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PILOT'S
AND
FLIGHT ENGINEER'S
NOTES

LANCASTER

A.L.2 Front Cover

MARK I—FOUR MERLIN XX, 22, or 24 ENGINES
MARK VII—FOUR MERLIN 24 ENGINES
MARK III & X—FOUR MERLIN 28, 38 or 224 ENGINES

PROMULGATED BY ORDER OF THE AIR COUNCIL

AMENDMENTS

Amendment lists will be issued as necessary and will be gummed for affixing to the inside back cover of these notes.

Each amendment list will include all current amendments and will, where applicable, be accompanied by gummed slips for sticking in the appropriate places in the text.

Incorporation of an amendment list must be certified by inserting date of incorporation and initials below.

A.L. NO.	INITIALS	DATE	A.L. NO.	INITIALS	DATE
1			7		
2			8		
3			9		
4			10		
5			11		
6			12		

Photo by CHARLES E. BROWN

LANCASTER I, III & X

NOTES TO USERS

THIS publication is divided into six parts: Descriptive, Handling, Operating Data, Emergencies, Supplementary Notes for Flight Engineer, and Illustrations and Location of Controls.

These Notes are complementary to A.P. 2095 Pilot's Notes General and assume a thorough knowledge of its contents. All pilots should be in possession of a copy of A.P. 2095 (see A.M.O. A93/43). Flight Engineers should also have a copy of A.P. 2764 when issued.

Words in capital letters indicate the actual markings on the controls concerned.

Additional copies may be obtained from A.P.F.S., Fulham Road, S.W.3, by application on R.A.F. Form 294A, in duplicate, quoting the number of this publication in full—A.P. 2062A, C and F—P.N.

Comments and suggestions should be forwarded through the usual channels to the Air Ministry (D.T.F.).

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Pilot's and Flight Engineer's Notes

LANCASTER I, III & X
PILOT'S & FLIGHT ENGINEER'S NOTES

LIST OF CONTENTS

PART I

A.L.2 Part I Para. 1

INTRODUCTION

1. The Lancaster I, III, VII and X are heavy bombers, the difference between them being mainly in the power plants. The Lancaster I is fitted with Merlin XX, 22 or 24 engines, which have SU carburettors; the Lancaster VII is the Austin built version of the Mark I, with Merlin 24 engines, having the Glenn Martin 250 CE 23 turret installed in the forward mid-upper position. The Lancaster III and X are fitted with Merlin 28, 38 or 224 engines, which have Bendix Stromberg pressure-injection carburettors; hydromatic propellers are fitted to all marks. Lancaster X are Canadian built and differ from British-built Lancasters in some of the instruments and in the electrical system. The Lancaster Mk. III with Mod. 1480 incorporated is known as the Lancaster ASR Mk. III. Mod. 1480 introduces navigational equipment and suitable gear for dropping an airborne lifeboat.

2. **Fuel tanks.**—Three self-sealing tanks are fitted in each wing, numbered 1, 2 and 3 outboard of the fuselage between the front and rear spars. On some aircraft the tanks may be marked Inner, Centre and Outer instead of Nos. 1, 2 and 3. The positions are:

No. 1 (Inner): Between the fuselage and the inner engines
No. 2 (Centre): Between the inner and outer engines
No. 3 (Outer): Outboard of the outer engines.

Capacities are:

Port and starboard	No. 1:	580	gallons	each
„ „ „	No. 2:	383	„	„
„ „ „	No. 3:	114	„	„
		1,077	„	„ side
		or 2,154	„	in all.

Provision is made on some aircraft for carrying one or two 400-gallon tanks fitted in the bomb cells; these tanks are connected so that their contents may be transferred into either or both No. 1 wing tanks and thence to the engines. When the maximum bomb load is carried, the No. 2 tanks should be filled first, and the remainder of the fuel put in No. 1 tanks. This is on account of strength considerations of the aircraft structure.

3. **Fuel cocks.**—The pilot controls four master engine cocks (24, 30). On Lancaster I aircraft, the master engine cocks also control the slow-running cut-outs. The flight engineer controls two tank selector cocks (77) which select No. 1 or No. 2 tank on each side. (No. 3 tank replenishes No. 2, see below). A cross-feed cock (marked BALANCE COCK) connects the port and starboard supply systems, and is on the floor just forward of the front spar, with the handle visible through a hole in the spar cover.

When the 400-gallon tanks are fitted in the bomb cells they each have an ON-OFF cock situated behind the front spar in the centre of the fuselage.

4. **Vapour vent system** (Lancaster III and X aircraft only).—A vent pipe from each carburettor is connected to the No. 2 tank on the same side of the aircraft, and allows vapour and a small quantity of fuel (approx. ½ gal. per hour, per carburettor, but some later carburettors may have a second vent allowing 10 gallons per hour) to return to the tank. This carburettor is designed to work full of fuel, and it therefore requires the vent to carry away any petrol vapour and dissolved air. It also assists in re-establishing the flow of fuel to the carburettors when the pipe-lines and pump have been run dry due to a tank emptying.

5. **Electric fuel booster pumps**

(i) Originally, on Lancaster I aircraft, immersed pumps were fitted in all tanks; Mod. 594 (temporary) removed the immersed pumps from No. 1 tanks and fitted stack pipes in their places.

A later Mod. 512 put back the immersed pumps in No. 1 and No. 2 tanks and incorporated suction by-pass lines to allow fuel to be drawn from the tanks when the pumps are not in use. In aircraft incorporating Mod. 539, including all Lancaster III aircraft, a Pulsometer FB Mk. I pump is fitted in each tank and by-pass lines are incorporated at No. 1 and No. 2 tanks. On Lancaster X aircraft, Thomson pumps, similar to the Pulsometer pumps, and by-pass lines are fitted.

No. 3 tank is used to replenish No. 2 tank (*see* Figs. 5 & 6) by switching on the No. 3 tank pump. When the 400-gallon tanks are fitted in the bomb cells they each have a similar pump fitted to transfer their contents to the No. 1 tanks.

(ii) The main use of the electric fuel pumps in No. 1 and No. 2 tanks is to maintain fuel pressure at altitudes of approximately 17,000 ft. and over in temperate climates, but they are also used for raising the fuel pressure before starting and to assist in re-starting an engine during flight. If one engine fails during take-off and the electric fuel pump is not ON, air may be drawn back into the main fuel system before the master engine cock of the failed engine can be closed, thus causing the failure of the other engine on the same side; therefore at take-off the pumps in Nos. 1 and 2 tanks must be switched on; this is also a precaution against fuel failure during take-off as an immediate supply is available by changing over the tank selector cock. The pump in each tank in use should also be switched on at any time when a drop in fuel pressure is indicated or when it is necessary to run all engines from one tank by opening the cross-feed cock

A.L.2 Part I Para. 6

6. **Fuel contents gauges.**—On Lancaster I and III, the switch (76) on the flight engineer's panel must be set ON before the fuel contents gauges will indicate. On Lancaster X there is no fuel contents gauge switch; the gauges will indicate whenever electrical power is available. Mods. 1198 and 1384 introduce "Gallons-gone" fuel flowmeters which are also under the control of the flight engineer.

7. **Fuel pressure indicators**—Fuel pressure warning lights (79) show when the fuel pressure at the carburettor falls below 6 lb./sq.in. on Lancaster I aircraft, and 10 lb./sq.in. on Lancaster III aircraft. They are switched off by the fuel contents gauges switch (76), and this switch must, therefore, always be on in flight. On Lancaster X, fuel pressure gauges (73) are fitted on the flight engineer's panel. They will indicate whenever battery power is available.

A.L.2 Part I Para. 8

8. **Priming pumps.**—There is one cylinder priming pump in each inboard engine nacelle, drawing fuel from the No. 1 tank on that side; each pump serves one inboard and one outboard engine. On Lancasters I, III and VII aircraft this is accomplished by having two priming cocks fitted in each nacelle. On Lancaster X the priming pump handle is turned to the left to prime the left engine, to the right to prime the right engine, and to the mid-position for off.

A.L.2 Part I Para. 8 (*contd.*)

On Lancaster I, III and VII the priming pumps may be type K40 (40 ccs.) with a T-handle, or A.M. type B (10 ccs.) with a round handle. The American type priming pumps fitted on Lancaster X have approximately the same capacity as the A.M. type B pump, Another cock and a short pipe may be fitted beside the priming pump and can be used to connect an outside supply of high volatility fuel for cold weather starting.

9. **Oil tanks.**—Each engine has its own tank; capacity 37½ gallons of oil with 4½ gallons air space.

10. **Oil dilution.**—The four push-buttons (81) are on the flight engineer's panel.

MAIN SERVICES

11. Hydraulic system

A.L.2 Part I Para. 11 (i)

(i) Each turret is operated by an individual engine-driven pump.

Port outer ...	...	Tail turret.
Starboard inner	...	Front turret.
Starboard outer	...	Mid-upper turret (except on Lancaster VII where the mid-upper turret is electrically operated.)

(ii) Two pumps (one on each inboard engine), with a hand-pump as an alternative, charge a small accumulator and operate:

Undercarriage
Flaps
Bomb doors
Carburettor air intake shutters
Fuel jettisoning

Owing to the large capacity of the flap and undercarriage jacks, it is not normally possible to operate them by the hand-pump in the time available in an emergency.

12. Pneumatic system

A.L.2 Part I Para. 12 (i)

12. **Pneumatic system**

(i) A compressor on the starboard inner engine charges an air bottle and operates:

Wheel brakes
Radiator shutters
Supercharger rams (on all aircraft except early Lancaster I)
Idle cut-off rams (on Lancaster III and X aircraft only)

The air bottle charges to 300 lb./sq. in. except when Lincoln type undercarriage is fitted (Mod. 1195) when the bottle charges to 450 lb./sq. in.

A.L.2 Part I Para. 12 (i) (*contd.*)

A pressure-maintaining valve in the supply line from the air bottle only allows pressure to be supplied to the radiator shutters, superchargers and idle cut-off rams, if the pressure in the air bottle exceeds 130 lb./sq. in. (160 lb./sq. in. when Mod. 1195 is fitted). This is to ensure sufficient pressure for the brakes, which operate at 80 lb./sq. in. (125 lb./sq. in. when Mod. 1195 is fitted). It is necessary therefore to check on the triple pressure gauge that pressure is sufficient before S ratio is engaged, or radiator override switches or idle cut-off controls are operated.

(ii) A vacuum pump is fitted on each inboard engine, one for operating the instruments on the instrument flying panel, and the other for operating the gyros of the Mark XIV bombsight; the change-over cock (17) is on the right of the instrument panel beside the suction gauge (23), and in the event of failure of the vacuum pump supplying the flying instruments the changeover cock can be used to connect the serviceable pump with the flying instruments and cut out the bombsight. It is not possible to operate flying instruments and bombsight on one vacuum pump.

A.L.1 Part I Para. 12 (iii)

(iii) A compressor fitted on the port inboard engine operates the Mark IV or Mark VIII Automatic Pilot, and the computor unit of the Mark XIV bombsight. For operation of the Mark XIV bombsight, the automatic pilot control cock must be set to OUT except on those aircraft in which Mod. 1161 is incorporated.

A.L.2 Part I Para. 13

13. **Electrical system.**—Two 1,500 w. generators are fitted on all aircraft except Lancaster VII which have two 3,000 w. generators. The generators are fitted one on each inboard engine and connected in parallel, charge the aircraft batteries (24 volt) and supply the usual lighting and other services including

Propeller feathering pumps
Flaps and undercarriage indicators
Pressure head heating
Fuel booster pumps
Radio equipment
Landing lamps
Engine starting and booster coils
Dinghy inflation
Controls for radiator shutter and supercharger gear-change rams
Controls for idle cut-off rams (on Lancaster III and X aircraft).
Mid-upper turret (on Lancaster VII aircraft).

Bomb gear and bombsight
Fire-extinguishers
Fuel contents gauges
Fuel pressure warning lights or gauges
Camera
Heated clothing
DR compass

An alternator may be fitted to each outboard engine, to supply any special radio equipment.

A ground/flight switch on the starboard side of the fuselage, immediately aft of the front spar, isolates the aircraft batteries when the aircraft is parked or when using a ground starter battery. Two generator switches are provided on the electrical control panel.

AIRCRAFT CONTROLS

14. **Trimming tabs.**—The elevator (62), rudder (63) and aileron (61) tab controls (on the right of the pilot's seat) all operate in the natural sense and each has an indicator.

A.L.1 Part I Paras. 14 & 14A

14A. **Automatic pilot.**—On early aircraft the Mark IV Automatic Pilot, and on later aircraft the Mark VIII Automatic Pilot, is fitted, driven by a compressor on the port inboard engine. *See* A.P. 2095 for operation, which is normal except on some aircraft in which Mod. 1161 is incorporated, when a stop is provided to prevent the control cock from being moved from the SPIN to the OUT position.

15. **Undercarriage control.**—The undercarriage lever (64) is locked in the DOWN position by a safety bolt (65) which has to be held aside in order to raise the lever. The bolt engages automatically when the lever is set down. The undercarriage may be lowered in an emergency by compressed air (*see* Part IV, para. 56).

WARNING.—There is no automatic lock to prevent the undercarriage being raised by mistake when the aircraft is on the ground.

16. **Undercarriage indicator** (39).—On Lancasters I and III the indicators show as follows:

Undercarriage locked down:	Two green lights
,, unlocked:	Two red lights
,, locked up:	No lights

The indicator switch (4) is interlocked so that it must be on when the port engine ignition switches are on. An auxiliary set of green lights can be brought into operation by pressing the central knob if failure of the main set is suspected. The red lamps are duplicated so that failure of one lamp does not affect the indication of undercarriage

unlocked. The lights can be dimmed by turning the central knob. On Lancaster X a pictorial type of indicator is fitted. When the indicator switch is on and electrical power is available, the pictorial indicator shows the position of the undercarriage wheels and wing flaps at all times. The disappearance of small red flags shows when the wheels are locked up or down.

17. **Undercarriage warning horn.**—The horn sounds if either inboard throttle is closed when the undercarriage is not locked down. The outboard throttles do not operate the horn. A testing pushbutton and lamp are behind the pilot's seat, on the cockpit port rail.

A.L.1 Part I Para. 18

18. **Flaps control.**—If the flaps have been selected partly down, and it is desired to lower them fully, it may be found that the flaps will not lower further for some considerable time. This is due to the pressure in the accumulator having fallen below the pressure required to operate the flaps, but not sufficiently to cause the hydraulic pumps to cut in. To overcome this, move the flaps selector (60) to UP, and then immediately put it fully DOWN; this causes the hydraulic pumps to cut in. After the flaps have been selected fully down for landing, the flaps selector (60) should be left DOWN until landing is complete, to avoid any possibility of the flaps creeping up.

On Lancasters I and III the flaps position indicator (26) is switched on by a separate switch (27).

In an emergency the flaps may be lowered by compressed air after lowering the undercarriage (*see* para. 57).

19. **Bomb doors.**—The control (43) has two positions only. The bomb release system is rendered operative soon after the doors begin to open and before they are fully open. The position of the doors must therefore be checked visually before releasing bombs. If the bomb doors open only part way and then stop, it is probably due to icing around the hinges and joints, which raises the hydraulic pressure sufficiently to bring the cut-out into operation, which stops any further movement of the doors. If the bomb doors selector is moved to SHUT and then immediately to OPEN, the doors will usually open further; it may be necessary to repeat this several times to get the doors fully open.

As strenuous pumping for 15 minutes is required to open the doors with engines stopped, they should be opened before stopping engines if the aircraft is to be bombed up before the next flight.

For emergency operation of bomb doors by compressed air, *see* Part IV, para. 58.

ENGINE CONTROLS

20. **Throttle controls**

(i) *Merlin XX, 22, 28 and 38 engines.*—Climbing boost +9 lb./sq.in. is obtained with the throttle levers (28) at the gate. On Merlin XX installations, and originally on Merlin 22, 28 or 38 installations, going through the gate gives a boost of +12 lb./sq.in. at ground level only. A later modification to Merlin 22, 28 or 38 engines gives +14 lb./sq.in. boost at ground level only with the throttle levers through the gate.

The boost control cut-out (32) gives +14 lb./sq.in. in M gear and +16 lb./sq.in. in S gear on all the above Merlins.

(ii) *Merlin 24 engines.*—Originally no boost control cut-out was fitted and no climbing gate. The fully forward position of the throttle lever gave +18 lb./sq.in. boost for take-off and combat. On these installations the automatic boost control does not allow the butterfly to open fully to maintain +9 lb./sq.in. boost up to full throttle height unless the throttle levers are progressively advanced to the fully forward position during the climb. However, a modification is now being introduced which overcomes this, and when this is incorporated a boost control cut-out is fitted which gives +18 lb./sq.in. for take-off and combat; the throttle quadrant is fitted with a gate at +9 lb./sq.in. boost, and the fully forward position gives + 14 lb./sq.in. at ground level only, for take-off at moderate loads.

A.L.1 Part I Para. 20 (iii)

(iii) *Merlin 224 engines.*—The throttle quadrant is fitted with a gate at +9 lb./sq.in. boost; the fully forward position gives +14 lb./sq.in. at ground level only, for take-off at moderate loads. The boost control cut-out gives +18 lb./sq.in. for maximum take-off and combat.

21. **Mixture control**

(i) *Merlin XX, 22 and 24 engines (Lancaster I).*—S.U. carburettors are fitted. The mixture strength is automatically controlled by boost pressure, and the pilot has no separate mixture control. A weak mixture is obtained below +7 lb./sq.in. boost (+4 lb./sq.in on Merlin XX). The carburettor slow-running cut-outs are operated by closing the master engine cocks.

A.L.3 Part I Para. 21 (ii)

(ii) *Merlin 28, 38 and 224 engines (Lancasters III and X).*—Bendix-Stromberg pressure injection carburettors are fitted. There is no pilot's mixture control, the mixture strength being regulated by the power, so that an economical mixture is obtained below +7 lb./sq. in. boost.

The carburettor idle-cut-outs, which are used in starting and for stopping the engines, are operated by electro-pneumatic rams controlled by four two-position switches (11) or four pushbuttons (if Mod. 1753 is fitted) mounted on the pilot's panel above the engine starter buttons. When two-position switches are fitted the top position is the ENGINE RUN position, and the bottom position is the IDLE-CUT-OFF position; when pushbuttons are fitted, they have to be held in to keep them in idle cut-off.

NOTE.—If the pneumatic supply pressure is less than 130 lb./sq.in. (160 lb./sq.in. when Mod. 1195 is embodied) it is possible to start the engines with the slow running cut-out switches in the IDLE-CUT-OFF position; then, when the supply pressure builds up the idle cut-off rams will operate and all four engines will stop.

22. **Propeller controls.**—The speed control levers (29) for the Hydromatic propellers vary the governed r.p.m. from 3,000 down to 1,800. The feathering buttons (19) are on the right of the instrument panel. For feathering and unfeathering procedure *see* Part IV, paras. 53, 54.

23. **Supercharger controls**

(i) On early Lancaster I aircraft the supercharger controls for all four engines are operated mechanically by one lever.

(ii) On later Lancaster I and on all Lancaster III and X aircraft, the superchargers are operated by electro-pneumatic rams of the single-action spring-return type. In the case of electrical or pneumatic failure the rams will return to the M ratio position. A switch, fitted to the pilot's instrument panel immediately below the engine speed indicators, controls all four engines simultaneously, and a red warning light beside it (25) indicates S ratio on the ground only (i.e. when the undercarriage is down).

A.L.2 Part I Paras. 24 to 26

24. **Radiator shutters.**—The shutters are automatically controlled when the switches forward of the flight engineer's panel are in the up position. When the switches are down the thermostatic control is over-ridden, and the shutters are opened; this position should be used for all ground running, taxying and marshalling

25. **Carburettor air-intake heat control.**—A single lever for the hydraulic operation of all four carburettors' warm air intakes is on the left of the pilot's seat.

When Mod. 1198 is fitted the control has 3 positions, COLD, WARM and HOT (emergy.). If the control is at WARM, air is then drawn into each engine through the warm air-intake inside the bottom engine cowling. When moved to HOT, a flap in the bottom engine cowling is opened by an electro-pneumatic ram and allows hot air to be drawn from the radiator to the engine. The WARM position may be used to prevent the formation of ice when flying in icing conditions, but this will reduce the range (see para. 49 (iii)).

If the flight is continued, instead, in COLD until carburettor icing becomes evident, the HOT position should then be used, but only until the ice has cleared.

If Mod. 1198 is not fitted, there are only two positions COLD and WARM, but the latter position should be regarded as having a similar function to the HOT position when the 3-position control is fitted, as air is drawn from the radiator to the engine through a hole in the engine cowling when the control is at WARM.

OTHER CONTROLS

26. **Intercommunication.**—On Lancaster X, Bendix interphone station boxes are fitted. For inter-communication the selector switch must be set to INTER and the INCREASE OUTPUT control set full on.

A.L.1 Part I Para. 26A

26A. **Fuel jettison control**

The control for the jettison valves in No. 1 tanks is on the floor to the left of the pilot's seat, and is painted red. It is pulled up and turned anti-clockwise to jettison fuel.

NOTE.—The fuel jettisoning system must not be operated unless the pressure in the hydraulic accumulator is more than 650 lb. sq.in. When the flaps are lowered prior to jettisoning, the accumulator pressure should build up rapidly to 650–850 lb. sq.in. If, however, the gauge indicates a lower pressure, one of the main hydraulic systems should be operated momentarily, e.g. the bomb doors control should be moved to OPEN and then returned at once to CLOSED. This will cause the hydraulic cut-out valve to function and the pumps will build up pressure in the system. To ensure the most efficient operation of the jettison system the control valve should be opened as the rising pressure passes 650 lb. sq.in., and a member of the crew should watch the gauge and signal the pilot at this moment.

PART II

HANDLING

NOTE.—All speeds quoted are for aircraft with the Pilot's A.S.I. connected to the static vent (*see* para. 47).

A.L.2 Part II Para. 27 (i), (ii)

27. **Management of fuel system**

(i) *Testing electric fuel booster pumps.* Before starting the engine, each booster pump should be tested by ammeter (most aircraft have a permanent ammeter fitted on the flight engineer's panel while some early Lancaster I aircraft may have an ammeter test socket into which the ammeter must be plugged); to do this the switch for each pump (on Lancaster I, III and X aircraft) should in turn be set to the up (TEST) position, after ensuring that the idle cut-off switches are in the IDLE CUT-OFF position and air supply pressure is greater than 130 lb./sq. in (160 lb./sq. in. if Mod. 1195 is fitted) on Lancaster III and X aircraft. On Lancaster VII aircraft the pump switches are two-position switches and the pumps are tested by pressing the test-buttons above the switches.

The ammeter reading should be perfectly steady and should be between 4 and 7 amps for a Pulsometer FB1 Mk. I pump, between 7 and 9 amps for a Pulsometer FB1 Mk. II pump (which were fitted in place of FB1 Mk. I pumps by Mod. 1358), between 3 and 5 amps for a Thomson pump (fitted on Lancaster X), or between 2 and 4 amps for an immersed pump (fitted on early Lancaster I). Aircraft with Pulsometer pumps may be recognised by the small blisters on the underside of the wings.

(ii) *Use of tanks:*

Structural considerations render it advisable that fuel should always be kept outboard as much as possible.

(*a*) No. 2 tanks should be used for starting, warming up, take-off and the first hour of flight. This will allow space for carburettor venting, where applicable. (See Part I, para. 4.) When overload tanks are used it may be necessary to re-select No. 2 tanks from time to time in order to prevent them from over-filling.

The electric fuel booster pumps in Nos. 1 and 2 tanks must be switched on for take-off, so that if for any reason the fuel supply from No. 2 tanks should fail, fuel pressure will be available immediately on turning the tank selectors to No. 1 tanks. See also Part I, para. 5.

A.L.2 Part II Para. 27 (ii) (Contd.)

(*b*) After the first hour of the flight No. 1 tanks should be selected. When nearly empty, transfer the fuel from the fuselage overload tanks, if in use, by turning on both long-range fuel cocks (behind front spar) and switching on overload tank pump switches. The fuel contents gauge should also be switched on. Transfer of fuel from long-range tanks takes approximately one hour. Turn off each long-range tank cock and pump switch when the tank is empty.

(*c*) Continue to run on No. 1 tanks until empty; then re-select No. 2 tanks and use until approximately 200 gallons remain in each. Then transfer the contents of No. 3 tanks by switching on the No. 3 booster pumps. Switch off the pumps when No. 3 tanks are empty.

A.L.2 Para. 9 Page 17

9. **Fuel jettisoning**

On aircraft embodying Mod. 1370 fuel may be jettisoned, if required, from No. 1 tanks, and the control for the jettison valves is on the cockpit floor to the left of the pilot's seat. It is painted red and should be pulled up and turned anti-clockwise to jettison fuel.

the engine cuts owing to exhaustion of fuel in one tank, back-firing may occur on turning on to another tank. For when the tank empties, the fuel pressure drops, and when the pressure falls to 4 lb./sq.in. fuel injection ceases. When the new tank is turned on, the carburettor restarts and delivers the fuel already in it, but this supply is followed by vapour from the fuel pipelines, causing weak mixture and back-firing until fuel is delivered from the new tank.

When an engine cuts due to exhaustion of one tank:

(*a*) Close the throttle and change over to another tank.

(*b*) Idle the engine till it runs smoothly and open up slowly.

(*c*) The use of the booster pump in the tank turned on will help to restart the engine.

28. Preliminaries

(i) *Before entering aircraft.*—Check pitot head covers removed.

Check all cowling and inspection panels, and leading edge secured. Check tyres for creep.

A.L.2 Part II Para. 28 (ii)

(ii) *On entering aircraft* check security of emergency escape hatches.

Check emergency air bottle pressure (1,100-1,200 lb./sq. in.) if gauge is fitted.

Check hydraulic accumulator pressure (220 lb./sq. in. minm., under no hydraulic pressure).

Check fuel cross-feed cock OFF.

Check position of all circuit breaker (overload) switches on Lancaster X aircraft (see para. 79).

Turn ground/flight switch to FLIGHT.

Switch on undercarriage indicator and flaps indicator switches (if fitted) and check indicators.

Switch on fuel contents gauges switch (if fitted) and leave it on, and check fuel contents.

Check master engine cocks OFF.

A.L.3 Part II Para. 29

29. Starting the engines and warming up.

(i) Test the fuel booster pumps by ammeter (*see* para. 27).

On Lancaster III and X aircraft the fuel booster pumps must never be switched on with the engine master cock open and the engine stationary, unless the slow-running cut-out switch (or pushbutton, if Mod. 1753 is fitted) is in the IDLE-CUT-OFF position, and the air supply pressure not less than 130 lb./sq.in. (160 lb./sq.in. if Mod. 1195 is fitted).

(ii) Have the ground/flight switch turned to GROUND and have a ground starter battery plugged in.

(iii) Set the engine controls as follows :

Master engine cocks ...	OFF
Slow-running cut-out controls	ENGINE RUN
Throttles	¼ inch open.
Propeller controls ...	Speed control levers fully up.
Supercharger control ...	Low gear (warning light not showing).
Air intake heat control ...	COLD
Radiator shutters	Over-ride switches at AUTOMATIC.

AUTOMATIC

A.L.3 Part II Para. 29 (contd.)

(iv) Have a fire extinguisher ready in case of emergency.

(v) Turn tank selector cock to No. 2 tank (*see* para. 27 (ii)) and turn on only the master engine cock of the engine to be started.

(vi) Prime the carburettor of the engine to be started by putting the slow running cut-out switch to IDLE-CUT-OFF, or by holding the pushbutton in, if Mod. 1753 is fitted (on Lancaster III and X) and switching the booster pump in the No. 2 tank on for a period of 10 seconds. Switch off the booster pump and then return the slow-running cut-out to the ENGINE RUN position.

(vii) High volatility fuel (stores ref. 34A/111) should be used if outside priming connection is fitted, for priming at air temperatures below freezing. The ground crew will work the priming pump until the fuel reaches the priming nozzles ; this may be judged by an increase in resistance.

(viii) Switch on the ignition and booster coil, and press the starter button. Turning periods must not exceed 20 seconds with a 30 second wait between each. The ground crew will work the priming pump as firmly as possible while the engine is being turned ; it should start after the following number of strokes if cold :

Air temp. °C.	+30	+20	+10	0	−10	−20
Normal fuel	3	4	7	12		
High-volatility fuel ...				4	8	18

NOTES.—(*a*) If the large priming pump, type K40 (with T-handle) is fitted (*see* para. 8) only one-quarter of these strokes will be required.

(*b*) The amount of priming given above applies when the engine is cold. Less priming will be required when it is warm, and when it is hot it is unlikely that any priming will be necessary. However, since individual engines differ in this respect the pilot should always discuss the amount of priming required with the ground crew concerned.

(ix) It will probably be necessary to continue priming after the engine has fired, and until it picks up on the carburettor. When the engine is running smoothly proceed to prime the carburettors and start the other engines in turn.

(x) When all the engines are running satisfactorily, switch off the booster-coil switch. The ground crew will screw down the priming pumps and turn off the priming cocks (if fitted).

(xi) Have the ground/flight switch turned to FLIGHT and the ground battery removed.

(xii) Open each engine up slowly to 1,200 r.p.m. and warm up at this speed.

(xiii) Switch DR compass ON and SETTING.

30. **Testing engines and installations**

While warming up:

(i) Check temperatures and pressures, and test operation of hydraulic system by lowering and raising flaps and bomb doors—but do not test bomb doors if a bomb load is on board.

A.L.2 Part II Para. 30 (ii)-(viii)

(ii) ~~Switch off electric fuel booster pump so as to test engine-driven pumps.~~

(iii) After warming up until the oil temperature is 15°C. and the coolant temperature is 60°C., switch the radiator shutters over-ride switches to OPEN, and at 1,500 r.p.m. test each magneto as a precautionary check before increasing power further.

(iv) Open up all four engines together to 0 lb./sq.in. boost and check operation of two-speed superchargers. R.p.m. should fall when S ratio is engaged, and on aircraft with electro-pneumatically operated supercharger gear-change, red warning light should come on. Return to M ratio.

(v) At the same boost exercise the constant speed propeller at least twice by moving the speed control lever through its full range. With the control lever fully down r.p.m. should fall to 1,800 r.p.m.

NOTE. The following comprehensive checks should be carried out after repair, inspection other than daily, or otherwise at the pilot's discretion. Normally they may be reduced in accordance with local instructions.

(vi) For each engine in turn open throttle to the take-off position and check take-off boost and r.p.m.—see para. 20.

(vii) Throttle back to +9 lb./sq.in., check that r.p.m. fall below 3,000 and if not, throttle back until a drop is shown, to ensure that the propeller is not constant speeding. Then test each magneto in turn. The drop should not exceed 150 r.p.m.

in turn. The drop should not exceed 150 r.p.m.

31. **Check list before taxying**

Ground/flight switch	FLIGHT
Navigation lights ..	On if required
Altimeter	Set
Instrument flying panel	Check vacuum on each pump — 4½ ~~lb./sq.in.~~
Radiator shutter switches	OPEN
Brakes pressure ..	Supply 250–300 lb./sq.in.

A.L.1 Part II Page 21

32. **Check list before take-off**

Autopilot	Clutch IN Control cock OUT (or SPIN, if Mod. 1161 is incorporated)
DR compass	NORMAL
Pitot head heater switch	ON
T—Trimming tabs ..	Elevator— 4½ divs. nose heavy at ~~55,000 lb.~~ 2½ divs. nose heavy at 55,000 lb. Rudder neutral Aileron neutral
P—Propeller controls	Fully up
F—Fuel	Check contents of tanks Master engine cocks ON Tank selector cocks to No. 2 tanks Crossfeed cock OFF Booster pumps in Nos. 1 and 2 tanks ON
Superchargers ..	MOD
Air intake ..	COLD
Radiator shutters switches	AUTOMATIC
F—Flaps	15°–20° down

A.L.2 Part II Para. 33

33. **Taking off**

(i) Align the aircraft carefully on the runway, making certain that the tailwheel is straight.

(ii) Open up to 0 lb./sq.in. boost against the brakes to check that all four engines are responding evenly.

(iii) Release the brakes gently and open the throttles slowly to the take-off position.

(iv) Keep straight by coarse use of the rudder and by differential throttle opening.

(v) As speed is gained, ease the control column forward to raise the tail. Do not attempt to raise the tail by exerting a heavy push force on the control column during the very early stages of the take-off run.

(vi) At 65,000 lb. ease the aircraft off the ground at 105 m.p.h. I.A.S. and at 72,000 lb. at 120 m.p.h. I.A.S.

(vii) When comfortably airborne brake the wheels and retract the undercarriage.

(viii) With flaps 20° down, safety speed at 65,000 lb. is 165 m.p.h. I.A.S. when using +18 lb./sq.in. boost and 3,000 r.p.m; at 72,000 lb. it is 175 m.p.h. I.A.S. In view of these high speeds power should, where practicable, be reduced early after take-off.

(ix) Raise the flaps in stages above 300 feet. Then return the selector to neutral.

(x) Switch off the electric fuel booster pumps in Nos. 1 and 2 tanks after the initial climb, but if a warning light comes on (or on Lancaster X fuel pressure gauge shows less than 10 lb./sq. in.), switch on No. 2 pumps immediately.

34. Climbing

(i) The recommended speed for a quick climb is 160 m.p.h. I.A.S. The most comfortable climbing speed is about 175 m.p.h. I.A.S.

(ii) Switch on electric fuel pumps of tanks in use, at any signs of fuel starvation (at approximately 17,000 feet in temperate climates).

35. General flying

A.L.2 Part II Para. 35 (i)—(ii)

(i) *Stability.* At normal loadings and speeds stability is satisfactory. At loads above 67,000 lb. there is a tendency for the aircraft to wallow. It is not advisable to attempt to correct this as use of the controls may aggravate it.

(ii) *Controls.* The elevators are relatively light and effective but tend to become heavy in turns. The ailerons are light and effective but become heavy at speeds over 260 m.p.h. I.A.S., and also at heavy loads.

The rudders also become heavy at high speeds.

A.L.1 Part II Para. 35 (iii) & 36

(iii) *Change of trim:*

Undercarriage UP	Slightly nose up
Undercarriage DOWN	Slightly nose down
Flaps up to 25° from fully DOWN	Slightly nose down
Flaps up from 25°	Strongly nose down
Flaps down to 25°	Strongly nose up
Flaps fully DOWN from 25°	Slightly nose up
Bomb doors open	Slightly nose up

(iv) *Flying at low airspeeds.*—Flaps may be lowered about 15°–20°, r.p.m. set to 2,650, and the speed reduced to about 130 m.p.h. I.A.S.

36. Stalling

(i) Warning of the stall is given by slight tail buffeting, which generally commences some 4 m.p.h. before the stall itself. At the stall the nose drops gently. Recovery is straightforward and easy.

(ii) The stalling speeds, engines off, in m.p.h. I.A.S. are:

	At maximum landing weight 55,000 lb.	At moderate load 62,000 lb.	At full load 65,000 lb.
Undercarriage and flaps up	105	112	118
Undercarriage and flaps down	85	92	100

(iii) *High speed stall.*—Adequate warning of the approach of a stall in a turn is given by strong rudder and elevator buffeting. At the stall the inner wing and nose drop gently together. Recovery is immediate on pushing the control column forward.

A.L.1 Part II Paras. 37–39

37. Diving

(i) On aircraft in which Mod. 1101 or 1131 is incorporated it is possible to recover from dives to the limiting speed without the assistance of the elevator trimming tab, even if the aircraft has been trimmed into the dive. If the elevator trimming tab is used, it should be applied with care, since it is powerful and sensitive.

(ii) On unmodified aircraft there is a strong nose-down change of trim as speed is gained in the dive. On these aircraft the elevator trimming tab should never be used to assist entry, but should be used to reduce the very heavy pull force otherwise necessary for recovery.

The flight engineer should be prepared to assist the pilot if required.

38. Check list before landing

Autopilot control cock	OUT (or SPIN if Mod. 1161 is incorporated) Clutches may be left IN
Supercharger	M (low) ratio
Air intake	COLD
Brake supply pressure	250–300 lb./sq.in.
Reduce speed to below 200 m.p.h. I.A.S. and carry out the following drill:	
Flaps	20° down on circuit
U—Undercarriage	DOWN (check by indicator, visually, and horn)
P—Propeller speed control	Up to at least 2,850 r.p.m.
F—Flaps	DOWN on final approach (leave selector DOWN)
F—Fuel	Booster pumps ON in tanks in use

A.L.2 Part II Para. 39

39. Approach speeds

Recommended final* approach speeds in m.p.h. I.A.S. are:

	At maximum landing weight 55,000 lb.	At overload 63,000 lb. (emergency only)
Flaps fully down		
Engine assisted	110	120
Glide	120	—
Flaps up		
Engine assisted	115	—

* These are the speeds at which the airfield boundary is crossed. The initial straight approach should, however, be made at a speed some 15-20 m.p.h. above these figures.

40.

(i) The aircraft will climb satisfactorily with the undercarriage and flaps down.

(ii) Climb at about 140 m.p.h. I.A.S. and, after raising the undercarriage, start raising the flaps a little at a time, retrimming as necessary.

41. Beam approach

	Indicated height: feet	I.A.S. m.p.h.	R.p.m.	Approx boost: lb./sq.in.	Actions	Change of trim
Preliminary approach	1,500	135	2,400	−1	Set 25° flap for all manœuvring	Nose up strongly
On QDR +30°	1,500	135	2,650	+2	Undercarriage down	Nose down slightly
At outer marker	600	130	2,650	−2 to 0 (descent at 400 ft./min.) +2 (level flight)		
At inner marker	150	120	2,850	0 to +2	Flaps fully down	Nose up slightly
Overshoot	up to 300	130–140	2,850	+9	Raise flaps to 25° Raise undercarriage	Nose down slightly Nose up slightly

All four throttles should be used together throughout the approach.
An increase in the rate of sink has no effect on the controls.

42. After landing

(i) Before taxying, raise the flaps and open the radiator shutters.

A.L.2 Part II Para. 42 (ii)

(ii) On reaching dispersal open up all four engines to not more than 0 lb./sq.in. boost and exercise the two-speed superchargers by changing to S (high) ratio, running in that ratio for 30 seconds and then changing back to M (low) ratio. Throttle back slowly and idle the engines for a short period at 1,000-1,200 r.p.m.

(iii) Before stopping the engines, open the bomb doors for bombing up (if required).

(iv) Switch off all booster pumps before stopping engines.

(v) *Stopping engines, Merlin XX, 22, 24.* With the engines running at 800 r.p.m., turn OFF the master engine cocks and switch OFF the ignition after the engines have stopped.

A.L.2 Part II Para. 42 (vi)

(vi) *Stopping engines, Merlin 28, 38 or 224.* To stop an engine check that the air pressure gauge reads at least 130 lb./sq. in. (160 lb./sq. in. if Mod. [illegible] is fitted). If not, open up starboard inner engine to charge the compressor, and then move the slow-running cut-out switch to the IDLE CUT-OFF (down) position with the engine running at about 800 r.p.m. If Mod 1753 is incorporated it is necessary to hold the push button in."

NOTE.—Merlin 28, 38 and 224 engines must not be stopped by turning off the master engine cock, as this will empty the carburettor of fuel and fill it with air. This entails much trouble when starting the engine again.

When all the engines have stopped, switch off the ignition and turn off the engine master cocks.

Check again that all the booster pumps are OFF, then set the slow running cut-out switches to the ENGINE RUNNING position and the radiator shutter over-ride switches to AUTOMATIC.

NOTE.—If the slow-running cut-out switches are left in the IDLE CUT-OFF position or the radiator shutter over-ride switches are left in the OVER-RIDE position, the rams will return to the ENGINE RUNNING and AUTOMATIC positions respectively as soon as the master switch is turned to GROUND. Then, if any ground maintenance work is carried out which necessitates turning on and off the master switch, the rams are being continually operated.

(vii) Switch off all electrical switches and turn master electrical switch to GROUND.

(viii) *Oil dilution.—See Pilot's Notes General A.P. 2095.* The correct dilution period for this aircraft is:

Air temperatures above—10°C. .. One minute
" " below—10°C. .. Two minutes

A.L.1 Part II Para. 42A

42A. A.S.I. conversion table

M.p.h.	Knots
85	74
92	80
100	87
105	91·5
110	96
112	97·5
115	100
118	103
120	104
125	109
130	113
135	117·5
140	122
145	126
150	130
155	135
160	139
165	144
170	148
175	152
180	157
190	165
200	174
360	313

PART III

OPERATING DATA

A.L.1 Part III Paras. 43 & 44

43. Engine data—Merlin XX

(i) *Fuel.*—100 octane only.

(ii) *Oil.—See* A.P. 1464/C.37.

(iii) *Engine limitations* with 100 octane fuel:

		R.p.m.	Boost lb./sq.in.	Temperature °C. Coolant	Oil
MAX. TAKE-OFF TO 1,000 FEET	M	3,000	+12		
MAX. CLIMBING 1 HOUR LIMIT	M	2,850	+ 9	125	90
	S				
MAX. RICH CONTINUOUS	M	2,650	+ 7	105	90
	S				
MAX. WEAK CONTINUOUS	M	2,650	+ 4	105	90
	S				
COMBAT 5 MINS. LIMIT	M	3,000	+14	135	105
	S	3,000	+16	135	105

OIL PRESSURE:
MINIMUM IN FLIGHT .. .. .. 30 lb./sq.in.

MINIMUM TEMPS. FOR TAKE-OFF:
OIL .. .. 15° C.
COOLANT .. .. 60° C.

44. Engine data—Merlin 22, 28 or 38

(i) *Fuel.*—100 octane only.

(ii) *Oil.—See* A.P. 1464/C.37.

(iii) *Engine limitations* with 100 octane fuel:

		R.p.m.	Boost lb./sq.in.	Temperature °C. Coolant	Oil
MAX. TAKE-OFF TO 1,000 FEET	M	3,000	+14		
MAX. CLIMBING 1 HOUR LIMIT	M	2,850	+ 9	125	90
	S				
MAXIMUM CONTINUOUS	M	2,650	+ 7	105	90
	S				
COMBAT .. 5 MINS. LIMIT	M	3,000	+14	135	105
	S	3,000	+16	135	105

OIL PRESSURE:
MINIMUM IN FLIGHT .. .. .. 30 lb./sq.in.

MINIMUM TEMPS. FOR TAKE-OFF:
OIL .. .. 15° C.
COOLANT .. .. 60° C.

A.L.1 Part III Para. 45

45. Engine data—Merlin 24 or 224

(i) *Fuel.*—100 octane only.

(ii) *Oil.*—*See* A.P. 1464/C.37.

(iii) *Engine limitations* with 100 octane fuel:

		R.p.m.	Boost lb./sq.in.	Temperature °C. Coolant	Oil
MAX. TAKE-OFF TO 1,000 FEET	M	3,000	+18*		
MAX. CLIMBING 1 HOUR LIMIT	M S	2,850	+ 9	125	90
MAXIMUM CONTINUOUS	M S	2,650	+ 7	105	90
COMBAT 5 MINS. LIMIT	M S	3,000	+18*	135	105

* +18 lb./sq.in. boost must not be used below 2,850 r.p.m.

OIL PRESSURE:
MINIMUM IN FLIGHT .. .. .. 30 lb./sq.in.

MINIMUM TEMPS. FOR TAKE-OFF:
OIL .. .. 15° C.
COOLANT .. .. 60 °C.

46. Flying limitations

(i) The aircraft is designed for manœuvres appropriate to a heavy bomber and care must be taken to avoid imposing excessive loads with the elevators in recovery from dives and in turns at high speed. Spinning and aerobatics are not permitted. Violent use of the rudder at high speeds should be avoided.

(ii) *Maximum speeds in m.p.h. I.A.S.:*

Diving	360
Bomb doors open	as for diving
Undercarriage down ..	200
Flaps down	200

A.L.2 Part III Para. 46 (iii)—47

(iii) *Maximum weights*

Take-off and straight flying	63,000 lb.
" " " "	‡64,000 lb.
" " " "	†65,000 lb.
" " " "	*72,000 lb.
Gentle manoeuvres	63,000 lb.
Landing and all forms of flying	55,000 lb.
Landing	*60,000 lb.

* These weights are permitted if Merlin 24 or 224 power plants are fitted, paddle-bladed propellers are fitted, Lincoln type undercarriage and tyres (Mod. 1195) are fitted and special adjustments are made to the tyre and oleo leg pressures. A careful check on aircraft structure must be kept and runways only must be used.

† This weight is permitted provided the following mods. are incorporated: Mod. 503 or 518, Mod. 588 or 598, Mod. 811 or SI/RDA. 600 and Mod.1004.

‡ This weight is permitted for Lancaster ASR. Mk. III.

(iv) *Bomb clearances angles:*

Dive	30°
Climb	20°
Bank	10° (with S.B.C.25°)

(v) *Airborne lifeboat Mk. IIA* (fitted on Lancaster ASR. Mk. III)

(*a*) The lifeboat may be dropped at any speed up to 138 m.p.h. (120 knots) I.A.S. provided the aircraft is in straight and level flight, without sideslip.

(*b*) The lifeboat may be jettisoned at any speed up to the limiting speed of the aircraft.

47. Position error correction

(i) All handling speeds are quoted for aircraft without H_2S blister with the pilot's ASI connected to the static vent in the port side of the fuselage. The position error correction is −1 m.p.h. at all speeds from 140 m.p.h. I.A.S. upward.

(ii) When H_2S blister is fitted, the position error correction for static vent is as follows:

From	130	145	170	210	m.p.h. I.A.S.
To	145	170	210	250	
Subtract	1	2	3	4	m.p.h.

(iii) For early aircraft in which the static vent connection has not been made correction is as follows:

From	120	140	160	180	200	m.p.h. I.A.S.
To	140	160	180	200	250	
Add	12	10	8	6	4	m.p.h.

(iv) On Lancaster ASR Mk. III the corrections are as follows:

(*a*) When the lifeboat is being carried, the correction is +3 m.p.h. at speeds below and +2 m.p.h. at speeds above 160 m.p.h. I.A.S.

(*b*) When the lifeboat is not being carried the correction varies from +1 m.p.h. at 110 m.p.h. I.A.S. to −1 m.p.h. at 250 m.p.h. I.A.S.

48. **Maximum performance**

(i) *Climbing:*

160 m.p.h. I.A.S. to 12,000 ft.
155 m.p.h. I.A.S. from 12,000 to 18,000 ft.
150 m.p.h. I.A.S. from 18,000 to 22,000 ft.
145 m.p.h. I.A.S. above 22,000 ft.
Change to S ratio when boost has fallen to +6 lb./sq.in.

(ii) *Combat.*—Use S ratio if the boost obtainable in M ratio is more than 3 lb./sq. in. (4 lb./sq.in. with Merlin 24 or 224) below maximum combat boost.

49. **Maximum range**

(i) *Climbing.*—160 m.p.h. I.A.S. at +7 lb./sq.in. boost with Merlin 22, 24, 28, 38 or 224 + 4 lb./sq.in. with Merlin XX, and 2,650 r.p.m. Change to S ratio when maximum boost obtainable in M ratio has fallen by 3 lb./sq.in.

(ii) *Cruising* (including descent):

(*a*) Fly in M ratio at maximum obtainable boost not exceeding +4 lb./sq.in. with Merlin XX, +7 lb./sq.in. with Merlin 22, 24, 28, 38 or 224 obtaining the recommended airspeed by reducing r.p.m. which may be as low as 1,800 if this will give the recommended speed. Higher speeds than those recommended may be used if obtainable in M ratio at the lowest possible r.p.m.

(*b*) The recommended speeds are:

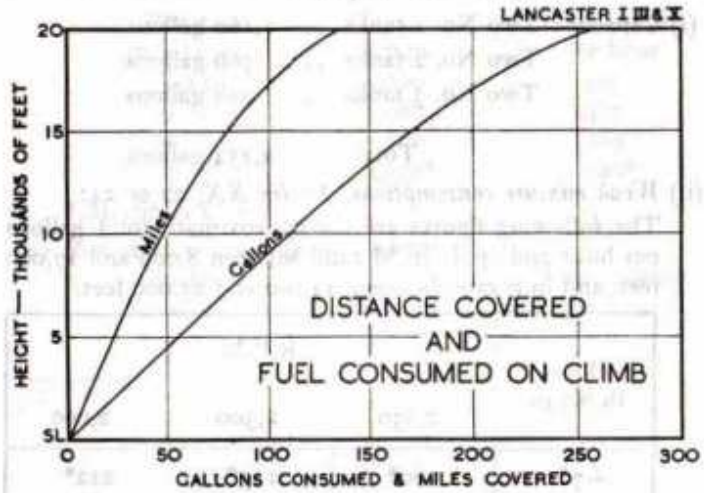
Fully loaded (outward journey):

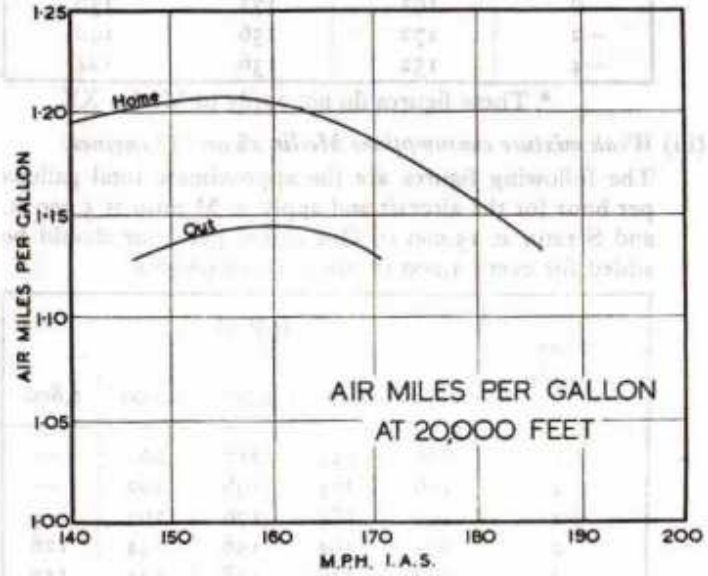
Up to 15,000 ft., 170 m.p.h. I.A.S.
At 20,000 ft. in S ratio, 160 m.p.h. I.A.S.

Lightly loaded (homeward journey):
160 m.p.h. I.A.S.

(*c*) Engage S ratio when the recommended speed cannot be maintained at 2,500 r.p.m. in M ratio.

(iii) The use of warm intakes will reduce air miles per gallon considerably. On this installation there is no need to use warm air unless intake icing is indicated by a drop of boost. *See* A.P. 2095—Pilot's Notes General.





50. Fuel capacity and consumptions

(i) Capacity:

Two No. 1 tanks	..	1,160 gallons
Two No. 2 tanks	..	766 gallons
Two No. 3 tanks	..	228 gallons
Total	..	2,154 gallons

(ii) *Weak mixture consumptions, Merlin XX, 22 or 24:*
The following figures are the approximate total gallons per hour and apply in M ratio between 8,000 and 17,000 feet, and in S ratio between 14,000 and 25,000 feet.

Boost lb./sq.in.	R.P.M.		
	2,650	2,300	2,000
+7*	260*	225*	212*
+4	228	204	188
+2	212	188	172
0	192	172	150
−2	172	156	140
−4	152	136	124

* These figures do not apply to Merlin XX.

(iii) *Weak mixture consumptions Merlin 28 and 38 engines:*
The following figures are the approximate total gallons per hour for the aircraft and apply in M ratio at 5,000 ft. and S ratio at 15,000 ft. One gallon per hour should be added for every 1,000 ft. above these heights.

Boost lb./sq.in.	R.P.M.				
	2,650	2,400	2,200	2,000	1,800
+7	240	235	217	200	—
+4	216	204	196	180	—
+2	196	184	176	164	—
0	172	164	156	144	128
−2	148	140	128	124	112
−4	124	120	108	104	96

(iv) *Rich mixture consumption, Merlin XX, 22, 24:*

Boost lb./sq.in.	R.p.m.	Total gallons per hour
+14	3,000	500
+12	3,000	460
+ 9	2,850	380
+ 7*	2,650*	320*

* Merlin XX only.

(v) *Rich mixture consumptions, Merlin 28, 38:*

Boost lb./sq.in.	R.p.m.	Total gallons per hour
+9	2,850	420

PART IV

A.L.2 Part IV Para. 51

51. Engine failure during take-off

(i) If for any reason the booster pumps in the tanks being used are not ON the master fuel cock of the failed engine must be turned off before feathering.

A.L.2 Paras. 51A and 51B Page 38

51A. Instrument appoach

The following peeds, together with the appropriate flap and approxnate power settings, are recommended for use during nstrument approaches with the under-carriage lowerec—

	Best lb./s in.	R.p.m.	Flaps	Airspeed (knots)
Pattern	3	2,400	20°	140
Final	2	2,850	35°-40°	115
Glide Path	2	2,850	35°-40°	115

51B. Flying in turbulent conditions

In turbulent cditions the aim should be to maintain a speed of approximately 160 knots.

A.L.2 Para. 69 Page 46

The pilot should, however, press the fire-extinguisher button as well, when the propeller has stopped turning. If the warning light is not on, pressing the feathering pushbutton will not operate the extinguisher. The fire extinguishers are also operated automatically by a crash switch.

and X, set mixture control to IDLE CUT-OFF.

A.L.2 Part IV Para. 52 (iii)

(iii) *Handling on three engines.* The aircraft will maintain height at loads up to 65,000 lb. on any three engines at 10,000 feet. and can be trimmed to fly without foot load. Maintain at least 145 m.p.h. I.A.S. The automatic pilot has sufficient power to maintain a straight course with either outboard engine out of action, but only if assisted by the rudder trimming tab. When an engine fails the automatic pilot should, however, be disengaged and the aircraft trimmed to fly hands off before re-engaging. See A.P. 2095.

A.L.2 Part IV Para. 52 (iv)-(vi)

(iv) *Landing on three engines.*—Lowering of flaps to 20° and of undercarriage may be carried out as normally on the circuit but further lowering of the flaps should be left until final straight approach, which should be made at a speed of 110-115 m.p.h. I.A.S.—see A.P. 2095.

(v) *Handling on two engines.*—It should be possible to maintain height below 10,000 feet at 140 m.p.h. I.A.S. on any two engines after release of bombs and with half fuel used; but with two engines dead on one side, the foot load will be very heavy. The automatic pilot will not cope with flight with two engines dead on one side.

(vi) *Landing on two engines.*—A left-hand circuit can safely be made, and is recommended, irrespective of which engines have failed. Keep extra height in hand, if possible, and lower the undercarriage as late as practicable, aiming to have it locked down just before commencing the straight approach to the airfield. The flaps may be lowered 20° before the undercarriage is lowered but they should not be lowered further until it is clear that the airfield is within easy reach. The final approach should be made at a speed of 115-120 m.p.h. I.A.S. See A.P. 2095.

may be necessary in the early stages. (*See* A.P. 2095, Part IV, Notes C and D.)

(vii) Do not attempt to maintain height above 10,000 feet, either on three or two engines.

(viii) *Fuel system.*—The cross-feed cock should only be turned on when it is desired to feed fuel from port (or starboard) tanks to starboard (or port) engines. In this case all live engines should be fed from one tank and the fuel booster pump for this tank should be on. The fuel selector for the tanks on the other side of the aircraft should be off. At all other times, the cross-feed cock should be off.

A.L.2 Part IV Para. 53 (i) (Page 35)

53. Feathering

(i) If possible engine master cock should be turned off immediately before feathering (see para. 52 (i)).

(ii) Close the throttle and (on Lancaster III and X aircraft) move the slow-running cut-out switch to IDLE-CUT-OFF position.

A.L.2 Part IV Para. 53 (ii)—(iv) (Page 36)

(iii) Press the feathering pushbutton and hold it in only long enough to ensure that it stays in by itself; then release it so that it can spring out when feathering is complete.

(iv) Switch off the ignition when the propeller has stopped (or nearly stopped) rotating, and turn off the engine master cock if not already done so.

NOTE.—If an engine fails during take-off the sequence may be (iii), (ii), (iv).

A.L.1 Part IV Para. 53 (v) & 54

(v) Engine auxiliaries which will be affected by feathering:

Port outboard ..	Alternator for special radio, rear turret hydraulic pump.
Port inboard ..	Generator, main services hydraulic pump, compressor for Automatic Pilot and computor unit of Mk. XIV bombsight, No. 1 vacuum pump.
Starboard inboard	Generator, main services hydraulic pump, front turret hydraulic pump, Heywood compressor for pneumatic system, No. 2 vacuum pump.
Starboard outboard	Alternator for special radio, F.N.50 mid-upper turret hydraulic pump.

A.L.3 Part IV Para. 54

54. Unfeathering

NOTE.—(*a*) Do not unfeather at speeds above normal cruising speed to avoid the risk of overspeeding.

(*b*) Do not practice feathering and unfeathering if the outside air temperature is below −15°C.

(i) Put the ignition on, set the throttle as for starting and the propeller control fully down.

(ii) Check that the fuel booster pump of the tank in use is OFF, then press the feathering pushbutton. As the engine starts to turn, set the engine master cock to ON. Continue to hold the button in until r.p.m. reach 800-1000.

(iii) If the propeller does not return to normal constant-speed operation it must be refeathered and then unfeathered again, releasing the button at slightly higher r.p.m.

55. Damage by enemy action

(i) *Fires.*—If fire occurs in bomb bay, pilot should open bomb doors, jettison bombs, and dive.

(ii) *Flight engineer's checks:*

Check fuel contents gauges. Should any abnormal consumptions be shown on the tank the aircraft is running on, or should any of the other tanks show a loss of fuel, proceed as follows:

(*a*) Cross-feed cock ON.

(*b*) Run all engines on the damaged tank, and switch on its booster pump. The fuel selector for the tanks on the other side of the aircraft should be off.

(*c*) When contents of damaged tank fall to 20 gallons, turn on fuel selector for the corresponding tank on the other side of the aircraft and turn OFF cross-feed valve.

(*d*) Watch fuel pressure warning lights or fuel pressure gauge and change over to other tank as soon as pressure drops; switch off booster pump in empty tank.

A.L.1 Part IV Para. 56

56. Undercarriage emergency operation

If the hydraulic system fails, the undercarriage can be lowered by compressed air from a special bottle or bottles, irrespective of the position of the undercarriage lever.

NOTE.—The flap selector should be neutral before using the undercarriage emergency air system.

On early aircraft the control is just aft of the front spar, but on later aircraft the knob (80) for working the air system is just forward of the flight engineer's panel. The undercarriage cannot be raised again by this method. Although the undercarriage will lower by this method irrespective of the position of the normal undercarriage selector, the undercarriage lever *must* be selected DOWN for landing before operating the emergency air system, and left in the down position after landing, except in cases where the undercarriage selector cannot be moved through mechanical defect. Otherwise any leakage of air pressure may cause the undercarriage locks to be released and the undercarriage to collapse.

57. **Flaps emergency operation**

After lowering the undercarriage by turning on the emergency air cock, the flaps may be lowered by operating the flaps control, which admits the air pressure to the flaps system. The flaps can be raised again, but there may not be sufficient air pressure to lower the flaps a second time; furthermore it may cause the header tank to burst. If it is absolutely necessary to raise the flaps by emergency method extreme care must be taken to raise them slowly by stages. If the flaps are lowered by the emergency method before landing, flaps must be left down after landing, owing to the likelihood of bursting the header tank.

A.L.1 Part IV Paras. 58, 59 & 60

58. **Bomb door emergency operation**

This system has been deleted.

59. **Bomb jettisoning**

(i) Open bomb doors and check visually that both are fully open. *See* para. 19.

(ii) Then jettison containers first by switch (15) on right of instrument panel.

(iii) Jettison bombs by handle (16) beside container jettison switch.

(iv) Close bomb doors.

60. **Fuel jettisoning**

NOTE.—(*a*) Only the contents of No. 1 tanks can be jettisoned.

(*b*) Jettisoning should not be attempted if the hydraulic accumulator pressure cannot be built up to at least 650 lb./sq.in. (*see* para. 26A).

A.L.1 Part IV Para. 60 (contd.)

(i) Reduce speed to 150 m.p.h. I.A.S. and lower flaps 15°.

(ii) Lift and turn jettison control on left of pilot's seat. Return control after jettisoning.

(iii) The jettison valve should be closed while there is still about 100 gallons remaining in each tank; if the jettison valve is left open, all the fuel will be jettisoned less approximately 70 gallons, but the last 30 gallons of jettisonable fuel runs out slowly and is inclined to get splashed over the fuselage. The jettison valve may be closed at any time during jettisoning.

Approximate weight of jettisonable fuel, leaving 100 gallons in each tank, is 6,900 lb.

A.L.2 Part IV Paras. 61, 62

61. **Parachute exits**

(i) Hatch in floor of nose should be used by all members of the crew if time is available; originally it was released by a handle in the centre, lifted inwards and jettisoned, but when Mod. 1336 is incorporated the hatch is enlarged and is opened by a handle at the port side. It opens inwards and is secured by a clip which holds the hatch up on the starboard side. It can also be opened from outside the aircraft.

62. **Crash exits**

(i) On Lancaster I, III and X three push-out panels are fitted in the roof (one above the pilot, one just forward of the rear spar, and one forward of the mid-upper turret) except when Mod. 977 (which moves the mid-upper turret forward) is incorporated, in which case the third panel is deleted.

(ii) On Lancaster VII there are two push-out panels in the roof, one above the pilot and one just forward of the rear spar.

63. **Dinghy and ditching**

(i) A type J dinghy stowed in the starboard wing may be released and inflated:

(*a*) from inside by pulling the release cord running along the fuselage roof aft of the rear spar;

(*b*) from outside by pulling the loop on the starboard side, rear of the tail plane leading edge.

(*c*) automatically by an immersion switch.

(ii) The flaps should be owered 30° for ditching, but if the flaps will not lower by the hydraulic system, do not attempt to lower them by the compressed air system, as this will also cause the undercarriage to lower (*see* paras. 56 and 57).

A.L.2 Part IV Paras. 64 to 68

64. **Engine fire-extinguishers**

Each engine is provided with a fire-extinguisher system.

When Mod. 1221 is incorporated four fire-warning lights (one for each engine) on the instrument panel indicate if there is fire in an engine and the pilot is thus warned to stop the engine, feather the propeller and then press the appropriate fire extinguisher button (22).

When Mods. 1067 and 1314 are incorporated the fire warning lights are mounted on the respective propeller pushbuttons (19), and if a fire warning light comes on, pressing the feathering button also operates the fire extinguisher system. The pilot should, however, press the fire extinguisher button as well (see A.P. 2095). If the warning light is not on, pressing the feathering pushbutton will not operate the extinguisher.

The fire extinguishers are also operated automatically by a crash switch.

65. **Hand fire extinguishers**

One on the right side of air bomber's compartment.
One on the left side of pilot's seat.
One on the right side forward of the front spar.
One on the right side aft of mid-upper turret.
One at the left side of the rear turret.

66. **Signal pistol**

This is stowed on top of the front spar; the firing position is in the roof forward of the stowed position.

67. **Signal cartridge stowage.**—Starboard side of fuselage just forward of front spar.

68. **Parachute stowages**

One on the roof of the fuselage forward of mid-upper turret.
One forward of tail turret.

69. **Static line for parachuting wounded men**

(i) If possible, fly aircraft at 130 m.p.h. I.A.S. with 15° flap.

(ii) Assist casualty to air bomber's compartment and place him feet first facing aft.

(iii) Check casualty's parachute harness, fit parachute, remove helmet.

(iv) Remove static line from stowage which is situated on starboard side of front exit. Care should be taken that the threads keeping the static line folded up are not broken. Take snap hook at end of static line and attach to parachute as follows.

(v) Pass the safety becket on the static line through the double 8 cord loop, then pass the small snap hook through the safety becket.

(vi) Snap the hook down on to the rip-cord handle. Insert safety pin to lock the shroud of the snap hook.

(vii) Stow the slack of the static line between the becket and the snap hook under the adjacent pack elastic to prevent this slack length getting caught up on anything and thus pulling the rip-cord too soon.

(viii) Open and jettison front hatch.

(ix) Slide the man through the exit feet first facing aft. Care must be taken to keep his hands to his sides. Do not hold on to the static line by hand.

70. **Emergency packs.**—On starboard side at rest station.

71. **Projectible kite container.**—Along port side at rest station.

72. **Crash axes**

One on port side of fuselage aft of main entrance door.
One on starboard wall in front of rear spar.

73. **Incendiary bombs.**—Two are provided on front face of front spar for destruction of aircraft.

74. **First-aid equipment.**—Starboard side of fuselage aft of main entrance door.

PART V

SUPPLEMENTARY NOTES FOR FLIGHT ENGINEER

75. **Oil system.**—A self-sealing oil tank is fitted in each nacelle; the normal capacity is 37½ gallons with 4½ gallons air space. A stack pipe in each tank retains 2–3 gallons for feathering the propeller. Normal high-pressure oil feeds the propeller constant speed unit.
Under cruising conditions, it is recommended that the oil temperature should not exceed 60°C., but up to 90°C. may be used without damage to the engine. The oil consumption should be between 8 and 16 pints per hour.

A.L.1 Part V Paras. 76 & 77

76. **Coolant system**

A horse-shoe type header tank, filled with 30% Glycol and 70% distilled water, is mounted over the reduction gear of each engine. On the ground with engine running a small coolant discharge is normal, but not in flight.

From B block on each inboard engine coolant is led to the cabin heating radiator, through which the flow of air is regulated by controls either side of the fuselage at the wireless operator's station.

On later aircraft there are two radiators, one for the forward cabins regulated by a control forward of the front spar on the starboard side, and one for the rear part of the aircraft regulated by a control aft of the rear spar on the starboard side.

77. **Hydraulic systems**

The accumulator, supplied by two pumps, has an air charging valve and a pressure gauge which should read 220 lb./sq.in. when there is no pressure in the system.

A.L.1 Part V Para. 77 (contd.)

Misleading pressure gauge readings will occur if the accumulator air pressure is incorrect. The gauge should read between 800–900 lb./sq.in. under working pressure when the cut-out operates, isolating the pumps. The accumulator then provides the initial pressure to operate the various systems. When the pressure falls between 220–300 lb./sq.in. the pumps will automatically be cut in to operate the system and build up accumulator pressure again.

Fuel jettison.—When the fuel jettison control is operated an air inlet valve is opened in the top of each No. 1 tank, and at the same time a valve is opened at the bottom of each tank, breaking a small washer and releasing a spring-loaded stocking. Do not jettison below 100 gallons (*see* para. 60).

The valves may be closed at any point, but the stocking will not be retracted. When repacking, ensure that the stocking is dry and serviceable. Reseat the inlet and outlet valves. Before fitting one of the spare shear washers carried in the housing, the spindle must pass centrally through the jettison valve.

A.L.2 Part V Para. 78

78. **Pneumatic system**

The pressure (normally 300-320 lb./sq. in.) is controlled by a pressure regulating valve, which recommences charging when the pressure drops to 270-280 lb./sq. in. If the pressure drops to 130 lb./sq. in. or below, a pressure-maintaining valve closes, rendering the entire pneumatic system, with the exception of the brakes, out of operation. Therefore M supercharger ratio will be engaged, and the idle cut-off and radiator flaps will be inoperative. If pressure cannot be built up, to stop Merlin 28, 38 or 224 engines, throttle down to minimum r.p.m. and close the master fuel cocks. This will drain the carburettor, which should be carefully primed to expel all the air from the fuel chambers before re-starting (see para. 42 (vi)).

When Mod. ~~1196~~ 1145 (incorporating the "Lincoln" type undercarriage) has been fitted, the air supply pressure is increased to 450 lb./sq. in., the pressure regulating valve permits re-charging when the pressure drops to 390-410 lb./sq. in., and the pressure-maintaining valve closes when pressure drops to 150 lb./sq. in.

79. **Electrical system**

Four accumulators, connected in series parallel, giving a capacity of 80 ampere hours at 24 volts, are charged by two generators. Two ammeters on the main electrical control panel indicate the total generator output to services and battery charging. On the same panel a voltmeter indicates the state of the accumulators, reading 28–29 volts in flight under normal conditions and over 24 on the ground with engines stopped. On Lancasters I and III, spare fuses and a fuse location table are inside the hinged door. The main generator fuses are at the top inside the main control panel. Spare fuses are carried in the lid of the fuse box.

The switches below are for ground fault tracing and must be left on and not touched in flight.

On the front of the panel are two earth warning lights, a resin light switch (locked to prevent its movement) and the air bomber's station light switch of which the push button is for use on the ground in conjunction with the earth warning lights.

On Lancaster X, overload switches are fitted in the heavier circuits and flick off if the current becomes too great. Allow five or ten minutes for the service to cool down and turn the switch on.

80. **Undercarriage failure**

Should the red warning lights remain steady or the green lights not appear when the undercarriage is selected down, operate the warning light changeover switch. If this is ineffective select undercarriage up and return the selector down. If this is still ineffective check the accumulator pressure gauge reading. Should it be 300 lb./sq.in. there is probably no pressure in the system. Select the undercarriage up and down again. The pressure may drop between 200 and 300 lb./sq.in. then rise between 850 and 900 lb./sq.in. when the cut-out operates. If about 800 lb./sq.in. is indicated and the undercarriage appears to be down visually the indicator is probably faulty. If there is still some doubt use the emergency air

pressure to make certain the undercarriage is down, turning the cock off when the operation is complete. This conserves the air pressure for further use; if it is necessary to use the flaps emergency system the method of operation is described in para. 57.

81. **Gauges.**—The gauges on the engineer's panel in the Lancaster X are the four point type fitting into sockets and are therefore interchangeable.

PART VI

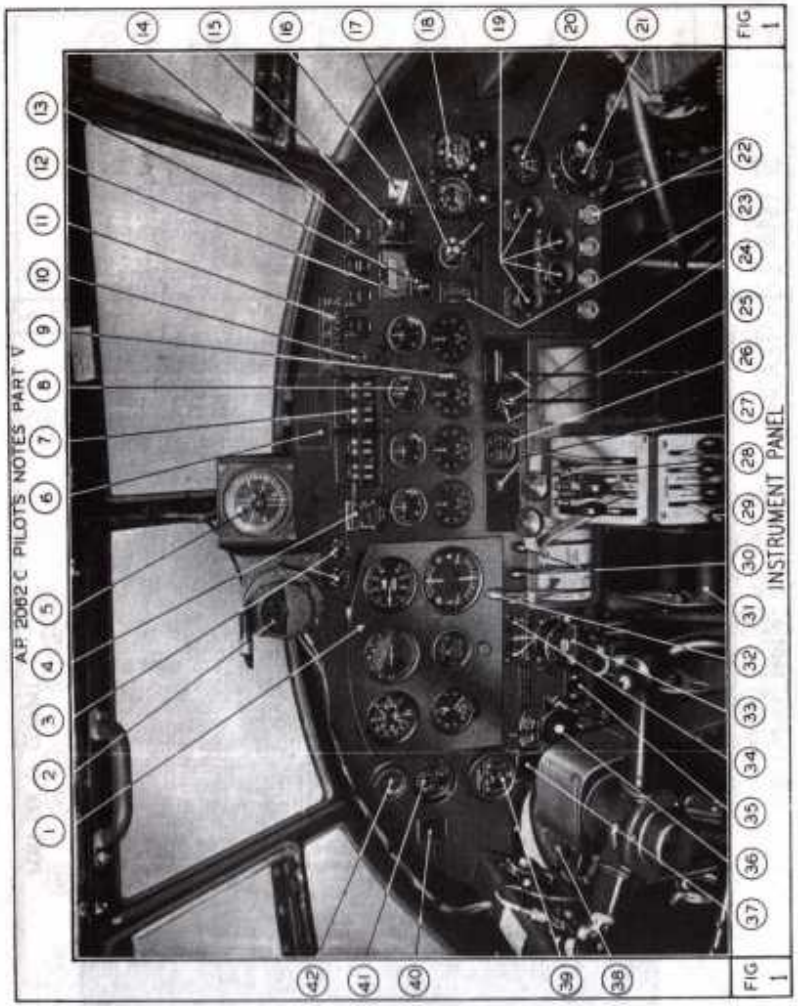
ILLUSTRATIONS AND LOCATION OF CONTROLS NOT ILLUSTRATED

LOCATION OF CONTROLS

Service	*Location*
Undercarriage warning horn test pushbutton	Behind pilot's seat.
Cross feed cock	On floor, just forward of the front spar.
Priming pump and cock (if fitted)	In each inboard nacelle
Air intake heat control	Left of pilot's seat.
Radiator shutter switches	On starboard cockpit wall.
Supercharger gear change lever (on early Lancaster I)	To right of starboard master engine cocks.
Ground/flight switch.	On starboard side aft of front spar.
Cockpit heat controls	One each side of the fuselage just forward of the front spar. Two adjustable louvres in fuselage nose.
Oxygen master valve	At forward end of oxygen crate
Camera pushbutton control	On starboard rail of cockpit.
Reconnaissance flare stowage	On either side of fuselage forward of flare chute.
Flame floats or sea markers stowage	On either side of fuselage adjacent to flare chute.

FUSES

Location	*Service*
(*a*) Inside junction box at forward end of bomb aimer's compartment	Bomb gear fuses.
(*b*) Pilot's auxiliary fuse panel	Oil and radiator thermometer fuses.
(*c*) Navigation panel	Radio fuses.
(*d*) Mid turret position	Mid-upper and underturret, call lights, and, on early aircraft beam approach fuses.
(*e*) Main electrical control panel	General services.



KEY TO *Fig. 1*

INSTRUMENT PANEL

1. Instrument flying panel.
2. D.F. Indicator.
3. Landing light switches.
4. Undercarriage indicator switch.
5. D.R. compass repeater.
6. D.R. compass deviation card holder.
7. Ignition switches.
8. Boost gauges.
9. R.p.m. indicators.
10. Booster unit switch.
11. Slow-running cut-out switches.
12. I.F.F. detonator buttons.
13. I.F.F. switch.
14. Engine starter switches.
15. Bomb containers jettison button.
16. Bomb jettison control.
17. Oxygen regulator.
18. Feathering buttons.
19. Triple pressure gauge.
20. Signalling switchbox (identification lamps).
21. Fire-extinguisher pushbuttons.
22. Suction gauge.
23. Starboard master engine cocks.
24. Supercharger gear change control lever.
25. Flap position indicator.
26. Flap position indicator switch.
27. Throttle levers.
28. Propeller speed control levers.
29. Port master engine cocks.
30. Rudder pedal.
31. Boost control cut-out.
32. Signalling switchbox (recognition lights).
33. Identification lights colour selector switches.
34. D.R. compass switches.
35. Auto controls steering lever.
36. P.4. compass deviation card holder.
37. P.4 compass.
38. Undercarriage position indicator.
39. A.S.I. correction card hold.
40. Beam approach indicator.
41. Watch holder.
42.

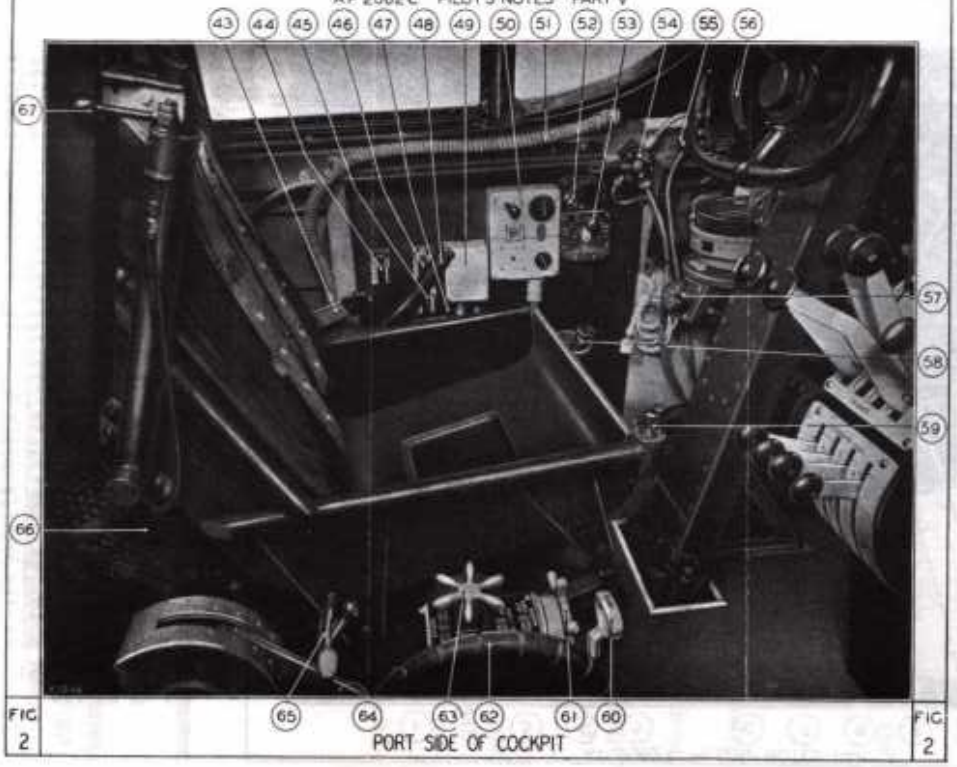


FIG. 2 PORT SIDE OF COCKPIT FIG. 2

KEY TO *Fig. 2*

PORT SIDE OF COCKPIT

43. Bomb doors control.
44. Navigation lights switch.
45. D switch.
46. Auto controls main switch.
47. Pushbutton unit for T.R. 1196.
48. Seat raising lever.
49. Mixer box.
50. Beam approach control unit.
51. Oxygen connection.
52. Pilot's call light.
53. Auto controls attitude control.
54. Auto controls cock.
55. Auto controls clutch.
56. Brake lever.
57. Auto controls pressure gauge.
58. Pilot's mic/tel socket.
59. Windscreen de-icing pump.
60. Flaps selector.
61. Aileron trimming tab control.
62. Elevator trimming tab control.
63. Rudder trimming tab control.
64. Undercarriage control lever.
65. Undercarriage control safety bolt.
66. Portable oxygen stowage.
67. Harness release lever.

KEY TO *Fig. 3*

FLIGHT ENGINEER'S PANEL

LANCASTERS I & III

68. Ammeter.
69. Oil pressure gauges.
70. Pressure-head heater switch.
71. Oil temperature gauges.
72. Coolant temperature gauges.
74. Fuel contents gauges.
75. Inspection lamp socket.
76. Fuel contents gauge switch.
77. Fuel tanks selector cocks.
78. Electric fuel booster pump switches.
79. Fuel pressure warning lights.
80. Emergency air control.
81. Oil dilution buttons.

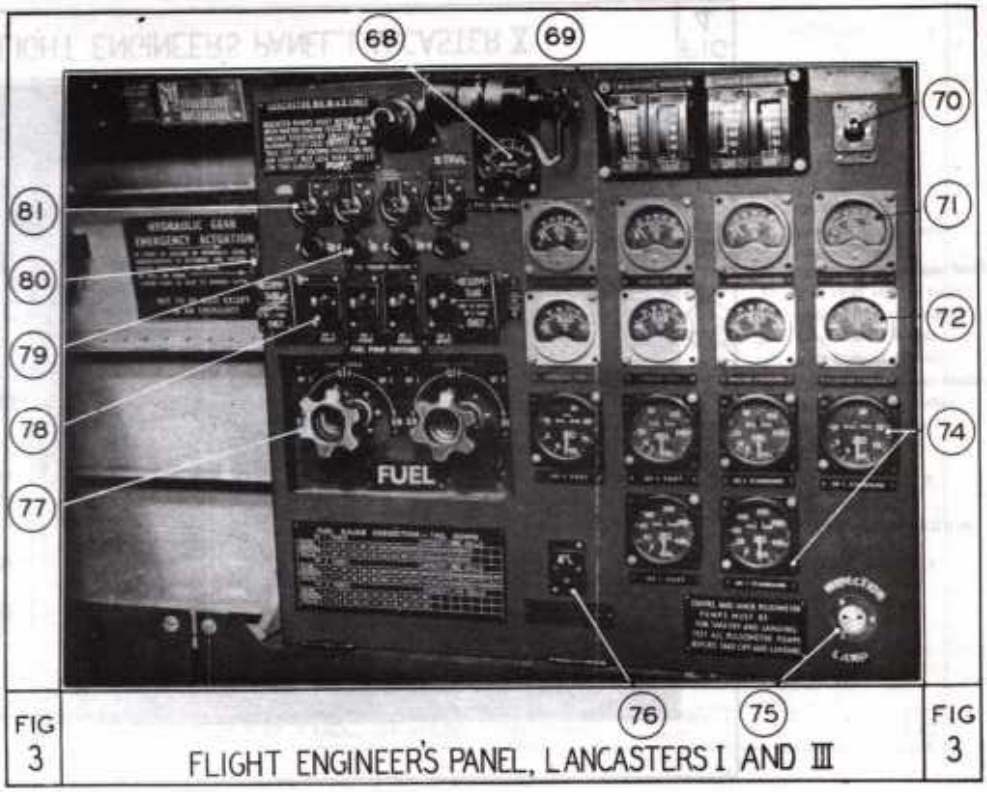


FIG 3 FLIGHT ENGINEER'S PANEL, LANCASTERS I AND III FIG 3

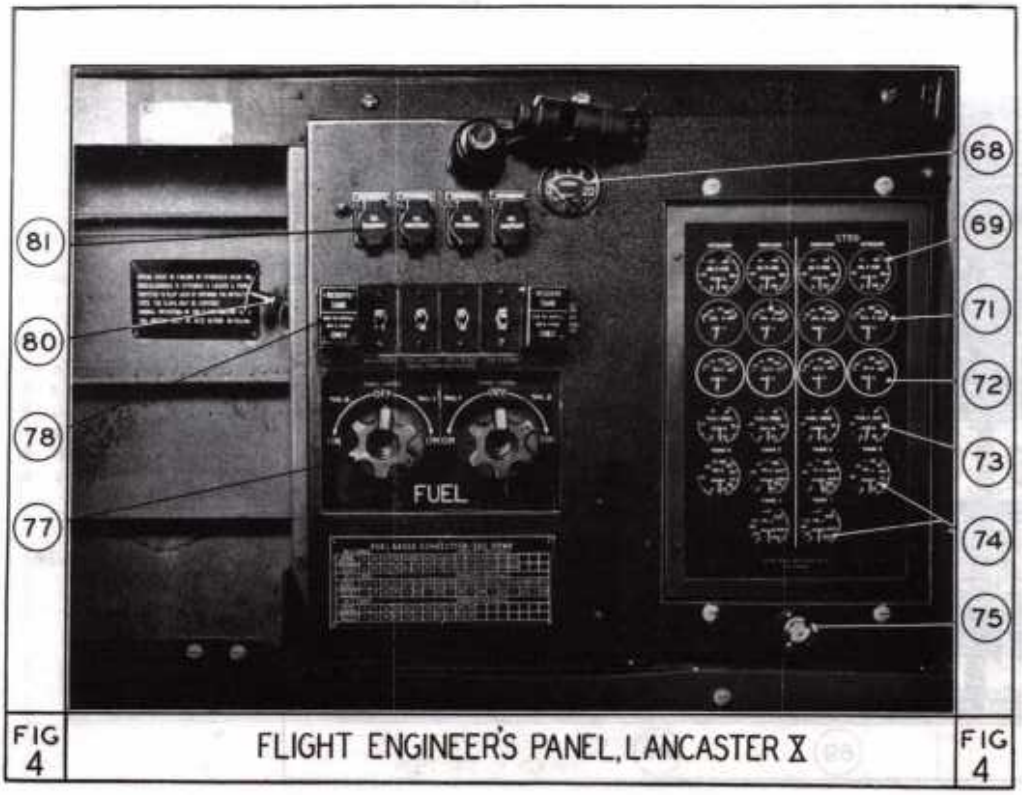


FIG 4 — FLIGHT ENGINEER'S PANEL, LANCASTER X — FIG 4

KEY TO *Fig. 4*

FLIGHT ENGINEER'S PANEL LANCASTER X

68. Ammeter.
69. Oil pressure gauges.
71. Oil temperature gauges.
72. Coolant temperature gauges.
73. Fuel pressure gauges.
74. Fuel contents gauges.
75. Inspection lamp socket.
77. Fuel tanks selector cocks.
78. Electric fuel booster pump switches.
80. Emergency air control.
81. Oil dilution buttons.

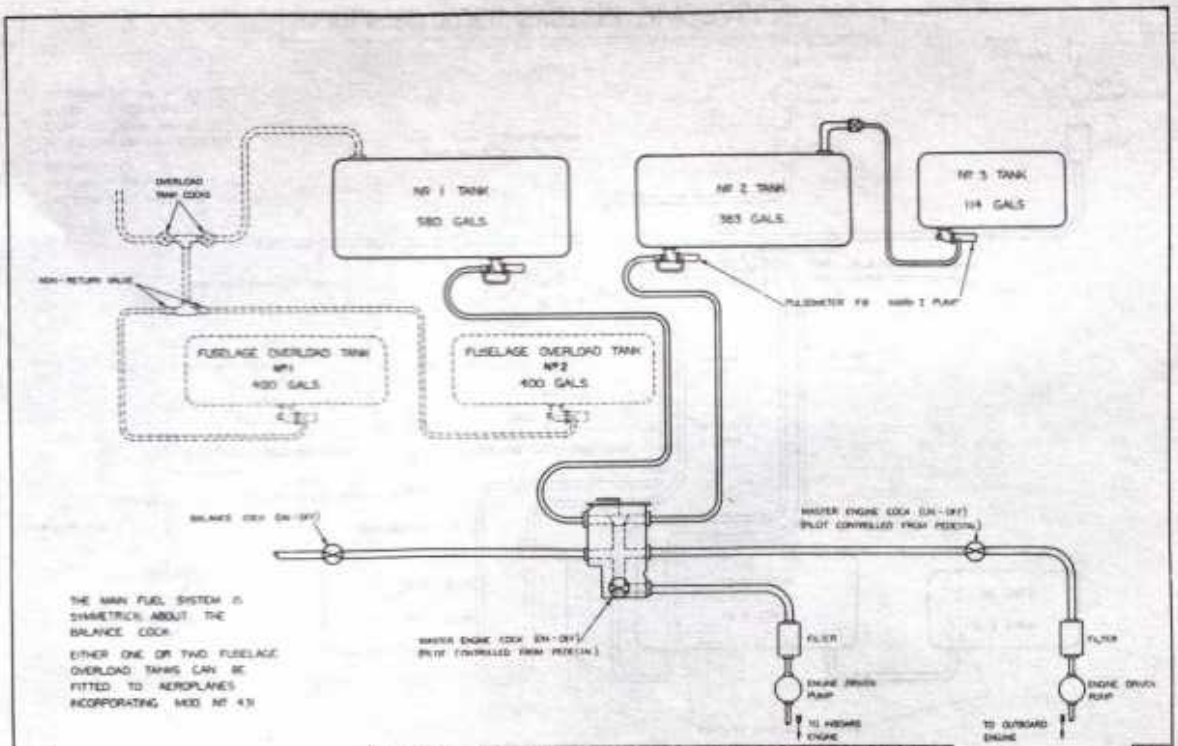


FIG 5 — SIMPLIFIED FUEL SYSTEM DIAGRAM. PULSOMETER PUMPS. — FIG 5

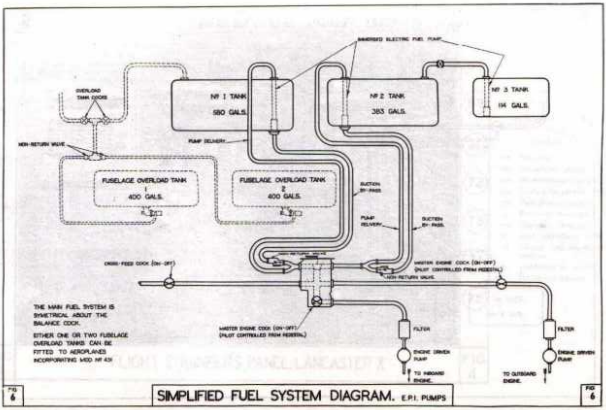


FIG 6

SIMPLIFIED FUEL SYSTEM DIAGRAM. E.P.I. PUMPS

FIG 6

Aviation Archaeology in Greece