at Sea-Level, is shown on Fig. 11. At a take-off weight of 200,000 lb. this is 6,800 ft.

9.2. Range performance is dependent on the Receiver Aircraft fuel requirements and is therefore variable and 2 examples are shown on Fig. 9 and 10 respectively.

9.3. Fig. 9 shows the range of the tanker accompanied by two Lightning aircraft plotted against various head winds, and at 3 Tanker A. U. W.'s. In still air a range of 2,600 nautical miles is possible.

9.4. Fig. 10 shows a similar plot for the tanker and 1 T. S. R. 2 aircraft. In still air a maximum range of 2,850 nautical miles is possible.

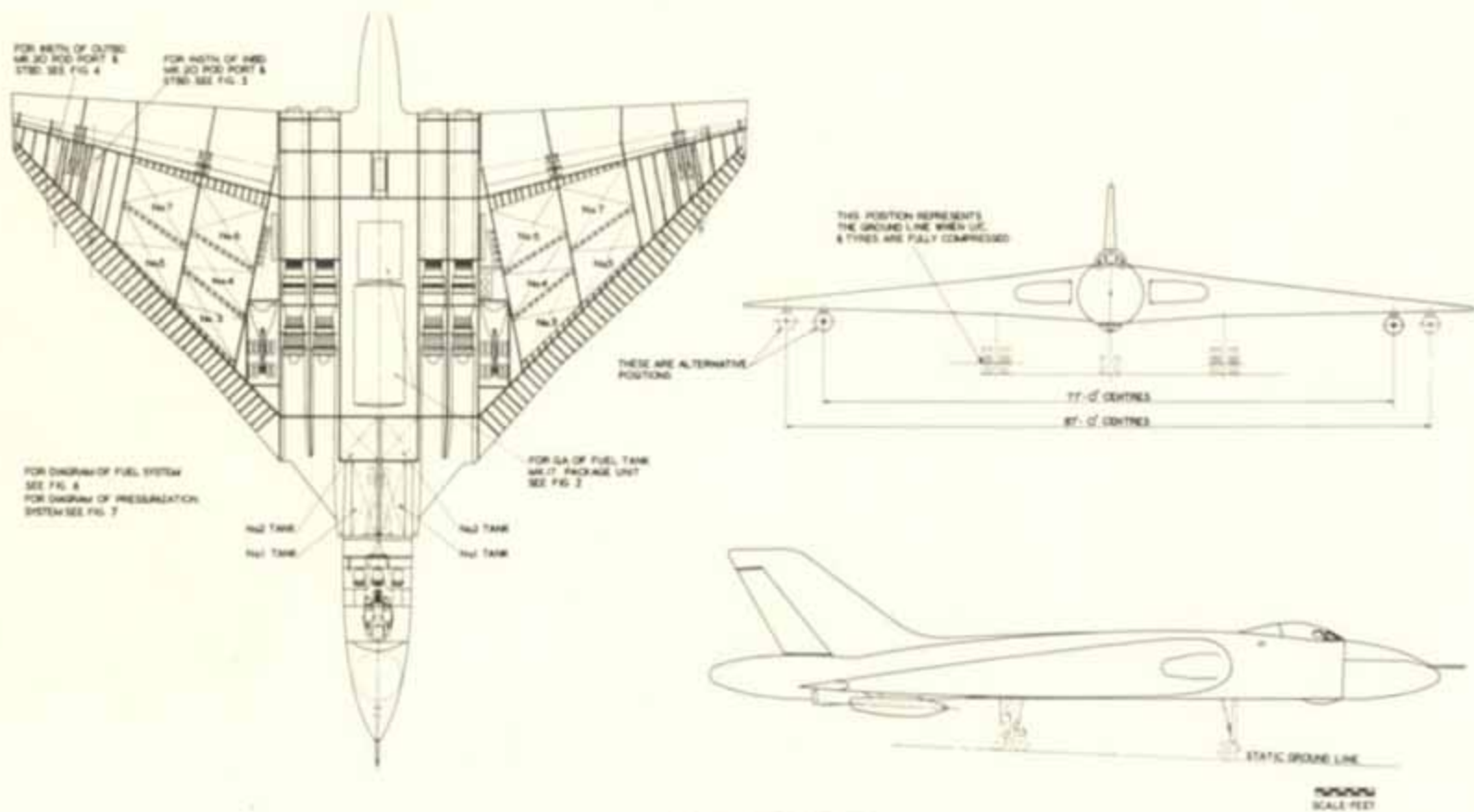
10. DEVELOPMENT AND PRODUCTION TIME SCALE

10.1. The estimated time scale is shown at Fig. 12, this is quoted in elapsed time from the receipt of an L. T. P.

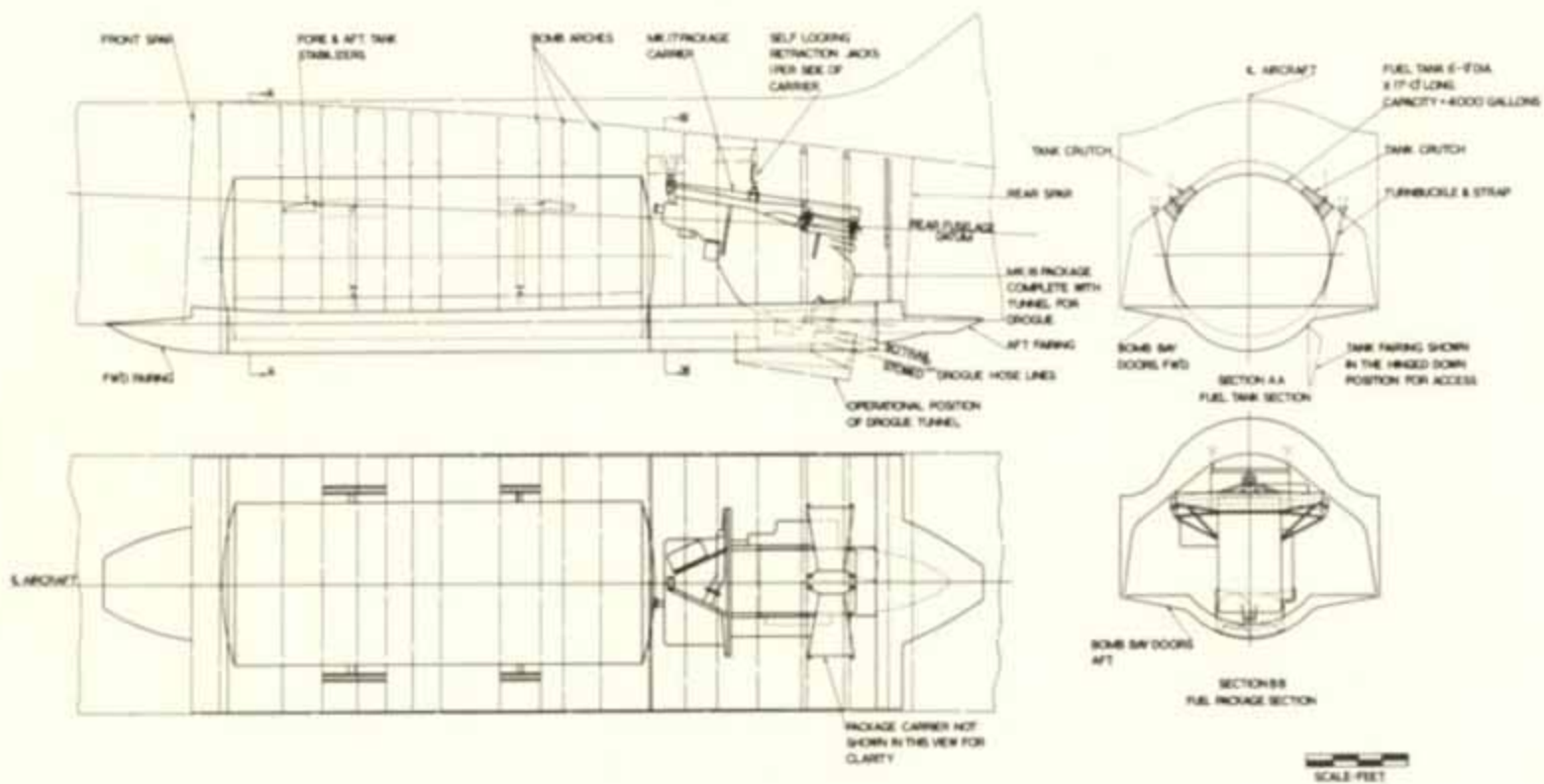
10.2. The design period would cover 12 months, but manufacture of components would commence prior to its completion. No T. 1 aircraft is envisaged, the 1st Production aircraft would be used as a check installation to establish Templates etc.

10.3. The first Service Aircraft returned for conversion would be required 13 months from L. T. P. and would be completed in 10 months followed by 4 months of Flight Test, culminating in a C. A. Release, 27 months from L. T. P.

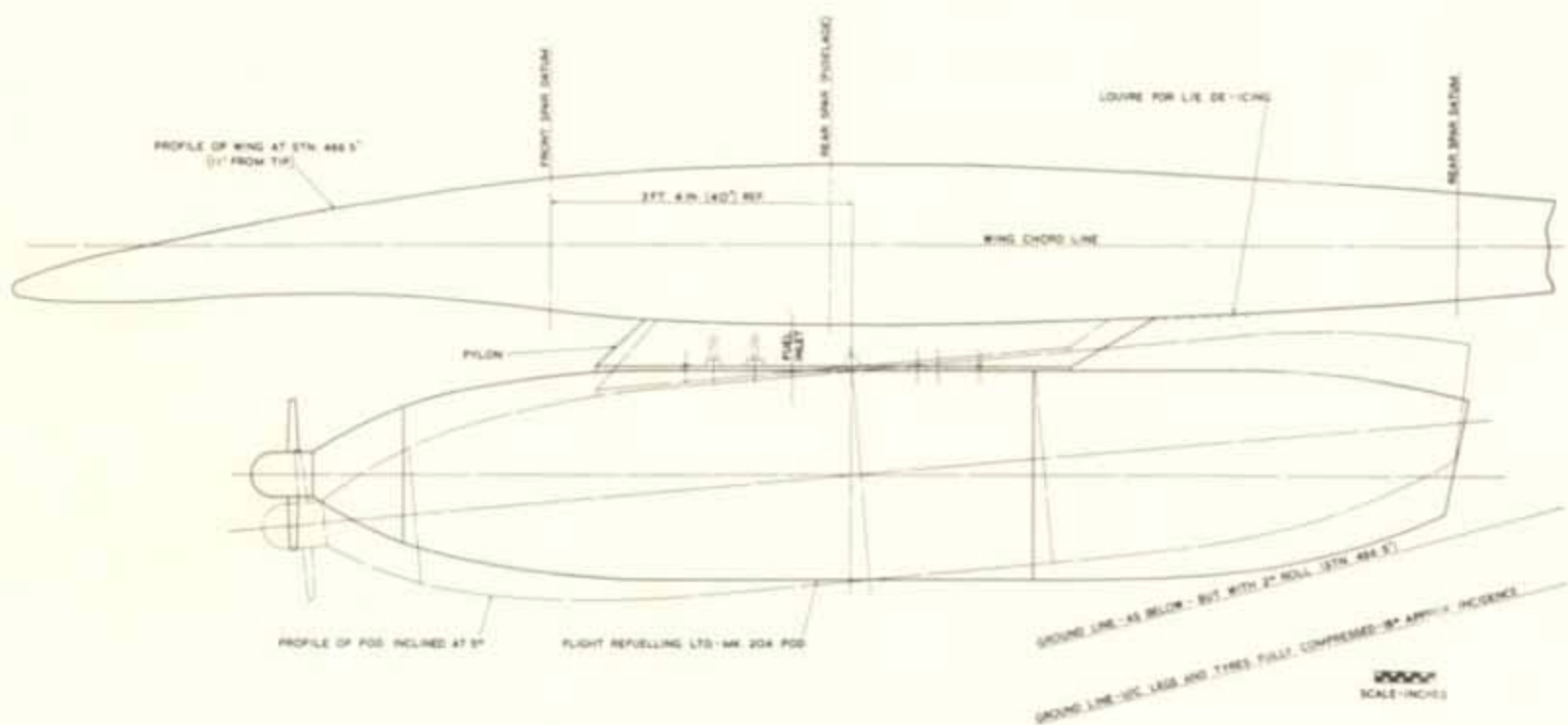
10.4. Production delivery would be 1 aircraft per month for the first 2 months, followed by 2 per month subsequently.



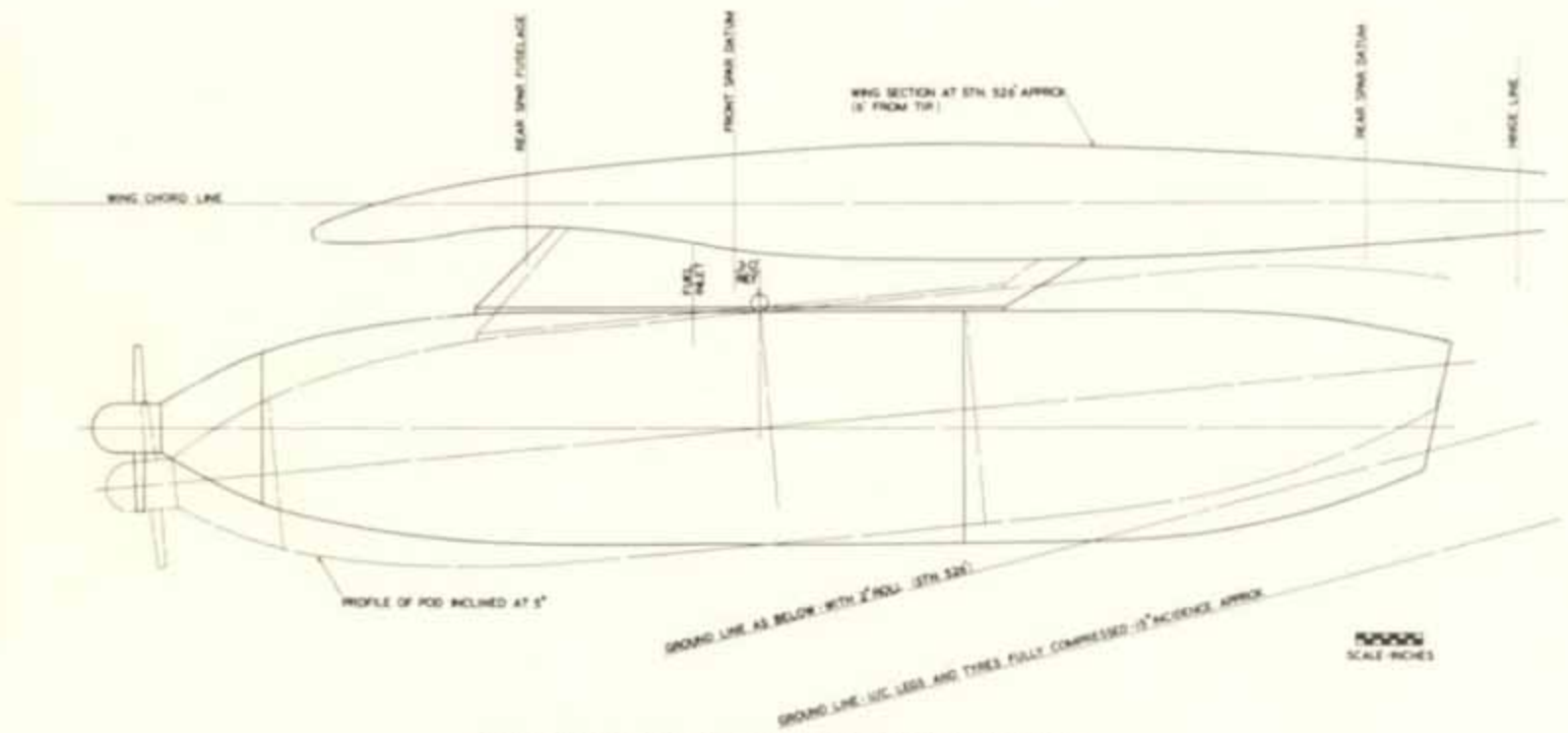
G. A. OF AIRCRAFT



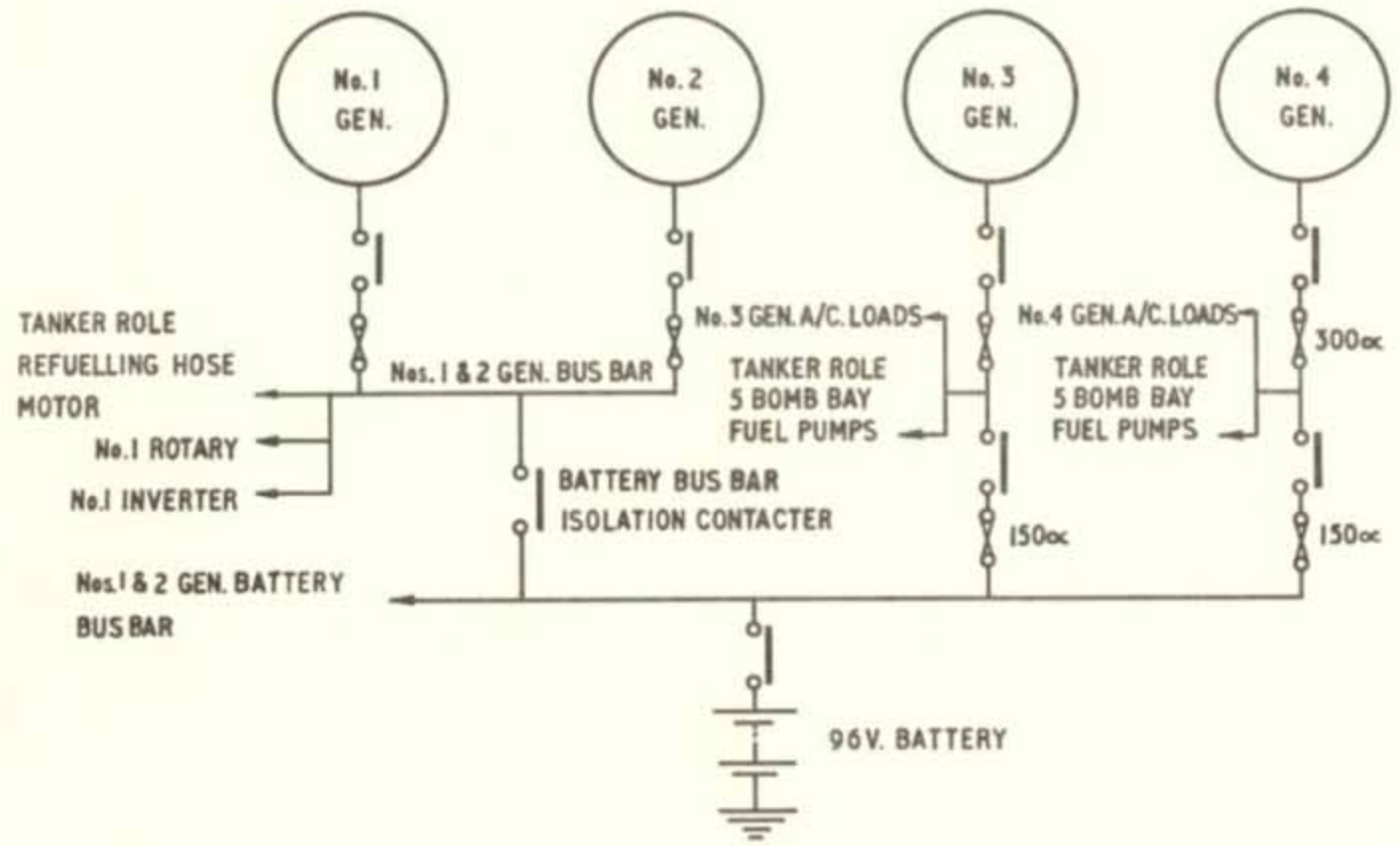
GA OF TANK & MK.17 PU IN BOMB BAY



MTG. OF MK. 20A PACKAGE UNIT AT 77 FT. CENTRES



MTG. OF MK. 20A. PACKAGE UNIT AT 87FT CENTRES.



MAIN GENERATING SYSTEM TANKER LOAD DISTRIBUTION

Failure	Nos. 1 & 2 Generators	KW Load	No. 3 Generator	KW Load	No. 4 Generator	KW Load
Normal Running	No. 1 & 2 Group Main Fuel Pumps Up-rated (7 off)	2.544	No. 3 Group Main Fuel Pumps Up-rated (4 off)	1.45	No. 4 Group Main Fuel Pumps Up-rated (3 off)	1.09
	No. 1 & 2 Group Aux. Fuel Pumps	0.84	No. 3 Group Aux. Fuel Pumps	0.336	No. 4 Group Aux. Fuel Pumps	0.54
	5 P. F. C. Motors	5.6	2 P. F. C. Motors	2.24	3 P. F. C. Motors	3.36
	No. 1 112/28v Rotary Trans.	3.1	No. 2 112/28v Rotary Trans.	3.1	No. 3 112/28v Rotary Trans.	3.1
	Windscreen de-mist	1.0	No. 2 Inverter type 350	0.8	No. 3 Inverter type 350	3.75
	No. 1 Inverter type 350	3.75	Bomb-bay Fuel Pumps	3.8	Bomb-bay Fuel Pumps	3.8
	No. 4 & 5 Inverters type 153	2.62				
	Refuelling winch motor	22.5				
	<u>TOTAL</u>	<u>41.954</u>	<u>TOTAL</u>	<u>11.726</u>	<u>TOTAL</u>	<u>15.64</u>
	No. 3 Failed	No. 1 & 2 Gen. Reduced Load (i. e., less No. 4 & 5 Inverter, Rotary and Rudder Motor)	35.014			Increase in Rotary Load
No. 3 Gen. Reduced Load (i. e., less Inverter and Rotary)		7.826				
<u>TOTAL</u>		<u>42.84</u>			<u>TOTAL</u>	<u>17.04</u>
No. 4 Failed	No. 1 & 2 Gen. Reduced Load (i. e., less Nos. 4 & 5 Inverter, Rotary and Rudder Motor)	35.014	Increase in Rotary Load	1.4		
	No. 4 Gen. Reduced Load (i. e., less Inverter and Rotary)	8.75				
	<u>TOTAL</u>	<u>43.764</u>	<u>TOTAL</u>	<u>13.126</u>		
LOAD ON NO. 3 & 4 GENERATORS IN PARALLEL						
No. 1 or 2 Failed	Load on No. 1 or 2 (Battery Bus-bar Isolation Contactor Open & No. 1 Rotary and Inverter off see Fig. 5) Refuelling winch motor.	22.5	No. 1 & 2 Gen. (Battery Bus-bar Isolation Contactor Open, see Fig. 5)	12.604		
			No. 3 Generator Load	11.726		
	<u>TOTAL</u>	<u>22.5</u>	No. 4 Generator Load	15.64		
		<u>TOTAL</u>	<u>39.97</u>			

ELECTRICAL LOADING ON 22.5 KW GENERATORS

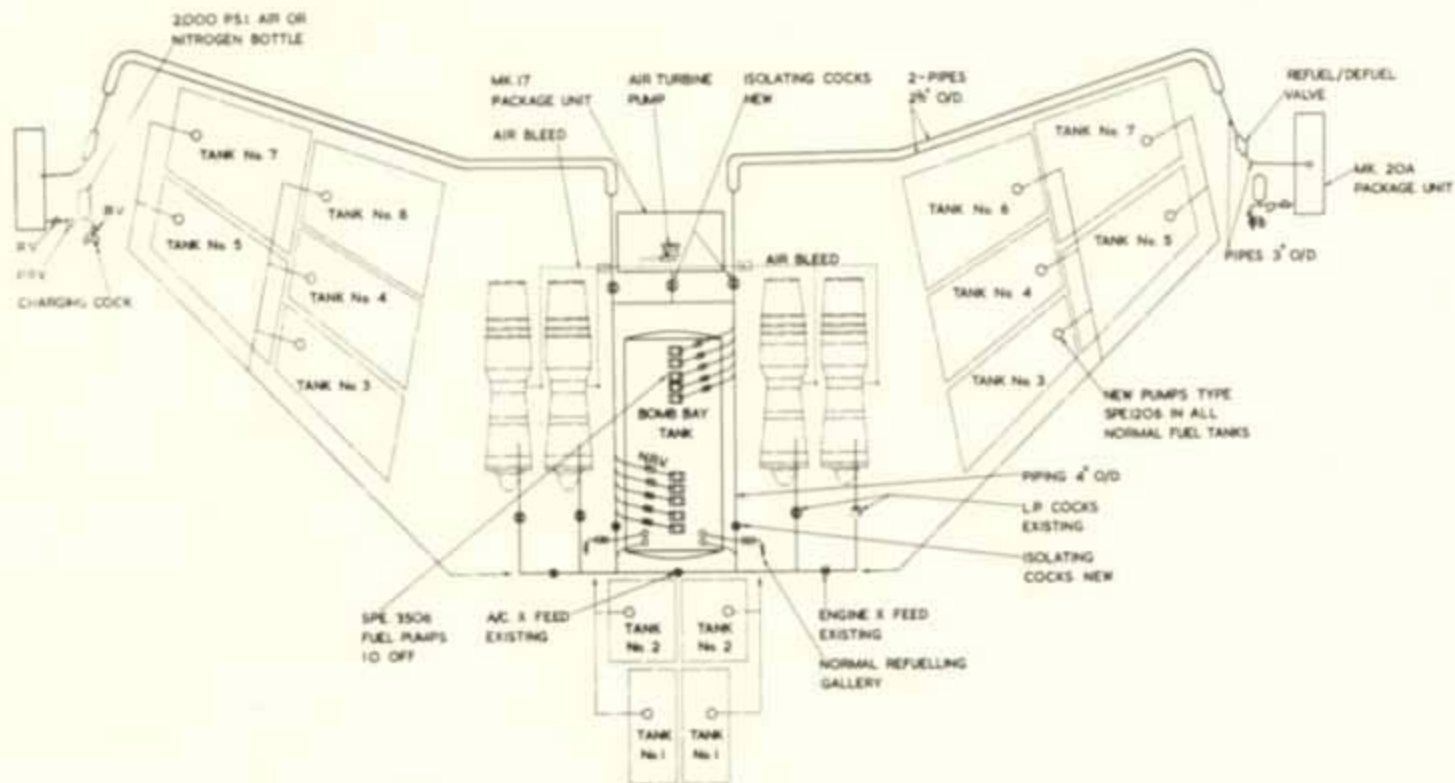


DIAGRAM OF FUEL SYSTEM

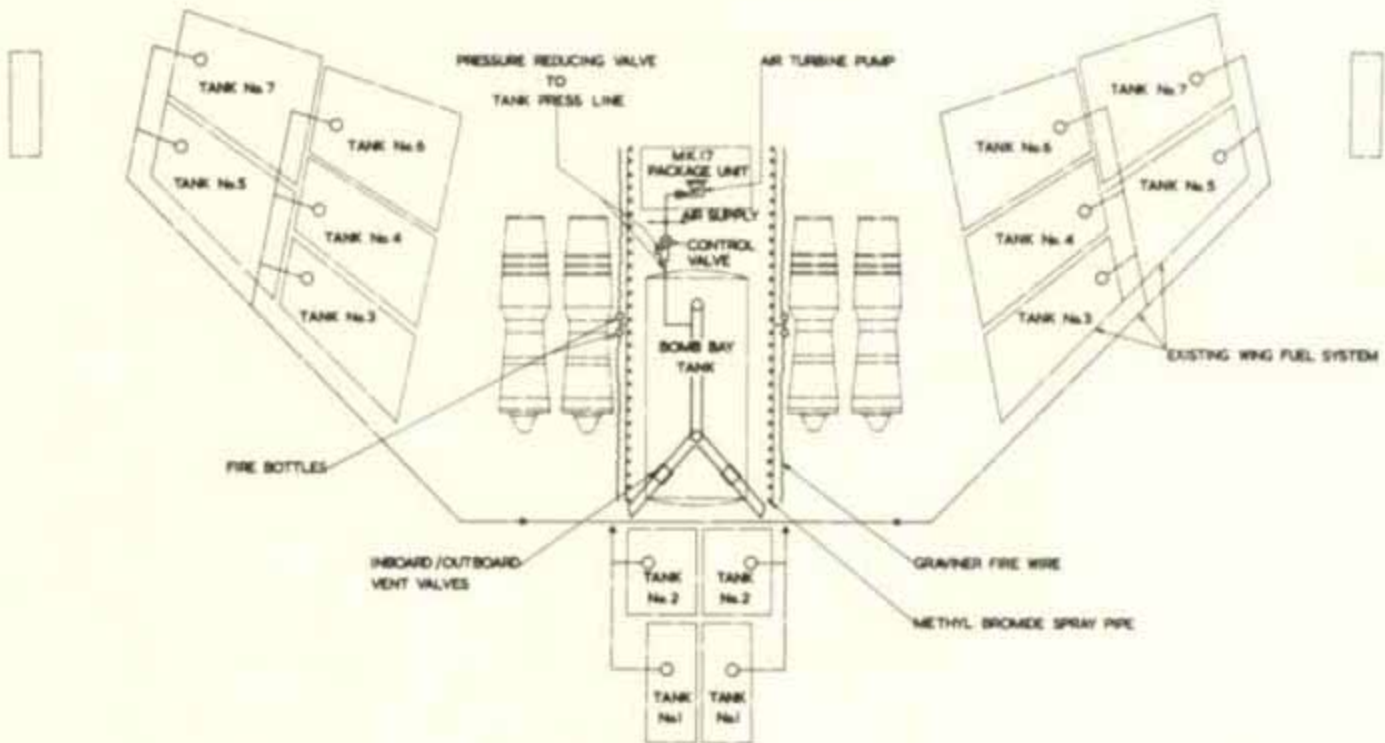
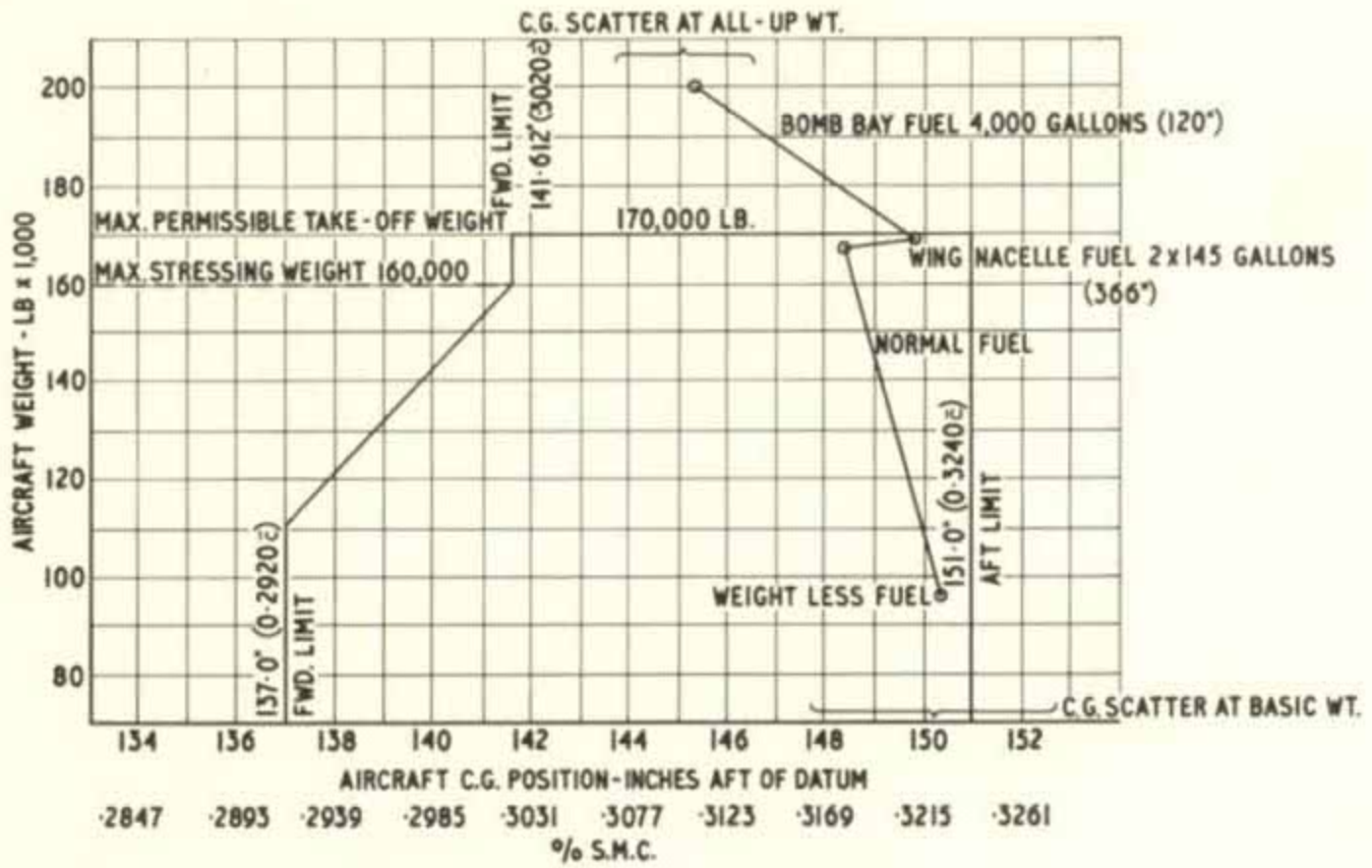


DIAGRAM OF VENTING SYSTEM, METHYL BROMIDE & FIRE WIRE SYSTEM ETC.

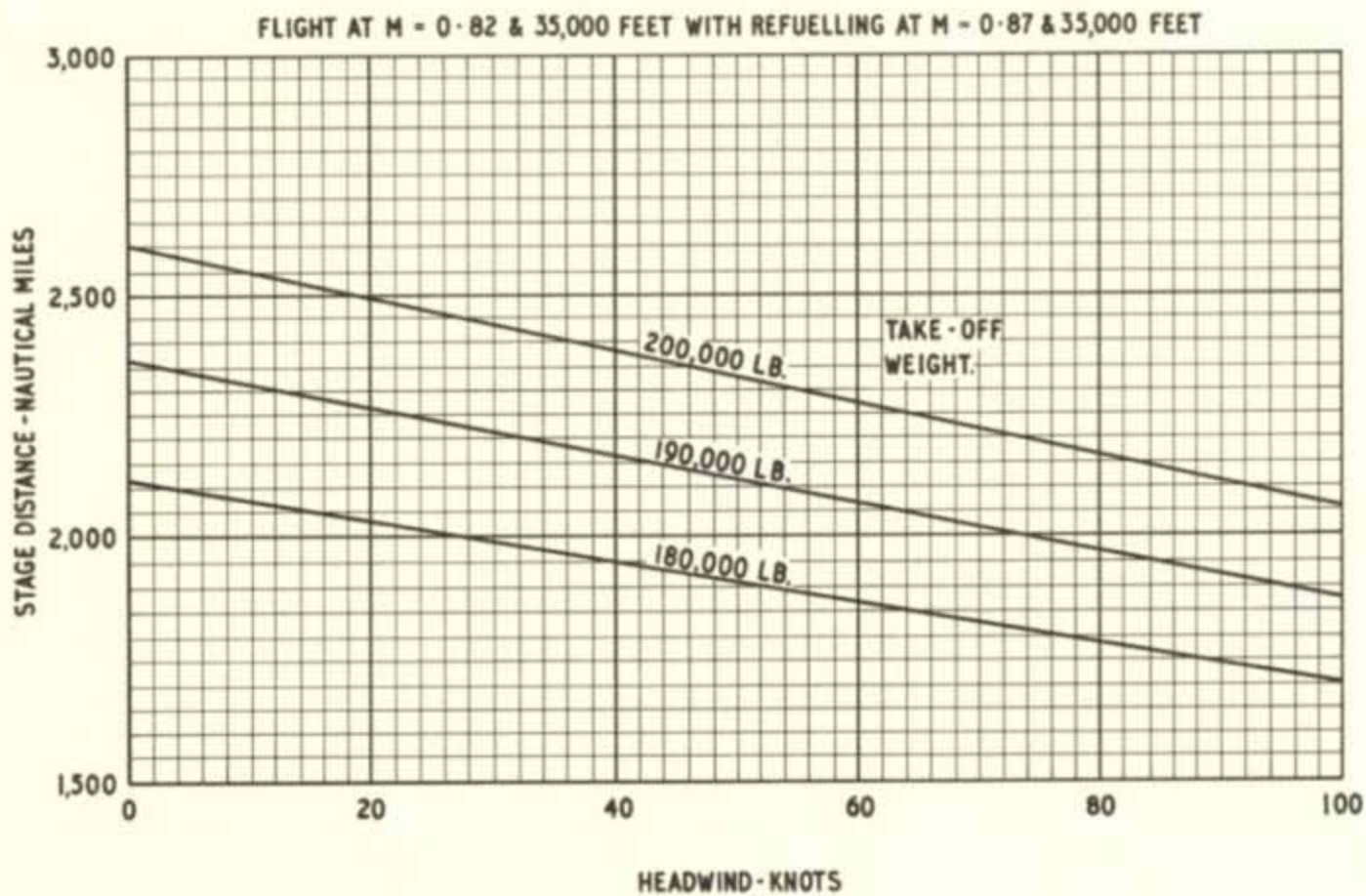


C.G. ENVELOPE - LIMITS SHOWN ARE WITH U/C. DOWN.

TANKER CONVERSION

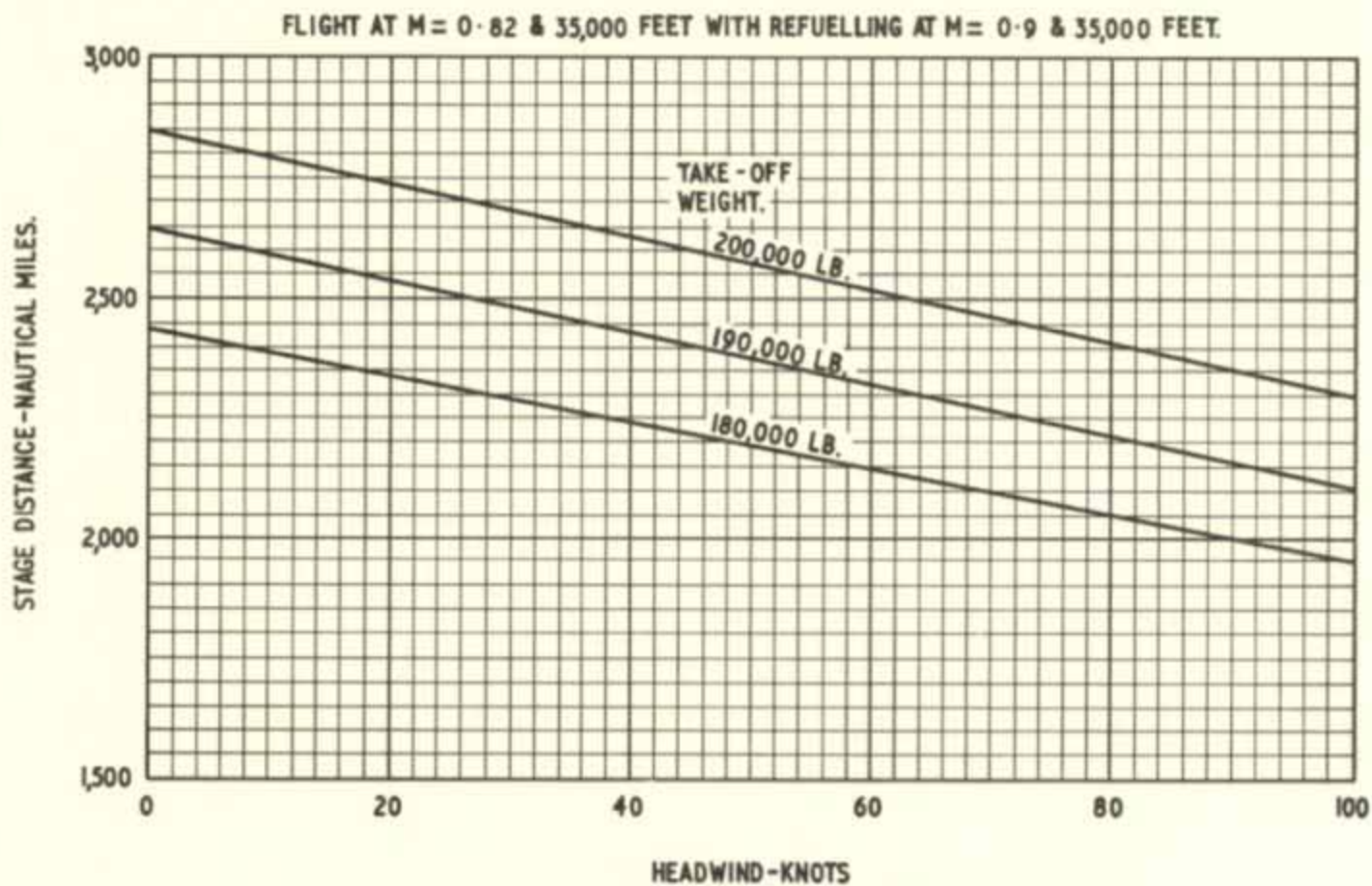
WEIGHT SUMMARY

	lb.
Present Aircraft Basic Weight. Less E.C.M. & Crew	86,871
Piping Connections	+ 200
Pumps 10 - SPE. 2506 (24 lbs.)	+ 240
Electrics	+ 250
Misc.	+ 50
Bomb Door to Fairing Changes	- 450
Bomb Bay Tank	+ 2,000
Bomb Bay Tank Support Structure	+ 40
Mk. 17 Refuelling Unit	+ 2,030
Mk. 17 Refuelling Unit Support Structure	+ 230
2 - Mk. 20A Refuelling Units (834 lbs.)	+ 1,668
2 - Mk. 20A Refuelling Units Support Structure	+ 200
Additional Radio & Electrics	+ 126
Flood Lighting & Electrics	+ 20
Spares:-	
E.C.M. Bay Wheels & Tyres	+ 1,427
"Window" Bays	+ 573
Basic Weight	<u>95,475</u>
Normal Fuel (99.7%) 9284 galls. @ 7.7. SG	71,493
Wing Pod Fuel 290 galls. @ 7.7. SG	2,232
Bomb Bay Fuel 4,000 galls. @ 7.7. SG	30,800
All up Weight	<u><u>200,000</u></u>
Total Fuel 13,574 galls.	104,525

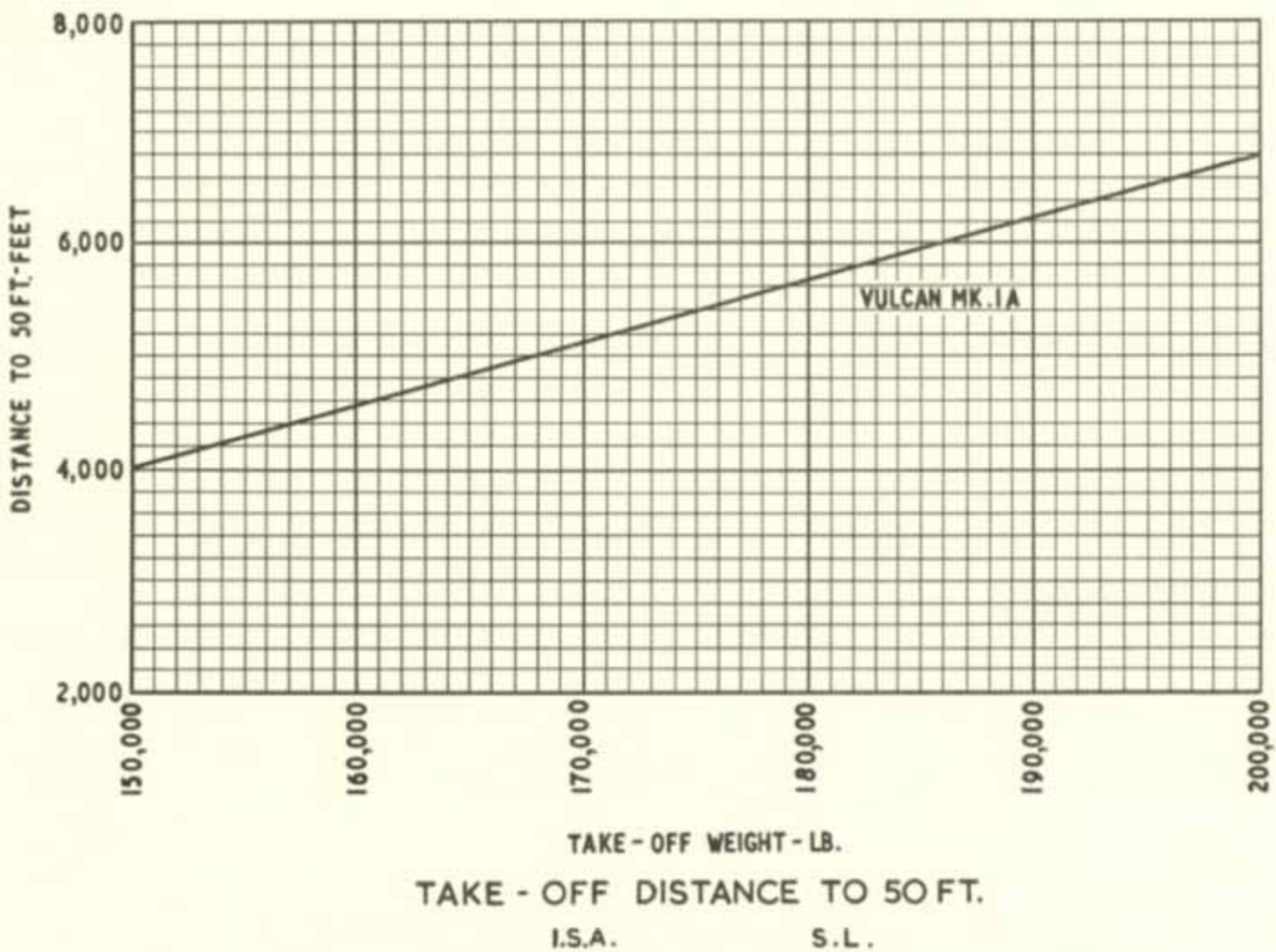


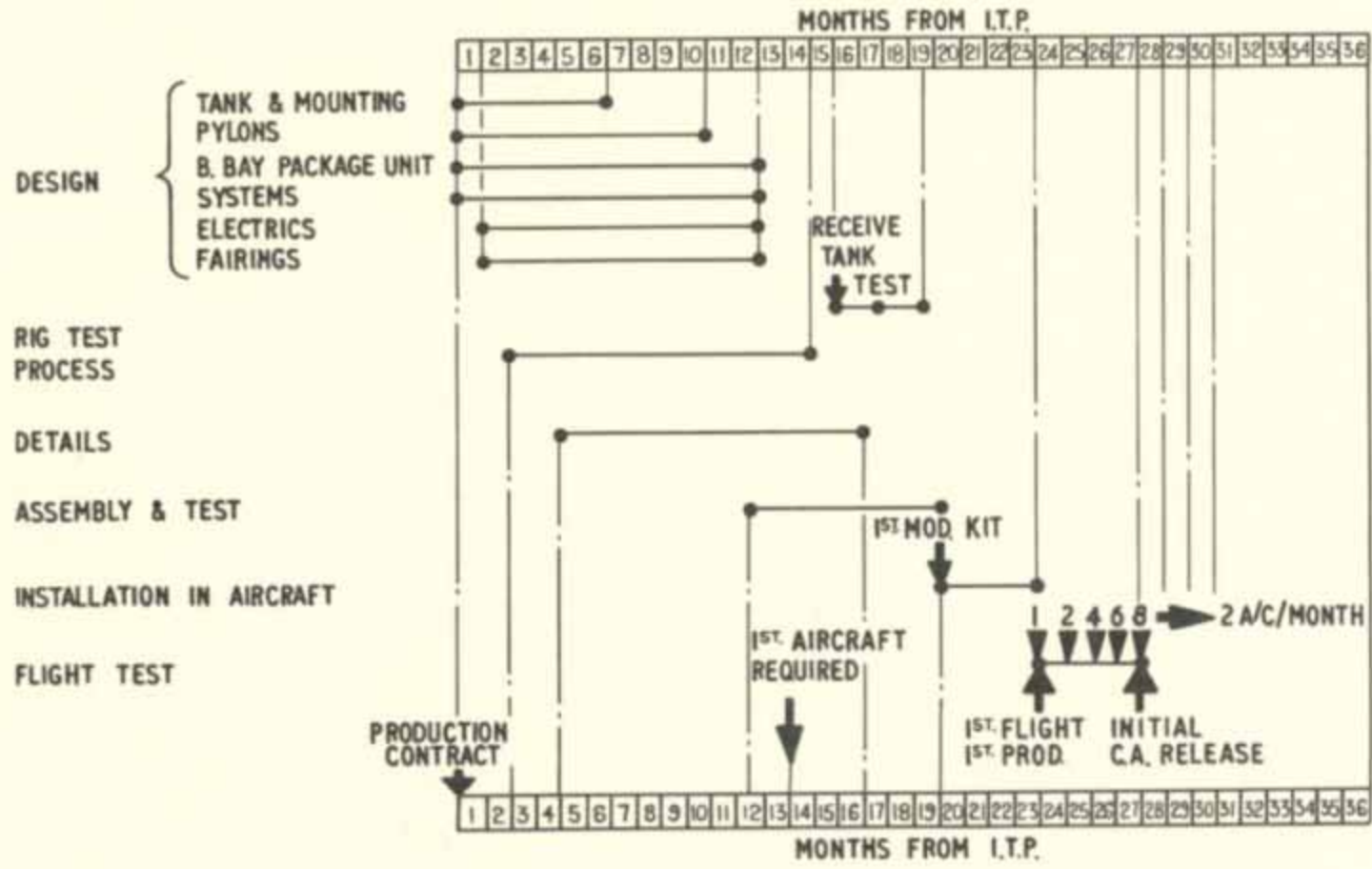
ACCOMPANIED BY TWO ENGLISH ELECTRIC LIGHTNINGS

STAGE DISTANCE WITH NO RESERVES



ACCOMPANIED BY ONE T.S.R. 2 AIRCRAFT.
STAGE DISTANCE WITH NO RESERVES.





TANKER VERSION - OVERALL PROGRAMME

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