

SUMMARY.

The design study summarised in this Report is based on R.A.A.F. Technical Requirements Specification No. A.C.103, Stage 4, and subsequent amendments requested at M.R. Lincoln L.T.C. Meeting No.23 for the conversion of Lincoln Mk.30A Bomber into Maritime Reconnaissance Aircraft Lincoln Mk.31.

The essential items of the conversion consist of the introduction of E.C.M., M.A.D., Wombat and Retro-Ejector installations, while retaining most of the present equipment.

The aircraft is manned by crew of 10 including a tactical crew of 4 located at existing nose stations. Controls and indication for the new installations have been added to the port stations in the nose. Existing flight deck stations remain unaltered.

A new E.C.M. Radome is positioned under the nose section between the escape hatch and bomb bay.

The tail gun-turret has been replaced by a 15 ft. non magnetic extension to the rear fuselage to house the M.A.D. detector head.

Cut-outs beneath the fuselage just aft of the bomb bay cater for Wombat aerials. Further aft, Retro-Ejector and its associated compressor are grouped on port between the ASV.7 Scanner and the entrance door.

Except for Radio installations and Intercomm., which are replaced by their more modern equivalents, all present installations and applicable Modifications have been retained; also stores and fuel requirements remain unaltered.

The estimated A.U.W. of the aircraft when fitted with four (4) Merlin 102 (AUS) engines, including all stores and full fuel (including long range tanks) is 84,251 lb. i.e., exceeding the maximum permissible weight of 82,000 lb. Consequently only part of the specified stores or fuel can be carried on a particular flight to keep A.U.W. within limits.

The corresponding estimated C.G. position of +54.86 ins. (27.41% SMC) is satisfactory. (Permissible limits of C.G. :- Forward +45 ins. Aft, +63 ins.)

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1.0 INTRODUCTION.

This report covers investigations of the conversion of Lincoln Mk.30A Bomber to R.A.A.F. requirements for a Maritime Reconnaissance version. As these requirements have been evolved over a period, reference should be made to similar studies that have been made previously.

- 1.1 During the past few years a gradual conversion was carried out by means of series of independent modifications.
- 1.2 In November/December, 1954 at the request of the R.A.A.F. (letter Ref. 201/59/150) a Design Study was carried out by G.A.F. into fitment of AN/APS-20 Radar Equipment to replace the existing ASV-7 installation.

Also Electronic Counter Measures (E.C.M.), Wombat, Autolyucus and modern Radio and Intercomm. equipment were required. For these installations, the crew functions were re-allocated and opportunity was taken to make improvements in the layout and comfort of crew stations.

Results were submitted in a Report - "The Design Study into fitment of AN/APS-20 Radar equipment to M.R. Lincoln Mk.31 Aircraft (December, 1954)" together with Drawings Nos' EXT.1890 and EXT.1894 inclusive.
- 1.3 Additional investigations were carried out in January/February, 1955 covering further R.A.A.F. requirements and resulted in the Addendum No.1 to the above Design Study.
- 1.4 In July, 1955 the version based essentially on APS-20 lapsed (R.A.A.F. letter Ref. 615/55 A73-2/42A, dated July 4, 1955 - Modifications to Final Version), and a requirement was made for a version with ASV-7 Radar, Autolyucus, M.A.D., Retro-Ejector and Wombat.
- 1.5 In October, 1955 (R.A.A.F. letter Ref. 1079/55, dated October 31, 1955) the following installations were deleted from the final version requirements :- Autolyucus, Optical Plotting Table, V.H.F. Homing. (A.R.I.18048) and Nose Optical flat glass panel for low level bombing.
- 1.6 In April, 1954 fitment of M.A.D. equipment was approved as a Modification L.905 (for prototype only).
- 1.7 In January, 1956 Technical Requirement Specification No. A.C.103 for Maritime Reconnaissance Aircraft - Lincoln Mk.31 (conversion of Lincoln Mk. 30A Bomber) was issued by the R.A.A.F. with some amendments following at L.T.C. Meeting No.23, held on February 16, 1956.
- 1.8 The present Design Study is based on para. 1.7 and is the subject of this Report.

2.0 GENERAL LAYOUT OF AIRCRAFT.

The equipment layout proposed by G.A.F. for the M.R. Lincoln Aircraft is shown in the attached Drawing No. EXT. 1926.

The E.C.M. Radome will be mounted centrally below the fuselage nose between the escape hatch and the bomb bay. The rear turret will be removed and replaced by a fuselage extension mounting the M.A.D. Detector Head, while a third Fin, made necessary by the introduction of the E.C.M. Radome at the nose, will be fitted to the fuselage picking up at the existing tailplane frames.

The crew of 10 includes a four-man tactical team, and all are placed at existing stations.

2.1 Layout of Equipment

2.1.1 Magnetic Anomaly Detection (M.A.D.)

The detector head in a waterproof capsule and the coil will be mounted in a 15 feet non-magnetic extension made to the rear fuselage with all equipment not requiring attention in flight grouped ahead of the tailplane front spar.

The milliammeter recorder, control console and magnetic compensator will be placed at the forward port tactical station.

2.1.2 Electronic Counter Measures (E.C.M.)

This installation consists of 4 groups :-

Radar Set AN/APR-9,
Signal Analyser Group AN/APA-74,
Direction Finder Group AN/APA-69A and
Broad Band Passive Directional Receiver AN/UPD-501.

The two E.C.M. scanning type antennae and four tuning units will be housed in a Radome beneath the nose fuselage. A retractable, mechanical linkage type, mechanism and remotely controlled relays will be provided for changing antennae in flight.

The control consisting of three indicators and two control units will be added to the existing Port Sonobuoy Station in the nose fuselage. The existing Sonobuoy indicator and control will be repositioned further to port to provide the required space.

The bulk of equipment will be mounted on the re-designed crate aft of the rear main spar.

The details and requirements for the two AN/UPD-501 antennae are not available and therefore these antennae are not shown on the Diagram of Equipment.

2.1.3 Wombat

Perspex panels will be fitted in the lower fuselage skin immediately behind the bomb bay for Wombat Aerials. Some re-arrangement of the present pyrotechnic rack will be required.

The Wombat Indicator and Wind Finding Attachment will be fitted at the existing Route Navigator Station with the remaining units of the installation mounted on the equipment rack aft of the main spar.

2.1.4 Retro-Ejector and Compressor

Since no detail dimensional data of this installation is available, the space only has been reserved in the rear fuselage for the Air Compressor, Ejector and Air Bottles. The remote control box will be placed in the nose fuselage at port forward station beside the M.A.D. Recorder. Thirteen markers will be stored in the reworked pyrotechnic crate, thirteen in the new rack and the remaining thirteen in the magazine of the ejector.

2.1.5 Miscellaneous New Equipment

Other equipment items specified do not in general, comprise multiplicity of units. All units not requiring attention during the flight will be fitted at the equipment rack aft of main spar, while the controls will be added to the appropriate operators station.

The table below lists miscellaneous new installations and the location of their controls.

2.1.5 Miscellaneous New Equipment (cont'd.)

INSTALLATION.	LOCATION OF CONTROLS	REMARKS
Instrument Landing Service (I.L.S.) A.R.I.18011.	Pilot Station.	
I.F.F. Mk.10 AN/APX-6. A.R.I.5848.	W/T. Operator Station.	Replaces I.F.F. Mk.3.
G.P. Radio Collins 618.S.	W/T. Operator Station.	Replaces G.P. Radio T.1154/R.1155.
V.H.F. Radio TR.1987.	W/T. Operator Station.	Replaces V.H.F. Radio TR.5043.
Intercomm. AN/AIC-5A.	Operating Assy at W/T. Operator Station; 3 main Control Units at Pilot, Co-pilot and W/T. Operator Stations. Other Control Units one at each of the remaining Crew Stations plus Launching Chute, Retro-Ejector, Fire Control, Ditching and Elsan Stations.	Replaces existing normal and special Intercomm.

2.2 Crew Stations

The crew stations in the aircraft are indicated in Figure 1, together with tabulated lists of equipment allotted to each crew member.

2.2.1 Nose Tactical Stations

Four-man tactical team is stationed in the nose fuselage; the team consists of :-

The Tactical Navigator - stationed at the forward starboard table with provision for sonobuoy and homing weapon release.

Spare Tactical Navigator - seating either at the Bomb Aimer's station or forward port station, the latter being fitted with M.A.D. display and Retro-Ejector remote control.

Sonobuoy No.1 Operator - at rear starboard station operating Sonobuoy Indicator and Control.

Sonobuoy No.2 Operator - seating at the rear port station operating the second Sonobuoy Indicator and E.C.M. system.

2.2.2 Flight Deck Stations

The Pilot, Co-Pilot, Radar Operator, Route Navigator and W/T. Operator stations remain essentially the same as in the present aircraft except for the addition of I.L.S. to the Pilot and replacing the Radio and Intercomm. installations with their more modern equivalents (see para. 2.1.5).

2.2.3 Stations in the Rear Fuselage

The Action Station at the Launching Chute on port side has been retained while the Retro-Ejector Station will be added on the starboard side in the vicinity of the Launching Chute.

3.0 ELECTRICAL POWER REQUIREMENTS.

The effect of the Stage 4 equipment requirements on the electrical power capacity is summarised in the Table below.

3.1 To cater for the 115 volt single and 3 phase A.C. supplies for the new requirements, it is proposed to fit two Jack and Heintz Inverters, Type F-45-3 having an A.C. output of 2250-2500V.A. each.

3.2 For the 80 volt A.C. supplies required for ASV, Mk.7A etc., it is proposed to retain one only of the two existing Motor Generators, Type 4B.

3.3 Summary of Power Requirements

Power Type Required.	Proposed Generating Source.	28V D.C. Power Required	
		Steady	Peak
a. 1 ph 380-420 c.p.s. 115 V 1619 V.A.	Jack & Heintz Inverter Type F-45-3 (Total output 2250 VA)	3164 W	3164 W
b. 3 ph 380-420 c.p.s. 115 V 600 V.A.	Jack & Heintz Inverter Type F-45-3 (Total output 8500 VA)	2352 W	2352 W
c. 1 ph 2000 c.p.s. 80 V 1485 V.A.	Motor Generator Type 4B. (Total output A.C. 2000 W)	2772 W	2772 W
Total D.C. Requirements for Inverters.		8288 W	8288 W
28 V D.C. Requirements for New Equipment.		4361 W	4937 W
28 V D.C. Requirements for Existing Equipment retained in Aircraft.		6336 W	14778 W
TOTAL D.C. REQUIREMENTS.		18985 W	28003 W

3.4 The present generating capacity (24 K.W.) can cater for this steady loading under normal operating conditions, but in the peak with "everything on" the maximum generating capacity is exceeded.

If the R.A.A.F. can indicate a diversity factor, depending on the operational scheme for the equipment to be observed, there may be no need to increase the present D.C. generating capacity. Otherwise a new 6 K.W. Generator (Type P3) installed on one of the inboard engines would be required.

4.0 AERODYNAMIC ASSESSMENT OF MODIFICATIONS.

The wind tunnel test for APS-20 version including M.A.D. tail extension and large APS-20 Radome have indicated the agreement between the estimated and tested characteristics.

Further wind tunnel test should be carried out to prove the following estimates for this design study version.

4.1 Stability Estimates

The longitudinal static margin will be reduced by some 0.8% S.M.C. and there will be some small increase in C_{M_0} of the order of -0.004. The associated loss in longitudinal stability can be corrected by a forward shift of the C.G. of the aircraft by 0.8 S.M.C.

The directional static stability will be reduced by some 20% in the already marginal value of $n_v = +0.043$. This will lead to fin stalling and rudder locking in a sideslip or when flying with asymmetric power.

This will be corrected by an addition of a third fin to bring the n_v to a more acceptable value of +0.07 (with engines on).

4.2 Radome Wake and Propeller Buffeting

With the proposed E.C.M. Radome shape there should be no propeller buffeting.

4.3 Performance

The addition of the new radome and M.A.D. extension will increase the profile drag coefficient by .0008.

This will cause a reduction of top speed by some 3 knots at 5,000 feet, resulting in top speed of 212 knots T.A.S.

The reduction in range, when flying at 82,000 lb. at 5,000 feet and 1.14 times minimum drag speed, i.e. 159 knots T.A.S. will be of the order of 1.6%. This will result a still air range of 2,360 nautical miles.

5.0 STRUCTURAL MODIFICATIONS.

Except for the radome, fuselage extension, retro-ejector mounting and the introduction of the third fin, the structural modifications required will be of a minor nature.

5.1 Radome and Fuselage Extension

The construction and attachment of these components will follow "Neptune" practice.

The Radome will be a moulded sandwich in glass cloth and will be constructed in two halves symmetrical about the centre line of the aircraft and hinged at the side of the fuselage to permit access to the antennae for maintenance.

The Fuselage extension will be a sandwich construction having glass cloth facing supported on a honeycomb core.

5.2 Third Fin

A third fin of approximately half the normal area of an existing Lincoln fin will be fitted on the fuselage, picking up on the present tailplane spar frames. The component itself will be of straight-forward construction and except for the attachment fittings, there should be little reinforcement required to the pick-up frames.

5.3 Retro-Ejector Mounting

Approximately three to four frames in the rear fuselage will have to be cut on the lower side of the aircraft and bridged over the floor to provide a cut-out for the retro-ejector barrel. Further reinforcement to take 3,200 lb. recoil and fairings over the outside portion of the barrel will be necessary.

Due to non-availability of the dimensional data on the equipment, the more precise description of the structural modifications for the retro-ejector cannot be stated.

5.4 Miscellaneous Structural Modifications

Cut-outs for Wombat aeriels will be made in the underside of the fuselage immediately behind the bomb bay. These will be covered by perspex in glass cloth frames and there should be little reduction in fuselage torsional stiffness.

Some local stiffening of the front and centre fuselage will be required and will entail mainly the reinforcement of existing members.

6.0 ARMAMENT STORES.

The Armament Stores requirements were stated by the R.A.A.F. at Lincoln L.T.C. Meeting No. 23. The only change to the items previously required for APS-20 version is the inclusion of 39 retro-ejector markers.

Total Requirements are listed on Table 6. Although stowages and fixed fittings will be provided for the full range of armament, these weapons will have to be selected in conjunction with the fuel requirements for a particular flight in order that the maximum permissible A.U.W. of the Lincoln aircraft is not exceeded (see para. 7.0).

7.0 WEIGHT ESTIMATE AND C.G.

The weight analysis shown in Tables 1-9 has been based on M.R. Lincoln Mk.31 aircraft incorporating all latest approved modifications up to Mod. L.956 inclusive. The basic weight of the aircraft has been determined by deleting rear gun turret, ammunition tracks and certain fixed fittings (see Table 2). This weight has been termed the "provisional basic weight". Fixed and removable fittings and structure for new installations become then additional to this weight (see Table 1).

It will be seen from the analysis that the total A.U.W. including all stores and the maximum fuel is 84,251 lb. which is 2,251 lb. in excess of the maximum permissible A.U.W. of Lincoln aircraft of 82,000 lb.

This A.U.W. is limited by the strength of the undercarriage and it is felt that to increase this limit would entail extensive further modifications.

The corresponding C.G. position of +54.86" (27.41%) is satisfactory, being within permissible limits.

Although appropriate fixed fittings will be provided for all the weapon and installations requested, as the weight limitation makes it impossible to fit the complete range, it is suggested that the R.A.A.F. select for each particular operation appropriate weapons and fuel that will maintain the A.U.W. below 82,000 lb.

8.0 CONCLUSIONS.

8.1 Appropriate fixed fittings will be provided for all installations and stores requested. However, the estimated A.U.W. of the aircraft including all stores and full fuel exceeds the maximum weight by 2,251 lb. Consequently the total equipment and stores requirements could be met only at the expense of some fuel load.

8.2 The D.C. electrical power already available in the aircraft could supply the new needs if a diversity factor can be allowed in assessing the load value for intermittent rating of the equipment. Nevertheless, to provide for the increased A.C. demand, two new inverters will be required.

8.3 The estimated loss in performance at 82,000 lb. A.U.W. amounts to approximately 1.6% decrease in speed and approximately 1% decrease in range.

The addition of a third fin will be necessary to correct the directional static stability reduced by the introduction of the E.C.M. Radome.

8.4 The existing lay-out of the crew has been retained to minimise the work required in the conversion. However, the crew comfort and visibility of indicators for various installations could be considerably improved by re-grouping the crew stations as proposed in the Report: "Design Study into Fitment of AN/APS-20 Radar Equipment into Lincoln Mk.31. (December, 1954/March, 1955)," i.e. tactical crew sitting side by side along one continuous table in the port side of the nose, and the flight deck crew placed to port, leaving the starboard side free for traffic outside a black-out curtain. This lay-out utilises the limited space available in a more efficient manner also it is more flexible and would permit the fitment of E.C.M. display at a Radar Operator's station in the centre fuselage, and would also allow a better view of the M.A.D. Recorder to both the Operator and Tactical Navigator.

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APPENDIX 1.

NOTES ON "BUNYIP" INSTALLATION

Since the completion of this Design Study the R.A.A.F. requested that space provision for "BUNYIP" should be included in Stage 4 (R.T.O. letter Ref. 304/56, dated 29/3/1956).

Detailed data on "BUNYIP" is not available at present, nevertheless the following summary indicates the extent of modifications which would be required to cater for this installation.

"BUNYIP" consists of the Attack Radar and two twin Search Radars, the total system containing approximately 33 units, 2 aerials each 20 feet long with cross-sectional area of 12"x 9" fixed to the sides of the fuselage, and one Scanner fitted preferably under the "chin" of the aircraft.

The weight of this installation is 770 lb. approximately, and with the radome and associated structural additions, mounting crates, cabling etc. will total approximately 1,000 lb.

Power consumption of 8.5 K.W. at 28.5 V. D.C. would require additional generators since the present electrical supply would not be sufficient.

Fitment of "BUNYIP" into M.R. Lincoln would therefore involve modifications far more extensive than those already considered in this Report and to obtain a more detailed appreciation of this equipment another Design Study investigation would be required.

TABLE 1. M.R. Lincoln Mk. 31 Design Study
March 1956

A.U.W. & C.G. POSITION ESTIMATE FOR M.R. LINCOLN MK. 31.

FULLY EQUIPPED AND FULLY LOADED

ITEM	WEIGHT LB.	+ ARM IN.	- MOMENT LB. IN.	+ MOMENT LB. IN.
Basic Weight of M.R. Lincoln including all Modifications up to L.942 inclusive (Based on weighing of A/c.65)	45,526	+ 51.49		2,344,272
<u>Add</u> : Effect, of Mods. L.943-L.956 inclusive.	20			126
<u>CURRENT BASIC WEIGHT</u> Including all Mods. up to L.956 inclusive.	45,546	+ 51.47		2,344,398
<u>Deduct</u> Fixed Equipment removed. (see Table 2)	573			348,400
<u>PROVISIONAL BASIC WEIGHT</u>	44,973	44.38		1,995,998
<u>Add</u> ; Structural Additions (see Table 3)	315			116,210
Existing removable equipment to remain in A/c. (see Table 4)	1,952			137,878
Fixed and removable equipment added. (see Tables 5 & 9) (for Detail Analysis)	1,985			278,701
Expendable Items (Armament & Pyrotecnic). (see Table 6)	8,410			957,316
Fuel and Oil (Maximum) (see Table 7)	24,616			1,333,310
Crew (see Table 8)	2,000		197,000	
<u>TOTAL ALL UP WEIGHT :</u>	84,251	54.86" (27.41% S.M.C.)		4,622,413

NOTE : Maximum permissible All Up Weight for M.R. Lincoln = 82,000 lb.

C.G. Limits Forward + 45" = (20.5% S.M.C.)

Aft + 63" = (33.2% S.M.C) Cruising.

+ 59" = (30.4% S.M.C) Landing.

TABLE 2.

FIXED EQUIPMENT REMOVED

	DESCRIPTION.	WEIGHT LB.	+ARM - INS.	-MOMENT LB. IN.	+ MOMENT LB. IN.
1.	Rear Turret (465 lb.) including Fittings and Ammo Trunk.	520	+670		348,400
2.	I.F.F. Mk. 3 Fixed Fittings.	13	-	-	-
3.	G.P. Radio)				
4.	V.H.F. Radio) Fixed				
5.	Intercomm.) Fittings	40	-	-	-
	Norm. & Spec.) only				
Total Fixed Equipment Removed.		573	-	-	348,400

TABLE 3.

STRUCTURAL ADDITIONS

	DESCRIPTION	WEIGHT LB.	+ ARM. - INS.	-MOMENT ^{LB.} INS.	+MOMENT ^{LB.} INS.
1.	Third Fin	95.0	+580		55,100
2.	E.C.M. Radome	75.0	-188	14,200	
3.	M.A.D. Extended Tail Structure	100.0	+753		75,300
4.	Cooling Facilities	35.0	-120	4,200	
5.	Re-introduction of Discharges 1.75" Structure	10.0	+411		4,110
Total Structural Additions		315	-	-	116,210

TABLE 4.

EXISTING REMOVABLE EQUIPMENT RETAINED

DESCRIPTION	REF. NO.	WEIGHT LBS.	+ ARM INS.	-MOMENT LB.INS.	+MOMENT LB.INS.
ASV-7 Radar	ARI.5753	353.3			62,128
Loran	AN/APN-9	36.0	- 78.0	2,808	
Barah		10.0		840	
Radio Altimeter	AN/APN-1	21.0	+484.4		10,172
S/B Receiver Installation	ARI.5487	140.0		25,980	
Dinghy Radio	SCR.578B	35.0	+484		16,940
Radio Compass	SCR.269G	89.8			10,257
Auto-Pilot	Mk.9	100.0		11,200	
Driftmeter	Type B3	26.0	-256.0	6,656	
Tactical G.P.I.	Mk. 1B	18.0	-209.0	3,762	
Compass	GM2B	38.3			2,678
Astro Compass	Mk.2	6.0	+ 6.0		36
Drift Recorder	Mk.2	5.5	- 65.4	360	
Misc. Nav. Equipment		30.0	- 68.5	2,055	
Portable Oxy.Bots.6 off		36.0	+126.7		4,561
Camera (Oblique)	F.24	25.0	+620.0		15,500
Camera (Vertical)	F.24	25.0	+420.0		10,500
Bomb Sight Computer	T.2	45.0	-270	12,150	
Sighting Head	Mk.14	13.3	-300	4,050	
Hot Food Equipment		31.7			1,027
Black-out Curtains		45.0		3,283	
Window Covers & Bag		5.0		942	
Covers (Engine etc.)		20.0	+420		8,400
Access Ladder		26.0	+433.2		11,783
Jury Struts		40.0	+170		6,800
Tool Kit		10.0	+452.5		4,525
Signalling Lamp	Aldis	6.0	- 70.0	420	
First Aid Kit		6.0	530.5		3,183
Dinghy & Emerg. Equip.	Type,Q	158.0	+126.0		19,908
Dinghies	Type K	135.0		3,501	

cont'd.

TABLE 4 (cont'd.)

DESCRIPTION	REF. NO.	WEIGHT LBS.	+ ARM INS.	-MOMENT LB. INS.	+MOMENT LB. INS.
Nose Turret Guns 2 off	Browning 0.5 ins.	140.0	-300.0	42,000	
Mid-Upper Guns 2 off	Hispano 20 mm.	270.0	+236.4		68,000
Signal Pistol		6.5	+6.0		39
TOTAL REMOVABLE EQUIPMENT RETAINED.		1,952.1			137,878

TABLE 5

FIXED AND REMOVABLE EQUIPMENT ADDED

1	DESCRIPTION	WEIGHT LBS.	+ARM INS.	-MOMENT LB. INS.	+MOMENT LB. INS.
1.	M.A.D.	252			109,645
2.	E.C.M.	517		37,216	
3.	Wombat	294			65,562
4.	Retro. Ejector and Compressor	190			90,202
5.	I.L.S.	81			4,000
6.	I.F.F.	57			6,342
7.	Colins Radio	120			8,559
8.	V.H.F. Radio	96			6,782
9.	Intercomm.	146			221
10.	Wire Recorder	18			1,697
11.	Add'l Elect. Services	214			22,902
	TOTAL FIXED AND REMOVABLE EQUIPMENT ADDED.	1,985			278,701

NOTE:- For Detail Analysis see Table 9.

TABLE 6.

EXPENDABLE ITEMS

DESCRIPTION	REF. NO.	WEIGHT LBS.	+ ARM INS.	-MOMENT LB.INS.	+ MOMENT LB.INS.
Ammunition for Nose Turret Guns 600 Rounds.		180.0	-293.0	52,740	
Ammunition for Mid-Upper Guns 720 Rounds.		450.0	+242.5		109,125
Non Direct, Sonobuoys 24 off.	T.1939	768.0			295,136
Marine Markers 24 off		504.0			149,781
Flame Floats 36 off		90	+280.0		25,200
Reconnaissance Flares 10 off		240	+280.0		67,200
Signal Cartridges 24 off		8.2	+6		49
Photo-Flash Cartridges 1.5" 12 off		6.0	- 11.9	71	
Photo-Flash Cartridges 1.75" Mk.1		-	-	-	-
Glow Warm Rockets 8 off		504.0	+ 61.2		30,845
" " 8 off		504.0	+ 79.7		40,169
Torpedoes 2 off	Mk.34	2,314.0	+160.8		372,091
Torpedo Carriers 2 off		118.5	+160.8		19,055
Dir. Sonobuoys 3 off	T.1946	207.0	+122.5		25,358
" " 3 off	T.1946	207.0	+199.0		41,103
Dir. S/B Carrier 1 off		30.5	+122.5		3,736
" " " 1 off		30.5	+199.0		6,070
500 lb. Bombs or Depth Charges 4 off		2,000.0	-107.0	214,000	
Bomb Adaptor 1 off		22.5	-107.0	2,408	
Bomb Carriers 4 off		79.0	-107.0	8,453	
Marine Marker (Retro Ejector) 13 off-(in Magazine)		49.0	+460		22,540
" " 26 off		98.0	+280		27,440
TOTAL EXPENDABLE ITEMS		8,410.2			957,316

TABLE 7.

FUEL AND OIL

DESCRIPTION.	WEIGHT LBS.	+ARM. INS.	-MOMENT LB.INS.	+MOMENT LB.INS.
No.1 Tank 1,160 gallons	8,352	+59.0		492,768
No.2 Tank 1,090 gallons	7,848	+62.5		400,500
No.3 Tank 600 gallons	4,320	+69.0		298,080
Oil Tank 144 gallon	1,296	+27.6		35,770
TOTAL MAIN TANKS - Fuel 2,850 gallons Oil 144 gallons	21,816			1,317,118
Forward Long Range Tanks 190 gallons plus 104 lb. Tank Weight.	1,472	-30.5	44,896	
Rear Long Range Tank 170 gallons plus 104 lb. Tank Weight.	1,328	+46.0		61,088
TOTAL LONG RANGE FUEL & TANKS 360 gallons	2,800		-	16,192
TOTAL MAXIMUM FUEL 3,210 gallons OIL 144 gallons & LONG RANGE TANKS WEIGHT	24,616			1,333,310

TABLE 8.

CREW

	WEIGHT LBS.	+ARM. INS.	-MOMENT LB.INS.	+MOMENT LB.INS.
Pilot	200	-120	24,000	
Co-Pilot	200	-120	24,000	
Route Navigator	200	- 60	12,000	
W/T Operator	200	- 4	800	
Radar Operator	200	- 90	18,000	
Tact. Navigator	200	-225	45,000	
S/B Operator No.1	200	-176	35,200	
S/B Operator No.2	200	-185	37,000	
Bomb Aimer	200	-285	57,000	
Mid-Upper Gunner	200	+280		56,000
TOTAL CREW	2,000		197,000	

TABLE 9.

DETAILED WEIGHT ANALYSIS FOR NEW INSTALLATIONS

DESCRIPTION	REF. NO.	WEIGHT LB.	+ ARM In.	-MOMENT LB. IN.	+MOMENT LB. IN.
1. MAGNETIC ANOMOLY DETECTION (M.A.D.)					
	AN/ASQ-8				
1. Detecting Head	DT37/ASQ-8	14.6	+853		12,454
1A. Capsule for Item 1.	GAF Manuf.	9.0	+853		7,677
2. Electronic Control Amplifier.	AM.294/	28.0	+538		15,064
3. Magnetometer Driver	O-90/	31.0	+538		16,678
4. Detector Amplifier	AM.295/	27.0	+538		14,526
5. Power Supply	PP.447/	43.0	+538		23,134
6. Millimeter Recorder	RD.47/	16.0	-217	3,472	
7. Control Console	C-820/	6.3	-217	1,367	
8. Magnetic Compensator	CN-191/	6.0	-217	1,302	
9. Switch Box	SA-181/	6.3	+535		3,371
10. Position Deviation Indicator.	ID-378/	3.0	+527		1,581
11. Coil Assembly	MX-1361/	9.5	+778		7,391
12. Accessories	-	12.2	-	-	-
13. Cables & Looms (est.)	-	20.0	-	-	-
14. Mtg. & withdrawing Mech. for Head.	GAF Manuf.	10.0	+853		8,530
15. Mounting Crate (est.)	GAF Manuf.	10.0	+538		5,380
				6,141	113,786
					<u>6,141</u>
TOTAL M.A.D.		251.9			109,645
2. ELECTRONIC COUNTER MEASURES					
<u>RADAR GROUP</u>		AN/APR-9			
1. R.F. Tuner	TN128/APR9	21.0	-166	3,486	
2. " "	TN129/	21.0	-166	3,486	
3. " "	TN130/	21.0	-166	3,486	
4. " "	TN131/	21.0	-166	3,486	
5. Mixer-Amplifier	CV-43/	15.0	+159		2,385
7. Remote Control	C.426/	6.0	-198	1,188	
8. Power Supply	PP-336	36.0	+139		5,004
9. " "	PP-337/	14.5	+151		2,189
10. Mtg. for R.F. Tuners 4 off		10.8	-166	1,792	
11A. Mtg. for Mixer- Amplifier	MT606/	3.0	+159		477
11B. Mtg. for Power Supply Item 9.	MT606/	3.0	+151		453
12. Mtg. for Indicator	MT607/	3.0	-208	624	
13. Mtg. for Power Supply Item 8	MT605/	3.0	+139		417
14. Accessories	-	2.7	-	-	-
TOTAL RADAR GROUP		181		6,623	-

TABLE 9 - DETAILED WEIGHT ANALYSIS FOR NEW INSTALLATIONS (cont'd.)

DESCRIPTION	REF. NO.	WEIGHT LBS.	+ ARM. - INS.	-MOMENT LB.INS.	+MOMENT LB.INS.
<u>SIGNAL ANALYSER GROUP</u>		<u>AN/APA-74</u>			
15 Indicator	IP-37/APA-74	37	-208	7,696	
16 Power Supply	PP-384/	27.6	+168		4,637
17 Mtg. for Indicator	MT-1145/	2.75	-208	572	
18 Mtg. for Power Supply	MT-1146/	2.87	+168		482
19 Data Recording Instrument (est)	KD-2	10.0	-195	1,950	
20 Mtg. for Data Rec- ording Instrum.	MT-1286/	1.1	-195	281	
21 Filter, Amber		.15	-195	29	
22 Filter, Green		.15	-195	29	
23 Accessories		1.5	-	-	-
TOTAL SIGNAL ANALYSER GROUP		83.1	-	5,438	-
<u>DIRECTION FINDER GROUP</u>		<u>AN/APA69A</u>			
24 Direction Finder Control	C-527/APA69	3.6	-199	716	
25A Antenna Drive	TG-8/	13.5	-199	2,686	
25B " "	TG-8/	13.5	-181	2,443	
26 Antenna Assembly	AS-434/	12.0	-199	2,388	
27 Antenna Coupler	CU-174/	.6	-199	124	
28 Antenna Reflector	AT-182/	2.5	-181	452	
29 Antenna	AS-436/	1.0	-181	181	
30 Azimuth Panoramic Indicator	IP81/APA69A	27.4	-208	5,699	
31 Mtg. for Item 30	MT-1005/ APA69A	2.5	-208	520	
32 Accessories		2.0	-	-	
TOTAL DIRECTION FINDER GROUP		78.6		15,209	
<u>BROAD BAND PASSIVE DIRECTIONAL SEARCH RECEIVER GROUP</u>		<u>AN/UPD-501</u>			
33 Receiver Indicator	R.5088/ UPD-501	29.0	-205	5,945	
34 Power Supply	PP-5040/	16.5	+175		2,887
35 Mtg. for Item 33		4.0	-205	820	
36 Mtg. for Item 34		4.0	+175		700
37 Aerial	AT-5008. (XP-1)	30.0			
TOTAL BROAD BAND SEARCH GROUP		83.5		3,178	
<u>MISCELLANEOUS ALSO REQUIRED FOR E.C.M.</u>					
38 Retracting Mech. for Antennas (est)		30.0	-192	5,760	
39 Relay Sys. for Tuners (est.)		6.0	-168	1,008	
40 Cables & Looms (est)		35.0			
41 Mtgs & Fittings (est)		20.0			
TOTAL MISCELLANEOUS		91.0		6,768	

TABLE 9 - DETAILED WEIGHT ANALYSIS FOR NEW INSTALLATION (cont'd.)

DESCRIPTION	REF.NO.	WEIGHT LBS.	*ARM. INS.	-MOMENT LB.IN.	+MOMENT LB.IN.
TOTAL ELECTRONIC COUNTER MEASURES.		517.2		37,216	
<hr/>					
3. <u>WOMBAT</u>					
Details of equipment not available.					
TOTAL ESTIMATED		294	+223		65,562
<hr/>					
4. <u>RETRO. EJECTOR & COMPRESSOR</u>					
1 Ejector		70	AVERAGE		
2 Magazine (Empty)		16)		
3 Local Control Box		3	APPROX. ARM		
4 Remote Control Box		3.5)		
5 Air Storage Bottle		36.0	+476		
6 Air Compressor		36.0)		
7 Mtg. Structure		15.0)		
8 Cables		10.0)		
TOTAL RETRO. EJECTOR AND COMPRESSOR		189.5			90,202
<hr/>					
5. <u>INSTRUMENT LANDING SERVICE (I.L.S.)</u>	<u>ARI.18011</u>				
1 Receiver Localizer/ Marker	R.1964	17.6	+143		2,517
2 " Guide Path	R.1965	16.7	+136		2,271
3 Combined Junction Box	Type 157	2.8	+140		392
4 Mounting Tray	Type 933	2.0	+140		280
5 Junction Box	Type 164	2.0	+137		274
6 Control Unit	Type 705	1.7	-140	238	
7 Indicator	Type 7	1.4	-140	196	
8 Voltage Regulator	S.A./C.R.) A.1200) or Type 60)	2.7	+137		370
9 Accessories		3.5			
10 Connectors		10.0			
11 Mtg. Batten for Item 6 (est)	Type 43	.5	-140	70	
12 Aerial, Localizer/ Guide Path	Type 236	3.5	-290	1,015	
13 Aerial, Marker (est)	Type 243	2.0	-290	580	
14 Cables (est)		15.0			
TOTAL INSTRUMENT LANDING SYSTEM		81.4			4,005
<hr/>					
6. <u>I.F.F. MARK 10</u>	<u>AN/APX-6 (ARI.5848)</u>				
1 Transponder	RT.82/APX.6	38.5	+155		5,967
2 Control	C-544/	1.4	-20	28	
3 Mtg. for Item 1	MT-362/	1.5	+155		232
4 Impact Switch		1.3	+155		201
5 Indicator Lamp Assy (est)		1.5	+155		232
6 Antenna	Type 100	1.3	+105	136	
7 Switch Unit	Type 2160	1.2	+105	126	
8 Cables		10.0			
TOTAL I.F.F.		56.7			6,342

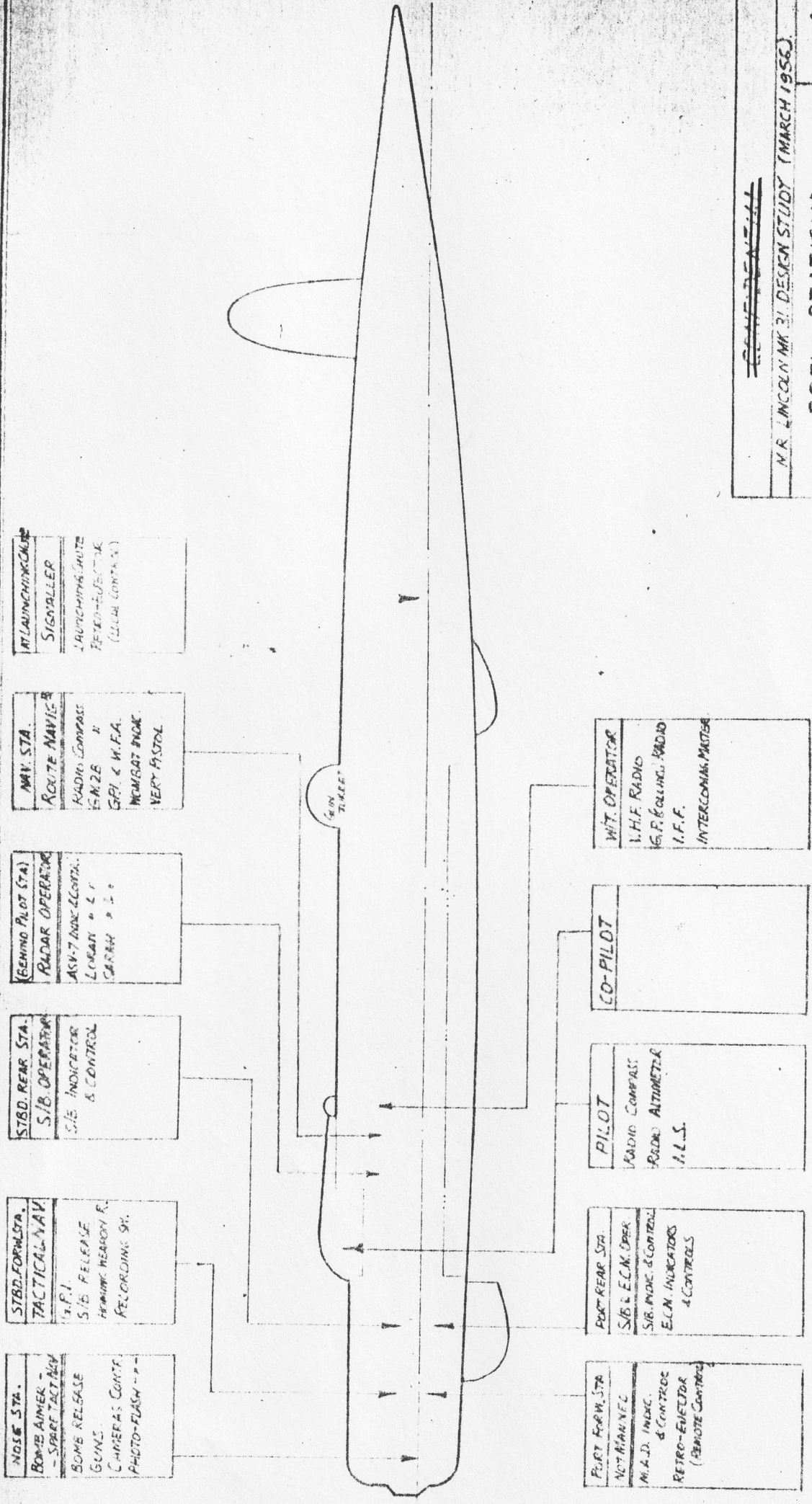
TABLE 9 - DETAILED WEIGHT ANALYSIS FOR NEW INSTALLATIONS (cont'd.)

DESCRIPTION.	REF.NO.	WEIGHT LB.	+ARM INS.	-MOMENT LB.IN.	+MOMENT LB.IN.
7. COLLINS RADIO	618.S				
1 Control Unit	614-D.1	1.5	- 30	45	
2 Transceiver (incl. Mtg 350S-1)	618S-1	60.0	+ 83		4,980
3 Auto Tuning Unit (incl. Mtg 350D.3)	180L-2	20.0	+ 84		1,680
4 Power Supply (incl Mtg 350T-1)	416W-1	24.0	+ 81		1,944
5 Cables - Connectors (est)		15.0			
TOTAL COLLINS RADIO		120.5			8,559
8. V.H.F. RADIO					
1. Trans-Receiver	TR.1987	69.0	+ 98		6,762
2 Control Unit		.6	-130	78	
3 Mtg for Item 1		1.0	+ 98		98
4 Cables and Connectors (est)		25.0			
TOTAL V.H.F. RADIO		95.6			6,762
9. INTERCOMM.	AN/AI C-5A				
1. Operating Assy.	OA-53A/AIC-5	42.7	- 26	1,110	
2 Mtg for Item 1	MT-778/	1.9	- 26	49	
3 Control Unit (Pilot)	C-380A/	3.8	-130	494	
4 Control Unit (Co Pilot)	"	3.8	-130	494	
5 Control Unit (W/T Operator)	"	3.8	- 17	65	
6 Control Unit (S/B Operator)	C-379A/	1.8	-185	333	
7 Control Unit (S/B & ECM Operator)		1.8	-176	317	
8 Control Unit (M.A.D. Operator)		1.8	-225	405	
9 Control Unit (Tact. Navigator)		1.8	-225	405	
10 Control Unit (B/Aimer)		1.8	-285	513	
11 Control Unit (Radar Operator)		1.8	- 90	162	
12 Control Unit (Route Navigator)		1.8	- 60	108	
13 Control Unit (Fire Control)		1.8	- 10	18	
14 Control Unit Ditch. Sta.		1.8	+ 55		99
15 " " " "		1.8	+ 55		99
16 Control Unit (Mid Upper Turret)		1.8	+233		419
17 Control Unit (Launching Chute)		1.8	+392		706
18 " " " "		1.8	+392		706
19 Control Unit (Retro Ejector)		1.8	+445		801
20 Control Unit (Elsan)		1.8	+550		950

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TABLE 9. - DETAILED WEIGHT ANALYSIS FOR NEW INSTALLATIONS (cont'd.)

DESCRIPTION	REF.NO.	WEIGHT LBS.	+ ARM INS.	-MOMENT LB.IN.	+MOMENT LB.IN.
21 Main Terminal Box (est)		10.0	+ 76		760
22 Distributing Box (est)		1.0	-188	188	
23 " " " "		1.0	+392		392
24 " " " "		1.0	- 90	90	
25 Cables & Connectors (est)		40.0			
26 Fixed Fittings (est)		10.0			
TOTAL INTERCOMM.		146			221
=====					
10. WIRE RECORDER	IC/VRW-7	17.5	+ 97		1,697
=====					
11. ADDITIONAL ELECTRICAL SERVICES					
1. Distribution Control Panel (est)		30.0	+192		5,760
2 Inverter) Jack & (F45-3		57.0	+140		7,980
3 Inverter) Heintz (E-1275-L)		57.0	+162		9,234
4 Sundries (est)		10.0			
5 Looms & Cables (est)		60.0			
TOTAL ADDITIONAL ELECTRIC SERVICES		214			22,902
=====					
TOTAL FIXED AND REMOVABLE EQUIPMENT ADDED TO AIRCRAFT		1985			278,701
=====					

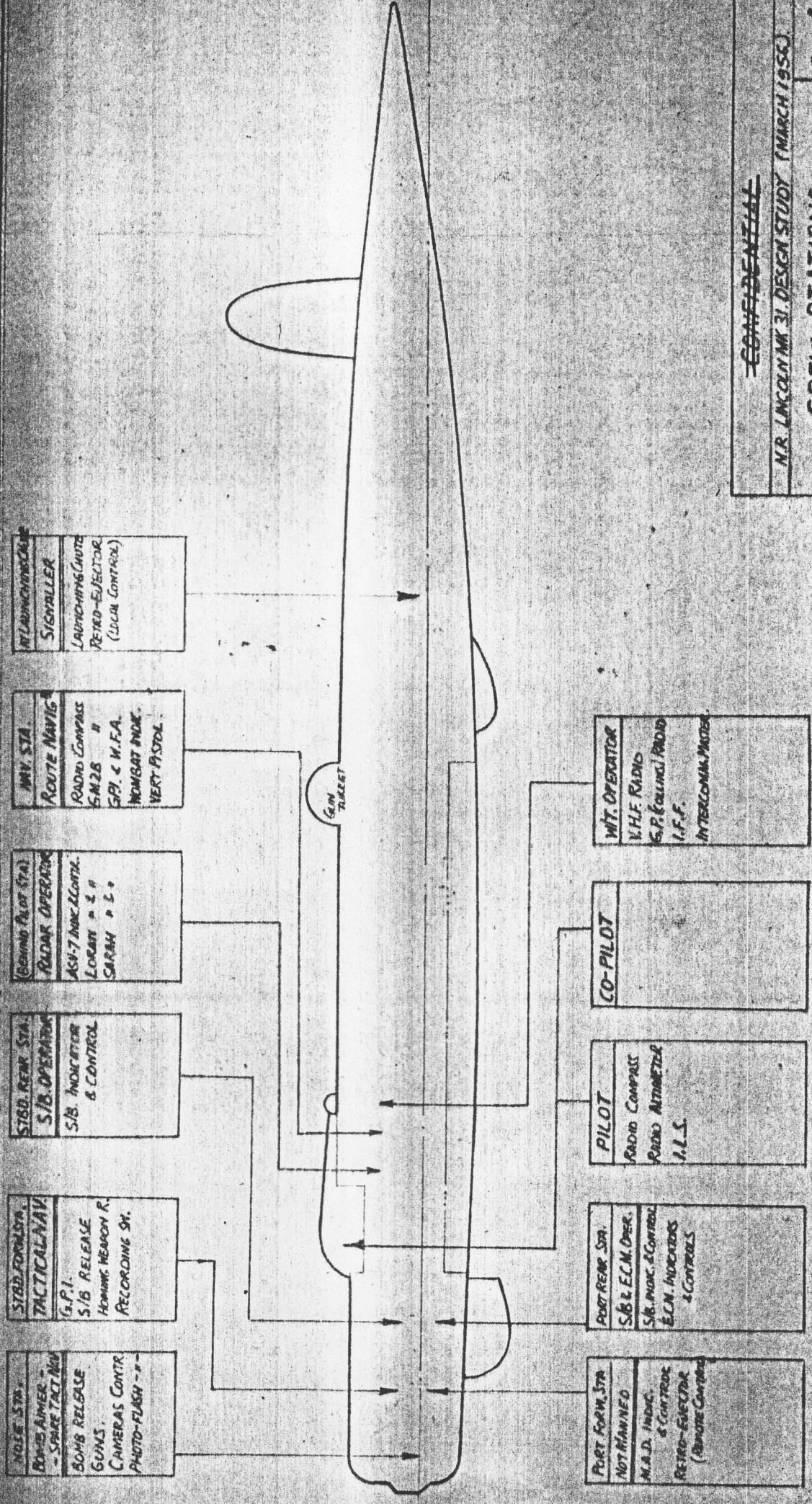


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M.R. LINCOLN MK 31 DESIGN STUDY (MARCH 1956)

CREW STATIONS

FIG. 1.



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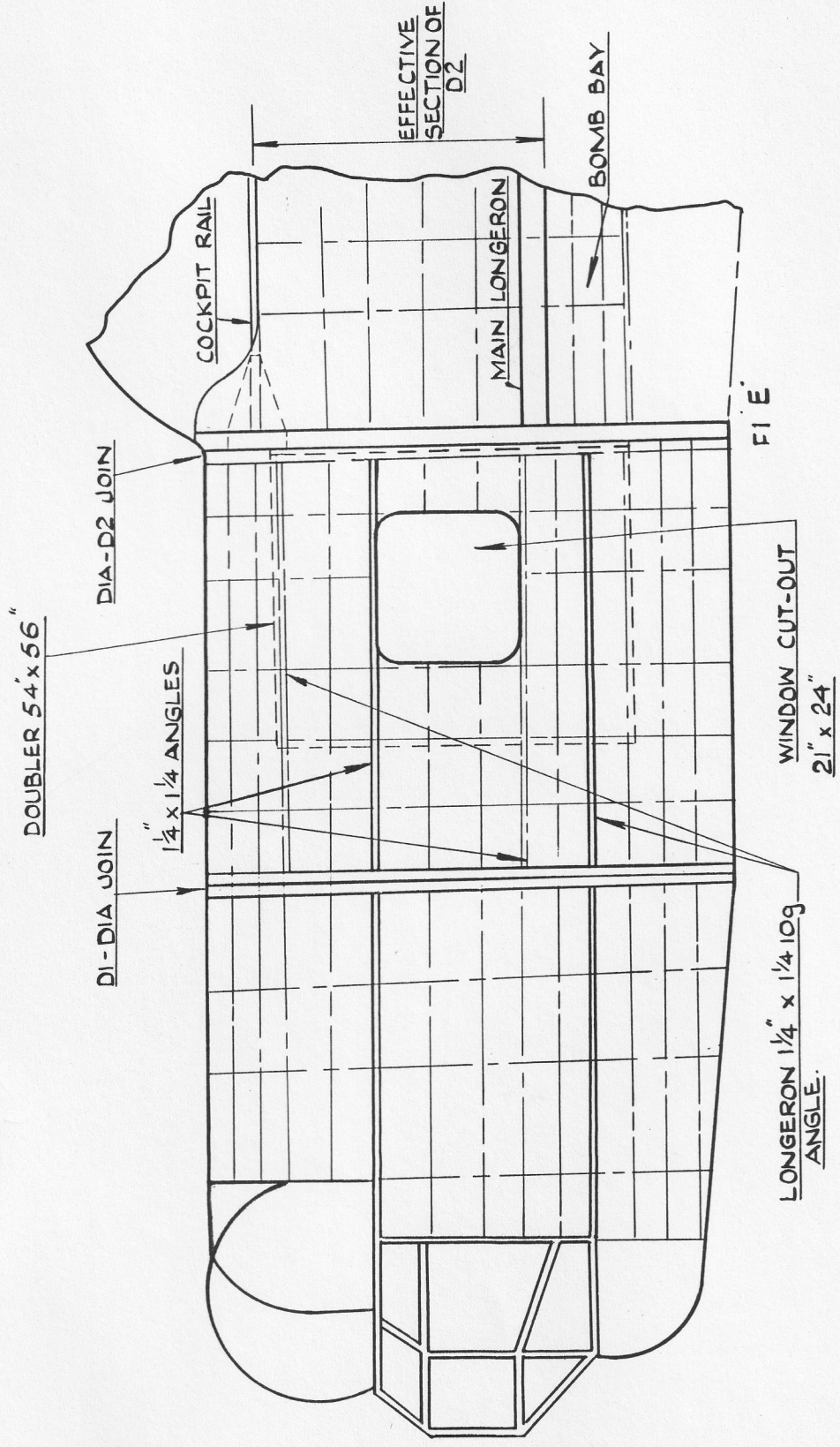
M.R. LINCOLN MK 31 DESIGN STUDY (MARCH 1956)

CREW STATIONS

FIG. 1.

x

STBD. SIDE OF FUSELAGE FORWARD OF COCKPIT



PREPARED BY S. B. DeLoach
DATE 4-5-52
PROJECT S.R. LINCOLN

C.S. (MISLE)
OR
A

PS

SM

MT

K

HJ

S

EF

TRUSS FRAMEWORKS
FOR SUPPORTING
A PROJECT

SCALE: 1/16

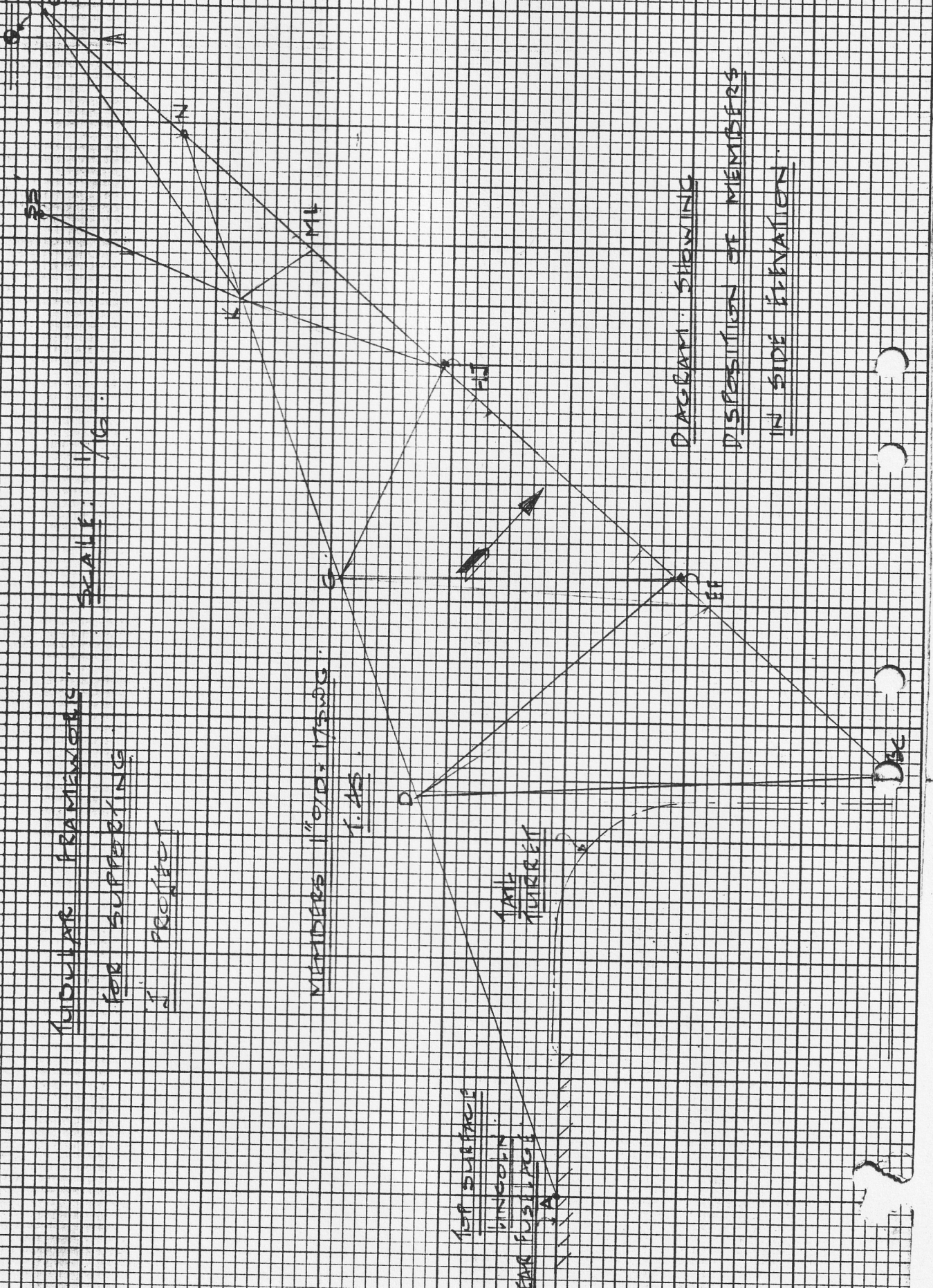
MEMBERS 1" x 12" x 175 LB
1.45

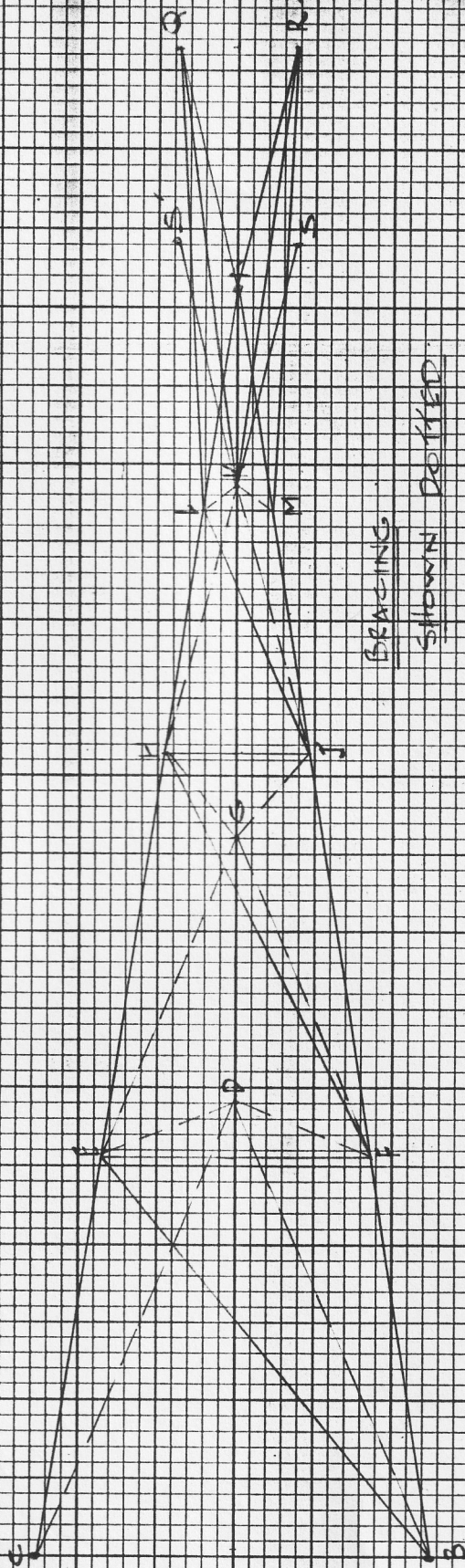
TOP SURFACE
BRIDGE
BEAM FUSING
IN

1" x 12" x 175 LB
TRUSS

DIAGRAM SHOWING
POSITION OF MEMBERS
IN SIDE ELEVATION

Disc





BRACING
SHOWN DOTTED

PLAN VIEW OF STRUCTURE
IN DIRECTION OF ARROWS

May 6 1953

A73-65 2nd test flight with E. Tower
1 1/2 hrs This A/c filled with effel
1 hr 15 min lower for 'J' project

May 6 3rd test flt

55 min.

From Log Book of E.M. 'Ted' Barden
via K Meggs