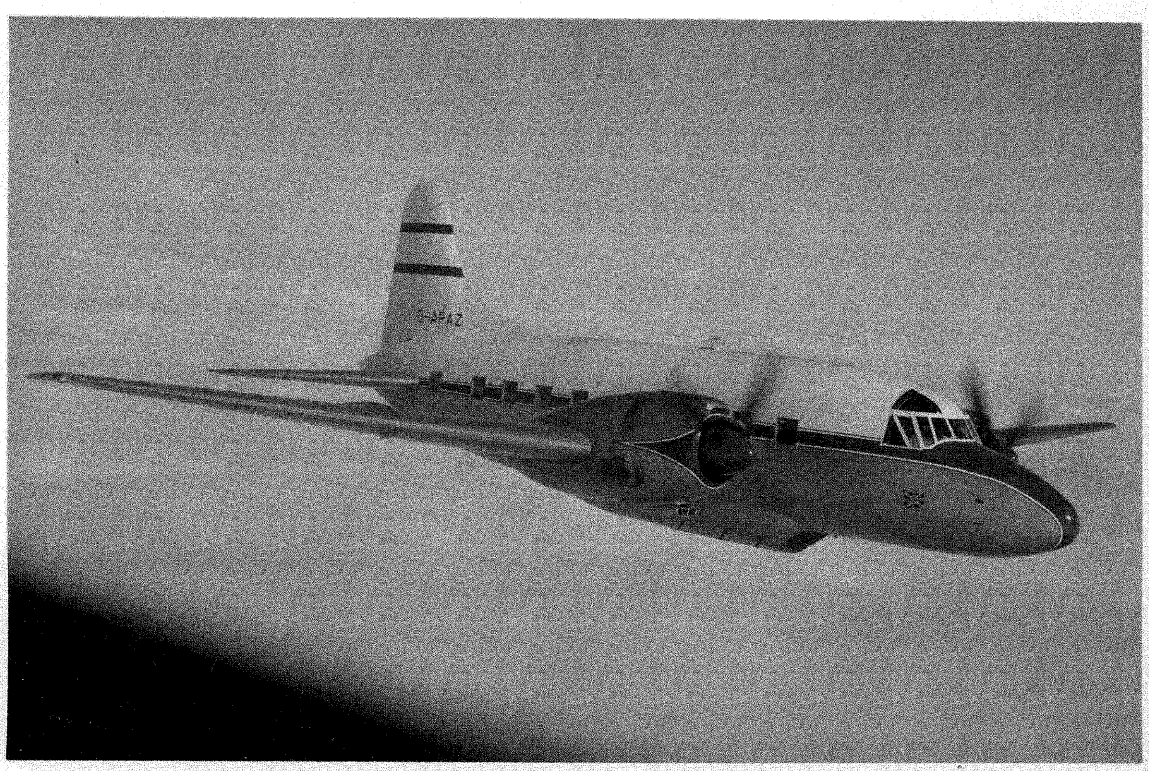
THE COLLEGE OF AERONAUTICS

CRANFIELD

Conversion from military to civil standard of Varsity WF.415 now G-APAZ and its preparation for use by Smiths Aircraft Instruments in accordance with the terms of M.O.S. Contract 6/Aircraft/14707/CB6(a)

Edited by H.W.Gover



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C O N T E N T S

1. SUMMARY OF REQUIREMENTS AND BRIEF DESCRIPTIONS

Varsity WF.415 was delivered as a standard aircrew training aircraft and had been in storage at No. 48 M.U., Hawarden, for a considerable period.

Under the contract the College was required to:-

1. Prepare the aircraft for delivery flight to Cranfield.
2. Carry out a Major Inspection.
3. Embody all outstanding modifications as required by R.T.O.Vickers.
4. Convert the aircraft from military to civil category.
5. Embody the required special modifications (listed in Part 4,Section 1).
6. Maintain the aircraft during a period of proving flights and A.R.B. Test Flights.

Prior to the delivery flight a discussion took place with the S.T.O. Hawarden. On the basis of this meeting a list of minimum requirements was raised by the Chief Inspector to fitness for flight to a one flight standard. A party of College employees was sent to prepare the aircraft, the operation taking five days.

On arrival at Cranfield the aircraft underwent an acceptance check and was completely stripped. The Inspection Schedule and Varsity Modification requirements were raised.

During the period required for the design of special modifications, the Major Inspection was carried out and the standard modifications embodied. It was decided that the sections of the aircraft affected by the special modifications (mainly cabin and cockpit area) would be inspected for defects and that the major inspection would be carried out on completion of these special modifications. This ensured that the spares required in these sections would be readily available and the major inspection, when carried out, would not uncover any serious defects. To avoid unnecessary load on the Design Department it was decided that during this period certain of the special modifications should be embodied to Flight Department drawings approved by Design The work was confined to non-structural parts. This permitted completion of a considerable number of the special modifications during overhaul, thereby releasing skilled man power for the more extensive special modifications as they were designed. During the period, close liaison was maintained with Design Department to ensure that equipment required would be available on receipt of drawings, thus avoiding, as far as possible, delay due to protracted delivery dates.

2. OVERHAUL AND CONVERSION TO CIVIL REQUIREMENTS

A Major Inspection was carried out to the standard of AP.4331, Vol. 4, Part 4 . All defects (approximately 450) were listed on check continuation sheets and sebsequently listed in the Chief Inspector's survey report DF/CAI/315(A). In addition certain other work was carried out to satisfy the requirements of the Air Registration Board, the main items being :-

1. Sealing of Fireproof bulkhead.
2. Reconnection of Fuel and Oil cock controls (separate control embodied to STI.4).
3. Individual control for each engine air intake.
4. Mandatory civil notices to be displayed in the cockpit and externally.
5. External civil registration markings.
6. Satisfy Notices to L.A.E's 15, 20, 35, 46.

The overhaul followed the normal routine for this type of aircraft, extra items being a power plant change, removal of inner planes, and completely stripping same for embodiment of Modification 516 at Brooklands Aviation Limited. From the above it is evident that the inclusion of the aircraft on the civil register did not involve the Department in many extra man-hours. Respraying to the required colour scheme was rather expensive in man-hours, due, mainly, to the dirty condition after storage, the removal of Service Training yellow bands and other markings and the fact that a lanolised fluid had been used for external protection. This fluid was, of course, most helpful in that no serious corrosion defects were found.

The following modifications were embodied during the overhaul.

115 Non magnetic bolts in the area around the magnetic compass.

274 Spring loaded brake pedal to increase sensitivity.

284 Fuel Contents Gauge - improved power unit.

285 Fuel tank isolating valve - new type seal.

294 Brake system - introduce new control valve.

302 Mainplane - strengthen navigation light mounting.

316 Electrical - locking of earthing points.

322 Main fuel filter reposition.

336 Oxygen system - rigid pipes in lieu of flex.

344 Maintenance ladder - anti-slip strips.

348 Nose Oleo - improve oil seal.

350 Main and Nose Oleo - new type oil seal.

355 Main Undercarriage new trimmer block and mounting bolt.

356 Electrical - Uniflexpren cable on control column.

371 Engine nacelle - new type Rotol gear boxes.

377 Rudder hinge - support bracket re-designed.

384 Brake system - new type reducing valve.

392 Electrical - new type Jaguar actuators.

403 Emergency hatch - hand rail and foothold fitment.

409 Undercarriage door control tube end fittings - light alloy to steel.

410 Nacelles - reposition tank drain outlet.

416 Aileron Control - stronger guide brackets.

418 Flaps - introduce reinforced jack cylinders.

421 Nacelles - rubber grommets to prevent drain pipe chafing.

424 Nacelles - access panels for ease of maintenance.

425 Nacelle - re-route fuel drain pipe.

429 Main undercarriage - increase clearance at shuttle valve securing bolts.

431 Flap hinge fitting - material change.

432 Elevator Con Rods - increase gauge.

440 Cowling stay supports tubes - stronger eye-bolt.

444 Undercarriage - addition of attachment bolts jack mounting.

452 Pressure head - reposition to prevent water collection.

453 Main Wheel - hub of new design.

458 Elevator - extra drain holes.

460 Re-designed elevator Trim chain guard.

466 Throttle lever spring catch, redesigned locking.

491 Mainplane to centre section attachment pins - Cadmium coat in lieu of clean finish.

499 Main undercarriage - change material specification wheel axle.

504 Nose undercarriage - change material specification wheel axle.

508 Elevator control - new type stop and safety bracket.

516 Centre section - modified lower spar booms (lifed at 2,500 hours).

The following Special Technical Instructions were satisfied :

STI/Varsity 2, 3A, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22.

STI/Misc. 93, 152, 167C, 174, 177, 198B, 202A, 212A, 221, 231A,

STI/Inst. 4, 5A, 6, 9, 10, 11, 12, 13, 14, 15A, 16, 17A, 18, 19, 20, 22, 25, 28, 30, 35, 41, 52A.

STI/Elect. 1, 4A, 12A, 16, 17A, 19, 21A, 23A, 26, 27, 28, 29, 30B, 31, 32, 33A, 34, 36A, 37, 38, 40A, 43, 45B, 47, 52A, 60A, 63A, 67B, 68A, 70, 72B, 73, 77, 85A, 91, 98, 112, 119B, 126.

3. Report of Design Work

3.1. Installation of special racking. Drg. Nos. M.179-6, M.179-7, M.179-8, M.179-13 (2), M.179-14

A top-hat section similar to that used on 'Dakota G-AMZE' was selected as being the most suitable to form the basis of the vertical structure in the cabin. This was attached to the aircraft structure via local brackets picking up on the floor intercostals, suitably reinforced to take the specified load and at the top via bolts through the top-hat flange to a channel section longeron running forward and aft between the formers and rivetted to the aircraft skin.

A welded tubular steel structure seemed to be indicated for the benches in view of its inherent strength, versatility and ease of manufacture. Weight although not a serious consideration compared very favourably with a light alloy rivetted (or bolted) structure to carry the same order of loading and bearing in mind the other advantages, this philosophy was finally agreed with Smith's Instruments and design proceeded. $\frac{3}{4}$" o.dia. x 22 s.w.g. T.45 tube was used and the resulting structure, despite some nominal distortion during welding fully justified its selection.

Attachment to the aircraft structure was by means of 2 B.A. bolts through welded foot plates at the base of the bench vertical members, picking up through the floor intercostals at the centre line and, outboard, through the flange of the vertical top-hat members.

Stressing of the integral structure and its attachments was a little difficult since the system of support is of necessity, highly redundant; however, an approximate method of solution using pessimistic assumptions was adopted and found to be satisfactory.

3.2. Installation of Forward and Aft Passenger Seats

Drg. Nos. M.179-34
M.179-65

Floor cross-members in the region of the aft passenger seats are fairly substantial sections consisting of 8" deep beams of 'I' section. Installation of seat pick-up points in this area therefore did not present any great difficulty from a structural point of view. However, the physical problems were quite considerable since access was difficult and adequate clearance had to be maintained between primary control runs and existing 'bracketry'. These difficulties were eventually resolved and the pick-up structure satisfactorily installed.

16 s.w.g. light alloy 'top-hat' sections formed the basis of the structure running forward and aft between the existing floor cross-members and picking up via shear connections on the cross-member webs. Using the standard method of attachment for the seat legs, 'keyhole' plates were bolted through from the top, picking up on the 'top-hat' flanges and suitably packed to accommodate the seat leg base fittings. Whilst the same 'top-hat' section was used for both double and single seats, it was necessary to strengthen the section locally in the case of the doubles and this was achieved simply, by rivetting a 10 s.w.g. light alloy strip along the bottom flange.

Forward seat attachment was arranged in a similar manner, however, the nose wheel structure top-hat section, bounding the parachute exit being utilised to react the inboard leg loads and the 'keyhole' plates designed to suit. The floor cross-members in this region are not quite so substantial as those aft and it was necessary to strengthen them locally, again by means of a heavy gauge strip along the bottom flange. It was also necessary in view of the proximity of engine control rods, to reduce the depth of the top-hat section by approx. $\frac{1}{2}$", maintaining strength by increasing the thickness to 14 s.w.g. and rivetting a 10 s.w.g. strip inside the bottom flange. An equivalent moment of inertia was achieved by this means.

3.3. Arrangment of D.F. Loops and Fuselage Reinforcement

Drg. Nos. M.179-9
M.179-10

Two 18" square cutouts were made in the upper fuselage cabin roof to accommodate the Marconi D/F Loops. The loops were mounted on the aircraft fore and aft centre line between formers at stations 217.93 and 242.34, and stations 261.00 and 283. The distance between centres of these loops is 43" which adequately caters for the minimum requirement of 36" for the installation.

Structural information re stringer end loads and skin shear loads in this area was obtained from 'Vickers' and the reinforcing structure designed accordingly. Basically, this consisted of a box structure, around the cut-outs to support the free edges and act as a base for the aerial mounting plates, a 'Z' section member, backed with a standard 'Vickers' stringer section bounding the cut-outs and running forward and aft between stations 196 and 296, picking up with the original No. 2 stringer run at station 196 and the astrodome flange. An additional backing stringer, again between stations 196 and 296 on stringer No. 3. Positive shear connections via skin angles at all formers in the area and a 20 s.w.g. doubling skin extending to stringer No. 3 port and starboard and again between stations 196 and 296 forward and aft. An assessment of the probable load diffusion has been made and a summary of this is included in the type record addendum. From this assessment it is evident that the reinforcing structure is adequate to cope with the order of loading envisaged.

3.4. Assembly of Navigator's Table. Drg. Nos. M.179-16
M.179-19

A navigator's table and folding bench seat is attached to the floor structure approximately 4 feet aft of the Pilot's seat on the port side of the aircraft. A welded tubular structure was selected for reasons similar to those applicable to the instrument bench. The table top is $\frac{1}{2}$" plywood and is clipped to the tubular frame, the inboard edge being parallel with the aircraft chord line. Integral with the table is a braced foam rubber/'Vynide' covered bench seat which can be readily hinged and secured under the main structure when not in use.

The observer station is not used for take-off or landing. Therefore, it is necessary for the structure to satisfy two different stressing conditions.

(a) Flight Case - Observer and Table Equipment.
(b) Crash Case - Table equipment only.

Due to these conditions and the associated loading at the table foot attachments, a 'top-hat' section cross member is introduced at the forward table floor position to take the bending loads. The aft feet pick up through the top flange of an existing floor cross member at station 174 and by which is reinforced by an angle rivetted along its bottom edge, and webbed stabilising brackets at the attachment points. The seat hinge is mounted centrally on the floor between the inboard table feet and picks up through the existing nose wheel structure top-hat section bounding the parachute exit.

3.5. Installation of Type 8A and Type 103 Inverters

Drg. No. M. 179-17

The requirement specifies the installation of two type 8A and 3 type 103 inverters and associated control panels etc. in the bomb aimer's compartment.

Due to space considerations and A.R.B. requirements for enclosure of the inverter compartment to obviate fire hazards, these items were mounted in a fabricated metal box sealed off from the ambient air. Clean air is ducted in from the port side of the bomb aimer's nacelle via a standard 'Varsity' air intake and flexible temperature resistant ducting into the box, and exhausted in a similar fashion from the starboard side through a specially designed extractor. The ducting run on the inlet side, is curved fairly sharply upwards to the base of the main floor in order to obviate water ingress. This has been achieved without paying any appreciable penalty in airflow restriction and ducting diameters were selected with this in mind. The rise also provides a safeguard against any possible 'creeping' of de-icing fluid into the duct from the fuselage whilst propellor de-icing is taking place, although this hazard has in fact, been the subject of an air test which has established that 'creeping' of the fluid into the duct is in any case extremely unlikely. Control panels, starters, relays, terminal blocks, torque switches etc., were attached to the box side panels and connected to suit the installation. This was considered to be the best method for achieving complete bench construction of the installation and simplicity of wiring prior to assembly in the aircraft.

The existing luggage floor, forward end, provided the base for attaching the inverter box. Existing pads rivetted to the corrugated floor section in a number of positions have centrally tapped 2 B.A. holes, which were utilised in the attachment of the box base board.

The two 8A inverters were mounted on a small board via 'top-hat' section stiffeners and A/V mountings, the tophats being bolted to the underside of the board. Similarly the three 103 inverters were attached to a second board, the whole thus being flexibly mounted inside the fabricated box. Temperature bulbs have been mounted in the compartment

between the 103 inverters as close as possible to the casings, in order to give some indication of 'carcase' temperature. Corresponding instruments were installed vertically on the starboard side sill panel such that they are within the range of vision of both pilots.

Adoption of the 'bench assembly' philosophy previously mentioned, by integrating all accessories on the box side panels and treating each as a separate unit for wiring etc., has proved to be most satisfactory. Maintenance is eased, due to close proximity of the units, wiring runs are kept to a minimum, physical 'installation problems in the aircraft are overcome and a high degree of soundproofing is achieved.

3.6. Modifications to Oxygen System Drg. Nos. M.179-42
M.179-61

A revised oxygen system was installed to supply the forward two seats in the passenger cabin, four points on the special benching and one point on the navigator's table.

The final outlet at each station is standard, viz. flowmeter, cut off valve and economiser in that order; all items have been suitably attached to adjacent structure with special brackets to College of Aeronautics design.

Oxygen is supplied to the outlets from the existing system. The seat position flowmeter is connected to the medium pressure line under the starboard side aircraft floor via bulkhead connector and a standard manifold. The bench positions are similar but connected to an existing medium pressure line under the main spar, utilising a now redundant manifold run. Low pressure oxygen is taken to the navigator's table via a bulkhead connector from the existing manifold in the bomb aimer's compartment.

The installation is simple, using, where possible, existing pipe runs, and attaching all items to adjacent structure with special brackets and pipe clips. Kick guards have been provided in appropriate positions covering outlets through the aircraft floor and adjacent to the economisers at the forward seat positions, to obviate inadvertent damage to the installation. All materials used are standard oxygen equipment items in accordance with A.P.970 and S.I.S. 2611.

3.7. Revised Pitot-Static System Drg. No. M.179-41

A new duplicate system has been installed on the starboard side front fuselage diametrically opposite that existing; this consists of a new pitot head together with static plates, the latter being mounted approximately 4" above the existing plates, port and starboard, and attached via standard stiffener plates on the inside of the fuselage skin. The new pitot head is a standard "Varsity" item but is modified to opposite hand to suit the installation.

The new static vents and pitot head were connected via 5/16" diameter aluminium tubing, as in the original installation, and supply the co-pilot's instruments and the special cabin equipment.

The original pitot static system is unaltered and feeds the pilot's instruments only.

All connectors, L.P. unions and aluminium tubing are standard pitot-static items. Piping runs have been suitably clipped to the aircraft structure throughout their lengths.

3.8. Assembly of Servometor Levers Drg. No. M.179-74

Fitment of torque cut out switches to the elevator and rudder servomotors in the aircraft rear fuselage necessitated the manufacture of new levers, the existing 'Varsity' levers having a smaller P.C.D. for the pick-up bolts.

The new levers are identical to those existing in material, operating centres, thickness and small-end bearing attachments, but are increased in diameter at the seromotor output flange to include the torque cutout switch spigot and increased P.C.D. of the attachment bolts. A lug is also included on the rudder lever on the centre line above the T.C. switch position to attach the potentiometer actuating cable.

Detail of Bellcrank and Servomotor Levers (Auto-Throttle)

Drg. No. M.179-76

Bellcranks having an additional pickup bearing adjacent to the final fuselage throttle control tube attachments now replace the original levers on the forward face of the former at station 242.34, port and starboard.

The bell cranks are similar in every detail to the originals apart from the inclusion of the additional pickups, in fact, all the original bearings are used in the new assemblies.

The auto-throttle servomotor levers are designed to allow 60° of servomotor output movement. They are of simple plate construction including similar bearings to those in the bellcrank levers.

Due to non-availability of the auto-throttle servomotors, the system is, as yet, unconnected.

3.9. Installation of "Maxaret" Braking System

Drg. Nos:- M.179-11
M.179-12
M.179-15
M.179-52

251M Dunlop No.: AV.2190
252M " No.: AH0.26586

Requirement for the installation of the above system originated from the A.U.W. restriction of 34000 lbs. imposed when operating from Staverton Airfield. This is a mandatory limitation due to runway lengths and imposes rather a severe penalty on the operator. A first step towards the easing or lifting of this restriction was thought to be the introduction of the above system and this has, in fact, been done.

Enquiries of both "Vickers" and "Dunlops" produced the information that whilst a project study had been carried out on such a system for the particular aircraft, nothing further had been done and it had not as yet been fitted. A survey, however, indicated that the installation could be carried out reasonably simply and design proceeded.

A duplicate system already existed in the aircraft and this was retained as an emergency system should there be any "Maxaret" failure. Hand actuation by the Pilot or Co-pilot of a control valve, in the event of such a failure, allows pressure through to the existing Mk.III differential control valve thereby bringing the emergency system into operation. The return line from this valve was "teed" into the existing return line from the Mk.III reducing valve, the unit itself being sited between the reducing valve and the control valve in the existing line.

Installation of the "Maxaret" unit did not present any major problems. The wheels were suitable for use with the units and mods. to the torque plates to provide a mounting face were design-approved by Dunlop's and carried out by the College. The existing 2-way junction block on the wheel boss was replaced by a 3-way block designed and manufactured by the College and the remainder of the system consisting mainly of piping runs with standard couplings, flex-pipes, tee-pieces etc., installed without a great deal of difficulty.

All drawings, diagrams etc., of the proposed alteration to the system have been submitted to Dunlop's and their written approval obtained. This approval is recorded both on the "Maxaret" installation G.A. and in the type record addendum.

3.10. Installation of "Doppler" Navigation Aid

Drg. Nos:- M.179-62
51V "Vickers" No. 66879 Sht. 61
52V " " " " 229
53V " " " " 69
54V " " " " 73
61V " " " " 231
264M "Marconi" Drg. No. ED9/22132

The addendum to the specification of mods. stipulated the requirement for the above item, electrical provision having already been made by the addition of a 103 Inverter in the compartment, over and above the original requirement (2 off).

A "Vickers" 'special order only' modification had actually been carried out on a Service Aircraft to install this unit, design having been authorised by "Vickers", on a sub-contract basis, to Marshall's of Cambridge. It was fairly obvious that time and money could be saved on the contract if the drawings could be obtained and utilised as far as possible for the College installation. After some administrative difficulty arising out of release of the drawings, this was in fact done and installation proceeded.

The main structural item was the Aerial and Aerial window installation. This entailed removal of the lower bomb-doors and integration of the upper doors in a skin-stiffener combination, providing a permanent structure for housing the dielectric aerial window, the aerial itself being suitably mounted on the reinforced fuselage skin in this area. These drawings were used in their entirety with some slight modification, however, it was found necessary to re-design the installation of the T/R and tracking units for a variety of reasons. C.G. considerations made this desirable but the main factor influencing the decision was the inaccessibility of the position existing as per the mod. drawings. These called for the units to be sited in the bomb-aimer's compartment, adjacent to the window, a position which, due to blanking and locking of the Stbd half of the bomb-aimer's access door in order to cater for instrument bench attachments, would have been extremely difficult to achieve without a fairly extensive modification to the adjacent flooring. The units were accordingly re-sited in a position aft of the Auto-Observer/ Parachute stowage on the port cabin floor. Installation was quite simple and was achieved by means of forward and aft "top-hat" sections forming continuous beams over the floor cross-members. A run for the wave-guide to the aerial was agreed with "Marconi" representatives and installation of this item was carried out to a drawing prepared by this firm and approved by the College.

In general, the main structural design items are covered by the foregoing report. Sundry other items of installation, electrical and radio particularly, necessitated a fair amount of design work, however, these items, in themselves do not merit individual attention and they are adequately covered by the drawing lists embodied in the type record addendum. Design certificate clearance was obtained, according to Technical Procedure Requirements, from the R T.O. Vickers whilst the aircraft was under A.I.D. control. Copies of these certificates are also included in the type record addendum and they cover "phased" flying from the initial flight after conversion on 23rd December 1957 with a limited quantity of installed equipment operational, to the final phase with all specified equipment functioning up to A R B. C. of A. clearance on 5th May, 1958.

LIST OF MODIFICATIONS TO AIRCRAFT

Title	Drawings	Issued By
Blanking of Flare Chute Access Floor	M.179-2	C. of A.
Filler Patch - Flare Chute Opening	M.179-3	C. of A.
Mods. to Bomb-Aimer's Access Door	M.179-8	C. of A.
Arrangement of D.F. Loops and Fuselage Reinforcing	M.179-10 (2 shts.)	C. of A.
Detail of 'Maxaret' Junction Block	M.179-11	C. of A.
Installation of 'Maxaret' Units	M.179-12 A.V.2190	C. of A. Dunlop Rubber Co.
G.A. of 'Maxaret' System	M.179-15	C. of A.
Installation of Type 8A and Type 103 Inverters	M.179-17 (4 shts.)	C. of A.
Wiring Diagram - Additional Press. Head Heater	M.179-22	C. of A.
Theoretical Circuit - Radio A C. Supply and Control 115V. 3 Phase	M.179-24	C. of A.
Circuit for Repositioning of Fuel Contents Gauges and Power Units	M.179-27	C. of A.
Circuit for Introducing Combined Oil Press. & Temp. Gauge	M.179-28	C. of A.
Circuit for Removal of Oil Cooler Shutter and Gill Indicators from Pilot's Panel to Panel 'D'	M.179-29	C. of A.
Routing Diagram - Radio Supply and Control	M.179-30	C. of A.
Mods. to Hydraulic Tank	M.179-31	C. of A.
Assy. of Floor Pick-ups for Passenger Seats (Aft).	M.179-34	C. of A.
V.H.F. Radio Installation	M.179-38	C. of A.
Intercomm. and Mixing Wiring Diagram	M.179-39	C. of A.
Schematic Layout and Revised Pitot/Static System	M.179-41	C. of A.
Mods. to Oxygen System	M.179-42	C. of A.
Radio Fuse Panel Wiring Diagram	M.179-43	C. of A.
Instrument Panel for 'Varsity' Aircraft	224M (2 shts) RES/D,E/1360	C. of A. Smiths Aircraft Instruments

Title	Drawings	Issued By
Lower Sill Panel for 'Varsity' Aircraft	225 M RES/E/1446	C. of A. Smiths Aircraft Instruments
Radio Fuse Panel Assy.	AD/82	C. of A.
Repositioning of Fire Warning System and Feathering Controls	ADV/84	C. of A.
Installation of V.R. Filter, Loop Controller and Station Boxes - Pilot's Cabin	ADV/88 (4 shts.)	C. of A.
Installation of Station Boxes in Passenger Cabin	ADV/91	C. of A.
Radio Junction Box	ADV/96	C. of A.
Additional Pitot Assy. (Stbd.)	ADV/97	C. of A.
Repositioning of Fuel Contents Gauges Stbd. Shelf - Pilot's Cabin	ADV/99	C. of A.
Mounting Bracket - 'Pacitor' Power Unit	ADV/100	C. of A.
Installation of Oil Cooler and Gill Indicators	ADV/101	C. of A.
Installation of Transmitter for Oil Pressure Indicator	ADV/107	C. of A.
Modifications to Introduce Individual Switching for Pressure Heads and Air Intake Controls	ADV/108	C. of A.
Installation of Oxygen and Intercomm. Components	ADV/115 (2 shts.)	C. of A.
Layout of Inverter Control Panels	ADV/119 (4 shts.)	C. of A.
MODIFICATIONS ADDITIONAL TO LIST COVERED BY DESIGN CERTIFICATE DATED 19/12/57		
Wiring Diagram - Twin A.D.F. Installation	M.179-50	C. of A.
Assy. of Hydraulic Brake Control Operation	M.179-52	C. of A.
Wiring Diagram - Turn and Slip Indicators	M.179-53	C. of A.
Wiring Diagram - Interconnections A.C. Junction Box-SR33	M.179-55	C. of A.
Wiring Diagram - SR14/15 on/off Switching and Voltage Reg.	M.179-56	C. of A.
V.O.R./I.L.S. Installation	M.179-57	C. of A.
Radio Junction Box - Internal Wiring	M.179-59	C. of A.
Wiring Diagram - Servo Amps. and R.M.I's	M.179-60	C. of A.
Foot Guards - Oxygen Installation	M.179-61	C. of A.

Title	Drawings	Issued By
Guard for Nosewheel Steering Chain	M.179-63	C. of A.
Assy. of Floor Pick ups for For'd Passenger Seat	M.179-65	C. of A.
Installation of Autopilot Gyro Unit	M.179-67	C. of A.
Installation of Flight Control Panel - Autopilot	M.179-68	C. of A.
Deatil of Servomotor Levers	M.179-74	C. of A.
Detail of Bell-crank and Servomotor Levers. Auto-Throttles	M.179-76	C. of A.
Wiring Diagram - Oleo Leg Indicator Circuit	M.179-78	C. of A.
Installation of Radio Altimeter Aerials and T/R Unit	M.179-80	C. of A.
Location of Emergency Equipment	M.179-81	C. of A.
Installation of Additional Roof Lights	ADV/138	C. of A
Installation of Oxygen Economisers	ADV/140	C. of A.
Mods. to Filler Neck and Vent - Hydraulic Header Tank	ADV/142	C. of A.
Adaptor for Oil Pressure Transmitter	ADV/151	C. of A.
Installation of Autopilot Cut-out Switches	ADV/157	C. of A.
Wiring Diagram - Artificial Horizon and Motorised Altimeter	ADV/168	C. of A.
Mods. to Elevator Trim Control to Incorporate Auto-Trim Sprocket	ADV/176	C. of A.
Installation of Micro-Switch for Oleo Extension Indication	ADV/178	C. of A.
Bracket for Additional Instrument Panel Light	ADV/180	C. of A.
Provision for Map Cases and Mods. to Ladder Stowage	ADV/181	C. of A.
Installation of Oxygen Pt. at Navigator's Table	ADV/183	C. of A.
Mounting Structure for Radio Altimeter T/R Unit	ADV/184	C. of A.
Aerial Mounting Box - Radio Altimeter	ADV/185	C. of A.
Mods. to Control Locking Lever	ADV/189	C. of A.
Detail of Throttle Lever Knobs and Instinctive Cut-out Switches	ADV/190	C. of A.
Installation of 'Doppler' Waveguide	ADV/192	C. of A.
Wiring Diagram - Additional Instrument Panel Light	ADV/194	C. of A.
Mounting of G.S. Aerial ('Doppler')	51V 66879 Sht.61	C. of A. Vickers
Assy. of G.S. Aerial Window ('Doppler')	53V 66879 Sht.69	C. of A. Vickers

Title	Drawings	Issued By
Circuit for Pilot's Switch and Dimmer Switch	322 M LS/EFI/28	C. of A. Smiths Aircraft Instruments
Cable Harness - Type D.2 Autopilot	324 M LS/EFI/17	C. of A. Smiths Aircraft Instruments
Mods. for 'Maxaret' Installation	251 M A.V.2190	C. of A. Dunlop Rubber Co.
Dowel	252 M AHO 26586	C. of A. Dunlop Rubber Co.

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M.179-1	G.A. 'Smiths' Installation -'Varsity' G-APAZ	C	24/4/58
M.179-2	Blanking of Flare Chute Access Floor	A	30/4/57
M.179-3	Filler Patch - Flare Chute Opening	A	6/9/57
M.179-4	P. and S. Terminal Block Mountings (For'd)	A	13/5/57
M.179-5	P. and S. Terminal Block Mountings (Aft)	A	17/5/57
M.179-6	Detail Assy. - Removable Bench Top	A	7/6/57
M.179-7	Detail Assy. - Instrument Bench	D	20/12/57
M.179-8	Mods. to Bomb Aimer's Access Door	B	16/10/57
M.179-9	Detail of Mounting Plate - Suppressed Loop Aerial	A	11/9/57
M.179-10(2)	Arrangement of D.F. Loops and Fuselage Reinforcing	B	15/11/57
M.179-11	Detail of 'Maxaret' Junction Block	C	22/10/57
M.179-12	Installation of 'Maxaret' Unit	B	6/12/57
M.179-13(2)	Installation of Instrument Bench and Panelling	A	6/11/57
M.179-14	Interchangeable Panel - Main Racking	A	7/10/57
M.179-15	G.A. of 'Maxaret' System	A	4/12/57
M.179-17(4)	Installation Type 103 and Type 8A Inverters	A	9/12/57
M.179-21	Wiring Diagram /S.103 Inverter Distribution Panel	A	25/10/57
M.179-22	Wiring Diagram Additional Press. Head Heater	A	29/11/57
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M.179-24	Theoretical Circuit - Radio A.C. Supply and Control 115V. 3 Phase	B	24/4/58
M.179-25	Theoretical Circuit - Air Filter and Hot and Cold Air Control	C	7/1/58
M.179-26	Additional Fuselage Lighting	B	20/12/57
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M.179-33	A.C./D.C. Distribution Panel Wiring	A	5/12/57
M.179-34	Assy. of Floor Pick-ups for Passenger Seats (Aft)	B	12/2/58
M.179-35	Routing Diagram - Flashing Navigation Lights	B	16/1/58
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M.179-38	V.H.F. Radio Installation	A	4/12/57
M.179-39	Intercomm. and Mixing Wiring Diagram	B	24/4/58
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Drawing No.	Title	Issue	Date
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ADV/102 (2)	Installation of Flashing Light Components	C	28/11/57
ADV/103	Blanking of Fuselage Skin (Top) Aft of Astrodome	A	12/10/57
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ADV/115 (2)	Installation of Oxygen and Intercomm. Components	B	28/11/57
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ADV/133	Installation of Parachute Stowage/Auto Observer	A	3/12/57
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M.179-19	Installation of Navigator's Table	A	18/2/58
M.179-49	Installation of M.F.S. Junction Box	A	20/12/57
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M.179-51	Wiring Diagram - Voltmeter, Ammeter and Generator Failure Warning Lights	A	20/12/57
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M.179-57	V.O.R./I.L.S. Installation	A	20/3/58
M.179-59	Radio Junction Box - Internal Wiring	A	20/3/58
M.179-60	Wiring Diagram - Servo Amp. and R.M.I's	A	20/3/58
M.179-61	Foot Guards - Oxygen Installation	A	30/1/58
M.179-62	Installation of T/R and Tracking Units - "Doppler"	A	30/1/58
M.179-63	Guard for Nosewheel steering Chain	A	4/2/58
M.179-64	Detail Assembly Aileron Servo Desynn Transmitter	A	18/3/58
M.179-65	Assembly of Floor Pick-ups for Forward Passenger Seat	B	20/3/58
M.179-66	Detail Assembly Elevator Servo Desynn Transmitter	A	14/2/58
M.179-67	Installation of Autopilot Gyro Unit	A	17/2/58
M.179-68	Installation of Flight Control Panel-Autopilot	A	24/2/58
M.179-69	Installation of Rudder Surface Desynn Transmitter	A	27/2/58
M.179-71	Assembly of Cover for Periscopic Sextant	A	6/3/58
M.179-72	Desynn Potentiometer and Torque Limit Switch Connections	A	24/4/58
M.179-73	Circuit from Type 24 Control Panel to Navigator's Table	A	25/4/58
M.179-74	Detail of Servometer Levers	B	13/3/58
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M.179-80	Installation of Radio Altimeter Aerials and T/R Unit	A	25/4/58
M.179-81	Location of Emergency Equipment	A	25/4/58

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ADV/138	Installation of Additional Roof Lights	A	17/12/57
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ADV/140	Installation of Oxygen Economisers	A	19/12/57
ADV/141	Radio Cabling Supports	A	20/12/57
ADV/142	Mod. to Filler Neck and Vent (Hydraulic Header Tank)	A	31/12/57
ADV/143	Installation of Terminal Pts. for Pitot/Static Lines	A	10/1/58
ADV/151	Adaptor for Oil Pressure Transmitter	A	1/2/58
ADV/157	Installation of Autopilot Cut-out Switches	A	27/2/58
ADV/158	Fuse Holder for "Doppler" Units (Nav. Table)	A	27/2/58
ADV/160	Alterations to Cable Fairings - Stbd. Side Pass. Cabin	A	5/3/58
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ADV/168	Wiring Diagram - Artificial Horizon and Motorised Altimeter	A	17/3/58
ADV/176	Mods. to Elev. Trim Control to Incorporate Auto-Trim Sprocket	A	24/3/58
ADV/177	Bracket for Auto Trim Servomotor	A	24/3/58
ADV/178	Servomotor Output Flange	A	25/3/58
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ADV/181	Provision of Map Cases and Mods. to Ladder Stowage	A	27/3/58
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ADV/183	Installation of Oxygen Pt. at Navigator's Table	A	9/4/58
ADV/184	Mounting Structure for Radio Altimeter T/R Unit	A	10/4/58
ADV/185	Aerial Mounting Box - Radio Altimeter	A	10/4/58
ADV/186	Installation of Auto-Throttle Junctin Box	A	11/4/58

Drawing No.	Title	Issue	Date
ADV/187	Clip for Stowage of "Doppler" Test Leads	B	15/4/58
ADV/188	Installation of Auto-Throttle Warning Lamps & Engage Switch	B	25/4/58
ADV/189	Mods. to Control Locking Lever	A	18/4/58
ADV/190	Detail of Throttle Lever Knobs and Instinctive Cut-out Switches	A	17/4/58
ADV/191	Attachment of Fire Extinguisher Bottles to Benches	A	21/4/58
ADV/192	Installation of "Doppler" Waveguide	B	21/4/58
ADV/193	Bracket for Auto-Throttle Channel Switches	A	21/4/58
ADV/194	Wiring Diagram - Additional Instrument Panel Light	A	23/4/58
ADV/195	Installation of Automatic Elevator Trim	A	23/4/58
ADV/196	Guard for Automatic Elevator Trim Chain	A	25/4/58
ADV/197	Wiring Diagram - Hydraulic Tank Level Inspection Lights	A	25/4/58
264M	Assembly of "Doppler" Waveguide (Marconi No. ED9/22132)	A	10/4/58
322M	Circuit for Pilot's Switch & Dimmer Switch (Smith's No. LS/EFT/28)	1	11/11/57
323M	Cut-Outs for Top Panel - 3rd Bay Forward (Smiths No. LS/EFT/30)	4	11/2/58
324M	Cable Harness - Type D.2 Autopilot (Smiths No.LS/EFI/17)	9	11/2/58
325M	Cut-Outs for Centre Panel - 3rd Bay Forward (Smiths No. LS/EFI/32)	1	11/2/58
330M	Cable Harness - Auto-Throttle Installation (Smiths No. LS/EFI/33)	1	11/4/58
331M (2)	Wiring Diagram - Auto-Throttle Junction Box (Smiths No. LS/EFI/34)	2	3/4/58
51V	Mounting of G.H. Aerial (Vickers No. 66879 Sht.61)	B	9/1/58
52V	Aerial Window (Vickers No. 66879 Sht.229)	A	9/1/58
53V	Assembly of G.S. Aerial Window (Vickers No. 66879 Sht.69)	B	14/1/58
54V	G.A. of G.S. & B.S. Installation (Vickers No. 66879 Sht. 73)	B	14/1/58
61V	Electrical Test Schedule - Aerial Window (Vickers No. 66879 Sht.231)	A	14/1/58
251M	Mods. for "Maxaret" Installation (Dunlop No. AV.2190)	A	13/11/57
252M	Dowel (Dunlop No. AH0.26586)	1	13/11/57
305M	Installation of Glide Path Aerial (Scottish Aviation (Drg. No. VV.302)	A	24/9/57

4. Manufacture and Installation of Special Modifications

4.1. Specification of Modifications

4.1. Removal of Existing equipment

Remove all cabin gear, seats, fixtures and cables which are not part of the basic airframe as envisaged and modified below. Remove autopilot and mountings complete with cables. Remove G4 compass complete. Remove all radio units and cables except aerials Fuel contents gauges power units to be repositioned in bomb bay compartment.

Installation of Special Racking

A composite structure of two benches containing shelves for radio and equipment together with vertical panelling, is required to run a total length of 16 feet down the length of the cabin. They key vertical post will be mounted as close as possible to the rear side of the spar on the starboard side of the cabin, offering a face (for mounting panels) 2 feet from the aircraft centre line and reaching from the cabin floor to the roof. The height at this point is approximately 6 feet. There should be further vertical posts forward and aft of this key post at such spacing as to mount metal panels 2 feet wide by 1 foot by $\frac{1}{8}$th inch so that the panels offer a flush finish parallel with the aircraft centre line, the panels being held by 2BA mush head screws at 6 inch spacing, one half inch from the side edge of the panels. The panelling will reach 10 feet forward of the key post and 6 feet aft and will commence 3 feet from the floor and reach to the roof. Panelling from the Dakota G-AMZE will fit into this pattern but further panels of $\frac{1}{8}$th inch Dural sheet will be required to complete the plan. In addition there should be a vertical athwartships panel A/V mounted at the rear end of the structure between the vertical panels and the starboard fuselage side to take gyro and other sensitive instruments. This panel could well be 2' by 1' depending on the possible position of the extra vertical supports and should be as high as possible to allow easy access to the rear of the main structure. Finish to panels should be black dye anodised after shot blast and this should be contract out via Smiths.

A 6 foot long bench 2 feet deep and 3 feet high is required at each end of the structure, this leaving a 4 feet gap over and forward of the spar. The benches should offer two shelves each to take SBAC radio racking and other equipment at 15 inch depth spacing, leaving the remaining space at the bottom or floor-end. The shelving and bench tops should be reinforced to take a load per shelf weighing 300 lbs static and surface loading 20 lbs/sq.inch static. The bench tops should be removable in 2 feet square sections, of $\frac{1}{8}$" Dural reinforced with ribs to take the above weights. To accommodate the forward bench, the right hand door of the bomb bay well will have to be fixed shut (and possibly reinforced if it has to take extra weight). The left hand door should be made quick-detachable and the access ladder moved to be central in the remaining space. The whole structure to be finished matt black except bench tops and panelling which will be black dye anodised after shot blast.

This arrangement will make the most efficient use of the space available, allow of easy access all round and ensure adequate vision of the cockpit, from most parts of the cabin for ground tests.

Installation of Autopilot Type D.2

The servomotors will be fitted to the existing Mark IX Autopilot Pick-up points in the controls runs by means of the adapter brackets from G-AMZE. This should involve no design work except that position indicating desynns are required on elevator and aileron servos and rudder surface, and 360° potentiometers on elevator and aileron surfaces and on rudder servo and spring tab. The indicators from the desynns will be mounted in a panel above the forward bench which also holds power supply indicators. The cables from the potentiometers and desynns should terminate in the special junction box supplied by Smiths, to be mounted above the forward bench. The potentiometers will require pulley wheels on their drive shaft and should connect with the servomotor or control lever via flex wire and tension spring. No indicators are required for these. The gearing or pulley size will be such as to allow 330° of potentiometer wiper movement for full travel of the respective surface.

The box units and pressure unit will be mounted on the front bench top shelf, access being made from the gangway. The gyro will be mounted on a small table below the front port window. The table should be lower than in G-AMZE so that light falls on top of the unit and the table should be rounded to the contour of gyro unit if practicable. If these requirements mean that the unit will be less than 9 inches from the floor, it may be mounted on the floor direct, if necessary in a different position altogether to avoid being kicked or damaged. Combined flight panel will be installed on the rear of the throttle pedestal in place of the panel holding the windscreen wiper controls. A kick guard will be needed in the rear end of the panel and a piece of $\frac{1}{4}$ inch steel tubing on a firm anchorage is envisaged. The windscreen wiper controls etc., will be fitted on the sill panel to a plan to be supplied.

Cut-out buttons are required outboard on each control wheel with an additional button on the pilot's side for the auto-throttle control. These are additional to the press to transmit buttons which should also both be outboard.

Consideration must also be given to the fitting of rotary or spring strut torque limiter on each servo and the attendant auto-cut-out line.

Changes to Instrument Panel

Smiths will undertake the design only of a new instrument panel and knee panel for approval by the College Design Department and manufacture by the College. This will entail the fitting of a one piece main instrument panel if structurally possible. A new sill panel is required and changes are also to be made in the side panels. The finish of all these panels will be shot blasting and black dye anodising, except those designed by Smiths which will be grey anodised, or matt grey stoved.

The port side panel is to take the three hydraulic and one air pressure gauge from the sill panel and in place of the bomb control panel will be the station box of the intercomm.

The starboard side panel will hold the six fuel gauges (tilted at an angle to be seen from the pilot's seat), the fuel flow meter and the station box of the intercomm.

The feathering buttons, warning lights and fire buttons are to be mounted on the narrow base of the overhead electric control panel, below the dimmer switches and to the port side.

The oil pressure gauge is to be changed on each engine for a direct mounted AC inductor type and in general all engine instruments will be of the twin needle type embodying two indicators, in order to save panel space. Miniature desynn gill and shutter indicators are to be above their respective control switches.

Installation of GM.2 Compass

The GM2. is not now required.

Installation of M.F.S.

The M.F.S. junction box will be required on the L.H. upper panel bay above the rear bench. The gyros vertical and azimuth gyros will be on the lower shelf at the rear of the front bench. All other units will be accommodated on the shelves, bench top or panelling of the rear bench, with the exception of indicators and detectors. Cable looms supplied by Smiths will be run in the ducting between the various units to a plan to be supplied at a later date. Mountings for two detectors for the twin compass systems are required in the tail of the aircraft, the detectors to be not less than 2' apart and at least 18" away from ferrous metal parts of the aircraft. The M.F.S. will be installed before initial flight.

Installation of Radio

Three V.H.F. sets are required, two of which (TR1985 and TR1896) came with the aircraft. The TR1987 is the third and the controllers should be grouped on the cockpit coaming if possible. The aerial sighting will probably be decided when the ultimate controlling body for this aircraft has been determined, but there may already be an additional approved site (see Vickers R.T.O.). The V.H.F. sets should be mounted under the forward bench. The modification to 40 channels per set is required as soon as this is approved. The S.B.A. is not now required and should be removed complete.

An SR32/33 navigation receiver is required, the receivers being mounted below the rear bench as far forward as possible, and the output to terminate on a junction box on the first panel bay of the rear bench. Feeds from this box will go initially to the autopilot and the M.F.S. and a radial selector. All controllers will be mounted above the electrical switch panel in the cockpit on the spare panel already available. A new aerial will be required for the localiser (on the fin) and glide-path (on the nose). There should be an SRIM to cover this.

The SR14C/15C will be required from the Dakota to work from the same aerials, the output working into dummy loads in the same radio junction box until switched in place of the SR32/33 I.L.S. load via relays.

Two A.D.F. receivers to ARI.23021 are required mounted below the rear bench as far forward as possible and these will mean the installation of two suppressed loops on top of the fuselage. The outputs will feed three R.M.I. indicators supplied by Smiths to a scheme as follows: each pilot will have an R.M.I. with V.O.R. on the red needle (No. 1 pointer) and starboard A.D.F. on No. 2 needle. Port A.D.F. will feed No. 3 R.M.I. needle No. 1 only, with starboard A.D.F. on No. 2. All this will be achieved through the same radio junction box.

Separate tuning indicators attached to each A.D.F. controller are required. Compass drives for the R.M.I. cards will be fed from the M.F.S. to the S.T.C. compass coupler and then via two Marconi twin repeater amplifiers. Separate sense aerials are required to avoid the possibility of a double A.D.F. failure.

Intercomm ARI18089 is also specified and all audio circuits and transmit facilities will be fed through this system. There will be six station boxes; one to each pilot, one to each bench and two controlling all intercomm sockets at the cabin seats. Each bench should have three intercomm sockets and each pilot's box should have four intercomm sockets, one for each pilot and two on the fuselage side each side. The pilot's box will also feed a navigator's table and the co-pilot's will feed the bomb compartment. The bench station boxes will be mounted on the third bay of each bench on the top panel which should also take the junction boxes on the back, thus keeping the panels which cannot be removed to a minimum. The intercomm sockets will be on the gangway side of the benches at each 2' section.

The seats will be two pairs on the starboard side and two singles on the port side forward of the entrance door, with two singles aft of the door. Each side will be fed from its own station box.

The Wright & Weare tape-recorder ex-G-AMZE is to be used as a self contained unit and will not normally be carried in the aircraft. Provision is to be made, however, for bolting it to the front bay on each bench top and for linking it to the intercomm system at these points, allowing clearance for the panel mounted units at the back of the recorder.

The services required at each station box are three V.H.F., intercomm, two A.D.F. and V.O.R./I.L.S./Marker. When the SR14C/15C emergency switch is operated, the I.L.S. load is switched from SR32/33 to this receiver and the audio is similarly switched.

A survey is to be made by representatives of Standard Telephones to see if the aerials for the new radio altimeter can be fitted, the equipment itself not being required at this stage.

Electrics

Six inverters are required. Two Type 103 ex- G-AMZE with separate starting switches and a warning light for failure of each inverter. The output is to terminate on a fused distribution panel above the gap between the benches, the terminations being on fixed Plessey Mark IV panel mounted 6-way coupler sockets set at 3, wired Pin A phase A, Pin B phase B, Pin C phase C, Pin D DC+, Pin E DC-, Pin F unused, the DC+ being switched with the inverter. There should be 12 outlets for each inverter.

Two Type 1203 inverters ex- G-AMZE with starters which should be mounted adjacent to the distribution panel above, will feed two output 230v sockets each, of the Wylex 5 amp type, one from each inverter at each bench.

Two Type 8A inverters feeding one load with a warning light and combined manual change-over and starting switch are also required. The loads on these inverters will be fixed to AC bus bars (fused) for radio and instrument supply. The load will consist of all radio services, and instruments not concerned with navigation (e.g. engine oil pressure).

All inverters will be installed forward of the main spar below the floor in the bombing compartment and Type 8A's should be on resilient mountings to absorb noise. The switches and lamps for the 8A's and 103's should be on the sill panel accessible to the co-pilot. The control panels for the 103 inverters should be near the inverters. The 230v voltmeters for 1203 inverters and starting gear should be on the central electrical panel.

The lighting is to be greatly augmented with a similar layout to the Dakota, i.e. there should be ample illumination on both sides of the panel structure with added angle-poise lamps at the rear of the benches for work under the bench tops. There should also be adequate lighting in the bombing

compartment, and behind the instrument panel in the cockpit.

Above each bench at the lower end of the first and third panel bays will be a general services panel containing fused and switched DC+ on terminal blocks, earth bus bars, fixed couplers containing 3 phase AC and DC+ from each 103 inverter as above, 230v 50 cps AC and heavy duty DC and E terminal blocks, all suitably labelled.

Throttle Control

An automatic throttle control servometor is required to operate the throttle lever of each engine over the full range of movement. The servo should preferably be in parallel with the normal run and should join the linkage system at the point of change of direction at the wing root. Drawings of the servos will be provided and the final position determined after joint consultation.

The main amplifier unit will be installed on the lower shelf of the front bench in the cabin as far forward as possible. A cabling plan will be supplied by Smiths, with cables and all units.

Position indicating potentiometers are required at each servomotor, the leads being terminated alongside the autopilot position pots in the special junction box.

Additional Services

A second pitot head and static vents are required to feed the panel structure, with pressures available at both benches and at the camera recorder unit in a form for teeing off to various units - fixed tubing at the rear end of the front bench and front end of the rear bench is suggested with an additional supply at the parachute stowage. The heating switch should be installed next to the existing switch in the overhead cockpit panel and suitably labelled. This head is also to feed the co-pilot's cockpit instruments.

The possibility of fitting a periscopic sextant between the rear of the pilot's seat and the front of the front bench should be investigated. Kelvin & Hughes will be sending a representative to survey for this job.

The navigator's table is required 3 feet long and three feet from the floor behind the co-pilot and backing to the fuselage side, the leading edge of the table being parallel to the centre line of the aircraft, with a minimum depth of two feet at the narrow end. On this table will be the track control unit of M.F.S. There should be a short bench seat fixed in front of the table but not to be used for take-off and landing. There should be space left to permit access to the rear of the panel structure and also for a person to stand behind the co-pilot's seat.

The possibility of fixing Maxaret Braking units should be investigated and these are required if it is at all possible to fit them. At the time of writing no information is available on installation details.

Eight passenger seats are required but the positioning of these and the parachute stowage/camera recorder unit ex-G-AMZE will depend largely on the C.G. situation and ground balance of the aircraft. Ideally the seats should occupy the space forward of the entrance door and aft of the panel structure there being two double seats on the starboard side of a central gangway and two singles on the port side, with two additional seats aft of the door. The parachute stowage ideal position is opposite the rear bench with its rear end in line with the bench rear end. The panel of the camera recorder is to be in a plane suitable for gyro attitude indicators.

Ducting is required for all cable runs the ducts to have quick detachable lids and integral cable strapping every 18" or 2', the strapping being readily adjustable to the number of cables installed. Main runs of cables will be from the cockpit instrument panel down the length of the benches adjacent to the back and up each vertical support. The ducting should be of a simple design so that lengths may be added afterwards as required. The ducting over the length of the panelling should be of double the capacity of any other. There should be ducting to below the floor on both sides of the spar on the starboard side.

Oxygen is required for a total of six crew for eight hours - two pilots points unaltered, one additional point behind each pilot, two at each bench and four at the forward-most seats. If there is Oxygen in the bombing compartment this should be retained.

A navigation light flashing unit is required to be fitted and this may well go in the bombing compartment.

A number of cockpit instruments will be required from G-AMZE and some additional ones will be supplied by Smiths against a College order when these have been determined.

The positioning of emergency axes and fire extinguishers should be reviewed and augmented as necessary.

An early estimate of the C.G. position, ground balance and dry weight with all equipment on board is an essential requirement; the earlier this information is available the sooner the above requirements can be confirmed.

The finish of the aircraft is to be silver with white top and blue cheat lines, (the exact colours being specified below) to a plan to be submitted by Smiths.

Blue	-	Titanine TT10B "Bright Blue" to DTD772A
White	-	Titanine TT10B "White" DTD772A
Silver	-	Titanine TT10B "Silver" DTD772A

Addendum to Specification

These modifications are as follows :-

(1). Installation of Doppler

Doppler AD2000 is required to be installed and the equipment should include a ground position computor which will then make redundant the AP.1, GPI, WFA and AMU on the navigator's table. These latter items mentioned in the Specification (Issue 4) are not now required. The computor and indicator units are to be installed on the navigator's table, the remaining units as per Marshall's installation drawings, thus relieving the load on the Design Office at Cranfield.

(2). Automatic Elevator Trim

The Autopilot Type D.2 will be required to provide automatic elevator trim and this will entail the fitting of a servomotor mounting of a special design for this function, to drive the trim wheel in the cockpit via chain and sprocket. Design of this installation will be subject to joint consultation between Smiths and the College.

(3). ILS Indication

A 3 lamp marker system is required and this will entail the installation of the necessary filters to allow for discrimination.

Items not completed but which may be later required:

(1) Main access door warning light

(2) Electrical system master switch

(3) Additional flap to navigator's table

(4) Installation of tape recorder

4.2. Installation of Special Racking

The installation was divided under five main headings.

1. Manufacture of tubular steel benches
2. Strengthen floor, fuselage, manufacture and fit stanchions
3. Fitment of channels and racking for special equipment
4. Manufacture of table tops and panels
5. Fitment of oxygen, intercomm, pitot static connections, light brackets and other equipment.

The benches are of welded constructions, which caused some problems of distortion during manufacture. Channel section members were fitted between fuselage frames under the floor, stanchions installed and the fuselage roof strengthened between stanchions. The benches were then fitted all attachments drilled and pinned in position.

Final alignment checks were made and the whole structure removed for deburring, cleaning and protective treatment. Channels were bolted to the benches athwartships and anti-vibration mounted S.B.A C. racking fitted in position fore and aft to carry radio and special equipment. All panels were cut to house equipment as per specification, a modification carried out to the hydraulic header tank drip tray and the whole benching installed finally. A fault on the hydraulic system caused hydraulic fluid to be vented from the tank relief valve during tests. This constituted a fire hazard in the area and the tank was modified to vent excess fluid to the atmosphere should the fault occur again. The M.F.S. junction box was too large to be accommodated on the Panels, therefore a further modification secured this item permanently between two stanchions. A shock mounted panel required athwartships at the rear of the benches presented no problems, the panel being mounted on the rear stanchion and adjacent frame with suitable brackets. The bomb aimer's door, right hand side, was strengthened and bolted in position to carry the centre attachment of the front bench. The left hand door was modified with an extra bell-crank lever and locking pin connected to the existing locking device. This door is now detachable in lieu of hinged. No modification was considered necessary to the access ladder. Fitment of oxygen, intercomm, etc., presented no problems, there being ample space available after the equipment was installed.

4.3. Installation of Auto Pilot and Automatic Trim

This installation required modification to the Servo mounting brackets (ex Dakota) to suit the Varsity installation, the brackets being larger than those previously fitted. Fouling took place on the control rods and it was necessary to dress back to give clearance, fortunately, without serious reduction in strength. The desynns and potentiometers were mounted on brackets adjacent to the servo mountings and operated by lever and pulley systems.

A further requirement was the installation of an elevator limit switch. This took the form of a micro-switch operated by the bell-crank lever forward of the servo mounting. Fitment of the torque limiters required the manufacture of new servo lever arms with increased pin centre lengths.

Tests were carried out in the "throw out" condition to ensure that no fouling or geometric fault occurred on the connecting rods to the service and desynn equipment. The main gyro unit was mounted via two Top Hat members fitted to the floor and picking up on adjacent frames fore and aft. The flight panel was mounted in the position requested, but with a different method of attachment, which followed closely the existing wind screen wiper mounting attachment. This obviated any modification to the cockpit floor. Existing ducting forward of the main spar was given increased capacity to house cables from the junction box on racking to the gyro unit on the port side of the aircraft.

Automatic Elevator Trim was installed by modifying the pilot's handwheel port side to introduce a sprocket. The servo mounting was installed on the forward face of the throttle console and the drive achieved by chain and sprocket. A guard has been manufactured and fitted to cover the chain, this item being easily removable for inspection purposes.

4.4. Changes to the Instrument Panel

Main and Knee panels were manufactured as per specification and finished in stove enamelled grey. New brackets were required to connect these two items owing to lack of space and for the same reason, certain modifications were carried out to the anti-vibration mountings. Additional items installed included an FH7 Artificial Horizon and a motorised altimeter unit. The control units for both items were mounted forward of the instrument panel in suitable positions. To improve vision the pilot's and co-pilot's crash handles were re-positioned and the throttle/aircraft controls locking device was modified. The port side panel was removed and a new item manufactured for the repositioning of hydraulic gauges and radio equipment, the starboard side panel was modified in situ and a new panel mounted to house the fuel contents gauges and flowmeters. Owing to non-availability, the oil pressures and temperature installation was modified to desynn type as a temporary measure for the test flying period. This has since been remodified to the customers requirements. Certain alterations were made to the layout of the cockpit electrical panel but were such that the manufacture of a new panel was unnecessary. Apart from the usual lack of space, there were no particular problems in the whole installation.

4.5. Installation of M.F.S.

One extra detector unit mounting was required and this was fitted directly above, and was an exact copy of the existing mounting. The junction box and associated equipment was installed on the racking as per specification.

4.6. Installation of Radio

Aerials

I.L.S. installation required the fitment of marker, glide path and localiser aerials. The glide path aerial was mounted in a welded aluminium box structure shaped to suit the nose contour and the necessary "window" slot cut in the nose on the aircraft centre line. Two sword aerials were attached to the fin skin, the whole being strengthened by a rivetted internal box structure. Marker aerials, (a standard modification) were fitted on each side of the fuselage. A D.F. "Sense" aerials were mounted each side of the fuselage to the rear of the I.L.S. markers and the transformers were mounted in the bomb aimer's compartment. Suppressed loops were installed in the fuselage roof forward of the astrodome. This operation took five weeks and involved considerable strengthening of the fuselage in the area bounded by the astrodome and the former at Station 196. A further complication was that only one Loop cut-out could be made at a time owing to stressing problems. The reinforcing around the first cut-out required to be 90% completed before proceeding with the second. V.H.F. aerials were fitted in the existing positions with 10AJ/191 anti-flutter mountings.

Installation of the Doppler 2000 entailed the removal of the bomb doors, and joining of the two remaining side doors with a skin strengthened internally with frames and stringers. The skin now covers the aft section of the bomb bay. The bomb racks were modified to house the aerial and the forward half of the bomb bay was fitted with a resin-bonded fibre glass dielectric panel. A spare panel was manufactured concurrently to obviate setting up another mould at a future date.

The radio altimeter aerial was fitted under the fuselage just forward of the bomb aimer's window. This took the form of a welded Aluminium structure rivetted to and protruding from the fuselage. On this fairing are mounted the two aerials with dielectric panels.

Sets

With the exception of the Doppler 2000 and V.H.F, the radio sets were mounted in the rear benches. Doppler units were assembled on two Top Hat sections attached to the floor forward of the main door picking up on frames similar to the Auto Pilot Gyro unit. V.H.F sets were mounted in the front bench. The Wave Guide for the Doppler proved to be a simple installation, the bulk of the Guide being in the luggage bay. To mount the radio control panel the existing ply panel on the cockpit roof was removed, the skin at this point suitably strengthened with brackets which also served as a mounting for the control panel. It proved to be difficult to mount the A.D.F. Tuning indicators such that they could be easily read by both pilots, at the same time retaining a neat panel layout. This was overcome by the fitment of duplicated indicators on each side of the panel, each pilot viewing his own pair. Port and Starboard shelves in the cockpit were used to house Loop controllers, Station Boxes and V.R. Filters.

As stated, this entailed the manufacture of a new port shelf. A radio fuse panel was manufactured and installed under the existing electrical panel at the starboard forward end of the cabin. Intercomm, Station and junction boxes were fitted at various points in the cabin as per specification.

4.7. Electrical Installation

Inverters

The 103 and 8A Inverters were required to be fitted in the bomb aimer's compartment. In view of the fire hazard due to close proximity of the main hydraulic services, it was decided to manufacture a mounting platform for the inverters supporting a metal framed box. The box was to serve two purposes, (a) as a mounting for all control panels etc., and (b) to protect the inverters from a possible contaminated air supply. Clean air is now introduced to the box by means of a 4 inch flex pipe and a standard Varsity Air Intake 26TV.139 suitably modified for installation on the Port side of the bomb aimer's compartment. This air intake was further modified to take a duct from a refrigeration unit during prolonged ground running. An extractor duct was manufactured and installed on the starboard side of the bomb aimer's compartment, connected to the box by a 5 inch flex pipe. The temperature inside the box is recorded by thermo bulbs with temperature indicators fitted to the Starboard cockpit shelf viewable by both pilots.

1203 Inverters were mounted at the rear of the cabin for two reasons, (a) ease of installation and (b) to assist the C.G. Case. As far as possible existing Dakota units were used. Considerable floor strengthening was required.

Lighting

Extra light positions were situated throughout the cabin in the roof, port side panelling, and in the gangway outboard of the racking. A further light was fitted to facilitate viewing of the hydraulic header tank sight glass. The general services and A.C. supply panels were modified 2 feet by one foot panels previously manufactured and fitted as detailed in the specification. A flashing light control unit was fitted in the bomb aimer's compartment and additional external lights installed to comply with civil requirements.

4.8. Automatic Throttle

Connection of the Automatic Throttle Servo was provided by the removal of the rearmost throttle bell-crank lever in the fuselage (Port and starboard) and the manufacture of levers with identical geometry but with an extra pick up bearing. These have been fitted in lieu of existing levers. The connection to the servo motor has been left in abeyance due to non-availability of this item. The junction box was manufactured and fitted in position on the bench panelling with little difficulty. The throttle lever knobs were removed and replaced by re-designed items to house cut-out switches. The engage

switch was mounted on the throttle console, port side, in a position shrouded by the throttle friction lever when in the max. friction position, for obvious reasons. Channel switches were mounted on the throttle console, starboard side, to the rear of the "Maxaret" override control. "Failure warning/ press to test" lamps and "system engaged"lights were all mounted on the knee panel.

4.9. Maxaret Braking System

The Varsity has two separate hydraulic braking systems which normally function simultaneously, either system being capable of supplying the maximum braking should failure occur in any one. Since it was impracticable to install Maxaret Units in both these systems it was decided to use No. 1 System, No. 2 System to serve as an emergency.

The modification for No. 2 System consisted of the fitment of a Type AC.1250 control valve in the pressure line from the system to the Dual relay valve. This serves as an isolating cock which may be opened from the cockpit in emergency conditions by a direct pull handle mounted to the Starboard side of the throttle console. The control valve was mounted in the nose wheel bay on the starboard side. It should be noted that operation of the emergency handle does not apply the brakes but merely supplies pressure for operation of the brakes by the levers on the control column.

To install Maxaret units the four brake torque plates were modified to provide a mounting face. The junction blocks at the wheel positions were removed and two new items manufactured with an extra port for the "Maxaret" pressure relief line. Pipes were manufactured to suit the new installation and the relief line installed from the junction block on each leg to a 3-way union in the fuselage. From the third port of the 3-way union a pipe was introduced to link with the normal hydraulic system return line to the header tank. The two brake pressure gauges were re-positioned and labelled to read "Maxaret" and "Emergency Pressure". A further warning notice was considered necessary; this reads "Warning - Maxaret inoperative when in emergency". This is situated adjacent to the emergency handle.

4.10. Miscellaneous

Additional Pitot and Static Vents

Concurrent with the installation of these items was a modification to the existing pitot head which required re-positioning to line upnwith the aircraft centre line. Two modification sets were demanded to Embodiment Loan, the second set being modified to the opposite hand and fitted to the Starboard side of the fuselage in the corresponding position. Static plates were mounted on the fuselage approximately 4 inches above the existing.

Periscopic Sextant

It was decided to use the astrodome position for this item. A further astrodome was obtained, the perspex removed and a welded Aluminium flat based construction fitted. A 14 s.w.g. stiffener plate was rivetted internally and cut to house the periscopic sextant mounting. It is envisaged that when a sextant is required for an exercise, the existing astrodome will be removed and the modified item readily fitted.

Navigator's Table

This item is similar in construction to the racking and apart from the welding distortion and difficulty of access to fit strengthened members under the floor, it was a comparatively simple installation. For ease of access to the cockpit area the seat is hinged under the table when not required. The Doppler presentation units are mounted on the table.

Passenger Seats

Eight seats were fitted, two double and three single at the rear of the cabin and one single in the forward position three feet to the rear of the second pilot. Top Hat strengthening members were fitted at each seat pick up point and were bounded by fuselage frames. The seat fittings were bolted through the floor and the flanges of the Top Hat sections. This operation proved to be most troublesome owing to inaccessibility and the proximity of many extraneous fittings in the area, and averaged about sixty man-hours per seat installation.

Parachute Stowage and Auto Observer

This item was moved en bloc from the Dakota, repairs carried out where necessary and mounted on a plywood base with Top Hat members, the base board bolted to frames and floor stringers through existing floor attachment holes.

Ducting

The Ducting runs fore and aft from the rear to the forward end of the benches. From here a "U" shaped duct carried the cable to the cabin starboard side panels and thence along to the cabin/cockpit main frame. Owing to restriction in the cockpit area the section changes although the capacity remains approximately the same. It was found necessary to modify the cockpit starboard heater duct and diffuser to accommodate the ducting, and also the side panels in the area. In view of the extra cables which were required to be housed behind the cabin side panels, these too were modified and extended three inches towards the aircraft centre line from the main spar to the cockpit/cabin frame.

Oxygen

The oxygen system was found to be satisfactory as regard capacity. The only requirement was to rearrange the pick-ups and economisers to suit the new cabin layout.

Miscellaneous

The existing flare chute at the rear of the cabin was removed and the cabin floor and fuselage skin made good in this area. Seat disposition required the repositioning of the aircraft ladders. A new stowage was manufactured for the entrance ladder and this is now stowed adjacent to the main door. The maintenance ladder stowage was modified and positioned further aft on the port side. Map stowages were manufactured and are installed on the cockpit side panels adjacent to each pilot. On the undercarriage retraction test it found that the shock absorbers tended to stick up owing to the tightness of the new glands. It was considered hazardous, for should this happen during retraction in the air, the door retraction hook on the bottom of the strut could fail to contact the roller assembly on the door operating mechanisms. This in itself would be no hazard but should the leg then extend whilst in retracted position, the roller would act as a non-retractable up-lock. After some use the struts will, of course, act more freely, but as a safety measure, "press to make" micro switches were fitted to the struts, positioned in such a manner that they are contacted by the torque links at full extension.

Two lights (Port and Starboard) have been fitted to the cockpit knee panel labelled "Undercarriage legs fully extended". A further label adjacent to the undercarriage lever reads "Undercarriage must not be retracted unless 'leg extension' warning lights are ON".

4.11. Progress Meetings

Progress meetings were held at intervals of approximately one month, under the Chairmanship of Mr. K.W.R. Wynter, Nav.B.I., M.O S. These meetings proved to be of great value to all concerned.

5. SUMMARY OF EQUIPMENT

5.1. Redundant equipment removed from aircraft

Sec.	Ref.	Pt. No.	Description	Qty.
5Q	12667		Aerial Ammeter	1
5D	505		Junction Box	1
"	1483		Switch Bomb Jettison	1
5CX	557		Lamp	3
	909		Lamp	1
	1079		Lamp	4
	3465		Front Amber	1
	3466		Front Green	1
	3467		Front Red	1
5U	537		Voltage Regulator	1
	357		Junction Box	1
5UB	2399		Rotary Converter	2
	4935		Inverter 100B	2
5UC	2548		Control Panel Type 9	2
6A	1174		Astro Compass	1
	1519		Artificial Horizon	2
	1538		Altimeter	3
	3155		Altimeter	2
	2966		Indicator R.O.C.	2
	3371		Indicator Turn & Slip	2
	1582		Boost Gauge	2
	1590		Suction Gauge	1
	1611		Air Temp. Gauge	1
	2601		Oil Transmitter	2
	1299		E.S. Indicator	2
	1305		Gauge Engine Temp.	2
	1479		Gauge Oil Temp.	2
	2095		Transmitter	2
	1272		A.S. Indicator	5
	1912		Fuel Switch	1
	1914		Fuel Switch	1
6B	1994		Amplifier	1
	437		Mounting Tray	1
	634		Master Indicator	1
	249		Air Mileage Unit	1
	404		W.F.A.	1
	1993		Detector Unit	1
	458		A.P.I.	1
	258		Drift Recorder	1
	561		G 4B Gyro Unit	2
	408		Control Panel	1
6T	1		Gyro Unit	1
	3		Amplifier	1
	11		Junction Box	1
	13		Pilots Controller	1
	19		Switch Box	1

Sec.	Ref.	Pt. No.	Description	Qty
10A	14480		Mounting Tray	1
	14481		Mounting Tray	1
10B	9123		Trailing Aerial	2
	16025		Loading Unit	1
	13178		Aerial	1
10D	1587		Transmitter T.1154M	1
	1477		Receiver 1155L	1
	1669		Receiver 1125D	1
	1409		Receiver 1466	1
10B	13178		Whip Aerial	1
10E	542		Stowage Box	1
10H	8922		Connector	1
	1951		Connector	1
10K	17387		Power Unit	2
	13066		Power Unit	1
	1470		Power Unit	1
	297		Power Unit	1
10F	126		Switch Unit Type J	1
10L	250		Control Unit	1
	212		Control Unit	1
	16071		Control Unit	1
10U	16621		I.F. Amplifier	3
	90		Amplifier	2
10AJ	82		Mounting Tray	1
	52		Mounting Tray	1
10FB	366		Switch Unit	1
10HA	16528		Connector	1
	9303		Connector	1
	8925		Connector	1
	8926		Connector	1
	8929		Connector	1
	8936		Connector	1
	8939		Connector	1
	8940		Connector	1
	9302		Connector	1
10DB	8477		Receiver 3647	1
6A	3671		Mounting A.V.	2
11A	3454		Flare Chute	1
26TV		64864-319	Stowage	1
		64864-19	Stowage Camera	1
		64864-179	Stowage	1
		66864-49	Floor Rail	1
		64863-21	Mounting	1
		64864-155	Rack Flare Stowage	1
		64864 Sht 67.	Stool Navigator	1
		66864-33	Mounting Drift Meter	2
		64834-5	Instrument Panel	1
		64834-7	Instrument Panel	1
		64834-85	Instrument Panel	1
		66836-1	Distribution Panel	1
		64864-471	Rack	1
		64836	Junction Box	1

Sec.	Ref.	Pt. No.	Description	Qty.
		66864-103	Rack	1
		64864-49	Stowage	1
		66864-17	Stowage	1
		64836-215	Mounting	1
	1930		Aerial Tube	1
	501		Seat	1
	481		Rail Slide	1
	479		Rail Slide	2
	477		Rail Slide	2
	478		Rail Slide	2
	480		Rail Slide	1
	1918		Mast Aerial	1
	2477		Seat	2
	2478		Seat	1
	2479		Seat	2
	512		Ladder	1
	412		Plate Cover	1
	2311		Guard Rail	1
	397		Bomb Door L.H.	1
	391		Bomb Door R.H.	1
	408		Rod	2
	407		Rod	2
	398		Hinge	1
	399		Hinge	1
	392		Hinge	1
	393		Hinge	1
	1624		Actuator	1
	1618		Actuator	1
	2035		Valve	2
27N	84		Fire Extinguisher	2
26TV	1658		Stowage Dinghy	1
		64864 Sht 5.	Radio Console	1
Equioment Fitted:-				
5CW	2452		Dimmer Switch	1
	2525		Dimmer Switch	1
5CY	2559		Circuit Breaker	3
	2560		Circuit Breaker	2
	2561		Circuit Breaker	3
	2563		Circuit Breaker	1
5U	1693		Voltmeter	1
6D	430		Oxygen Flow Indicator	1
	1444		Oxygen Economiser	1
10A	17355		Mounting	2
	13157		Matching Unit	1
10B	9005		Winch Trailing Aerial	1
10D	1336		Dividing Unit	2
	13336		Panels Type 192	2

Sec.	Ref.	Pt. No.	Description	Qty.
10F	7741		Trans. Key	1
	2312		Relay Type 102	8
	494		Relay Type 220	1
10H	322		Socket Type 137	2
	428		Socket Type 169	1
	434		Plug Type 210	1
26TV		64864 Sht 57.	Navigators Table	1
Equipment Fitted				
5CY	2561		Circuit Breaker	1
6B	310		G.P.I. Switch Panel	1
	314		Motor Repeater	1
6D	430		Oxygen Flow Indicator	2
	1444		Oxygen Economiser	2
10F	2312		Relay Type 102	4

5.2. Unserviceable equipment removed from aircraft

Sec.	Ref.	Description	Qty.
5W	226	Actuator	4
	300	Actuator	6
	302	Actuator	2
5CW	930	Switch	2
	1937	Relay Type J	4
	2828	Master Switch	1
	3937	Micro Switch	1
	3945	Relay Type S4	1
	4360	Switch	1
	4171	Switch	1
	3955	Switch Inertia	1
	3521	Switch Inertia	1
	4212	Switch Inertia	1
	1212	Switchbox	1
	4102	Relay Type Q	4
	2017	Switch	1
5CX	701	Lamp	1
	2052	Lamp Landing	2
5CY	2853	Circuit Breaker	9
	3084	Suppressor	2
	4211	Acc Cut-Out	2
5CZ	4070	Inching Unit	3
5UA	4751	Generator E.D.	2
5UB	4795	Rotary Converter	2
5UC	2844	Voltage Regulator	4
	2899	Voltage Regulator	1
5UD	1488	Motor W/S. Wiper	1
5UE	218	Pump De-Icing	2
	4995	Fuel Pump	6
	5057	Pump Priming	1
	6244	Pump W/S. De-Icing	1
6A	2133	Desynn Transmitter	3
	2134	Desynn Transmitter	4
	2237	Generator E.S.I.	2
	2649	Fuel Transmitter	2
	2686	Pressure Gauge	1
	2691	Pressure Gauge	3
	2890	Tank Unit	2
	2891	Tank Unit	2
	2892	Tank Unit	2
	2893	Tank Unit	2
	2894	Tank Unit	4
	2895	Tank Unit	2
	2897	Tank Unit	2
	2898	Tank Unit	2
	2899	Tank Unit	2
	2900	Tank Unit	2

Sec.	Ref.	Description	Qty
	2902	Rectifier Unit	1
	2961	Fuel Meter	1
	3820	Pitot Head	1
	2888	Fuel Gauge	1
	1912	Pressure Switch	3
	1998	Power Unit	2
6D	430	Flow Indicator Oxygen	1
	743	Flow Indicator Oxygen	1
	129N	Cylinder Air	1
	1395	Regulator Oxygen	1
	1398J	Cylinder Oxygen	6
	1444	Economiser	8
6F	245	Harness ZB	2
10B	16446	Loop Aerial	1
10D	17937	T.R.1985	1
25M	19118	Pump Feathering	2
26FL	5169	Lock Switch	1
	5753	Fuel Cock	1
26TV	910	Actuator	2
	1086	Hinge Fitting	1
	1087	Hinge Fitting	1
	1088	Hinge Fitting	1
	366	Lever	1
	1577	Cover Access	1
	2180	Vent Funnel	1
	2962	Pipe	2
	1440	Rod	1
	3704	Pipe	2
	2351	Pipe	1
	2190	Pipe	2
	2488	Pipe	1
	6470	Pipe	1
	1971	Pipe	1
	457	Door	1
	464	Door	1
	1458	Gill Cowling	1
	6308	Window	1
	2212	Gear & Rod	1
	2971	Stay	1
	20	Flap	1
	24	Flap	1
	1331	Valve Isolating	1
	1089	Hinge Fitting	1
	2666	Control Rod	1
	2963	Pipe	2
	2887	Member	2
	2883	Member	2
	1070	Oleo Group	2
	36	Oleo Group	1

Sec.	Ref.	Description	Qty
	2228	Fuel Tank	1
	2229	Fuel Tank	1
	2230	Fuel Tank	1
	2231	Fuel Tank	1
	2232	Fuel Tank	1
	2233	Fuel Tank	1
	39	Panel	2
26FL	7058	Tab-Balance	2
27A	2712	Nose Wheel	1
	3560	Main Wheel	4
27B	2713	Element Cleaner	2
	2786	Oil Cooler	1
27G	2091	Air Filter	1
	2370	Valve Brake Control	1
	2092	Valve Pressure Reducing	1
	5199	Plate Friction	8
27M	616	Accumulator	1
	562	Filter	1
27N	85	Bracket	1
27V	2531	Ram Pneumatic	2
27G	4991	Plate Carrier	8
	4973	Plate Backing	16
27VA	2958	Relay Valve	1
	3970	Valve	2
	4119	Master Cylinder	1
	4565	Accumulator	2
	4206	Master Cylinder	1
37A	1813	Booster Coil	1
37B	5073	Plugs Sparking	56
37F	5800	Starter Motor	1
37G	505	Compressor	1
37J	4	Pump Vacuum	2
	88	Coupling	2
	264	Pump Hydraulic	2
37L	395	Drive	1
	182	Gear Box	1

5.3. Embodiment Loan equipment issued to Aircraft

Sec.	Ref.	Description	Qty.
27G	5199	Plates Friction	4
	5369	Plates Backing	10
	5440	Plates Friction	4
27M	562	Filter	1
	616	Accumulator	1
	9137	Adaptor	1
27N	72	Flame Switch	2
	73	Finned Heads	5
	85	Bracket	1
27P	0157	Water Tins	22
	0757	Rations Emergency	11
27V	2531	Ram Pneumatic	2
27BA	8768	Nut Union	1
	8816	Coupling	1
27FP	6	Pin	2
	23	Pin	2
	87	Fastener	12
	146	Fastener	12
	167	Fastener	24
	168	Fastener	12
	170	Fastener	12
	309	Fastener	12
	314	Fastener	12
	345	Spring	24
	648	Fastener	12
27VA	2956	Cylinder Master Assembly	1
	2958	Valve Relay	1
	3303	Clamp	1
	3704	Pipe	2
	3970	Valve	2
	4119	Master Cylinder	1
	4565	Accumulator	1
27WW	222	Blade	2
32B	726	Sponge	1
32C	679	Tubing	8 Ft
33C	1268	Seamarker	2
35	N.I.V.	Hercules Engine 264	1
36R	103429	Plate Locking	36
	105765	Guide Spring	1
	105799	Bolt	1
	106069	Bolt	10
	106077	Tabwasher	56
	106676	Washer Joint	1
36W	4844	Washer	296
37A	1813	Booster Coil	1
	16596	Pad Spring Group	2

Sec.	Ref.	Description	Qty
37B	5073	Sparking Plug	56
37F	5800	Starter Motor	1
37J	88	Coupling	2
44	161	Kite Aerial	1
26FL	101078	Mod Kit	1
26TV	100115	Mod Kit	1
	100241	Mod Kit	1
	100274	Mod Kit	1
	100285	Mod Kit	1
	100294	Mod Kit	1
	100301	Mod Kit	1
	100302	Mod Kit	1
	100316	Mod Kit	1
	100322	Mod Kit	1
	100336	Mod Kit	1
	100344	Mod Kit	1
	100377	Mod Kit	1
	100403	Mod Kit	1
	100409	Mod Kit	1
	100410	Mod Kit	1
	100416	Mod Kit	1
	100424	Mod Kit	1
	100444	Mod Kit	1
26TV	2905	Worm & Sleeve	2
	2906	Cap Starwheel	2
	2923	Fitting	32
	2951	Lever Actuating Group	1
	2962	Pipe	2
	2963	Pipe	2
	2967	Bracket	1
	2971	Stay	1
	2973	Strip Sealing	16
	2979	Eye Bolt	4
	2998	Pin Pivot	1
	3004	Ring Sealing	1
	3007	Strip Sealing	1
	3012	Bolt	24
	3026	Strip Sealing	2
	3043	Clip	2
	3049	Bolt	60
	3050	Bolt	48
	3052	Pin Clevis	12
	3100	Strip Sealing	2
	3114	Ring	4
	3171	Ring Joint	2
	3180	Ring Sealing	2
	3181	Connector	2
	3185	Connector	1

Sec.	Ref.	Description	Qty
26TV	3186	Ring Sealing	4
	3189	Bolt	1
	3190	Spring	16
	3192	Bolt	2
	3238	Strap	4
	3283	Clip	1
	3295	End Tube	1
	3317	Collar	28
	3499	Terminal Block	1
	3543	Bracket	1
	4040	Track Roller	2
	4043	Pin Hinge	8
	4195	Valve Isolating	1
	4228	Pin	4
	4290	Spring	4
27A	2717	Nose Wheel Assy.	1
	3560	Main Wheel	4
27B	1473	Ring Insert	4
	2702	Ring Joint	4
	2713	Element Cleaner	2
	2786	Oil Cooler	1
	2910	Element Assy.	1
27C	1880	Bellows	1
	1882	Dinghy	1
	1890	Drogue	1
	1894	Glove Type Paddles	2
	2033	Cup/Baler	1
	2035	Weather Apron	1
	2113	Kit Fishing	1
	2114	Outfit Repair	1
	2140	Pack Type Z	1
	2161	Apparatus De-Salting	22
	2176	Stoppers Leak	2
	2364	Heliograph	1
27G	2092	Valve Press. Reducing	1
	2370	Valve Brake Control	1
	2461	Valve	1
	2722	Maxaret Unit	2
	2732	Maxaret Unit	2
	4903	Plate Locking	4
	4904	Spring Locking	4
	4973	Plate Backing	6
	4991	Plate Carrier	8
26TV	1436	Strip Sealing	10
	1437	Strip Sealing	10
	1438	Stop	6
	1440	Rod Connecting	2
	1455	Gill Cowling	1

Sec.	Ref.	Description	Qty
26TV	1458	Gill Cowling	1
	1464	Tube Stay Support	1
	1538	Duct Bend	1
	1541	Stay	1
	1542	Stay	1
	1577	Cover Access	1
	1581	Cap	1
	1604	Pipe	2
	1610	Pipe	1
	1681	Cover	1
	1699	Strip Sealing	2
	1783	Plunger Locking	2
	1870	Ring Sealing	6
	1871	Ring Sealing	2
	1872	Ring Sealing	6
	1889	Ring Sealing	2
	1892	Fastener	1
	1894	Connector	11
	1901	Pipe	3
	1971	Pipe	3
	1972	Pipe	1
	1973	Pipe	2
	1992	Bolt	12
	1993	Bolt	4
	1994	Bolt	30
	1995	Bolt	15
	2012	Bolt	15
	2015	Link	1
	2054	Strip Port	1
	2064	Adaptor	4
	2080	Screw	144
	2180	Funnel	1
	2190	Pipe	2
	2213	Gear and Rod	1
	2228	Fuel Tank	1
	2229	Fuel Tank	1
	2230	Fuel Tank	1
	2231	Fuel Tank	1
	2232	Fuel Tank	1
	2233	Fuel Tank	1
	2331	Lever	1
	2351	Pipe	1
	2389	Ring	4
	2399	Strip Retaining	100
	2488	Pipe	1
	2489	Spring	1
	2532	Strip Sealing	1
	2533	Strip Sealing	4

Sec.	Ref.	Description	Qty
26TV	2558	Door Access	1
	2560	Circlip	2
	2592	Strip Sealing	2
	2599	Ring Sealing	1
	2601	Bush	1
	2607	Bolt	72
	2666	Rod Control	1
	2696	Bolt	48
	2756	Channel	1
	2764	Locking Pin	2
	2804	Cleat	1
	2840	Block Trunnion	2
	2859	Lock Group	1
	2882	Member	2
	2883	Member	2
26SR	6665	Bolt	3
	6739	Screw	288
	6774	Chain	2
26TV	N.I.V.	64816-783 Member	2
	N.I.V.	64827-4317 Bush	4
	N.I.V.	64839-365 Connector	2
	N.I.V.	64839-367 Connector	2
	20	Flap Port	1
	24	Flap Group Port	1
	36	Oleo Group	1
	39	Panel Top	2
	77	Pin Shackle	12
	85	Pin	8
	112	Bolt	12
	113	Bush	12
	114	Bolt	12
	115	Bolt	12
	122	Bolt	16
	125	Bolt	2
	137	Gasket	8
	139	Intake air	1
	161	Stop	60
	175	Strip Sealing	1
	229	Door Access	1
	266	Nut	4
	270	Pin	2
	343	Strip Sealing	1
	345	Strip Sealing	1
	347	Strip Sealing	1
	349	Strip Sealing	1
	351	Strip Sealing	1
	366	Lever	1
	423	Astro Dome	1

Sec.	Ref.	Description	Qty
26TV	425	Fillet	1
	433	Fillet	1
	436	Panel	1
	457	Door Access	1
	464	Door Access	1
	487	Curtain	1
	490	Curtain	1
	551	Ice Shield	4
	623	Control C.S.U.	1
	629	Strip Sealing	24
	633	Ferrule	2
	657	Strip Sealing	6
	669	Bolt	12
	697	Pipe	1
	712	Bolt	6
	738	Pipe	1
	747	Clip	1
	750	Clip	2
	910	Actuator	2
	1070	Oleo Group	2
	1086	Fitting Hinge	1
	1087	Fitting Hinge	1
	1088	Fitting Hinge	1
	1089	Fitting Hinge	1
	1093	Strip Sealing	1
	1096	Bolt	4
	1103	Lever	1
	1104	Lever Plunger Group	1
	1106	Pin Dowel	1
	1149	Cable	1
	1228	Strip Stbd.	1
	1250	Connector Elbow	1
	1389	Strip Sealing	4
	1390	Strip Sealing	2
	1417	Lever	2
	1428	Cover	2
10HZ	560230	Socket	6
	560240	Socket	1
	560250	Socket	1
	560260	Socket	11
	560330	Socket	5
	560360	Plug	2
	560820	Coupler Socket	20
	590100	Fuse Holder	96
	970055	Caps Protective	37
	970058	Gasket	67
	970059	Gasket	12
	970061	Outlet	12

Sec.	Ref.	Description	Qty
10HZ	970062	Outlet	68
	970068	Outlet R A.	1
	970108	Gasket	46
	970292	Clamp	35
12K	444	Cartridge	1
	461	Match Tin	1
	1113	Signals 2 Star	12
25M	11614	Tabwasher	2
	15735	C.S.U.	1
	18500	Tabwasher	1
	19118	Pump Feathering	2
	19512	Tabwasher	4
26FL	72	Ring Joint	8
	108	Element Gauge	1
	637	Stop	2
	673	Window	2
	823	Nut	24
	849	Spring	1
	877	Washer	56
	884	Bolt	1
	936	End Fork	1
	1181	Sleeve	4
	1540	Bolt	8
	1541	Shim	2
	1636	Spring	30
	1650	Ring Sealing	4
	2199	Spring	3
	2492	End	2
	2959	Ring	8
	5039	Bolt	4
	5133	Sleeve	1
	5169	Locking Switch	1
	5255	Circlip	2
	5359	Ring Gland	1
	5553	Pin	6
	5558	Twicklip	24
	5753	Fuel Cock	1
	5770	Clamp	30
	5772	Clamp	6
	5773	Section	10
	5800	Ring Joint	8
	5812	Surround	14
	6302	Mounting	2
	6308	Window	1
	6470	Pipe	1
	6618	Handgrip	4
	6922	Pin	2
	6979	Seal	1

Sec.	Ref.	Description	Qty
26FL	6980	Ring	1
	7026	Screw	256
	7058	Tab Balance	2
	7354	Bolt	6
	7378	Ring Gland	1
	7394	Piston	1
	9017	Section	2
	10015	Spring	1
	6695	Bolt	2
10B	1667	Terminal Unit	4
	16389	Aerial	1
	16446	Loop Aerial	3
	16566	Aerial	1
10D	16957	Dinghy	1
	17937	T.R.1985	1
	17939	T.R.1987	1
	18843	T.R.3710	1
	19598	Receiver A.D.F.	2
	19820	Junction Box	6
	19821	Junction Box	7
	19822	Junction Box	1
10H	2206	Socket	12
	4461	Terminal	33
	20303	Socket	1
	9560300	Plug	7
	9560820	Coupler Socket	24
	9970056	Caps Protective	2
	9970065	Outlet	6
	9970072	Outlet	6
	9970077	Ferrule	18
	9970078	Ferrule	18
	9970083	Ferrule	12
	9970084	Ferrule	12
	9970096	Thrust Ring	12
10J	13152	Loop Controller	2
10K	16244	Transformer	2
	16245	Aerial Transformer	2
10L	246	Control Unit	1
	260	Control Unit	1
	16073	Control Unit	2
	16320	Control Unit	6
10P	16303	Filter Voice/Range	1
10Q	61	Indicator I.L.S.	1
	16094	Tracking Unit	1
	16095	Indicator	1
10U	16596	Amplifier	1
10AJ	82	Mounting	3
	121	Crate	1

Sec.	Ref.	Description	Qty
10AJ	132	Mounting A.V.	6
	164	Mounting	4
	191	Mounting	3
10AL	97	Grommet	3
10AR	1026	Backplate	2
	1990	Backplate	1
	1991	Backplate	1
10AS	84	Washer	4
10CV	1503	Valve	2
10HA	11035	Connector	1
	11036	Connector	2
	14307	Connector	1
	14310	Connector	1
	14315	Connector	1
	15860	Connector	1
	16523	Connector	1
	16524	Connector	1
	16525	Connector	1
	16526	Connector	1
	16527	Connector	1
	16528	Connector	2
10HZ	560050	Plug	1
	560060	Plug	1
	560070	Plug	1
	560080	Plug	6
	560100	Socket	6
	560120	Socket	6
	560150	Plug	5
	560180	Socket	12
6A	2086	Indicator R. of C.	2
	2133	Desynn Transmitter	3
	2134	Desynn Transmitter	4
	2237	Generator E S.I.	2
	2239	Indicator	2
	2545	Gasket	2
	2649	Fuel Flow Transmitter	2
	2678	Switch	1
	2679	Plugs Protective	2
	2685	Gauge Pressure	1
	2686	Gauge Pressure	1
	2691	Gauge Pressure	3
	2715	Transformer	3
	2769	Air Temp. Indicator	1
	2890	Tank Unit	2
	2891	Tank Unit	2
	2892	Tank Unit	2
	2893	Tank Unit	2
	2894	Tank Unit	4

Sec.	Ref.	Description	Qty
6A	2895	Tank Unit	2
	2897	Tank Unit	2
	2898	Tank Unit	2
	2899	Tank Unit	2
	2900	Tank Unit	2
	2961	Fuel Meter	1
	3157	Clock Mk. 4B	2
	3304	Bulb	1
	3671	Mounting A.V.	2
	3782	Indicator Airspeed	2
	3820	Pitot Head	2
	3953	Indicator	1
6B	541	Indicator G.P.	1
	633	Amplifier	1
	655	Mounting Tray	1
	657	Backplate	1
	1673	Compass P12	1
6D	129N	Cylinder Air	1
	428	Caps Blanking	18
	454	Head Operating	1
	480	Valve Cut Off	9
	491	Union Reducing	1
	492	Union End	1
	515	Manifold	2
	527	Socket Bayonet	15
	615	Washer	2
	743	Flow Indicator	10
	1248	Pad Holders	2
	1395	Regulator Oxygen	1
	1398	Cylinder Oxygen	6
	1444	Economiser Oxygen	14
	1598	Flow Indicator	2
	1706	Washer P.T.F.E	2
	1714	Tubing	4
	1715	Tubing	4
	1716	Tubing	2
	1717	Tubing	8
	1872	Valve	1
	1892	Adaptor Base	1
	9430546	Cylinder	1
6F	245	Harness	2
26TV	100452	Mod. Set	2
	100460	Mod. Set	1
	100508	Mod. Set	1
	200748	Mod. Set	1

Sec.	Ref.	Description	Qty
5CW	4102	Relay	5
	4179	Switch	6
	4184	Switch	6
	5212	Switch Mk 5	1
	4247	Switch	1
	4517	Switch Type A	3
	4639	Switch Micro	2
	4829	Switch Push	2
	5015	Switch Magnetic	3
	5016	Switch Magnetic	3
	5499	Relay	3
	5500	Switch Magnetic	3
	5824	Switch	2
	5825	Switch	19
	5826	Switch	1
	5907	Switch Torque	4
5CX	701	Lamp	10
	720	Glass Dome	8
	1551	Lamp	1
	2052	Lamp Landing	2
	2783	Lamp Holder	4
	4013	Lamp Warning	8
	4856	Lamp	1
	4857	Lamp	1
	5154	Lamp Warning Amber	2
	5155	Lamp Warning Blue	4
	5164	Indicator	1
	5203	Lamp Warning Clear	2
5CY	587	Socket	2
	1002	Suppressor Type P	2
	2225	Socket	1
	2559	Circuit Breaker	4
	2560	Circuit Breaker	2
	2561	Circuit Breaker	2
	2564	Circuit Breaker	6
	2853	Circuit Breaker	7
	2967	Suppressor	2
	3084	Suppressor	1
	3946	Circuit Breaker	4
	4211	Acc. Cut Out	2
5CZ	430	Terminal Block	18
	1962	Fuse Box	3
	4070	Inching Unit	3
	5074	Indicator Electro	1
	5134	Flasher Unit	1
5LX	952295	Lamp Filament	10
5UA	4751	Generator E D.	2
5UB	4795	Rotary Inverter	2

Sec.	Ref.	Description	Qty.
5UB	5758	Inverter 103	3
	5992	Screen Assy.	3
	6016	Screws	12
5UC	2844	Regulator	3
	2899	Regulator	1
	5759	Control Panel 15	2
	5760	Control Panel 24	1
	5810	Voltage Regulator	1
	6409	Washer Glass Board	4
5UD	1488	W/S. Wiper Motor	1
5UE	218	De-Icing Motor	2
	4995	Fuel Pump	6
	5057	Priming Pump	1
	6244	Pump De-Icing	1
6A	1566	Oil Temp. Bulb	4
	1686	Static Vent	2
	1755	Plug	2
	1820	Stiffener Plate	2
	1912	Fuel Press. Switch	3
	1998	Pacitor Power Unit	2
	2082	Altimeter	2
5H	1	Block 2 Way	7
	2	Block 3 Way	11
	3	Block 5 Way	7
	4	Block 15 Way	6
	5	Block	1
	7	Block Cover	5
	8	Block Cover	11
	9	Block Cover	7
	10	Block Cover	6
	13	Block Terminal	2
	14	Block Cover	2
	19	Connecting Link	8
	41	Lug	4
	124	Socket Assy.	36
	125	Socket Assy.	114
	9400051	Cable Ferrule	140
	9400053	Cable Ferrule	12
	9400055	Cable Ferrule	36
	9400111	Cable Lug	18
	9400112	Cable Lug	6
5J	101806	Accumulator	2
5L	9952276	Lamp Filament 24V 10W	6
	9953273	Lamp Filament 28V 18W	3
5Q	207	Voltmeter 0-35	1
	4340	Ammeter 50-0-200A	2
5W	226	Actuator	5

Sec.	Ref.	Description	Qty
5W	300	Actuator	6
	301	Actuator	2
	302	Actuator	4
5X	106	Socket	2
	240	Ferrule	7
	333	Ferrule	2
	2134	Terminal Block	1
	2786	Grommet	6
	2863	Terminal Strip	7
	3181	Terminal Block	23
	3250	Coupling Nut	2
	3259	Link	8
	3268	Q.R.Block	11
	3271	Fuse Block	1
	6006	Plug	1
	6017	Plug	2
	6019	Plug	4
	6173	Link	13
	6190	Socket	1
	6317	Link	20
	6389	Socket	2
	6395	Fuse Block	10
	6480	Commoning Bar	12
	9400061	Tags 4 Amp	800
	9400062	Thimbles	712
	9400063	Tags	200
	9400064	Thimbles	200
	9400065	Tags	200
	9400066	Thimbles	200
5CW	930	Switch	2
	1212	Switchbox	1
	1722	Relay	3
	1937	Relay	4
	2007	Relay	4
	2017	Pressure Switch	1
	2472	Relay k 3	1
	2828	Master Switch	1
	3521	Switch	1
	3940	Relay Type R	1
	3942	Relay Type S.1	4
	3943	Relay Type S.2	3
	3945	Relay Type S.4	3
	3955	Switch	1

5.4. Embodiment Loan Equipment held at Cranfield for flying programme and subsequently transferred to Smiths Aircraft Instruments Ltd.

Sec.	Ref.	Description	Qty
5H	1	Block 2Way	3
	2	Block 3 Way	3
	7	Block Cover	5
	8	Block Cover	3
	19	Link	16
	41	Lug	2
	124	Socket Assembly	59
	9400051	Cable Ferrule	416
	9400053	Cable Ferrule	88
	9400055	Cable Ferrule	62
	9400059	Cable Ferrule	50
	9400111	Cable Lug	6
	9400112	Cable Lug	6
5J	101534	Accumulator 12V 40A	4
5L	9952511	Filament 60W	2
	9953273	Filament 28V 18W	3
5X	240	Cut Ferrule	4
	2134	Terminal Block	3
	2786	Grommet	6
	2863	Terminal Strip	7
	3181	Terminal Block	17
	3259	Link	4
	3268	Q.R.Block	10
	3271	Fuse Block 4 Way	10
	3274	Covers	10
	3278	Pillars	52
	6006	Plug	1
	6059	Plug	1
	6165	Covers	16
	6173	Link	8
	6317	Link	7
	6389	Socket	2
	6418	Thimble 2.5	1000
	6480	Commoning Bar	2
	9400061	Tags 4A	1200
	9400062	Thimbles	1488
	9400063	Tags	1900
	9400064	Thimbles	1900
	9400065	Tags	1900
	9400066	Thimbles	1900
5CW	1212	Switchbox	1
	1722	Relay Type P	1
	1937	Relay Type J	1
	2007	Relay Type Q1	1
	2472	Relay Type K3	1

Sec.	Ref.	Description	Qty
5CW	3942	Relay Type S1	1
	3945	Relay Type S4	1
	4098	Micro Switch	2
	4102	Relay	4
	4212	Switch	1
	4517	Switch Type A	2
	4836	Switch	4
	5015	Switch Magnetic	1
	5016	Switch Magnetic	1
	5500	Switch Magnetic	1
	5823	Switch	4
	5825	Switch	15
	5826	Switch	1
	5907	Switch Torque	1
5CX	701	Lamp	7
	720	Dome Glass	7
	1551	Lamp Type C	1
	2783	Lamp Holder	2
	3430	Screen	2
	4856	Lamp Type D	1
	4857	Lamp Type E	1
	5134	Floodlight	1
5CY	1002	Suppressor Type P	1
	2559	Circuit Breaker	5
	2560	Circuit Breaker	2
	2561	Circuit Breaker	3
	2562	Circuit Breaker	2
	2564	Circuit Breaker	6
	2866	Suppressor Type B	2
	2967	Suppressor	1
	3084	Suppressor Type X3	2
	4211	Acc. Cut-Out	2
	5336	Circuit Breaker	1
	5337	Circuit Breaker	2
5CZ	432	Terminal Block	2
	879	Fuse 2.5	20
	880	Fuse 5A	40
	881	Fuse 10A	20
	907	Fuse 25A	3
	1962	Fuse Box	1
	1963	Fuse Type N	8
	4057	Fuse 20A	20
5LX	952295	Filament 24V 12W	10
5UA	4751	Generator E.D.	1
5UB	4795	Rotary Inverter	2
	4935	Inverter 100B	2
5UC	2844	Regulator 23	1
	2899	Regulator 32	1

Sec.	Ref.	Description	Qty
5UC	5759	Control Panel 15	2
5UE	4344	Valve Fuel Priming	1
	4995	Fuel Pump	2
	5057	Priming Pump	1
	5836	Pump	1
6A	1912	Switch Fuel Pressure	1
	1998	Power Unit	1
	2123	Fuel Flow Indicator	1
	2133	Desynn Transmitter	1
	2134	Desynn Transmitter	1
	2237	Generator E.S.I.	1
	2649	Fuel Flow Transmitter	1
	2678	Switch	1
	2691	Gauge Pressure	1
	2715	Transformer	1
	2783	Air Temp. Bulb	1
	2887	Fuel Gauge	1
	2888	Fuel Gauge	2
	2889	Fuel Gauge	1
	2901	Rectifier Unit	1
	2902	Rectifier Unit	1
	2961	Fuel Meter	1
	3953	Indicator	1
	4006	Indicator	2
	5449	Transmitter Oil	2
6B	292	Flex Drive	1
	298	A.M.U.	1
	404	W.F.A.	1
	406	G.P.I.	1
	458	A.P.I.	1
6D	480	Valve Cut Off	2
	515	Manifold	2
	574	Line Filter	2
	684	Jet	6
	685	Jet	20
	743	Flow Indicator	1
	1377	Plug	8
	1398J	Oxygen Cylinder	2
	1444	Oxygen Economiser	3
	1598	Flow Indicator	10
10A	14480	Tray	1
	14481	Tray	1
10B	1667	Terminal Unit	2
	17373	Waveguide	1
10H	4461	Terminal	15
	18977	Sleeve	2
	18978	Sleeve	2
	19611	Socket	2

Sec.	Ref.	Description	Qty
10H	20199	Plug	1
	20224	Plug	6
	20225	Plug	1
	20226	Plug	2
	20227	Plug	2
	20302	Socket	2
	20303	Socket	5
	20305	Socket	1
	20317	Cover	1
	20325	Sleeve	6
	20326	Sleeve	4
	20327	Sleeve	2
	9549027	Socket	4
	9560047	Adaptor	1
	9560120	Socket	2
	9560180	Socket	2
	9560220	Socket	3
	9560300	Plug	10
	9560360	Plug	1
	9560400	Plug	1
	9560850	Socket	2
	9970058	Gasket	1
	9970059	Gasket	2
	9970060	Gasket	3
	9970061	Outlet	2
	9970064	Outlet	4
	9970067	Outlet	3
	9970074	Outlet	2
	997088	Sealing Ring	17
	9970091	Sealing Ring	12
	9970096	Thrust Ring	12
	9970102	Compression Ring	12
	9970108	Gasket	11
	9970293	Clamp	1
	9970296	Clamp	8
10K	18225	Aerial Transformer	2
10AR	2596	Clamp	3
	2597	Clamp	2
10AS	84	Washer	2
10CV	150.	Valve	2
10HZ	560050	Plug	14
	560060	Plug	9
	560070	Plug	5
	560110	Socket	6
	560120	Socket	6
	560150	Plug	7
	560240	Socket	5
	560250	Socket	5

Sec.	Ref.	Description	Qty
10HZ	560260	Socket	1
	560280	Plug	6
	560290	Plug	6
	560330	Socket	7
	560350	Plug	12
	560360	Plug	10
	590100	Fuse Holder	12
	970055	Caps	31
	970058	Gasket	49
	970059	Gasket	12
	970060	Gasket	20
	970061	Outlet	12
	970062	Outlet	23
	970064	Outlet	12
	970068	Outlet R.A.	23
	970071	Outlet R.A.	12
	970108	Gasket	22
	970292	Cable Clamp	32
25M	11614	Tabwasher	6
	15357	Washer	3
	15735	C.S.U.	1
	18500	Tabwasher	6
	19118	Pump Feathering	1
	14512	Tabwasher	6
	19537	Lockplate	1
	19550	Tabwasher	7
	19552	Tabwasher	7
26FL	72	Ring Joint	8
	108	Element Gauge & Holder	1
	637	Stop	2
	823	Nut	24
	849	Spring	1
	877	Washer	56
	884	Bolt	2
	936	End Fork	1
	1181	Sleeve	4
	1321	Circlip	1
	1540	Bolt	8
	1541	Shim	2
	1636	Spring	24
	1650	Ring Sealing	4
	1666	Nipple	4
	1920	Hose	1
	2199	Spring	3
	2492	End	2
	5039	Bolt	4
	5133	Sleeve	1
	5169	Locking Switch	1

Sec.	Ref.	Description	Qty
26FL	5255	Circlip	2
	5358	Sleeve	1
	5359	Ring Gland	1
	5553	Pin	6
	5558	Twicklip	12
	5676	Gasket	6
	5753	Fuel Cock	1
	5770	Body	15
	5772	Body	6
	5773	Section	5
	5800	Ring Joint	8
	6019	Stop	4
	6302	Mounting	1
	6317	Ring Sealing	2
	6470	Pipe	1
	6922	Pin	2
	6979	Seal	1
	6980	Ring	1
	7008	Element	2
	7026	Screw	88
	7058	Tab Balance	2
	7354	Bolt	6
	7378	Ring Gland	1
	7670	Strip Attachment	169
	7805	Bolt	24
	9017	Section	2
	10015	Spring	1
26SR	6659	Bolt	2
	6665	Bolt	1
	6774	Chain	2
26TV	N.I.V.	64839-365 Connector	2
	N.I.V.	64839-367 Connector	2
	16	Tab Trim & Balance	1
	77	Pin Shackle	12
	85	Pin	8
	112	Bolt	12
	113	Bush	12
	114	Bolt	12
	115	Bolt	12
	122	Bolt	16
	125	Bolt	2
	137	Gasket	8
	139	Intake	1
	161	Stop	60
	175	Strip Sealing	1
	266	Nut	2
	270	Pin	2
	271	Pin	2

Sec.	Ref.	Description	Qty
26TV	343	Strip Sealing	1
	345	Strip Sealing	1
	347	Strip Sealing	1
	349	Strip Sealing	1
	351	Strip Sealing	1
	366	Lever	1
	551	Ice-Shield	4
	623	Control	1
	629	Strip Sealing	24
	633	Ferrule	4
	657	Strip Sealing	6
	669	Bolt	12
	712	Bolt	6
	747	Clip	1
	750	Clip	2
	869	Valve	1
	910	Actuator	1
	1086	Fitting Hinge	1
	1087	Fitting Hinge	1
	1088	Fitting Hinge	1
	1089	Fitting Hinge	1
	1093	Strip Sealing	1
	1096	Bolt	4
	1099	Fitting Fork	2
	1103	Lever	1
	1104	Lever	1
	1106	Pin Dowel	1
	1149	Cable	1
	1206	Valve	1
	1228	Strip	1
	1250	Connector Elbow	1
	1321	Gasket	4
	1361	Chain	1
	1389	Strip Sealing	4
	1429	Lever	1
	1436	Strip Sealing	2
	1437	Strip Sealing	10
	1438	Stop	6
	1460	Rod	2
	1464	Tube Stay	1
	1465	Tube Stay	1
	1541	Stay	1
	1542	Stay	1
	1581	Cap	1
	1606	Pipe	1
	1649	Strip Sealing	2
	1783	Plunger Locking	2
	1869	Ring Sealing	4

Sec.	Ref.	Description	Qty
26TV	1870	Ring Sealing	6
	1871	Ring Sealing	2
	1872	Ring Sealing	6
	1887	Ring Sealing	2
	1888	Ring Sealing	2
	1889	Ring Sealing	2
	1892	Fastener	1
	1967	Clamp	2
	1973	Pipe	1
	1992	Bolt	6
	1993	Bolt	5
	1994	Bolt	30
	1995	Bolt	15
	2012	Bolt	2
	2013	Bolt	2
	2015	Link	3
	2027	Pin	2
	2030	Pin	5
	2054	Strip	1
	2062	Hose	2
	2064	Adaptor	2
	2080	Screw	144
	2124	Strip	2
	2151	Washer	8
	2153	Plug	2
	2212	Gear & Rod	1
	2213	Gear & Rod	1
	2331	Lever	1
	2397	Bolt	30
	2489	Spring	1
	2532	Strip Sealing	2
	2533	Strip Sealing	4
	2560	Circlip	4
	2592	Strip Sealing	2
	2599	Ring Sealing	5
	2601	Bush	1
	2607	Bolt	50
	2662	Lever	1
	2666	Rod	1
	2684	Lever	1
	2696	Bolt	60
	2724	Boss	2
	2740	Washer	12
	2764	Locking Pin	2
	2804	Cleat	1
	2840	Block Trunnion	2
	2870	Strip Sealing	16
	2880	Rod	2

Sec.	Ref.	Description	Qty
26TV	2906	Cap	2
	2923	Fitting	32
	2951	Lever	1
	2967	Bracket	1
	2971	Stay	1
	2973	Strip Sealing	16
	2979	Eye Bolt	4
	2998	Pin	1
	3007	Strip Sealing	1
	3012	Bolt	24
	3026	Strip Sealing	2
	3043	Clip	2
	3049	Bolt	24
	3050	Bolt	48
	3052	Pin	12
	3100	Strip Sealing	2
	3171	Ring Joint	2
	3180	Ring Sealing	2
	3181	Connector	2
	3185	Connector	1
	3186	Ring Sealing	4
	3189	Bolt	1
	3190	Spring	12
	3192	Bolt	2
	3202	Ring Gland	2
	3219	Cock $\frac{1}{4}$ BSF	1
	3238	Strap	4
	3283	Clip	1
	3295	End Tube	1
	3317	Collar	24
	3499	Terminal	1
	3543	Bracket	1
	3596	Cable	1
	4040	Roller	2
	4195	Valve	1
	4212	Cam	2
	4228	Pin	4
27A	2716	Tube Inner M.W.	4
	2717	Nose Wheel	1
	2718	Cover N.W.	2
	2719	Tube Inner N.W.	2
	2872	Cover Wheel	4
	3560	Main Wheel	2
27B	1473	Ring Insert	2
	2702	Ring Joint	2
	2910	Element Assy	1
27D	2962	Cover Pitot Head	1
27G	2092	Valve	1

Sec.	Ref.	Description	Qty
27G	2370	Valve	1
	2461	Valve	1
	2722	Maxaret Unit	2
	2732	Maxaret Unit	2
	2750	Valve	1
	4064	Brake Unit	1
	4065	Brake Unit	1
	4904	Spring	4
27M	562	Filter	1
	616	Accumulator	1
	618	Valve	1
	619	Valve	1
	620	Valve	1
	8825	Seal	2
	9137	Adaptor	1
27N	43	Flame Switch	2
	73	Finned Heads	3
27BA	8768	Nut	1
	8816	Coupling	1
27FP	6	Pin	2
	23	Pin	2
	87	Fastener	12
	146	Fastener	12
	167	Fastener	12
	168	Fastener	12
	170	Fastener	12
	314	Fastener	12
	345	Spring	24
	648	Fastener	12
	9430915	Fastener	12
27VA	2958	Valve Relay	1
	3303	Clamp	1
	3620	Hose Assy	2
	3704	Pipe	2
	3970	Valve	2
	4565	Accumulator	1
	5284	Valve Relay	1
34B	9100472	Fluid A.L.5	50
36R	85016	Cone	2
	10018	Washer	24
	103429	Plate Locking	36
	103559	Gasket	4
	105035	Washer Tab	6
	105541	Ring Sealing	6
	105542	Ring Sealing	6
	105579	Cable	2
	105691	Clip	6
	105692	Cuff	4

Sec.	Ref.	Description	Qty
36R	105693	Cuff	4
	105694	Joint	2
	105765	Guide Spring	1
	105799	Bolt	1
	105992	Spring	2
	106000	Washer	10
	106038	Seal	3
	106067	Bracket	2
	106068	Bolt	6
	106069	Bolt	22
	106070	Clamp	2
	106075	Pipe	2
	106076	Pipe	2
	106077	Washer	12
	106335	Spring	1
	106336	Spring	1
	106341	Washer	10
	106381	Washer	14
	106488	Pipe	2
	106489	Pipe	2
	106559	Elbow	2
	106602	Insert	1
	106668	Cover	1
	106671	Bolt	6
	106672	Packing	6
	106673	Trunnion	6
	106674	Trunnion	6
	106676	Washer Joint	9
	107156	Filter	2
	107181	Elbow	2
36W	1429	Nut	36
	1512	Spring Washer	36
37A	1813	Booster Coil	1
	16500	Magneto L.H.	1
	16501	Magneto R.H.	1
	16596	Pad Spring Group	2
37B	5073	Plugs Sparking	56
37F	5800	Starter Motor	1
37G	505	Compressor	1
37J	4	Pump Vacuum	1
	88	Coupling	1
	102	Relief Valve	2
	264	Pump Hydraulic	1
56R	9284	Spring	6
65A	3191	Carburettor	1
65D	576	Fuel Pump	1

5.5. Contractors Bought Out Items

(A) Radio Equipment

ADF Sense Aerial Mast 402A/8	2
" " " " 402B/A	4
" " " Rod 5262	2
Cable Looms - Intercomm.	44
Universal Racking - Member Horizontal	12
" Side R.H.	12
" " L.H.	12
Washer domed	50
Lock Device	14
Mounting A/V XM.589	12
" " XM.533	6
Washer limiting	24
Stop Plate	12
Mounting Plate	12
Test Set for V. O. R.	1
Crystal Units	3
Relay 40/617/115	24
Anchor Plate 30/613/202	24
Socket 40/742/611	24
Cables for V. O. R. Installation	1 set
" " I. L. S. "	1 set
" " Twin AD.7092D	1 set
Relay Magnetic 5 CW/4102	1
I.L.S. Marker Aerial 140.IU.41A	2
Tuning Indicator for A.D.F. type 1333	4
Resistors type 9 RC.7.J	28
Servo Amplifier type 1625	3
Backplate	2
Crystal Units 6287.78, 6032.22, 6043.33, 6054.44, 6165.55, 6265.56, 5230, 6565.56, 6248.89, 5930, 6065.55, 6076.67, 6087.78, 6198.89, 6354.44, 6770, 6990, 6398.89, 6410, 6432.22, 6498.89, 6554.44, 6840, 7230, Kc/s	25
Mounting Tray ED.98507	1
" " ED.98508	1
Aerial Window 66879/PT229	2

Radio Continued

114680 G.P. Backplate	1
3.LRU.123A Receiver	1
3.LRU.127A "	1
14.LRU.207A Power Unit	1
1.LRU.212B Control Unit	1
RL.7003-90D Indicator	1
28-LRU-433A Compass Coupler	1
L.14680/12 Backplate	1
L.14680/13 Backplate	1
3.LRU.128B Marker Receiver	1
1.LRU.212A Control Unit	1
140.LRU.48A Localiser Aerial	2
140.LRU.51A Glide Path Aerial	1
430.LRU.1A Junction Box	1
430.LRU.2A Junction Box	1
Tee Junction	3
154.LRU.103A Backplate	1
Z.560042 Pressure Brake	1
Crystals Glide Path	10
Wave Guide assembly for Doppler transmitter	1
ACP.1500/1 Radio Magnetic Indicator	3
Crystals type 4046	10
15444.44 (332.0 Mc/s)	1
15294.44 (329.3 ")	2
15461.11 (332.3 ")	1
15494.44 (332.9 ")	1
15611.11 (335.0 ")	1
15344.44 (330.2 ")	1
15594.44 (334.7 ")	1
15527.77 (333.5 ")	1
10037.5 (108.9 ")	1
140/LRE/8B Aerial for STR.30B1	1
SR.33A Marker Receiver (replacing 3.LRU.128B returned to suppliers)	1

(B) General Equipment

SS.2787	Strip Sealing	20'0	
9g	Forward facing Seat double	2	
	" " " single	4	
	Covers, seat	6	
T.45	Tube ¾" o/d 20G	246'0	
	½" Fibreglass cloth soundproofing	126 sq.ft	
	Stringer SS.2017/166	93'0	
	Intercostal SS.1824/206	49'0	
	Roof Lights type FM.1949	8	
	Mounting A/V MDSM.14	4	
	Cream vynide	5 yds	
	Mounting A/V 200PH 15	4	
	" " 200PH 25	8	
	" " 200PH 45	4	
	Nipple ACO.3087	6	
	Adjuster ACO.5864	1	
	Flexflite Hose 4" dia.	15'0	
	" " 5" dia.	8'0	
	Indicator Voltmeter S.78 0-35V	1	On Demand
101.BG	Twin Boost Gauge	2	On Demand
KB.105/18	Twin Engine Speed Indicator	2	
458.MV	Thermometer Twin Carb.Temp.	2	
303.MV	Thermometer Twin, Cyl. Head Temp.	2	

5.6. Equipment supplied by Smiths Aircraft Instruments Limited.

Sec.	Ref.	Pt. No.	Description	Qty
6A	5476		Comparator Unit	1
6T	201		Gyro Unit	1
	214		Pilots Controller	1
	234		Servomoter	1
	232		" Mounting	1
	352		Servomotor	1
	354		Servomotor	1
	355		" Mounting	1
		41 EAP	Pust to Break Switch	1
		139/2EAP	Torque Limiter	1
		232EAP	Mounting Servomotor	1
		244EAP	Engage & Trim Indicator	1
		46SFS	Vertical Gyro	2
		103SFS	Mounting Tray	1
		105SFS	Beam Compass Indicator	2
		106SFS	Annunciator Unit	2
		108SFS	Mounting Tray	1
		110SFS	Mounting	1
		481PG	Oil Transmitter	2
		ACP1500/1	Radio Magnetic Indicator	3
		FC7a	Control Unit	1
		KCA1801	Detector Unit	2
		KCA1902	Azimuth Gyro Unit	2
		KCA2101	Mounting	1
		LS2373	Potentiometer	4
		LS/EF1/17	Cable Harness	1
		LS/EF1/35	Servo Control Unit	1
		LS/MD/A8	Torque Cut Out	1
		RES950	Junction Box	1
		RES1300	Indicator Junction Box	1
		RES1430	Mounting Gearing Selector	1
		RES/D1440	Torque Switch Unit	1
		XAC8800	Locking Unit	1
		XAC10000/3	Altimeter 100,000'	1
		XAC11016	Amplifier	1
		XAC11418	Mounting Amplifier	1
		XAC11520/3	Control Unit	1
		XAC15647	Mounting Tray	1
		XAC16390	Compass Amplifier	2
		XAC16451	Junction Box	1
		XAC16483	Computer Unit	1
		XAC18270/1	Rack Mounting	1
		XAC18520	Mounting Gyro	1
		XAC18522/3	Director Horizon	2
		XAC18565/2	M.F.S. Selector	1
		XAC18579	Flight Control Panel	1

6.1. Radio Installation

The normal Varsity Radio/radar installation was completely removed. The only items retained in the present Radio Station are the TR.1985, TR.1987 and Aerial Position.

6.1.1. Intercommunication/Mixing System

Intercomm. and mixing is largely in accordance with ARI.18089. Six Station Boxes type 7681 are in use serving the following crew and passenger stations.

6.1.1.1. Pilot

Mounted on port shelf, with additional 359 sockets for observers standing behind the pilot's seat and one socket on the navigator's table.

6.1.1.2. 2nd Pilot

Mounted on the starboard shelf, with additional sockets for observers standing behind the 2nd Pilot's seat and one additional socket in the bomb-aimer's compartment.

6.1.1.3. Front and Rear Radio Rack

Each Control Unit feeds three 359 sockets spaced along the front edge of the rack.

6.1.1.4. Passenger Seats

Two station boxes are fitted on the Port and Starboard sides controlling 359 sockets adjacent to all passenger seats.

6.1.1.5. In order to satisfy M.T.C.A. and A.R.B. requirements, each station box, junction box and amplifier A1961 has been identified with a College of Aeronautics serial number.

6.1.1.6. 28 Volts supply to the station boxes is split into two sections of three boxes and fused. Fuse No. R2 feeds pilot, port passengers and forward rack. Fuse No. R3 feeds second pilot, starboard passengers and rear rack.

6.1.1.7. Wiring Diagram M-179-39 covers this installation.

6.1.2. V.H.F. Installation

6.1.2.1. Three V.H.F. sets TR.1934, TR.1936 and TR.1935 are fitted and give complete coverage of the V.H F. Band 100-156 Mc/s. These are mounted on the top shelf of the forward rack.

The three aerials, types 228, 226 and 229 respectively, are mounted above the fuselage in anti-flutter mountings Type 10AJ/91.

6.1.2.1. Continued.

Control Units type 382, are mounted on the scuttle above the Instrument Panel together with the frequency lists.

6.1.2.2. The three Transmitter receivers fitted were overhauled at Cranfield, and modified in accordance with M.T.C.A. Leaflet TCA-2966, as the original TR.1985, 1986 and 1987 series are not acceptable to A.R.B.

6.1.2.3. Fuses for the V.H.F. are situated in the Radio Fuse Panel, R4 - TR.1934, R5 - TR.1935 and R6 - TR.1936.

6.1.2.4. Wiring Diagram M-179-38 covers the V.H.F. installation.

6.1.3. I.L.S./V.O.R. Main SR.32/33. Standby SR.14/15C

6.1.3.1. Two types of I.L.S. equipment were fitted, SR.14/15C military equipment (removed from the Dajota G-AMZE) and SR.32/33. The SR.14/15C equipment was modified to Civilian requirements in accordance with M.T.C.A. leaflet TCA.5248, and overhauled and calibrated at Cranfield.

6.1.3.2. Both I.L.S. installations can be operated at the same time, one feeding the MFS, the other feeding a Standard Cross Pointer Indicator. Either equipment can be switched to operate the 'MFS' by means of a "Main/Standby" change-over-switch. The change-over of information is accomplished in the Radio Junction Box via Relays A to K. Information which is 'changed-over' is I.L.S. Localiser and Glide/path needles and flags, outer Marker Lamp and Telephone output.

6.1.3.3. Aerials

One Localiser/V.O.R. sword aerial is fitted on top of the Fin and serves both 'Main and Standby' equipments. The Glide/path aerial is suppressed in the nose panel feeding both Glide/path receivers.
Marker Aerials. Two wire aerials are mounted, one either side of the nose, and feed the marker receivers.

6.1.3.4. Outputs

I.L.S. and V.O.R. outputs are from the Radio Junction Box comprising a 12-way socket feeding the M.F.S., three sockets carrying I.L.S. indicator information, plus two sockets for V.O.R. Relative Bearing Information to feed the R.M.I's.

6.1.3.5. V.O.R. Information

Relative Bearing Information is fed to the Red needles of No. 1 and No. 2 Radio Magnetic Indicators via the Radio Junction Box. Radial Directional Information is fed via the Main/Standby switch and relays to either the M.F.S. or Cross Pointer Indicator.

6.1.3.6. Radio Magnetic Indicators

Three are fitted, each requiring a drive for the outer ring cards from the G.M.2 compass. Only one output is available and this is fed to the S.T.C. Compass Coupling Unit type SR.31, which gives three synchronous outputs, one of which is used for V.O.R. and two are fed via two servo Amplifiers, type 1625, to the R.M.I. outer ring cards.

6.1.3.7. Power Supply to the Servo Amplifiers type 1625, is via the 6-way Fused Sockets, which are connected to the G.M.2. A.C. Supply Inverters.

6.1.3.8. Drawing numbers 179-55-56-57 refers to the I.L.S./V.O.R. installation

6.1.4. Twin A.D.F. Installation

6.1.4.1. Two complete AD.7092D Installations have been fitted using Suppressed Auto D.F. Loops, type 1324A with Asynn Bearing Transmission Systems. A.D.F. relative bearing information is transmitted to the three Radio Magnetic Indicators; No. 2 A.D.F. feeds the Green (No. 2) needles of the three R.M.I's and No. 1 A.D.F. the Red (No. 1) needles of No. 1 R.M.I. only.
All feeds are via the Radio Junction Box.
No. 1 A.D.F. is controlled by the Pilot.
No. 2 A.D.F. is controlled by the second Pilot.

6.1.4.2. Aerials

The suppressed Loop Aerials are mounted on the upper fuselage and the sense aerials on either side of the bomb aimers nacelle.

6.1.4.3. Radio Junction Box

All terminations in the Radio Junction Box are Plessey quick release type providing easy re-arrangement of outputs. The I.L.S. Indicator loading is also situated in the R.J.B., loading resistors being connected to miniature terminal strips. The M.F.S. uses three output loads, no additional loading resistors being required.

6.1.4.4. The internal wiring diagram is M-179-60.

6.1.5. Radio Fuse Panel

6.1.5.1. A complete Radio Fuse Panel has been manufactured and fitted behind the second Pilot, housing fuses for the 115V. 3-phase A.C., 19V. Regulated Supply from the Regulator type 1253, and the unregulated 28V D.C. Spare fuses are located on the cover plate.
There are sufficient spare fuse holders for further radio supplied.

6.1.5.2. Internal wiring diagram M-179-43 refers.

6.1.6. Doppler Type AD.2000

6.1.6.1. Doppler AD.2000 has been fitted, the aerial being suppressed in the bomb-bay, the T.R. and Tracking Units fitted in the cabin, and Display Units on the Navigators table.

6.1.6.2. The G.P.I. Mk.4 Compass input requirement is type 'M' step-by-step. As this output is not available from the GM2, a "step-by-ste-pfrom synchronous" Converter had to be fitted.

6.2. Electrical and Instruments

6.2.1. Generating System

The original generating system has been retained viz. two 6KW Type P3 generators, each controlled by a Type 23 Regulator in conjunction with a master regulator Type 32.

6.2.2. Battery Installation

After careful analysis A.R.B. agreed that the 20 minute emergency case could be adequately met by the existing 24 volt 80AH installation.

6.2.3. Inverters

Seven inverters wer required for the complete installation, two 103 inverters for the M.F.S., one for each separate half of the system. There is one 103 inverter for the Doppler installation.

Two 8A inverters, one normal and one standby are fitted for radio AC loads and mandatory instrument loads.

Two 1203 inverters provide a supply directly to the panels above the tables.

The supplies for the 103 inverter and the heavy DC feed for the radio distribution panel are taken from Type D2 circuit breakers on the main power panel. These have been substituted for the original Type 'D' circuit breakers after the removal of Navigator, W/T crate and Bomb aimer heavy duty feeds.

Two existing 25 amp circuit breakers on Panel 'E' are used as supply sources for the two 8A inverters. Two additional 15 amp circuit breakers have been connected to the same bus bar as supplied for the 1203 inverters.

Control switches and power failure warning indicators for all 103 and 8A inverters are mounted in the cockpit roof panel. Separate control

switches are provided for each 103 inverter and a three position centre 'off' switch for the control of the 8A inverters, allowing manual selection in the event of failure of either.

Also mounted on the cockpit roof panel is the radio master switch, permitting isolation of all AC/DC supplies to all radio equipment. This in effect controls the Radio D2 circuit breaker on the main power panel, which in turn operates the relay, switching the AC supplies to the radio distribution panel. In the even of this switch being operated the 8A inverters continue to run, supplying mandatory instrumentation.

6.2.4. Inverter Compartment

This installation is basically a box, the four sides of which are detachable and carry the necessary control and distribution equipment for the five inverters mounted inside on the base. The top is detachable permitting inspection of the installation.

The port side panel carries four torque switches and four relays for the failure warning system, two relays for 8A inverters control, one relay for the 8A AC change over, two suppressors, a number of Plessey Mk.IV fixed plugs and sockets and S.B.A.C. terminal blocks through which supplies and control circuits are passed.

The front and starboard side panels carry control gear and main fuses for the 103 inverters.

The rear panel carries the three type 15 control units, plus the necessary Mk.IV plugs and sockets for distribution.

The design of the inverter compartment enabled the manufacture of the whole installation including cable harness and mounting of components to be carried out in workshops. Anchor nuts have been used where possible to facilitate the removal of panels and components.

6.2.5. Distribution Panels

The AC output from the two 103 inverters is distributed via two panels, one for each inverter, on the vertical rack between the two benches in the fuselage. The AC/DC feeds to the twelve Plessey Mk.IV coupler sockets on each panel, are taken from Plessey quick release terminal blocks via (panel mounted) Belling Lee fuses. Both panels are easily removable for servicing.

Four other general service distribution panels are mounted on the first and third vertical bays, directly above each bench.

D.C. switched and fused, the whole controlled by a 45 amp circuit breaker connected to captive headed Lee terminals. 115v 400 cycles 3 phase

AC is distributed via S.B.A.C. terminal blocks feeding Plessey Mk.IV panel mounting AC terminals in 3 pin 5 amp switch fused sockets. These panels are also easily detachable for servicing.

6.2.6. General

Full use has been made of original installations, i.e. distribution panels and cable ducts.

A comprehensive aircraft electrical load analysis has been prepared and has satisfied both A.I.D. and A.R.B. requirements.

6.3. Inspection Department Report Concerning Major Overhaul, Modification, and Transfer to Civil Register.

6.3.1. Major Overhaul

This inspection was prepared from AP.4331A Vol.4 Pt. 4 and the first sheets were completed and issued eight days after the aircraft's arrival at Cranfield on 21.3.57. To meet civil requirements the sheets were laid out in the standard College pattern providing time life, serial number and component change sheets. The total number of defects found during the survey amounted to more than 400.

6.3.2. Modifications

The requirements for standard aircraft modifications were discussed initially on 24th April at Cranfield with Mr. John, Assistant R.T.O. at Vickers. It was decided that a complete check through of all modifications should be made with Smith's, noting which lesser operating ones they required together with all those classified as B.2. The survey produced a list of more than 70 modifications, of which the finalised list was 43, having been further adjusted by modifications found embodied and special equipment modifications. Mod. 516 was an unexpected requirement which became due when the centre section spar life was reduced.

6.3.3. Inspection Authority, Control and Civilising Procedure

The problem of covering both the requirements of A.I.D. and A.R.B. arose at the commencemtn of the contract.

At the initial meeting with both authorities present, it was broadly agreed that the whole task would have to be completed to the satisfaction of the D.A.I. and that any further requirements necessary to meet Air Navigation Regulations would be to the satisfaction of the Air Registration Board.

This process has operated most smoothly during the whole contract. Both authorities were given all relevant information as it became available.

A diary of meetings held with A.R.B. Representatives is given below :-

24.4.57. Mr. H. Smith, Mr. Doggrell of Hatfield Area Office.

This was an initial discussion on the expected procedure with Mr. Amer, A.I.D. Inspector-in-Charge.

18.6.57. Mr. Loader, A R.B. Design Surveyor,
Mr. Doggrell,
Mr. Hudson, A.R.B. Power Plant Surveyor.

The initial aircraft survey was made on this visit, together with general power plant requirements concerning civil certification of engines, propellers, and various technical details to meet particular British Civil Airworthiness requirements.

16.6.57. Mr. Doggrell, Mr. Hudson.

Progress was made on this visit regarding the power plants. Both the engine and propeller civil log books were to hand and were accepted by the A R.B. Also, the general power plant requirements were completely clarified.

20.11.57. Mr. V. Hunt, A.R.B. Instrument Surveyor,
Mr. R. Bloodworth, A.R.B. Electrical Surveyor.

The electrical and instrumentation arrangements were thoroughly checked and finally agreed to on this occasion.

8. 1.58. A progress visit to discuss the future clearance of the aircraft since the A.I.D. flight test had been completed and certain electrical inverter trials were in progress. Clearance details were agreed to on this occasion.

11. 4.58. The College of Aeronautics Assistant Designer and Chief Inspector visited the Board to accelerate final preparations concerning Flight Manual, Weight, C.G., and performance details.

17. 4.58. Mr. Loader and Mr. Doggrell.

This was the preliminary check through of all clearance details in F.268, Log Books, Weight and Centre of Gravity Schedule, modifications and special equipment installations.

3. 5. 58. Mr. Doggrell.

Final acceptance of Log Book Certificates etc., and certification of the recommendation for the aircraft to be granted its C. of A. The preliminary Airworthiness Approval Note had been signed by Mr. James at A.R.B. Head Office on the previous day.

Further dates concerning the civil aspect of this aircraft are as follows :-

The Certificate of Registration was obtained on 16.4.57 and the application for the Certificate of Airworthiness made on the same day. The initial C. of A. application was for Special Categary Sub-division "G" only which was accepted, but further consultation with Smiths Instruments on this point necessitated a further application to include sub-division "H" but this was not accepted by the Air Registration Board.

The initial Test Flight Form 1090 was issued on 23,12,57 and the flight test F.797 was cleared on 27.1.58. A copy of the flight test in civil form was forwarded to the A.R.B. on 31.1.58 and accepted seven days later.

The Certificate of Airworthiness in the Special Category Sub-division "G" together with the Flight Manual was issued by M.T.C.A. on 5.5.58.

6.4. In addition to the A.R.B. test flight for the issue of the Certificate of Airworthiness herein appended, S.A.I. conducted a number of Flight Trials of which Report No. V/8 is included here as a typical example.

The full programme of Flight Trials up to the issue of the Certificate of Airworthiness is as follows :-

Report No. V.1.	Control Force Tests
Report No. V.2.	Auto Throttle Trials
Report No. V.3.	Control Force Tests
Report No. V.4.	Varsity M.F.S. Installation
Report No. V.6.	Varsity M.F.S. Installation
Report No. V.8.	D.2. Auto-pilot clearance

These reports are held by Smiths Aircraft Instruments.

Flight Trials - Report No. V/8

Introduction

This is a report on the flying carried out to Programme SAI/VAR/5 to enable the Type D.2 Autopilot Installation in Varsity G-APAZ to be cleared as a major modification prior to issue of Certificate of Airworthiness.

This installation involves increased servomotor torques over the previous Mk.9 installation.

Flying to Programme SAI/VAR/5 was carried out during the period 20th - 24th March, 1958 and the following flights made from Cranfield:

Flight No.	Date	Duration
V.25	20.3.58	2.40 hours
V.26	20.3.58	2.25 hours
V.27	21.3.58	2.30 hours
V.28	24.3.58	2.30 hours

Owing to the short time available and the onset of extremely poor weather conditions it was not possible to complete the whole programme. Elevator runaways at the forward C.G. position were omitted after consultation and agreement with the Air Registration Board. A further series of elevator runaway trials will be necessary when automatic trim is fitted to this channel as a modification at a later date, and a programme will be prepared in due course.

2. Equipment Installed

The autopilot equipment installed for the runaway trials was as listed on the appendix to Programme SAI/VAR/5.

Recording and runaway test equipment was also as specified in the programme.

3. Flight Tests

Runaways were filmed by switching on the camera recorder one second before the start of the failure and switching off when the pilot announced "Recovered".

Elevator runaways were carried out at the following C.G. positions:

Normal C.G. - 361.97 in. aft of datum.

Aft C.G. - 365.76 in. aft of datum.

The analysed results of the film recordings are tabulated in Appendix II to this report. It will be noted that in some cases the time of runaway falls short of the required time by 0.5 sec. This is due to the fact that the runaways were timed on the pilot's countdown and early cut-outs were in no instance due to the runaway in anyway endangering the aircraft. On the two channels fitted with Rotary Excess Torque Cut-outs (Rudder and Elevator) full speed runaways (i.e. maximum volts applied instantaneously to the servomotor) resulted in an immediate cut-out. These tests were not filmed and the conditions under which these immediate cut-outs were obtained are listed in Appendix I. The method of injecting the runaways was as described in the programme.

3. Conclusions

Aileron Channel

In all cases of runaways in the aileron channel maximum attained aileron angles were well within the limits given in Report R.I.D. 361. The attained angles are plotted against airspeed in Fig. 1 and the limiting curve given in R.I.D.361 is plotted on the same figure for comparative purposes.

Maximum attained bank angle in any runaway was 58° and at 95 knots in the approach configuration, maximum bank angle in any runaway was 8°, both of which are well within the desirable operational limits.

Rudder Channel

Maximum attained rudder angles are plotted against airspeed in Fig. 2, and the limiting curve given in R.I D. 361 is plotted on the same axes for comparative purposes. It will be seen that the attained angles are in all cases well within the limiting values.

Elevator Channel

It will be noted from the results of runaways at 95 knots, aft C.G. position, that the elevator micro-switch nominally set at 3° down, was in fact set at 3.75° down.

The maximum increment of 'G' obtained was -0.65 in the nose-down out of trim case at a selected decreased voltage (up to limit of Excess Torque Cut-out) at a nominal 170 knots. A plot of increment of 'G' against airspeed is given on Fig. 3. In no case was the amount of 'G' excessive.

4. General

The results obtained from this series of runaway trials confirm the theoretical investigation into the safety of the autopilot installation (as fitted with se vomotors and Excess Torque Cut-outs to the values stated in R.I.D.361) in that at no time were the operational limitations of the aircraft exceeded. In addition, the approach cases show negligible changes to any of the parameters under observation and the pilot expressed his confidence in dealing with such situations after or within the recommended period of time.

APPENDIX I

Report No. V.8

The following runaways resulted in an immediate cut-out on the Excess Torque Cut-out for the particular channel concerned.

Rudder Channel

Simulated rudder amplfier runaways with full motor volts (75v) instantaneously applied at the following speeds:

205, 170, 130 and 95 knots I.A.S. in both senses.

Elevator Channel

Simulated elevator channel failure with full motor volts (75v) instantaneously applied at the following speeds:

(a) Normal C.G. 205, 170, 130 and 95 knots I.A.S. in both senses.

(b) Aft C.G. in trim 205, 170, 130 and 95 knots I.A.S. in both senses.

(c) Aft C.G. out of trim

Nose-up trim - nose up runaway at 170 knots I.A.S.

Nose-up trim - nose up runaway at 95 knots I.A.S.

Nose-down trim - nose down runaway at 170 knots I.A.S.

Nose-down trim - nose down runaway at 95 knots I.A.S.

No other speeds were checked for this type of failure.

AILERON & RUDDER CHANNEL RUNAWAYS

TYPE OF RUNAWAY		Direction	Film Ident	Time(secs) To Cut Out	Time(secs) C/O to Rec.	I.A.S.(Knots) Start	I.A.S.(Knots) C/O	I.A.S.(Knots) Rec.	Height(Feet) Start	Height(Feet) C/O	Height(Feet) Rec.	Control Angles (Degrees) AILERON Start	AILERON C/O	AILERON Rec.	RUDDER Start	RUDDER C/O	RUDDER Rec.	Bank Angle (Degrees)	Heading Chge. (Degrees) C/O	Heading Chge. (Degrees) Rec.	Pendulum. Slip Ang. Deg. C/O	REMARKS
Yaw Gyro	Simulated Max Yaw Gyro Signal (8 volts)	R	01	4.5	7.0	172	172	176	7700	7700	7600	0	7.0R	1.5R	0.5L	4.0R	3.0L	58	3R	22R	0	Cut-out on Rudder Excess Torque Cut-out
		L	01	4.5	7.0	170	172	176	7600	7600	7450	0	6.5L	0.5L	0.5L	5.5L	1.5L	45	15L	15L	1R	
		L	11	5.0	6.5	132	132	133	7150	7150	7000	0	8.5L	1.0L	1.0L	8.0L	3.0L	45	12L	27L	1L	
		R	11	5.0	7.0	132	132	137	7000	7000	6910	0	8.0R	1.5R	1.0L	6.5R	0.5L	57	9R	34R	1R	
		L	21	2.0	2.0	93	93	93	7700	7700	7700	1.5L	10.5L	0.5L	1.0L	4.5L	2.0R	5	0	1L	2L	
		R	21	2.0	3.0	95	95	95	7700	7700	7700	1.0L	11.0R	0.5R	2.0L	2.5R	6.5L	8	0	0	0	
		L	31	5.0	6.5	204	202	202	7150	7150	7120	0	4.5L	1.5L	2.0L	4.0L	0	43	6L	19L	5L	
		R	31	5.0	7.0	204	204	204	7350	7350	7330	0	5.0R	1.0R	2.0L	4.0R	3.5L	50	17R	10R	2R	
Aileron Channel	Motor Volts Up to Limit of Excess Torque Cut-out	R	00	4.5	6.0	169	169	164	9250	9250	9200	0.5R	6.5R	2.0R	0.5L	0	0.5L	40	0	10R	5R	
		L	00	4.5	8.0	172	171	174	9300	9300	9200	0	7.0L	2.0R	0.5L	0.5R	1.0L	45	0	21L	2L	
		L	10	5.0	8.0	134	134	140	9250	9200	9150	0	8.5L	2.0R	0.5L	1.0L	0.5L	50	0	30L	5L	
		R	10	5.0	7.0	131	132	135	9200	9150	9050	0	8.0R	0.5R	0.5L	1.0L	1.0L	50	9R	21R	5R	
		R	20	2.0	3.0	95	95	95	8800	8800	8800	0.5L	9.0R	0	2.5L	2.5L	5.5L	8	0	2L	0	
		L	20	2.0	3.5	94	94	94	8700	8700	8700	0.5L	12.5L	1.5L	3.0L	3.0L	2.5L	8	0	2L	0	
		L	30	5.0	5.5	206	206	206	7400	7400	7350	0.5R	4.5L	0	1.0L	1.0L	1.0L	33	1L	15L	0	
		R	30	5.0	5.0	206	206	202	7350	7350	7300	0.5R	5.0R	2.0R	1.0L	1.0L	1.5L	33	3R	9R	5R	
Rudder Channel	Motor Volts Up to Limit of Excess Torque Cut-out	L	50	4.0	4.0	173	172	171	9700	9700	9710	0	4.0R	0	0.5L	2.5L	1.0L	5R	7L	7R	16R	
		R	50	5.0	3.5	171	171	172	10200	10200	10200	0	1.5L	0	0.5L	3.0R	0.5L	5L	3R	9R	7L	
		R	60	5.0	4.0	130	126	130	9150	9150	9150	0.5L	6.0L	0.5L	0.5L	7.0R	0.5L	8L	11R	17L	15L	
		L	60	4.0	7.0	132	130	130	8800	8800	8800	0	5.5R	0.5R	0.5L	7.0L	0.5L	8R	8L	7R	15R	
		R	70	2.0	5.0	95	95	95	8500	8500	8500	0	3.5L	0.5R	3.0L	1.0R	2.5L	0	0	3L	2R	
		L	70	1.5	2.0	93	93	93	8300	8300	8300	0.5L	0.5L	0.5L	3.0L	5.5L	3.0L	0	1R	5L	10L	
		R	80	5.0	2.5	205	204	204	7200	7200	7200	0	2.0L	1.5R	1.0L	2.5R	1.0L	3L	2R	5R	8L	
		L	80	5.0	2.5	204	205	205	7300	7300	7300	0	2.0R	0.5R	0.5L	3.0L	1.0L	7R	7L	4R	5R	

ELEVATOR CHANNEL RUNAWAYS

TIME OF RUNAWAY			FILM	TIME (secs)		IAS (knots)			HEIGHT (Feet)			ELEVATOR ANGLE (degrees)			INCREMENT OF	REMARKS
	DIRECTION		IDENT	TO CUT-OUT	C-O to REC	START	C-O	REC	START	C-O	REC	START	C-O	REC	G	
NORMAL C.G.		D	41	5.0	4.0	169	175	184	8920	8840	8600	+0.75	+2.0	+0.50	-0.45	
		U	41	5.0	4.0	169	166	163	9060	9090	9200	+0.75	0	+0.75	+0.10	
	MOTOR	U	51	5.0	5.0	129	126	120	8580	8585	8680	-0.25	-2.0	-0.50	+0.10	
	VOLTS TO	D	51	5.0	4.0	131	137	144	7515	7440	7250	-0.25	+1.25	-0.25	-0.4	
	LIMIT OF	D	71	2.0	2.0	96	96	96	8120	8120	8120	+2.5	+4.0	+3.75	-0.05	
	EXCESS	U	71	2.0	2.0	95	95	95	7970	7970	7970	+2.5	-0.25	+2.75	0	
	TORQUE	U	81	4.5	4.0	206	201	197	7360	7350	7525	+1.5	+0.5	+1.25	+0.15	
	CUT-OUT	D	81	5.0	5.0	203	209	217	7450	7370	7110	+1.5	+2.25	+1.50	-0.35	
AFT. C.G.		D	02	5.0	5.0	169	173	180	4700	4700	4500	+0.75	+2.0	+0.75	-0.40	
	MOTOR	U	02	5.0	4.0	169	166	161	4895	4905	5040	+0.75	-0.25	+0.75	+0.10	
	VOLTS UP	U	12	5.0	5.0	132	129	122	4815	4830	4960	0	-1.25	-0.25	+0.15	
	TO LIMIT	D	12	5.0	4.0	133	141	155	4720	4660	4440	0	+1.25	+0.25	-0.25	
	OF EXCESS	D	22	2.0	1.5	93	93	94	4280	4280	4280	+3.5	+4.0	+2.5	0	Cut-out on Limit Switch
	TORQUE	U	22	2.0	2.0	93	93	92	4360	4360	4360	+3.75	+0.75	+2.5	+0.10	
	CUT-OUT	U	32	5.0	3.5	203	196	189	5560	5600	5800	+1.50	+0.75	+1.25	+0.35	
		D	32	5.0	5.0	205	212	216	5400	5260	5000	+1.50	+2.25	+1.25	-0.35	
		U	42	5.0	0.5	170	159	156	6950	7080	7130	+0.75	-0.25	+1.75	+0.35	Nose-up out of trim
		D	42	5.0	6.5	169	178	197	6060	6260	5750	+0.75	+2.50	+0.75	-0.65	Nose-down out of trim
		U	52	2.0	2.5	94	94	94	5880	5880	5880	+3.50	-1.25	+1.75	+0.15	Nose-up out of trim

N.B. Down elevator bears + sign.

With full nose down out of trim at 95 knots an immediate cut-out was obtained at all injected values of motor voltage down to zero.

THE COLLEGE OF AERONAUTICS

FLIGHT TEST REPORT

Relevant Test Schedule: VICKERS DRAWING 66800 Sheet 100

Date: 31.12.57. A/C Types: VARSITY Registration: G-APAZ

Duration of Flight: 1.20 Engine: HERCULES 264 Pilots: R.A.Palmer, G.K.Dougan

AU.W: 36493-lbs Ground Temp: + 10°C Aerodrome Ht:

C.G.Position: 358.8" Aft of Datum

GROUND TESTS

	Elevator	Aileron	Rudder
Flying Controls:			
Correct functioning:	Satisfactory	Satisfactory	Satisfactory
Backlash and Friction:	"	"	"
Trimming Controls:			
Correct functioning:	Satisfactory	Satisfactory	Satisfactory
Backlash and friction:	"	"	"

Instruments:

Correct functioning: Satisfactory

Engine Ground Run:

	Port	Stbd
Take Off R.P.M:	2850	2850
Boost:	56 ins	56.75 ins
Oil Pressure:	100 p.s.i.	100 p.s.i.
Oil Temperature:	65°C	65°C
Cylinder Head Temperature:	210°C	200°C

Hydraulic System:

Function Test: Satisfactory

Record Main System Pressure: 2300 p.s.i.

No. 1 Brake System Pressure: 2300 p.s.i.

No. 2 Brake System Pressure: 2300 p.s.i.

Pneumatic Pressure: 440 p.s.i.

TAXIING

Functioning of brakes: Satisfactory Freedom from binding: Satisfactory

Ease of Ground Manoeuvring: Satisfactory. Function of Nose Wheel Steering: Satisfactory

---

TAKE OFF

Any unusual behaviour during take-off: NONE

Record:

	Port	Stbd
Take Off R.P.M.	2800	2800
Boost:	56 ins	56 ins
Oil Pressure:	100 p.s.i.	100 p.s.i.
Oil Temperature:	70°C	70°C
Cylinder Head Temperature:	200°C	200°C

PERFORMANCE

Climb (120 Kts. I.A.S. Gills 50% open from 1000 to 5000-ft. altimeter at 1013 mbs (R.P.M. 2400 Boost + 9).

Weight at start of Climb: 36277-lbs

Record every $\frac{1}{4}$ minute approximately.

Time:		0	+¼	+¼	+¼	+¼	+¼	+¼	+¼	+¼	+¼
Altitude:	1000	2000	2500	2900	3250	3606	3900	4200	4500	4806	5000
Air Temp:	+10	+10	+9	+8	+7	+6	+5½	+5	+4½	+4	+4

Record:

	Start		Finish	
	Port	Stbd	Port	Stbd
R.P.M.	2400	2400	2400	2400
Boost:	48"	48"	42"	42"
Oil Temp:	75°C	85°C	75°C	90°C
Oil Pressure:	100 p.s.i.	97 p.s.i.	100 p.s.i.	97 p.s.i.
Cylinder Head Temp:	190°C	190°C	190°C	190°C

Weight at end of climb: 36190-lbs
Climb Consumption: 12.4 galls

Cruise:

	Slow Cruise 'M' Gear		Max. Weak Misc. Cruise 'M' Gear		Emergency Cruise 'M' Gear (5 min. limit)	
R.P.M.	2000		2400		2800	
Boost:	0		2½		13	
Height:	5000-ft		5000-ft		5000-ft	
Oil Temperature:	70°C	80°C	70°C	80°C	70°C	80°C
	Port	Stbd	Port	Stbd	Port	Stbd
Carb. Temperature:	+20°C	+20°C	+10°C	+10°C	+10°C	+10°C
Cyl. Head Temperature:	150°C	150°C	180°C	180°C	190°C	190°C
Observed Fuel Flow over 2 min. period	1.63G/M	1.67G/M	2.2G/M	2.2G/M	7.7G/M	7.7G/M
Corrected Fuel Flow	49GPH	50GPH	66GPH	66GPH	231GPH	231GPH
Settled Carb. Temp: Hot Air:	45°C	45°C	+50°C	+50°C	+40°C	+40°C
Filter:	+20°C	+20°C	+20°C	+20°C	+20°C	+20°C
Oil Pressure:	100p.s.i	95p.s.i.	100p.s.i	98p.s.i.	100p.s.i.	95p.s.i.
Oil Temperature:	70°C	80°C	72°C	80°C	72°C	80°C

Single Engine Handling (Live Engine at T.O.B.)

Record Rudder Loads: Moderate
Wind Milling R.P.M. 1700 (1775)

Single Engine Climb (Stbd. feathered, gills closed)

Weight at start of climb: 35680-lbs

Time to climb from: 2000 ft. To: 3500 ft. 4 Mins.

Resultant rate of Climb: 375 uncorrected

Weight at end of Climb: 35669-lbs

Record:

R.P.M: 2400
Boost: 48 ins.
I.A.S: 105 Kts.
Oil Temp: 75°C

HANDLING

Elevators:	Power Off Flaps	UP	Satisfactory
	Power Off Flaps	DOWN	Satisfactory
	Elevator b_2		----------
	Stability in Dive		Satisfactory
Aileron:	Climb:		Satisfactory
	Cruise:		Satisfactory
	Dive:		Satisfactory
	Rates of Roll:		60° in 4 secs. 15°/Sec.
Rudder:	Cruise:		Satisfactory
	Slow Speed:		Satisfactory

Stalling Speed:	FLAPS DOWN	FIAPS UP
Stalling Speed:	67 K	80 K
Type of Warning:	72 K Airframe Buffet	89 K Airframe Buffet
Behaviour at Stall:	Normal	Normal
Stall Recovery:	Normal	Normal

FUNCTIONING TESTS:			Port	Stbd
Feathering:	Time to Feather		7 Secs.	6 Secs.
De-icing:	Propellers:	Satisfactory		
	Airframe:	Satisfactory		
	Windscreens:	Satisfactory		
Hydraulics:				
	Undercarriage:	Time UP:	10 Secs.	
		Time DOWN:	10 Secs.	
	Flaps:	Settings:	Satisfactory	
		Intercommunications:	Satisfactory	
		Time UP:	7 Secs.	
		Time DOWN:	10 Secs.	

FUNCTIONING TESTS (Contd.)

Cabin Comfort:

Heating:	Satisfactory
Cold Air:	Satisfactory
Pilot's Louvres:	Satisfactory

Pneumatics: 440 P.S.I. Pressure

Miscellaneous:

Supercharger 'S' Gear:	Satisfactory
V.H.F:	Satisfactory
Intercomm:	Satisfactory
P.12 Compass:	Satisfactory
Fuel Crossfeed:	Satisfactory
Oil Cooler Shutters:	Satisfactory
Gills:	Satisfactory
Fuel System:	Satisfactory
Landing Light:	Satisfactory
D.V. Windows:	Satisfactory

Optical Check on:

Transparent Windows:	Satisfactory
Windscreen Wipers:	Satisfactory
Seat Adjustment:	Satisfactory
Vibration:	Satisfactory
Voltage:	28 V

Instruments:

Suction:	$4\frac{1}{4}$" Hg.
Engine:	Satisfactory
Flying:	Satisfactory
Blind Flying:	Satisfactory
Electrical:	Satisfactory
Fuel Gauges:	Satisfactory

ENGINE & PROPELLER

Response of Engines to Throttle:	Satisfactory
Smoothness:	Satisfactory
Throttle Control:	Satisfactory
Propeller Control:	Satisfactory
Carb. Hot Air Control:	Satisfactory

Flight Test Certificate

Aircraft Type:	VARSITY T.1
Registration:	G-APAZ
Date:	31.12.57

I certify that I have tested the above aircraft and carried out all the tests specified in Series and Renewal Flight Test Schedule reference....., that the behaviour of the aircraft and its equipment was satisfactory and that the performance has been recorded.

I further certify that during my flying, I did not encounter any other features which would render the aircraft unsafe.

The following adjustments or rectification work is necessary before renewal/issue of the Certificate of Airworthiness, but I do not consider that a further flight is necessary.

Port rear fuel gauge sticking - To be removed.

Signed: .....

on behalf of: .....

.....

.....

ILLUSTRATIONS

1. Aircraft on acceptance
2. Aircraft overhaul in progress
3. Forward cabin prior to stripping
4. Rear cabin - crew seats removed
5. Full view of stripped out cabin
6. Centre section fitted with Mod.516 embodied.
7. Cockpit prior to modification
8. Standard inverter station
9. Installation of forward suppressed loop - in progress.
10. Installation of Stanchions for special racking - in progress view looking aft
11. Installation of Stanchions for special racking - in progress view looking forward
12. AC Supply Panels front view
13. AC Supply panels rear view
14. Inverter box side panels
15. Inverter box
16. Inverter box
17. Inverter installation in aircraft showing slow air inlet and exhaust
18. Forward special racking with some equipment in position
19. Rear special racking with radio equipment in position
20. Upper panels of rear special racking forward with radio junction box (flush mounted) and MFS junction box (protruding) in position
21. Upper panels of forward special racking with some equipment in position
22. Navigators Table with Doppler presentation units in position
23. Aileron servo unit and desynn transmitter
24. Elevator and rudder servo units, potentiometers and elevator limit switch
25. Auto pilot gyro unit
26. Modified cockpit showing new instrument panel, Auto elevator trim chain, Auto pilot control panels and Maxaret override
27. View of cockpit showing radio and electrical control panels and repositioned Feathering and Fire controls
28. Two views of cockpit side panels
    A. Right Hand) showing repositioned hydraulic gauges,
    B. Left Hand) radio controllers, fuel contents gauges, flowmeters and to of fuel contents gauges, two motor box temperature gauges
29. Radio fuse panel
30. Doppler units showing wave guide passing through cabin floor

Continued.....

Illustrations Continued

31. Rearward view of cabin showing seats in position
32. View of Doppler aerial with di-electric panel removed
33. Suppressed loop in position upholstery removed
34. Sword aerials on fin
35. View of under fuselage showing ADF Sense and ILS marker aerials and air intake to Inverter box
36. View of top fuselage showing VHF aerials, di-electric panels above suppressed loops and flashing light station (between panels)
37. Completed aircraft

* ADDENDUM

FIG 12 should read

INVERTOR BOX SIDE PANELS

FIG 14 should read
AC SUPPLY PANELS FRONT VIEW

FIG. 1. AIRCRAFT ON ACCEPTANCE

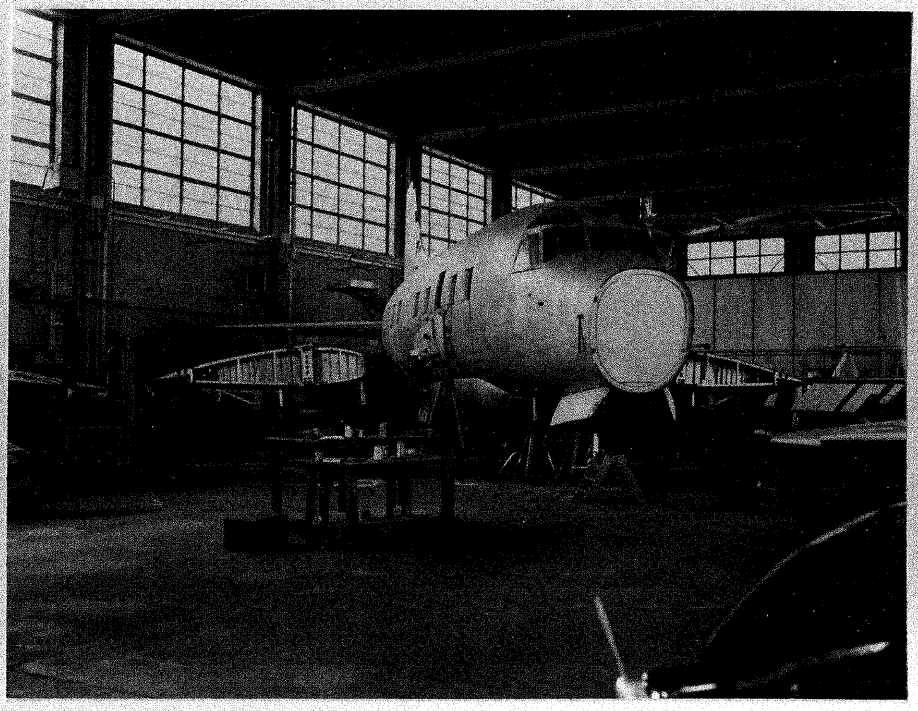


FIG. 2. AIRCRAFT OVERHAUL IN PROGRESS

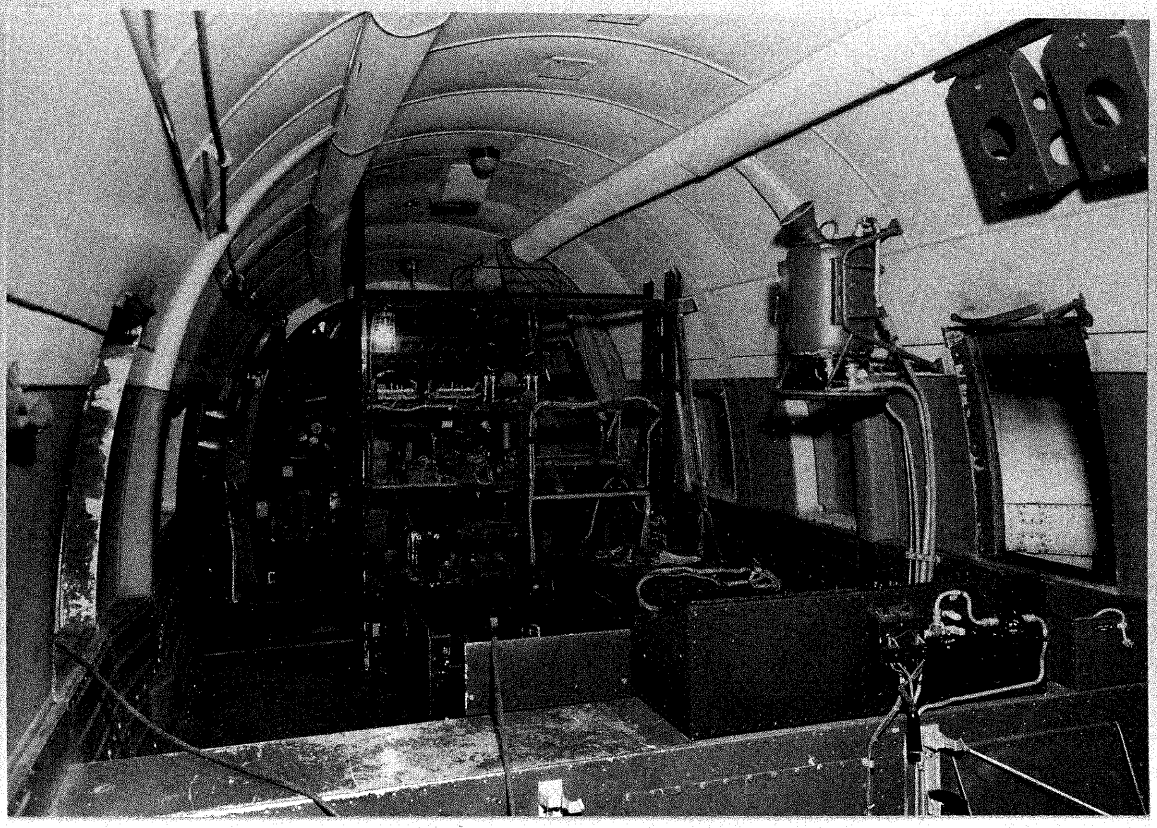


FIG. 3. FORWARD CABIN PRIOR TO STRIPPING

FIG. 4. REAR CABIN - CREW SEATS REMOVED

FIG. 5. FULL VIEW OF STRIPPED OUT CABIN

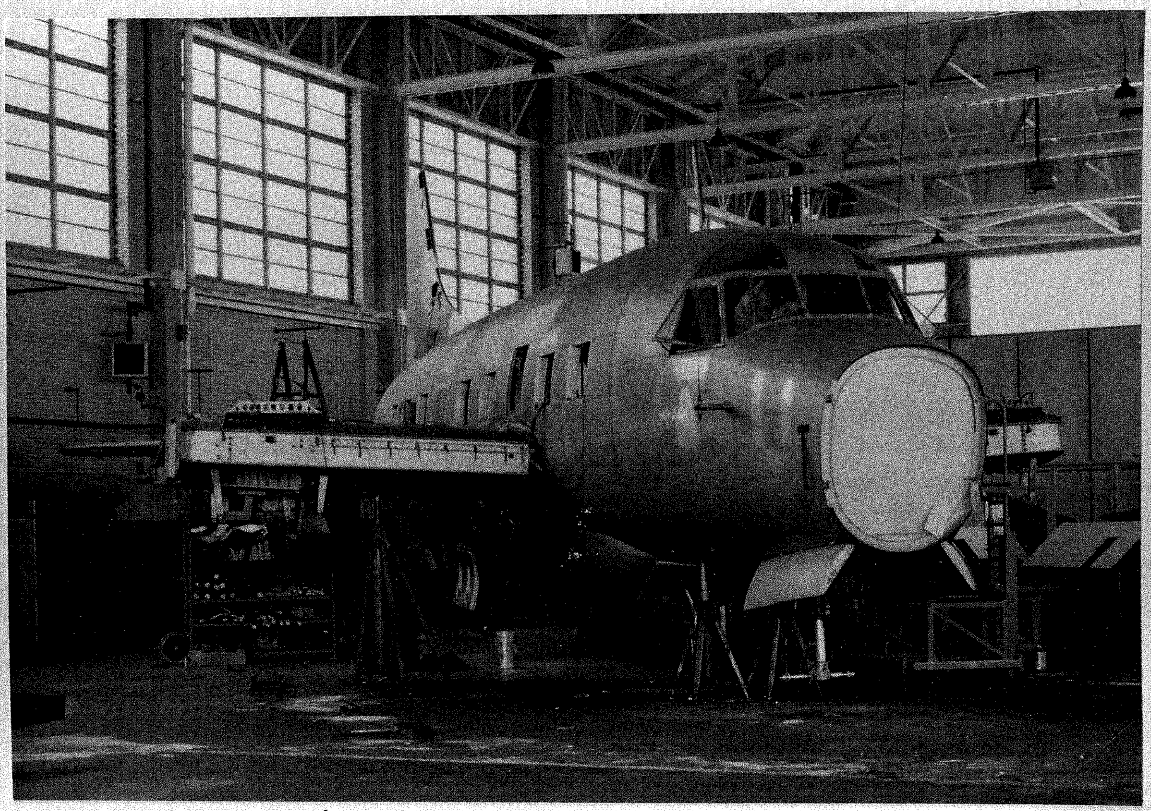


FIG. 6. CENTRE SECTION FITTED WITH MOD.516 EMBODIED

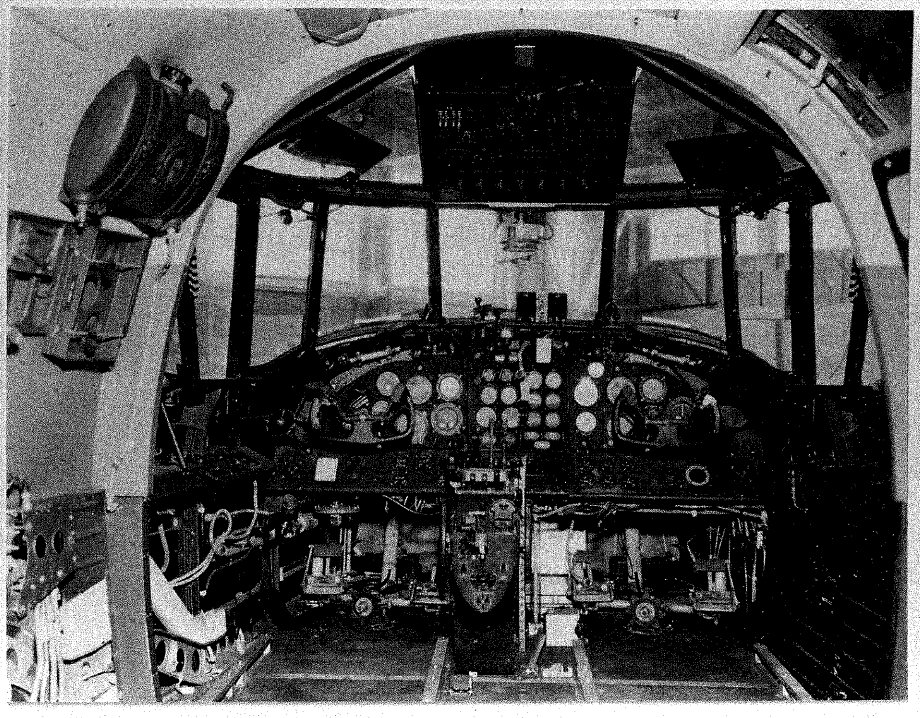


FIG. 7. COCKPIT PRIOR TO MODIFICATION

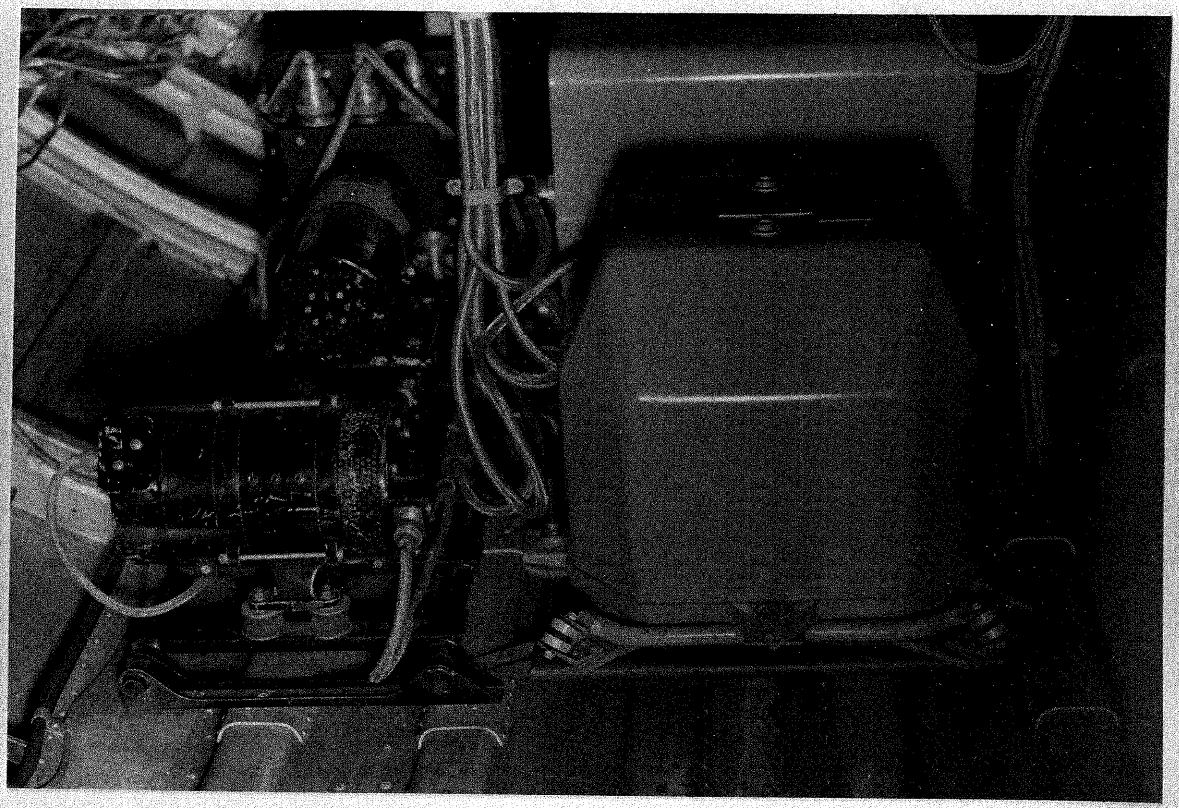


FIG. 8. STANDARD INVERTER STATION

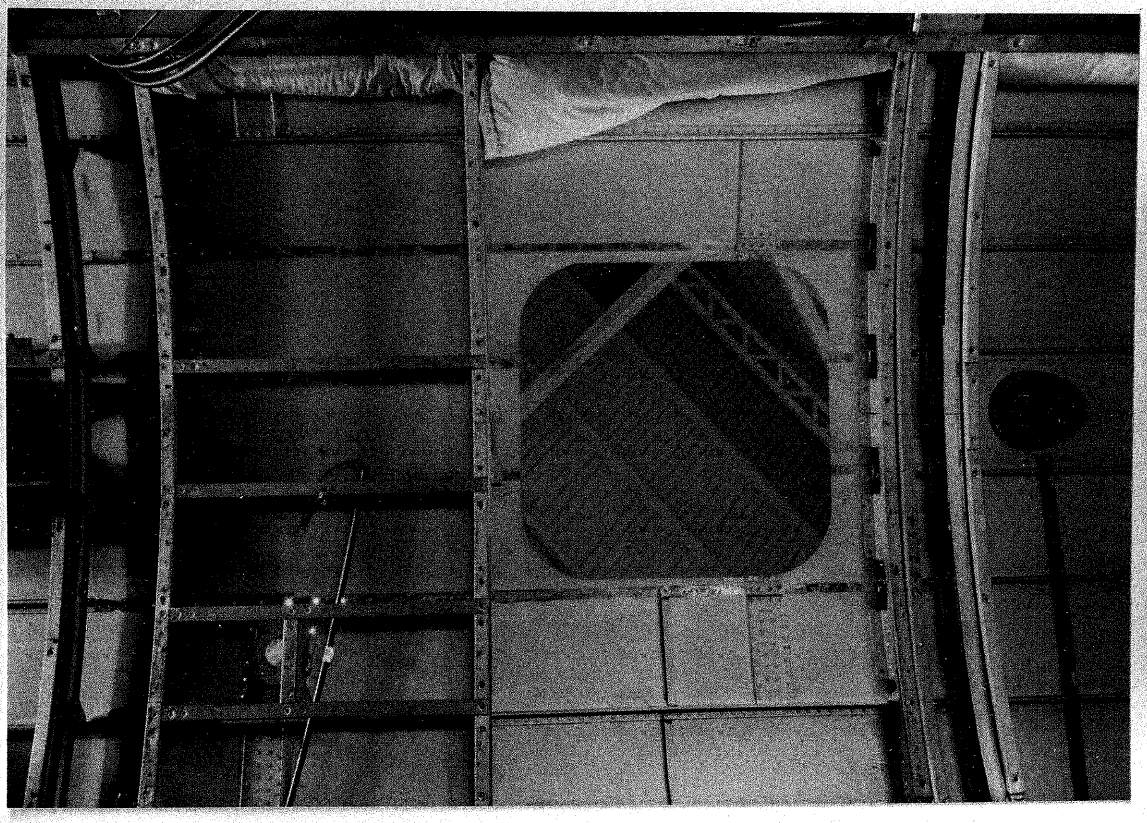


FIG. 9. INSTALLATION OF FORWARD SUPPRESSED LOOP - IN PROGRESS

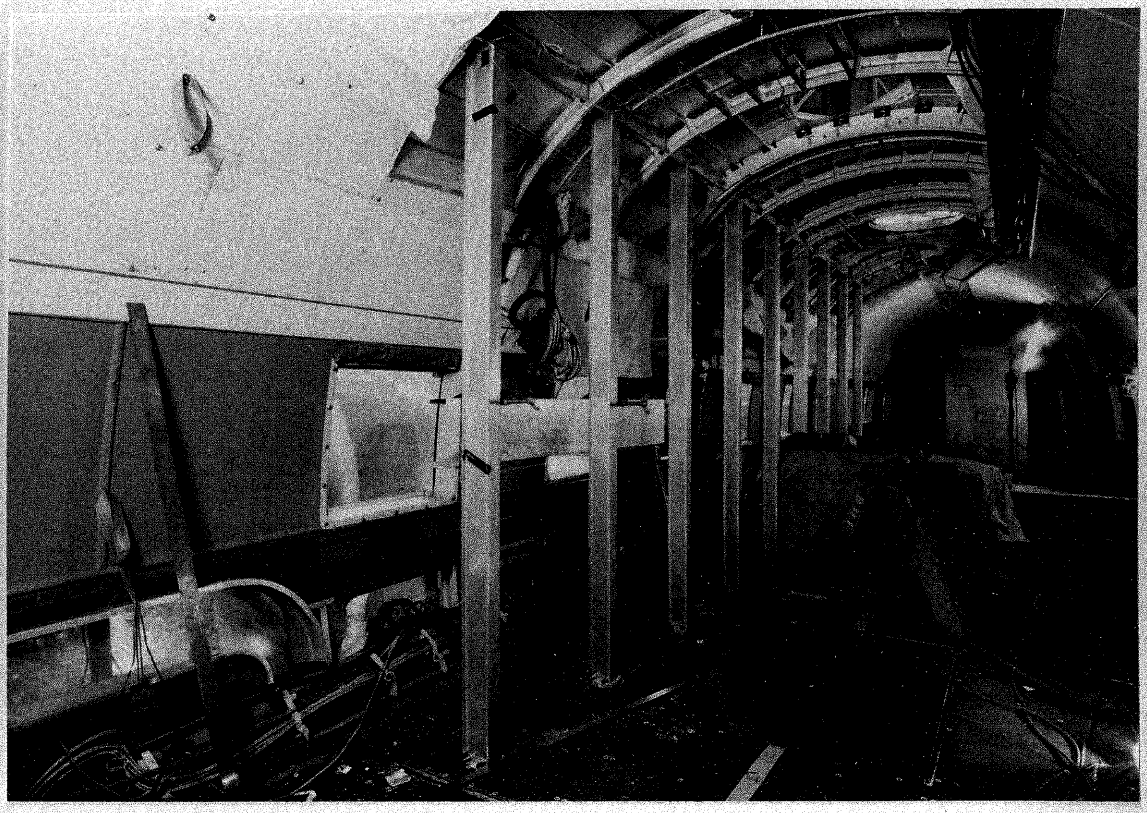
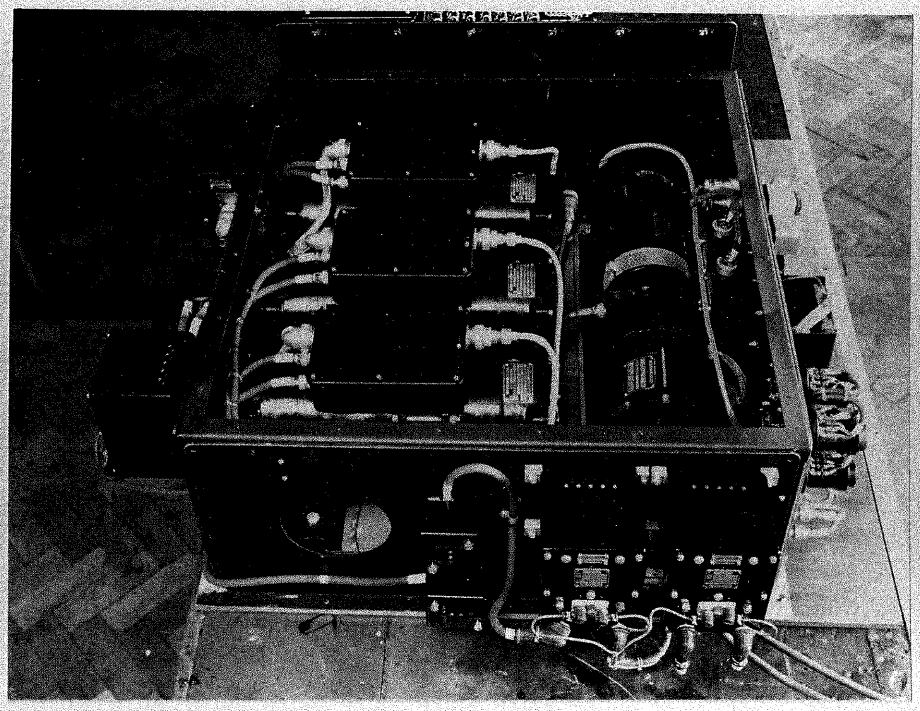


FIG. 10. INSTALLATION OF STANCHIONS FOR SPECIAL RACKING - IN PROGRESS VIEW LOOKING AFT.

FIG. 11. INSTALLATION OF STANCHIONS FOR SPECIAL RACKING - IN PROGRESS VIEW LOOKING FORWARD



* FIG. 12. AC SUPPLY PANELS FRONT VIEW

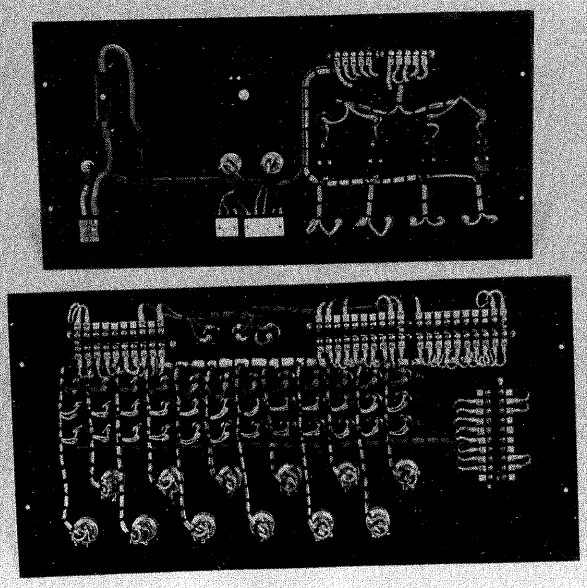


FIG. 13. AC SUPPLY PANELS REAR VIEW

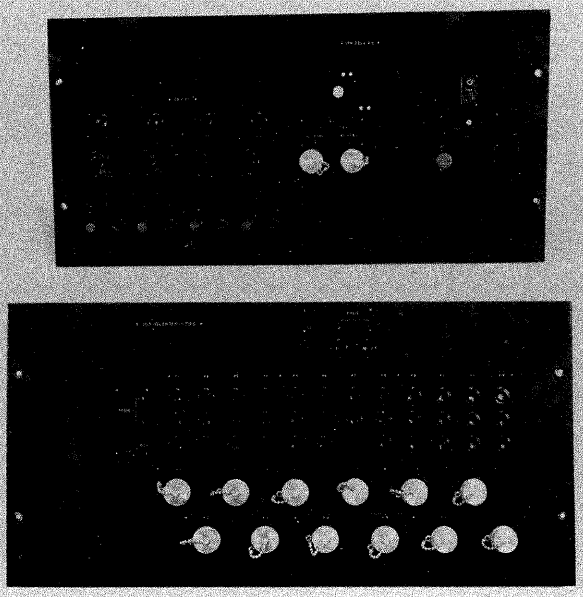


FIG. 14. INVERTER BOX SIDE PANELS

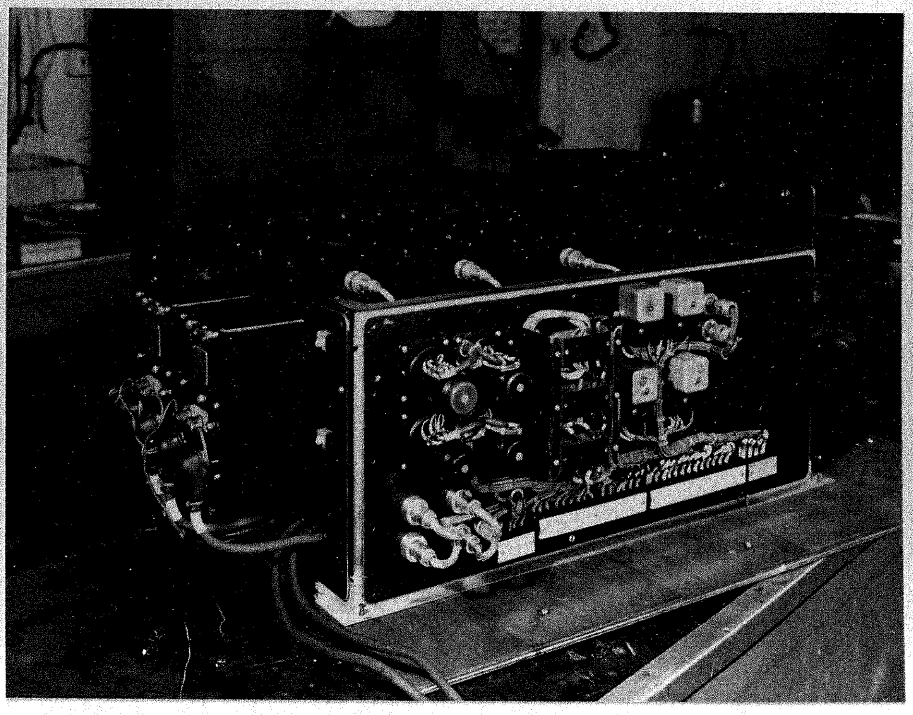


FIG. 15. INVERTER BOX

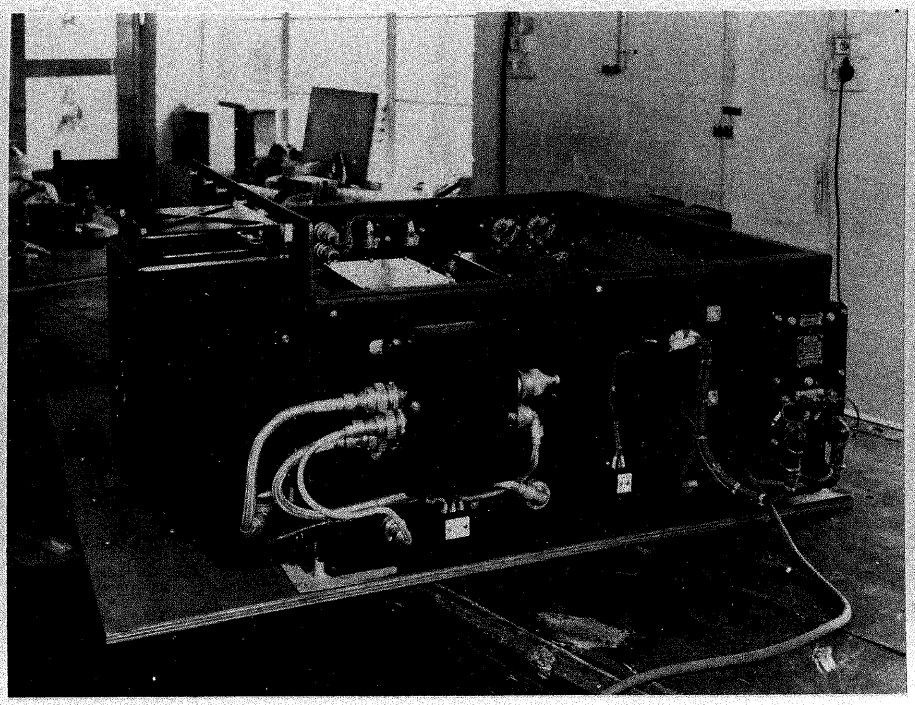


FIG. 16. INVERTER BOX

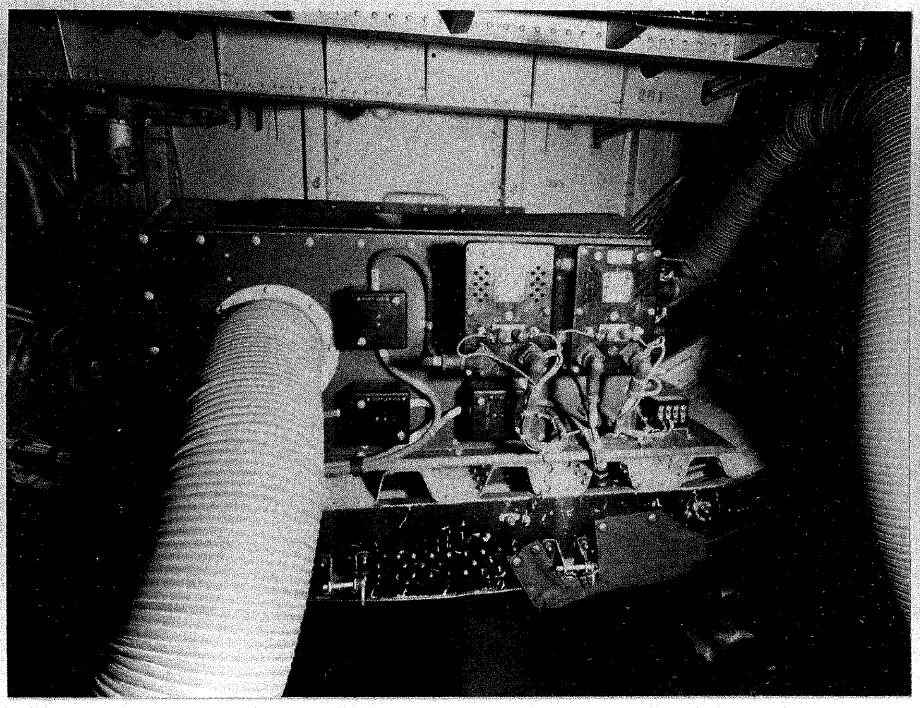


FIG. 17. INVERTER INSTALLATION IN AIRCRAFT SHOWING AIR INLET AND EXHAUST

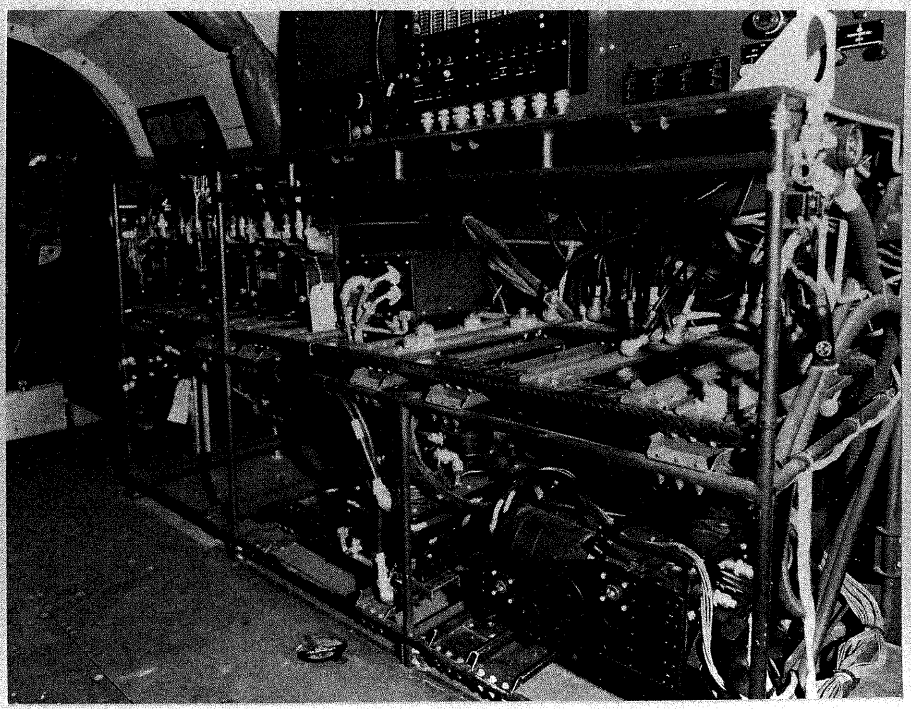


FIG. 18. FORWARD SPECIAL RACKING WITH SOME EQUIPMENT IN POSITION

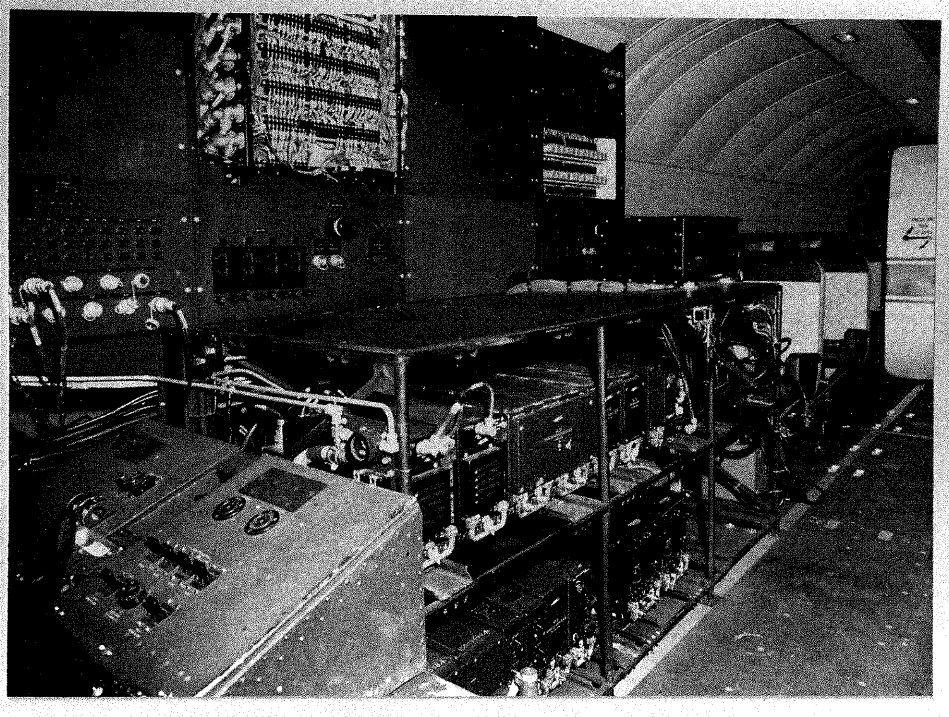


FIG. 19. REAR SPECIAL RACKING WITH RADIO EQUIPMENT IN POSITION

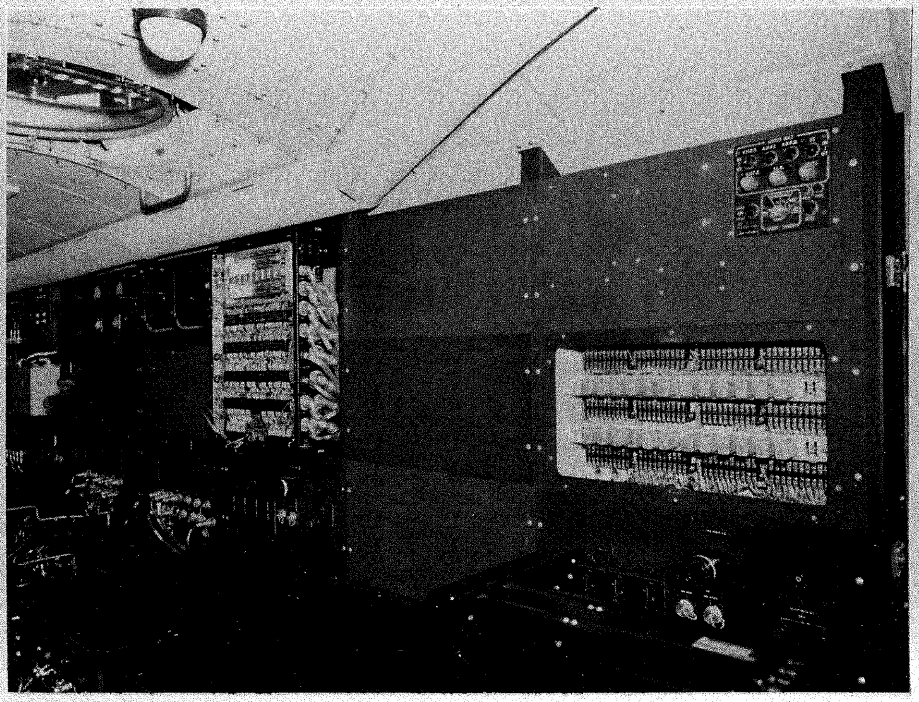


FIG. 20. UPPER PANELS OF REAR SPECIAL RACKING FORWARD WITH RADIO JUNCTION BOX (FLUSH MOUNTED) AND MFS JUNCTION BOX (PROTRUDING) IN POSITION

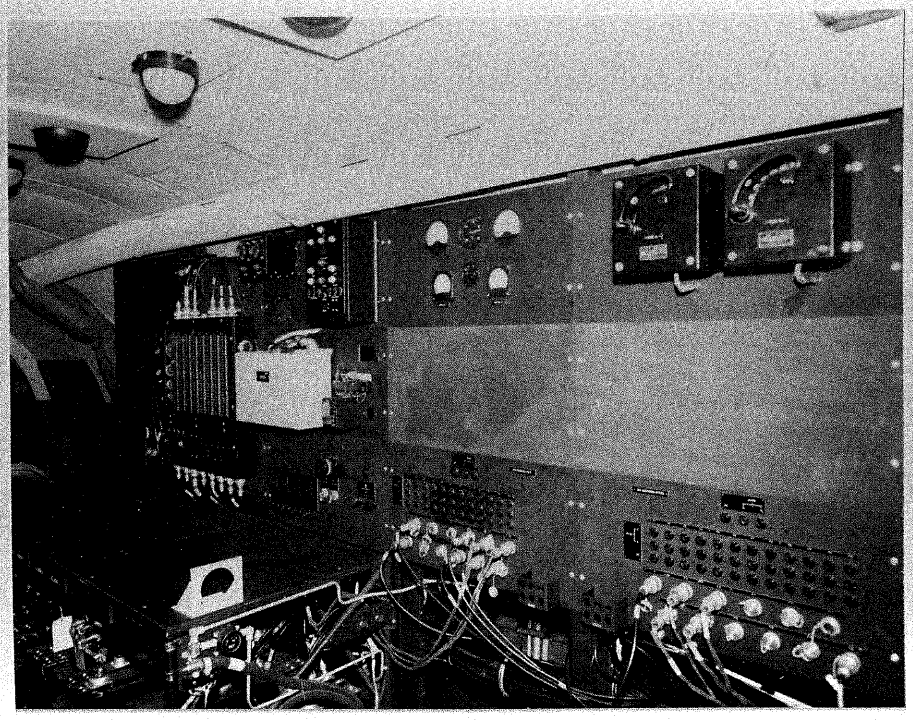


FIG. 21. UPPER PANELS OF FORWARD SPECIAL RACKING WITH SOME EQUIPMENT IN POSITION

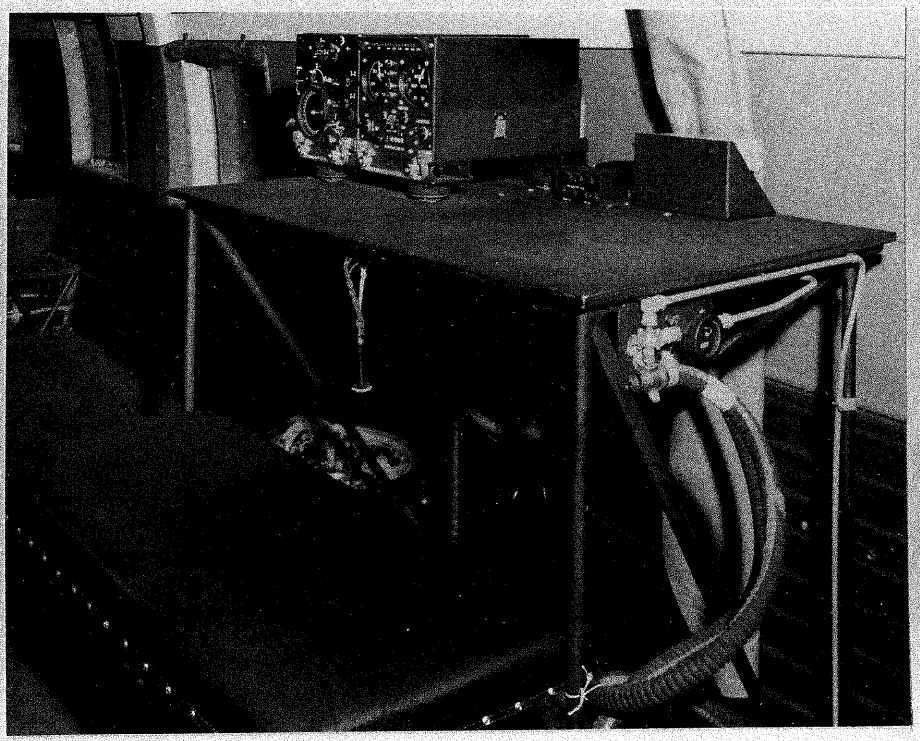


FIG. 22. NAVIGATORS TABLE WITH DOPPLER PRESENTATION UNITS IN POSITION

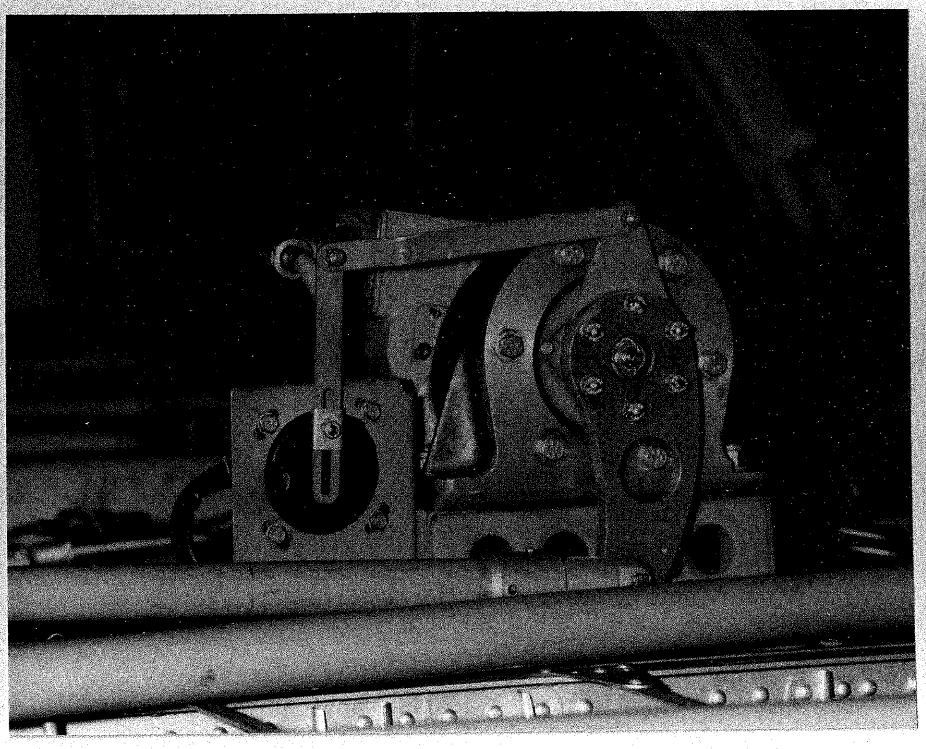


FIG. 23. AILERON SERVO UNIT AND DESYNN TRANSMITTER

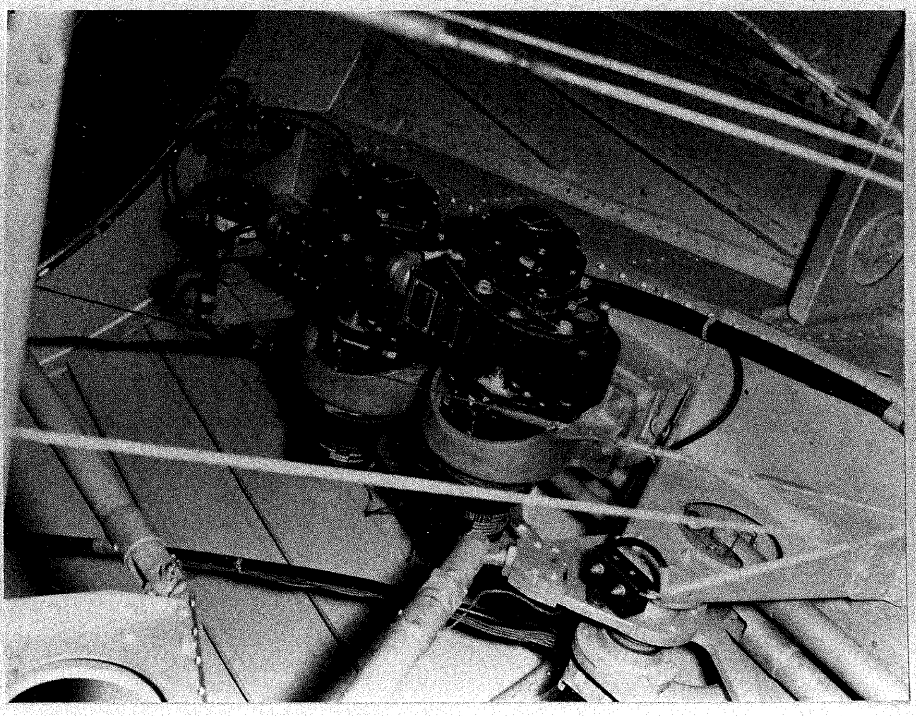


FIG. 24. ELEVATOR AND RUDDER SERVO UNITS, POTENTIOMETERS AND ELEVATOR LIMIT SWITCH

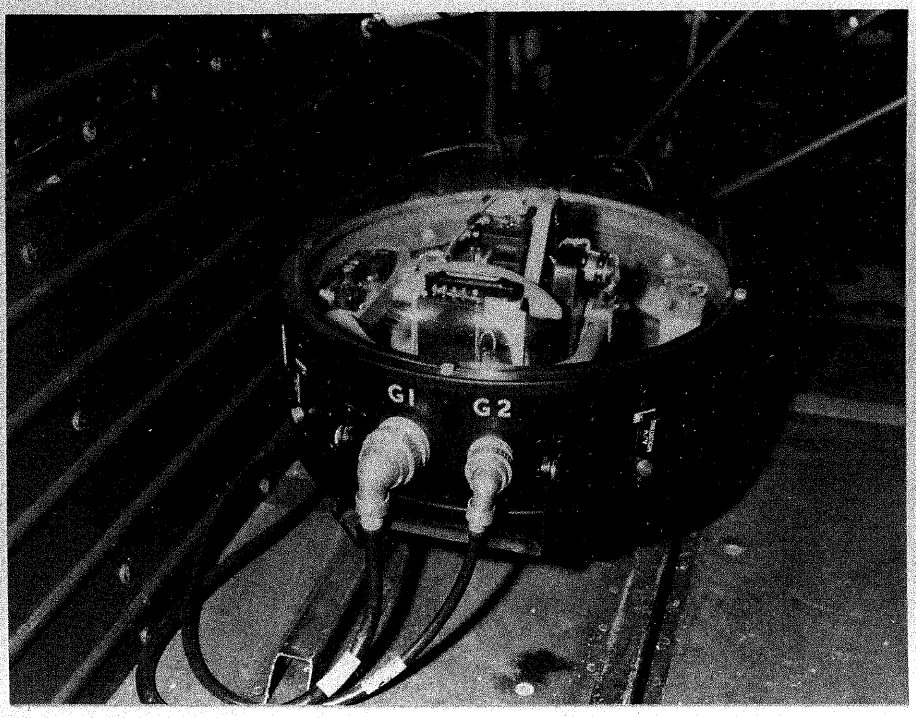


FIG. 25. AUTO PILOT GYRO UNIT

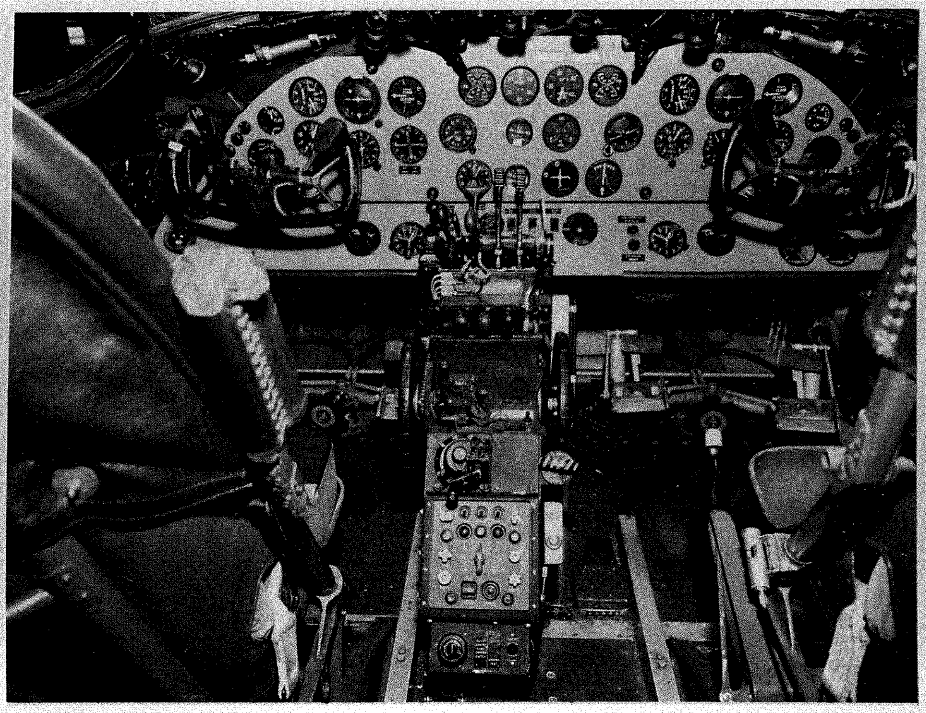


FIG. 26. MODIFIED COCKPIT SHOWING NEW INSTRUMENT PANEL, AUTO ELEVATOR TRIM CHAIN, AUTO PILOT CONTROL PANELS, AND AND MAXARET OVERRIDE

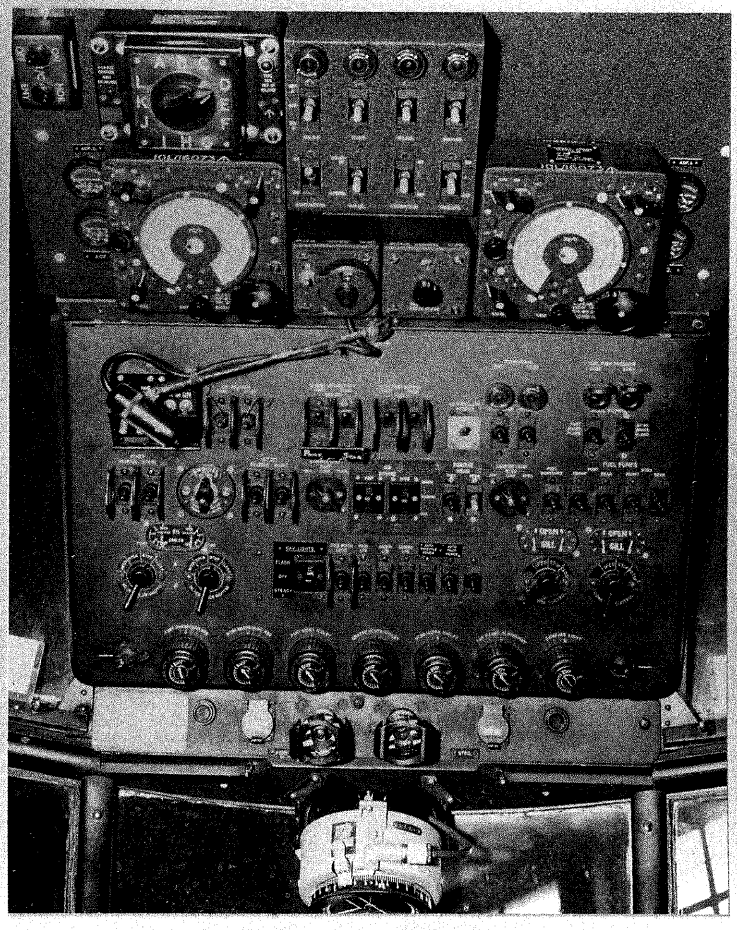


FIG. 27. VIEW OF COCKPIT SHOWING RADIO AND ELECTRICAL CONTROL PANELS AND REPOSITIONED FEATHERING AND FIRE CONTROLS

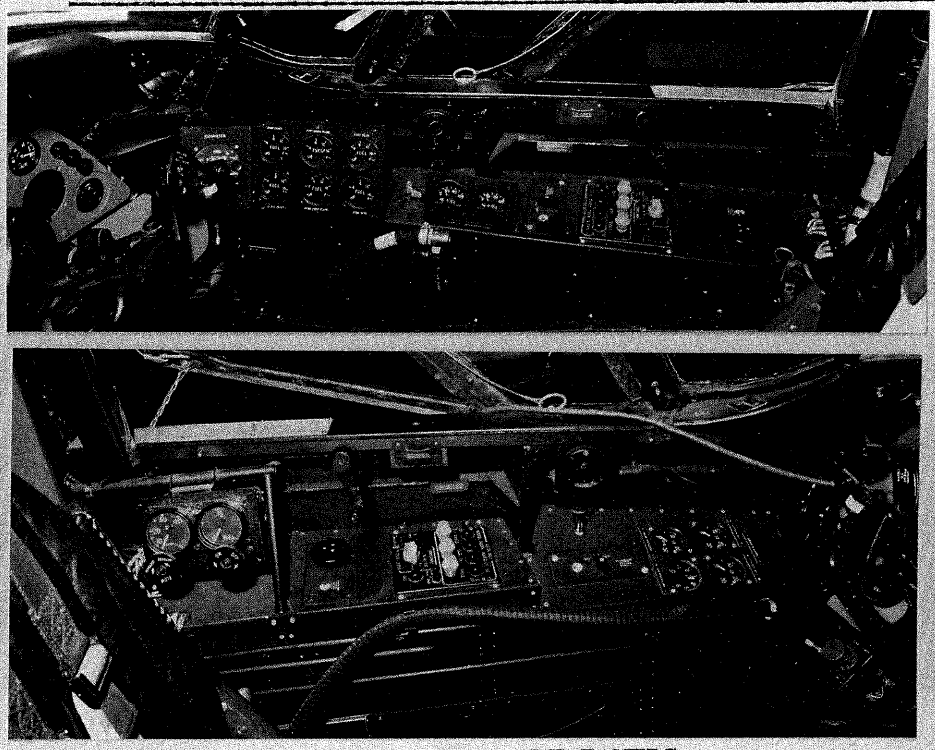


FIG. 28 TWO VIEWS OF COCKPIT SIDE PANELS
A. RIGHT HAND) Showing repositioned hydraulic gauges, radio
B. LEFT HAND) controllers, fuel contents gauges, flowmeters and to right of fuel contents gauges, two invertor box temperature gauges.

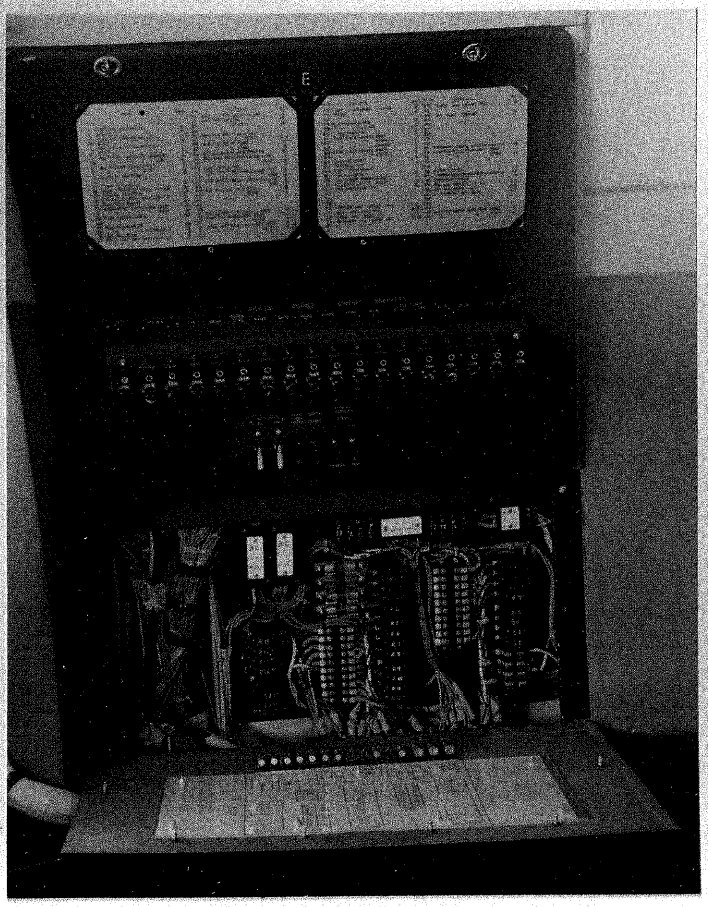


FIG. 29. RADIO FUSE PANEL

FIG. 30. DOPPLER UNITS SHOWING WAVE GUIDE PASSING THROUGH CABIN FLOOR

FIG. 31. REARWARD VIEW OF CABIN SHOWING SEATS IN POSITION

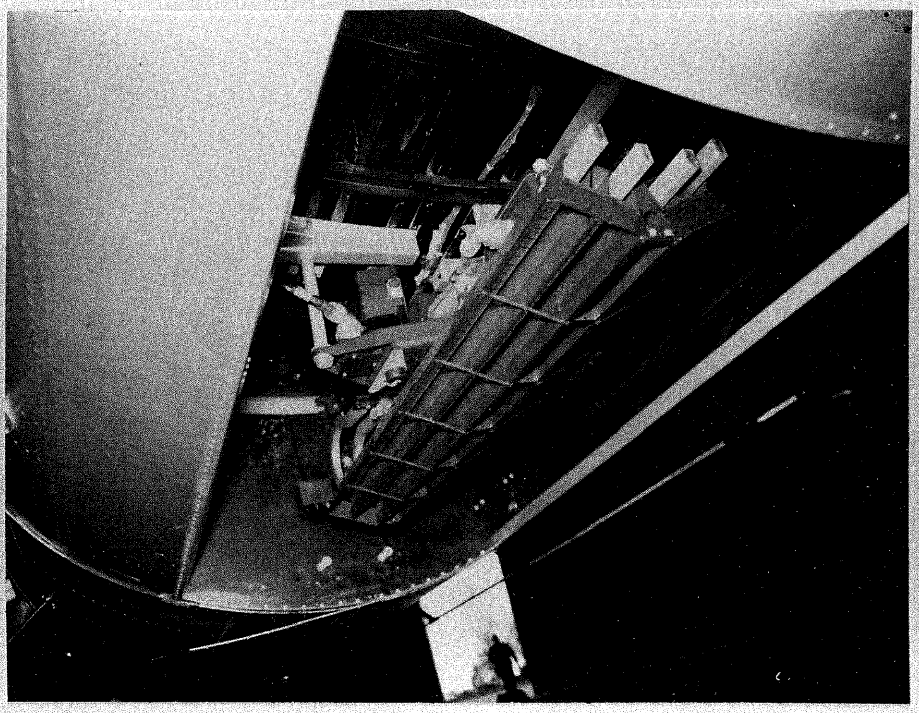


FIG. 32. VIEW OF DOPPLER AERIAL WITH DI-ELECTRIC PANEL REMOVED

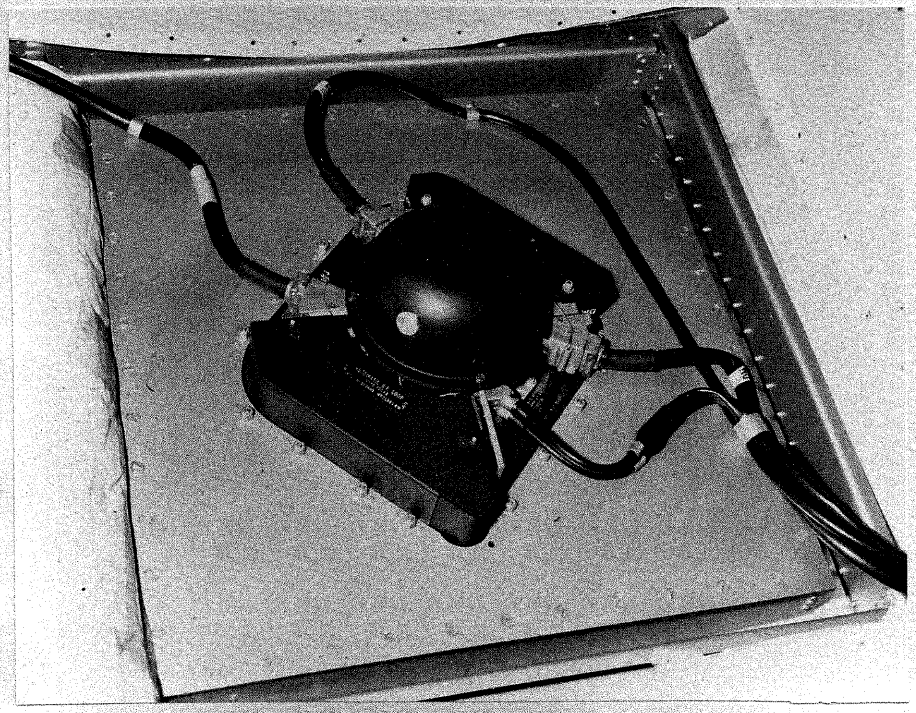


FIG. 33. SUPPRESSED LOOP IN POSITION
UPHOLSTERY REMOVED

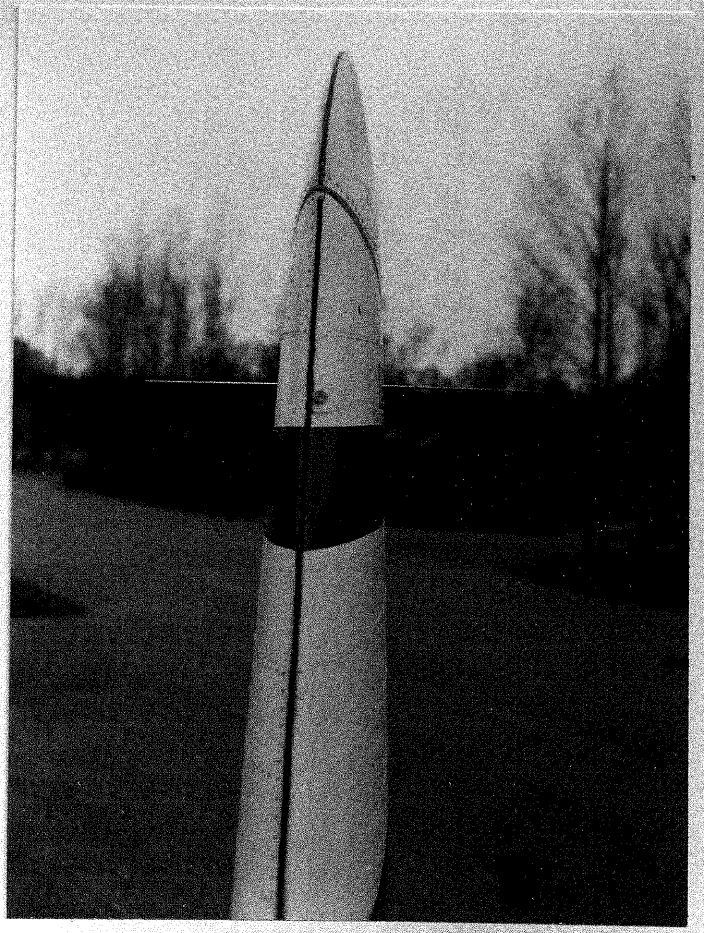


FIG. 34. SWORD AERIALS ON FIN

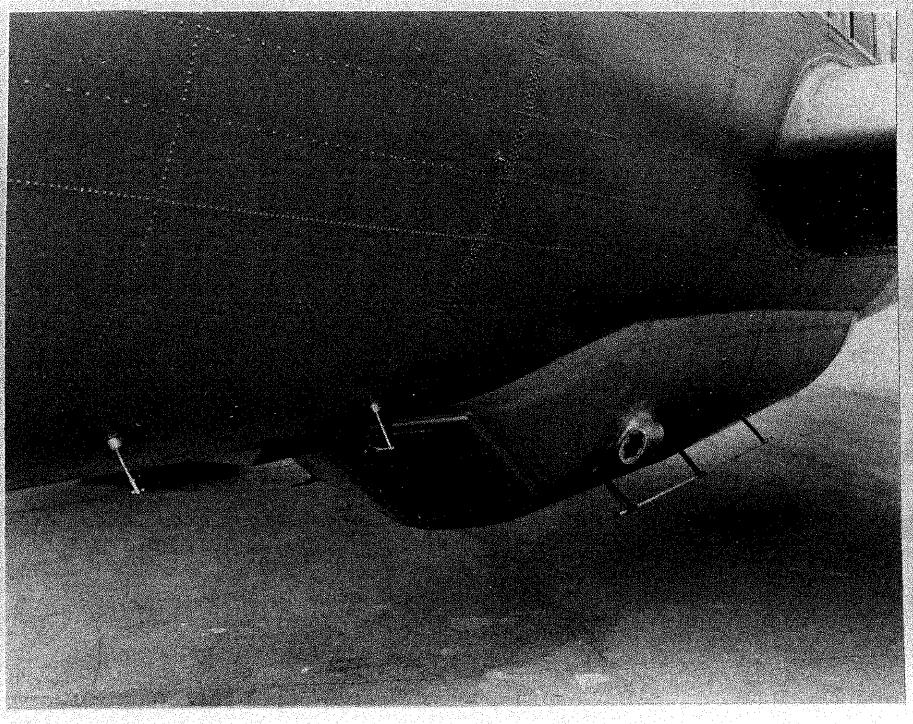


FIG. 35. VIEW OF UNDER FUSELAGE SHOWING ADF SENSE AND ILS MARKER AERIALS AND AIR INTAKE TO INVERTER BOX

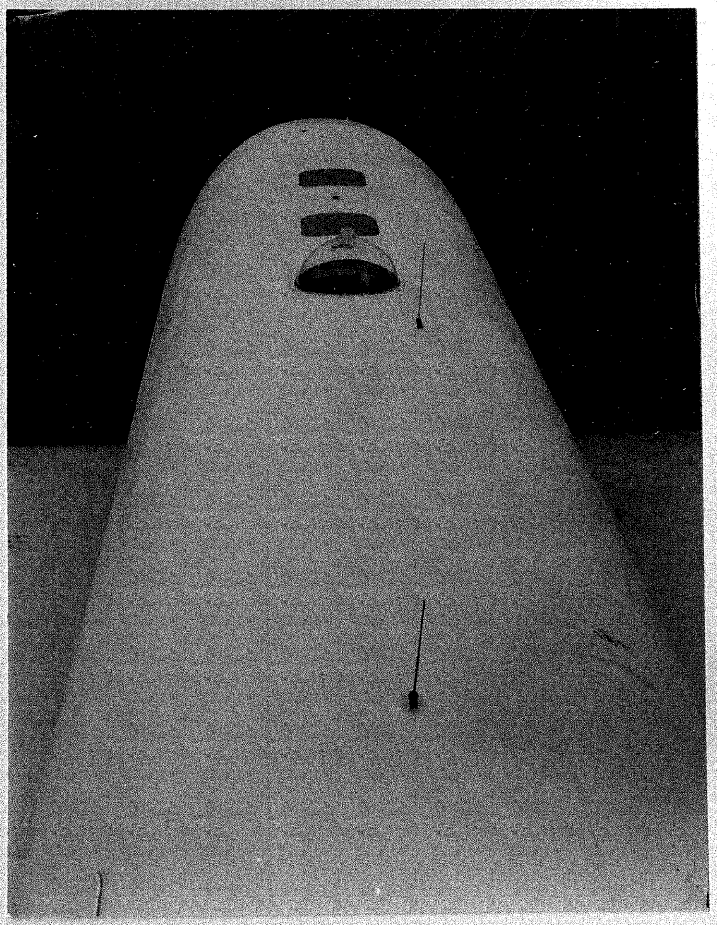


FIG. 36. VIEW OF TOP FUSELAGE SHOWING VHF AERIALS, DI-ELECTRIC PANELS ABOVE SUPPRESSED LOOPS AND FLASHING LIGHT STATION (BETWEEN PANELS)

FIG. 37. COMPLETED AIRCRAFT