PART III
HANDLING

MANAGEMENT OF SYSTEMS

53. Management of the fuel system

(a) The following drill applies to modified or partly modified aircraft (see para. 4(a)). On modified aircraft the L.P. fuel cocks are to be open throughout the flight, except in the event of engine fire or a forced landing. On partly modified aircraft the cocks are locked permanently open. For the differences in drill on unmodified aircraft see sub-para. (f).

CONDITION	FUEL PUMP SWITCHES					
	Port engine			Starboard engine		
	1.	2.	3.	1.	2.	3.
1. Start up	OFF	OFF	ON	OFF	OFF	ON
2. Taxy	OFF	OFF	ON	OFF	OFF	ON
3. Take-off to 2,000 ft.	ON	ON	ON	ON	ON	ON
4. 2,000 ft. until tip tanks empty	OFF	OFF	ON	OFF	OFF	ON
5. Tip tanks empty	Balance levels in No. 1 and 3 tanks					
6. Cruise	ON	OFF	OFF	OFF	OFF	ON
7. When No. 1 and 3 read 100 galls.	ON	OFF	ON	ON	OFF	ON
8. Top of descent or when No. 1 and 3 read 25 galls.	ON	ON	ON	ON	ON	ON
9. Landing	ON	ON	ON	ON	ON	ON

(b) *General*

(i) Deviations from the correct fuel drill can readily result in aft C.G. positions. This applies particularly when making repeated circuits and landings with all pumps on.

(ii) When using No 3 tank, while the fuel from the wing tip tanks is transferring to No. 3 tank, the fuel gauge for this tank will normally read full, but under certain conditions of flight the level may fall to 450 gallons before transfer has been completed. When the level in No. 3 tank falls steadily below 450 gallons, it indicates that the transfer of fuel from the wing tip tanks has ceased. Normally the rate of transfer from each wing tip tank will vary, giving rise to temporary lateral trim changes. If one tank will not feed at all, and the other one is empty, a safe landing is possible provided that the speed is kept about five knots above the minimum for adequate lateral control which should be checked at a safe height, and that weather and runway conditions are suitable. Otherwise, both tanks should be jettisoned before landing.

(iii) When any tank is empty its booster-pumps should normally be switched off, though there is no harm in leaving them running for a short time.

(iv) When No. 1 and 3 booster-pumps are on together, the rate of feeding will vary. No. 1 will normally feed faster than No. 3.

(v) In a steep climb, or when rapid accelerations or manœuvres are being made, there is a risk of fuel surge uncovering the pumps in No. 1 and 3 tanks if they contain less than 60 and 80 gallons respectively. The recuperators, if fitted, will maintain fuel pressure for short periods.

(c) *Reserve fuel*

The last 150 gallons in No. 2 tank is the minimum safe allowance for a circuit, an overshoot and a landing. The surge in No. 2 does not become dangerous until the level has fallen to 50 gallons but even below this level all fuel can be used provided all manœuvres or attitudes which might lead to fuel surge are avoided. In this condition the recuperators should not be relied upon to compensate for fuel surge through mishandling the aircraft.

(d) *Fuel booster-pump failure*

(i) If two or three booster-pumps on one side are on, no immediate indication will be given if one pump fails; but if all pumps fail, or if only one pump is on and it fails, the warning light on that side will come on, after the recuperator has discharged.

(ii) The effect of booster-pump failure depends on altitude, type of fuel and engine r.p.m. and may also vary between aircraft. It may also be influenced by the head of fuel in the tanks.

(iii) The engine-driven H.P. pump is designed to operate with a positive inlet pressure and as booster pump failure causes the pump to have to suck fuel from the tanks the delivery to the engine will be affected. At medium altitudes a drop of 50 to 100 r.p.m. may occur at full power, but this becomes progressively less at lower powers and is about 50 to 80 r.p.m. at 6,500 r.p.m. At higher altitudes, i.e., above 45,000 feet, flame-out may occur if using high r.p.m. If the distribution of fuel permits, another booster-pump should be switched on; the engine should first be throttled back, however, otherwise overfuelling may result when the booster-pump is switched on. Fuel from the tank with the failed pump may be used for the other engine. It should be remembered that the recuperator will not operate if no pump is functioning.

(e) *Bombs hung up*

(i) If a hang-up occurs on a forward station, keep the fuel level in No. 3 tank higher than in No. 1 by 100 gallons for each 1,000 lb. of bomb hung up. When No. 1 tank reads 25 gallons proceed as in 7 and 8 in the table.

(ii) If all bombs hang up, or a hang-up occurs on the mid station, use the normal fuel drill.

(iii) If a hang-up occurs on the rear station, keep the fuel level in No. 1 tank higher than in No. 3 by 100 gallons for each 1,000 lb. of bomb hung up. When No. 3 tank reads 25 gallons proceed as in 7 and 8 in the table.

(f) *Unmodified aircraft*

(i) On unmodified aircraft, when a pump is switched off its associated cock is closed. All selections should therefore be made by *first* switching on the next pump and *then* switching off the pump no longer required.

(ii) Particular care must be taken when fuel in a tank in use is getting low. If the tank empties there will be no gravity feed from other tanks as in modified aircraft and therefore when any tank is nearly empty another booster-pump, in a tank containing fuel, should be switched on.

54. **Management of inverters**

(a) During the starting procedure numbers 2 and 3 inverters should be checked as follows:—

(i) While starting the port engine, when the master starting switch is put on, the stand-by inverter for the flight instruments (No. 3) will be heard to cut in and the emergency instrument supply indicator will show white. Check that the Mk4B compass starts up.

(ii) While starting the starboard engine, when the master starting switch is put on, the normal inverter for the flight instruments (No. 2) will cut in; the indicator will then show normal (black).

(b) During prolonged taxying, the battery voltage may fall, resulting in a fall in No. 2 inverter output and a consequent automatic transfer to No. 3 inverter. It is undesirable to take off with No. 3 inverter supplying the flight instruments. If the indicator is showing white before take-off, the engines should be opened up to generator charge r.p.m., the starboard engine master switch put OFF, and after an eight-second delay put ON again. This should restart No. 2 inverter and the magnetic indicator should show black.

(c) Failure of both No. 2 and 3 inverters will be indicated by the failure of the flight instruments (except the turn and slip indicator) and of the oil pressure indicators. If the trouble is due to temporary overload it may be possible to regain the supply by operating the No. 2 and 3 inverter circuit-breakers. If the failure is complete, No. 5 inverter should be closed down, as without No. 3 inverter running there is no supply to the radar cooling motors.

(d) The principle cause of intermittent failure of the No. 2 inverter on long flights at high altitude is overheating, which results from the No. 2 inverter drawing in the heated exhaust air from the No. 5 radar inverter. The following procedure is recommended during flight:—

(i) Should the instrument supply change to emergency in flight indicating that the No. 2 inverter has failed, the No. 5 inverter should be switched off immediately and after 10 minutes the instrument supply should be reset to normal, i.e., to the No. 2 inverter.

(ii) In normal cruising flight where normally GEE or REBECCA only are used the No. 4 inverter should be used for power supply. The No. 5 inverter should be switched on when it is necessary to run GEE and REBECCA together or when Gee-H is to be used. On long flights using Gee only it is recommended that the load should be shared between the No. 4 and 5 inverters—a changeover being made every 30 minutes.

(e) In order to protect radar equipment from voltage and frequency surges, at least 30 seconds should be allowed for the inverter and its associated regulation equipment to stabilize before switching on the individual services supply switches. On no account must the inverter be started with the supply switches on.

(f) Both the No. 4 and 5 inverters should be run on every flight for at least 15 minutes whether or not the radar equipment is being used. This will eliminate corrosion of the machines brought about by lack of use.

55. **Management of the pressurizing and heating system**

(a) *Pre-Mod. 5 aircraft*

Ventilation will not be obtained on the ground after the engines have been started if the mixing valve is in the fully cold position. In flight ventilation will be obtained whatever the position of the mixing valve. Pressurizing will not commence until the aircraft has reached 10,000 feet, and then only if the mixing valve indicator needle is vertical or in the red sector.

(b) *Post-Mod. 5 aircraft*

Until the engines have been started, the cabin air switches must be left off. Ventilation starts when the cabin air switches are put on, and pressurizing will be obtained when the aircraft reaches 10,000 feet. The temperature may be adjusted to any position between fully cold and fully hot.

(c) *Depressurizing*

After landing, while taxying back to dispersal, action should be taken to ensure that no pressure will be kept in the cabin when the entrance door is opened. On pre-Mod. 5 aircraft the mixing valve should be set to fully cold and the D.V. panel opened. On post-Mod. 5 aircraft the air isolating cocks should be switched off and the D.V. panel opened.

56. **Engine handling**

(a) If the throttles are operated smoothly at all times and slam acceleration avoided, no engine troubles should be experienced.

(b) Above about 3,000 feet the effect of the A.C.U. is reduced and rapid acceleration of the engine up to 5,000 r.p.m. will cause over-fuelling and surging. Engine acceleration deteriorates progressively with altitude and care is required when increasing power at the higher altitudes.

(c) At all times during flight, engine speeds lower than 4,500 r.p.m. should be avoided. If the r.p.m. fall below this figure, care must be used when opening up again otherwise it is possible to stall the compressor. This applies especially when the speed is low and the aircraft is sinking.

(d) When flying at 7,800 r.p.m. with low forward speed, in an indicated air temperature of –55°C, or less, there is a risk of engine surge, resulting in flame extinction. This risk is reduced by avoiding r.p.m. higher than 7,800 –20 per 1°C. below –55°C., i.e., if the indicated air temperature is –60°C., r.p.m. should not be more than 7,700.

(e) *Pre-Mod. Avon 175 engines.*

At altitudes above 35,000 feet, the engine should not be throttled to below 6,500 r.p.m. otherwise the bleed valves will open. If the bleed valves open the throttle must be fully closed and not opened up again above 28,000 feet. During a descent with the throttles closed there may be an audible rumbling from the engines accompanied by a slight increase in j.p.t. This is not harmful, but the j.p.t. will become excessive if an attempt is made to open the throttle above 28,000 feet.

(f) *Use of H.P. fuel pump isolating valves*

Failure of the fuel pumps servo system will cause a sudden drop in engine r.p.m. If a sudden drop occurs in flight it should first be established that it is not due to booster-pump failure or to icing. If neither of these is the cause the throttle should be closed and the appropriate isolating valve switch set to ISOL (up). The throttle may then be opened carefully. If the engine functions normally the isolating valve switch should be left at ISOL. for the rest of the flight. In the event of having to go round again with the H.P. pumps servo system isolated, it should be remembered that only 70% of take-off thrust will be obtainable at low altitude. Also, as the A.C.U. does not function correctly, great care must be taken when opening the throttle.

(g) *Engine handling on descent*

The descent from 20,000 feet should be commenced at 5,600 r.p.m. and allowed to fall to a minimum of 4,500 r.p.m. If icing conditions prevail to ground level, r.p.m. between 6,000 and 7,000 must be avoided, particularly in the later stages of the descent.

STARTING, TAXYING AND TAKE-OFF

57. External checks

(a) *Safety check*

To be carried out on reaching the aircraft and before starting the external checks.

1. Ejection seats	Safety pins in position
2. All jettison switches	OFF
3. Pilot's canopy jettison switches	OFF
4. All master safety switches	OFF
5. Pilot's Notes	Stowed
6. Battery isolating switch	OFF (if external power is to be used)

(b) *External checks*

Ensure chocks and external power available, aerofoils free from hoar frost and ice. Tools, rags and other materials removed from aircraft, canopy cover removed and canopy clean. Then start at entrance door and work clockwise around the aircraft.

1. Main entrance door	Seating free from dirt, operation of the handle
2. Canopy	For cracks, damage and explosive bolts condition
3. Navigator's and upper bay hatches	Secure
4. Starboard lower equipment bay	Security of battery leads and condition
No. 5 inverter	Check blast plate on

5. Nosewheel bay	
Locking pin	Removed
Oleo	Extension
Hydraulic pipeline	For leaks or damage
Tyres	For cuts, creep and pressure
Nosewheel doors	For condition
6. Bomb bay	
Bomb doors	Open and condition
Brake hydraulic accumulator gauge	Minimum 1,350 lb./sq. in.
Undercarriage emergency toggle handle	Wire locked
Hydraulic jacks	For leaks
Hydraulic selector	Wired at FLIGHT
All fuel booster-pumps	For leaks
Control rods	Free and undamaged
7. Starboard inner mainplane	
Inlets and outlet	Unobstructed. No loose panels
8. Starboard wheel-bay	
Undercarriage lock	Removed
Shoot bolts	Serviceable
Check links	Undamaged
Main door	Security and condition
Pipelines and leads	Undamaged
Brake leads	No leaks or damage
Oleo	Extension
Tyre	Cuts, creep and pressure
Small door	Security and clearance
Uplock and micro switch	Undamaged
Fire extinguisher bottles	Security and not discharged
Main hydraulic accumulator gauge	Minimum 1,350 lb./sq. in.
9. Port side of starboard engine	
Panels	Fastened securely and condition
Drain holes	Free

10. Starboard engine	
Cover and intake guard	Removed
Intake	Free from loose articles and undamaged
Swirl vanes	Freedom of movement (Post-Mod. Avon 175)
Compressor	Free to rotate
Exhaust stubs	Secure
Breech block	Check loading and cartridge expansion
Safety disc (if fitted)	Serviceable
11. Starboard outer mainplane	
Leading edge and undersurface	Undamaged
Panels	Secure
12. Starboard wingtip	
Tip tank	Security, condition and freedom from leaks
Tank filler cap	Tightness
Tank vent valve	Seated
Navigation lights	Condition and serviceability
13. Aileron	Lock removed, freedom and full movement
Spring tab	Check fully up for possible torque-tube cracking
14. Starboard flaps	Condition
15. Starboard jet pipe	General condition and no vertical movement
Pyrometer	Free from deposit and undamaged
Shroud ring	Uncracked and check for wrinkling
Drain holes	Free
Turbine blades	Complete and undamaged
16. Starboard rear fuselage	Condition
Camera hatch	Secure, all screws fastened
Rudder stop	Undamaged

17. Tail unit	
Fin	Condition
Tail plane and elevator	Condition and lock removed
Tabs, geared and spring	Condition
Navigation lights	Both serviceable
18. Port rear fuselage	Condition
Fuel filler caps	Secure
19. Port jet pipe	As for check 15
20. Port flaps	Condition
21. Aileron	As for check 13
22. Port wing tip	As for check 12
23. Port outer mainplane	As for check 11 plus landing lamp for security and position
24. Port engine	As for check 10
25. Port wheel bay	As for check 8 plus air mileage unit secure
26. Port inner mainplane	As for check 7 plus outside air temperature rod for damage
27. Port fuselage	
Oxygen charging valves	Blanking caps fitted
Batteries	Leads secure
Inertia switch	Horizontal
Nosewheel selector	Wired in
Cold air unit cold air pipe	Secure
Battery hatch	Closed
Port lower equipment bay hatch	Closed
Navigator's window	Condition
Navigator's and upper equipment bay hatch	Secure
Pilot's canopy	Condition and explosive bolts secure
Static vents	Plugs removed
28. Pressure head cover	Removed
29. Bomb aimer's panel	Clean
30. Starboard static vent	Plugs removed

58. **Checks on entering aircraft**

1. Fire-extinguisher	Stowed
2. Crash axe	Stowed
3. First-aid kit	Stowed
4. Battery isolating switch	OFF
5. Generator switches	ON
6. Pilot's services and generator field circuit-breakers	Made
7. No. 4 & 5 inverters	Off
8. All radar	Off
9. Circuit-breakers at rear base of pedestal	Made
10. L.P. cock and pump circuit-breakers	Made
11. Oxygen selector cocks (Check with crew)	Wired to P.B.
12. Hydraulic hand pump handle	In position
13. Canopy drying cartridges	Check crystals blue
14. Intercomm. lead connections	Check all seats
15. Ejection seat safety pins	Remove and stow

16. When strapped in have rudder lock removed, take out flap and bomb door pins. Adjust rudder pedals. Thigh guard up. Adjust the seat for height so that the head is just touching the firing handle. The seat must not be raised higher than this position at any time in flight.

59. **Cockpit checks—left to right**

1. External power supply (if used)	ON
2. Flying controls	Check for freedom and full range of movement
3. Emergency bomb door selector	Wired SHUT
4. D.V. panel, vent valve and pressure head heaters	OFF
5. Canopy sandwich de-mist switch	OFF
6. Bomb door selector	OPEN

7. Bomb safety switch	OFF
8. Emergency bomb jettison switch	OFF
9. Oxygen (Check for all crew members)	Turn fully ON Check contents Check all connections including emergency supply Check NORMAL and HIGH flow on regulator Select high position on expiratory valve Emergency ON Tighten mask harness if leaking Wait 20 to 30 secs. and check waistcoat inflation Turn emergency oxygen valve OFF and return expiratory valve to OFF
10. Snatch unit lever cover	In position
11. Aileron and rudder trimmers	Check full operating range and return to neutral
12. Tail plane actuator	Check for "live" circuit by ensuring that the tailplane does not move when either the cut-in button or the tail trim switch is operated separately. Then operate the tailplane fully nose UP and nose DOWN, and return to neutral; then one division UP and DOWN, return to neutral. NOTE.—If external power is not used, leave this check until engines running.
13. External lights	As required
14. Internal lights	As required
15. Master safety and canopy jettison switches	OFF
16. Fuel pump isolating valve switches	NORMAL (Down)

17. H.P. cocks	Closed
18. Throttles	Closed
19. Friction nuts	Adjust
20. Intercomm.	Select NORMAL, switch ON (Check with crew)
21. I.F.F.	OFF
22. Canopy internal de-mist	OFF (Clockwise)
23. Undercarriage emergency selector	Wired in
24. Undercarriage selector Emergency override knobs	DOWN button in Horizontal
25. Flaps selector	UP and indicating UP
26. Undercarriage indicator	Three green lights Check changeover and day/night screen
27. Master start and ignition switches	OFF
28. Mk. 4B compass switch	COMP
29. Oxygen audio - warning switch	Wired ON
30. V.H.F.	Both sets OFF, selector switch to approach set, volume full.
31. Flying panel	Instruments undamaged. Set airfield height on altimeter Align Mk. 4B compass with E2A
32. Generator warning lights	On
33. Engine instruments	Undamaged
34. Fuel pressure warning lights	On
35. Fuel contents	Check
36. Fuel booster-pumps	Check singly against warning lights and aurally—leave OFF
37. Cabin pressure warning horn override switch	ON

38. Cabin heat and pressure control	Check operation and set to COLD (If Mod. 5 fitted, check cabin air switches, and set mixing valve to HOT)
39. Brake pressure	Minimum 1,350 lb./sq. in.
40. Entrance door jettison handle	Up (Strapped)
41. Airbrakes	In
42. Wheel brakes	On

43. Have external power disconnected and check with ground crew that starboard lower equipment bay door is closed.

44. Battery isolating switch — ON and check d.c. voltage.

60. **Starter loading**

(a) After checking that the MASTER STARTING switch is off, the breech cap is unscrewed and the spent cartridge removed by unscrewing the cap after releasing the locking ratchet by pressing on the spring-loaded stud in the cap. The cartridge case is removed from the cap by depressing the two buttons in the base. A new cartridge is fitted so that the extractor claws grip the base. The cartridge is then inserted into the barrel and the cap screwed home finger-tight only. If screwed too tight it may be difficult to unscrew subsequently and the starter may be damaged.

(b) On no account should any work be carried out on the starter while the engine is turning.

61. **Starting the engines**

NOTE.—1. Whenever the external battery is plugged in or removed, the battery switch and the aircraft battery isolating switch must both be off. On aircraft pre-Mod. 258, where the GROUND/FLIGHT switch is still fitted, the switch is to be at FLIGHT while the external battery is plugged in or out. When there is no GROUND/FLIGHT switch the battery is always to be plugged in or removed by moving the 3-pin adaptor and lead complete.

NOTE.—2. If no external battery is used, from the time that the battery isolating switch is switched ON until the generators cut in all electrical power is taken from the aircraft battery. Provided that checks are carried out without undue delay and the period spent on the ground before take-off is normal the aircraft battery can cope with these demands. An external battery is only required when it is anticipated that the time spent doing checks will be longer than normal. If an external battery is used it is recommended that it should be removed before starting the engines.

(a) *Checks before starting*

1. Port master start switch	ON
Inverter indicator	White
2. Starboard master start switch	ON
Inverter indicator	Black
3. Ignition switches	ON
4. No. 3 tank L.P. fuel pumps	ON
Fuel pressure warning lights	Out
5. L.P. fuel cock and pump circuit-breakers	Made

(b) For each engine in turn open the H.P. cock and press the starter button firmly.

(c) When the cartridge fires, the engine speed builds up rapidly to 1,500 to 1,800 r.p.m. and will then drop back slightly. When the engine lights up the r.p.m. increase slowly to the idling figure of 2,750 ± 100 r.p.m.

(d) Check that the oil pressure builds up to not less than 3 lb./sq. in.

(e) *Failure of an engine to start*

(i) If an engine fails to accelerate to idling r.p.m. the H.P. cock should be closed immediately and the

master starting switch set to off. When the engine has come to rest, the starter may be re-loaded. The master starting switch should be set to ON and the H.P. cock opened immediately before the new cartridge is fired.

(ii) If a cartridge fails to fire, the H.P. cock should be closed immediately. Wait for one minute before removing the breech cap. If a second cartridge fails to fire the electrical circuit should be checked.

(iii) Two cartridges may be fired in succession but a period of 10 minutes must elapse between each subsequent re-loading, otherwise the starter will over-heat.

(iv) After a failure to start, if the H.P. cock is closed without delay there should be no necessity to " blow through " the engine. If in doubt, excess fuel may be removed by firing another cartridge as follows:—

Master starting switch	ON
Ignition switch	OFF
H.P. cock	Closed

NOTE.—If an engine fire is suspected the L.P. cocks and pumps for the engine must also be put OFF.

62. Checks after starting

1.	Idling r.p.m.	2,750 ± 100
2.	Entrance door	Closed and secure
3.	V.H.F.	Both sets ON
4.	Bomb doors	Shut
5.	Flaps and airbrakes	Checked
6.	Instruments	Mk. 4B compass annunciating and synchronized with navigator's. Check with E2A. Erect Mk. 3B artificial horizon if necessary.

7.	Brake pressure	Minimum 2,000 lb./sq. in.
8.	Radio	V.H.F. approach frequency. R/T clearance local frequency. Set Q.N.H. Check with navigator.
9.	Generator warning lights	Out
10.	D.C. voltmeter	28-volts

When moving, check brake operation. At night, cockpit lights minimum, and taxying lights as required.

NOTE.—If a cold air unit is fitted, during the cockpit checks the cabin heat control is selected to HOT. After starting the engines, particularly in warm weather, discomfort will be caused if it is left at HOT, and it may then be selected to COLD. The cold air unit must not, however, be kept operating on the ground for more than ten minutes; during this time some improvement in cooling is obtained if the aircraft is headed into wind. If the time spent on the ground is likely to exceed ten minutes, either the heat control must be left at HOT or the cabin air switches should be left OFF until just before take-off and the D.V. panel opened.

63. Taxying

(a) *Checks before taxying:—*

1.	Radio	On and tested
2.	Instruments	Serviceability
3.	D.V. panel de-mister	ON
4.	Pressure head heater	As required
5.	Wheel brakes	Operation as soon as possible

(b) The hydraulic brakes are powerful. Rudder and control column loads can be high when taxying in strong winds.

(c) At aft C.G.'s high speed taxying should be avoided, owing to the tendency for the nose to rear.

(d) Under high crosswind conditions the engines may stall during acceleration and care should be taken when opening the throttles.

(e) If it is necessary at any time to stand tail into wind, the engines should be opened up sufficiently to ensure that the j.p.t. remain within the idling limits.

(f) Fuel consumption while taxying is of the order of two gallons per minute for each engine.

64. **Checks before take-off**

Trimmers	All neutral
Throttles	Friction nut tight
Airbrakes	IN
Fuel	Pump isolation switches NORMAL
	H.P. cocks ON, friction nut tight
	Contents
	L.P. pumps all ON
	Fuel pressure warning lights out
	L.P. cock and pump circuit-breakers made
Flaps	Selected and indicating UP
Instruments	Pressure head, D.V. panel and vent valve heaters ON
	Canopy sandwich de-mist as required
	Canopy internal de-mist OFF
	Inverter indicator black
	Artificial horizon erected, button out
	Altimeter set
	Mk. 4B synchronized—check E2A with navigator
	Turn and slip checked
	D.C. and A.C. volts
	J.P.T.'s and oil pressures

Oxygen	Contents; connected and flowing; emergency connected, check with crew
	Cabin pressure ON, heat as required
Hatches	D.V. panel closed, entrance door jettison handle UP and strapped, normal handle locked
	Master safety switches on—check with crew
Harness	Tight and locked—check with crew

NOTE.—If control locks have been used for taxying do not pressurize the cabin until the locks have been placed inside the aircraft and entrance door closed. Test controls for freedom and check trimmers.

65. **Take-off**

(a) Align the aircraft on the runway and apply the brakes. Open up the engines to 7,000 r.p.m. and check for poor throttle and j.p.t. synchronization, an indication of swirl vane malfunction (Post-Mod. Avon 175). If an engine is suspect, increase power; throttle and j.p.t. desynchronization will be more evident and the suspect engine will show a tendency to overspeed. If these symptoms are present the take-off should be abandoned and the cause investigated. If the check above is satisfactory, release the brakes and open the throttles fully. On Pre-Mod. Avon 175 engines check that the swirl vanes operate correctly by watching for the sudden drop in r.p.m. at about 6,500 r.p.m.

(b) There is a tendency for the nose-wheel to rise early in the take-off run. It should be held on to the runway until five knots before the unstick speed, when the control column should be moved firmly backwards aiming to fly the aircraft off at the correct unstick speed. If the nose-wheel is not held on the runway the take-off run is greatly prolonged and in extreme cases acceleration will be very poor.

Take-off weight (lb.)	Unstick speed (knots)
30,000	100
35,000	109
40,000	117
45,000	125

(c) The safety speed is 140 knots.

(d) When comfortably airborne apply the wheel brakes and retract the undercarriage. There is little change of trim, but care should be taken not to exceed 190 knots before the wheels are locked up, particularly at light weights when acceleration is high. If 190 knots is reached before the doors are closed, it is possible that they may not close at all. There is no visual indication that the doors are open, but buffeting will be felt. Should this happen speed should be reduced to about 170 knots to allow the doors to close.

(e) The aircraft accelerates rapidly with an increasing nose-up change of trim which should be trimmed out.

(f) If a climb to altitude is intended the engines should be throttled to 7,600 r.p.m. and the speed held at 330 knots. For circuit practice it is recommended that the speed be kept below 200 knots. For the climb to circuit height 7,000 r.p.m. is ample.

HANDLING IN FLIGHT

66. Climbing

(a) The aircraft is easy to trim on the climb and holds the trimmed speed well.

(b) The recommended climbing speed is 330 knots until 0.72M is reached at about 20,000 feet. Thereafter maintain 0.72M until the desired altitude is reached.

(c) R.p.m. tend to increase with altitude and must be restrained by careful throttling. At high altitudes the precise setting of desired r.p.m. is not easy. Jet pipe temperatures remain roughly constant up to about 30,000 feet, after which they may increase slightly at constant r.p.m.

(d) *Climbing checks* (at 10,000 feet and every subsequent 10,000 ft. level)

1. Oxygen contents, flow and connections (including emergency supply) check with crew.

2. D.C. and A.C. volts, inverter indicator black.
3. J.P.T.'s oil pressures.
4. Cabin altimeter.

67. General flying

(a) The aircraft is easy to trim and pleasant to fly at all altitudes. Lateral trim is sensitive to asymmetric thrust and rudder trim; a deliberate yawing of the aircraft produces a pronounced rolling motion in the direction of the yaw. It may be stopped by clamping the rudder and moving the ailerons to regain lateral level.

(b) *Controls.* These are well harmonized and smooth in operation at all altitudes. The rudder is light and sensitive for small deflections but quickly becomes heavier with increase of movement. It should be used with care at high I.A.S. The ailerons are light and effective, with very good response at speeds from the stall to high mach numbers, but at speeds above 0.83M their effectiveness decreases suddenly. The elevator is light and powerful, but becomes heavier at high speeds and, though still effective, produces poorer response at higher mach numbers.

(c) *Trimmers*

The tailplane incidence control is powerful at all speeds and becomes very sensitive at high I.A.S. The rudder trimmer is powerful and quick in operation; it requires care in its use. The aileron trimmer is the least powerful of the trimmers and slowest in operation.

(d) *Use of the tail trim and cut-in switches*

(i) *Testing in flight.* Checks must be made periodically in flight to ensure that the switches are functioning correctly by operating each switch separately. If the tailplane moves when the trim switch alone is operated, the flight may be completed and the trimmer still used, but it should be remembered that the safety factor of the double system will no longer exist and the possibility of a runaway is increased. For this reason speed must then be restricted to a maximum of 250 knots. If the tailplane moves when

the cut-in switch alone is operated, the switch must be released immediately; on no account may any further attempt be made to trim *in either direction*, and the aircraft must be restricted to a maximum speed of 250 knots and landed as soon as possible.

(ii) *Operation in flight*. With this system, tailplane runaway can only occur if there is a double failure. If the cut-in switch is held on, in anticipation of trimming, the safety factor provided by the double circuit is removed. Therefore, except when testing the circuits, the cut-in switch and trim switch must always be operated and released simultaneously.

(e) *Limited tailplane travel*

Modification action is in hand to limit the amount of available tailplane travel. The effect of this will be to enable the aircraft to be controlled at the maximum speed in the event of a double failure causing the tailplane to run away to the full travel. Further details will be issued by amendment when the Mod. is finalized.

(f) *Airbrakes*

At high I.A.S. these are effective but below about 300 knots their effectiveness decreases until at approach

speeds their effect is negligible. At high mach numbers their use causes increased buffeting with little deceleration and, at .81M, a slight nose-down change of trim. Their use above .82M is not recommended normally (but see para. 70 (c) (vi).)

(g) *Changes of trim*

Undercarriage down	Slight nose-up
Undercarriage up	Little change
Flaps down	Strong nose-up
Flaps up	Strong nose-down
Airbrakes out	Little change except for nose-down at high mach numbers
Airbrakes in	Little change
Bomb doors open or closed	No change

(h) *Buffeting*

(i) When lowering flaps fully slight buffeting occurs which decreases as speed is reduced.

(ii) When bomb doors are opened at high airspeeds and mach numbers marked buffeting occurs. Buffeting is correspondingly less with lower air speeds and mach numbers.

(j) *Flying at reduced airspeed*

Reduce speed to approximately 150 knots and keep the flaps up.

(k) *Flying in conditions of severe turbulence*

The recommended speed is 240 knots up to 35,000 feet.

(l) *Flying in icing conditions*

(i) There is no provision for anti-icing protection of the airframe or engines, and flying in icing conditions should therefore be avoided. If icing conditions are met in flight, climb or descend out of the icing region immediately. Throttle handling in icing conditions must receive the utmost care, and r.p.m. between 6,000 and 7,000 must be avoided.

(ii) To climb out of icing use 7,600 r.p.m. and climb at 350 knots or 0.75M. The throttles should not be moved unless essential, and then only very slowly.

(iii) To descend out of icing throttle back carefully to 5,800 r.p.m. and descend at 250 knots with airbrakes OUT (MID if three-position airbrakes are fitted). If the freezing level persists below 2,000 feet, r.p.m. must not be allowed to fall below 5,800 until finally committed to a landing.

(iv) If an engine surges in icing conditions, it should be throttled back and a maximum rate descent made to below freezing level. The engine may then be slowly opened up to 5,800 r.p.m. and left for five minutes, after which an attempt may be made to accelerate it. If the j.p.t. rises rapidly, the engine must be throttled back again immediately and a further period of five minutes allowed for it to de-ice.

(v) If flame-out occurs the engine may be re-lit after descending below freezing level, but great care must be taken when opening the throttle. R.P.M. of not more than 5,800 should be maintained for five minutes before opening up further.

68. **Stalling**

(a) The approximate stalling speeds in knots are:—

	32,000 lb. No wing tip tanks	*42,000 lb. Wing tip tanks*
Power off		
Undercarriage and flaps up ...	85 to 90	105 to 110
Undercarriage and flaps down	75	
Power on		
Typical approach conditions ... Undercarriage and flaps down	75	

NOTE.—The power off stalling speeds quoted above apply with the engines throttled back. When practising stalling, an engine speed of not less than 4,500 r.p.m. should be maintained to avoid the possibility of stalling the compressor.

(b) Warning of the approach of the stall is given by a slight buffeting some 10 knots above the stall which increases as the stall is approached; at the stall the buffeting may be severe enough to make accurate reading of the A.S.I. difficult. At about the speeds quoted above the nose and either wing may drop gently. Aileron control is effective in raising the dropped wing and the recovery from the stall is straightforward on release of the backward pressure on the control column. The height lost in recovery is small. The stalling speed is not noticeably affected by opening the air brakes or bomb doors, but a slight increase in buffeting may be noticed.

(c) At any time when G is applied ample warning of the approach of the stall is given by buffeting which increases steadily down to the stall at which there is a tendency for either wing to drop. Recovery is immediate upon releasing the pull force on the control column.

(d) With wing tip tanks the pre-stall buffet is more marked and at the stall slight aileron snatch occurs together with a mild wing drop. If ailerons are used to hold up the dropped wing the snatching becomes more marked and the wing drops sharply. The speeds at which these characteristics occur are 5 to 10 knots higher than the stalling speeds without tip tanks.

69. **High speed flying—Limitations**

(a) The aircraft is easily capable of exceeding its airspeed and mach number limitations even in level flight. Care is therefore needed to avoid exceeding the limiting I.A.S. of 450 knots without wing tip tanks or 365 knots with wing tip tanks.

(b) Up to 15,000 feet the limitation of 0.75M must not be exceeded. Above this speed severe buffeting and longitudinal oscillation commence suddenly and may over-stress the airframe.

(c) Between 15,000 and 25,000 feet a limitation of 0.79M is imposed for the same reasons as given in (b) above. In this height band, however, exceeding the limit inadvert-

ently is less likely to result in overstressing the airframe unless buffeting is severe.

(d) Above 25,000 feet the speed is limited by compressibility effects. (See para. 70 (c).)

NOTE.—When wing tip tanks are carried, a limitation of 0.80M is imposed which must not be exceeded, as the behaviour of the aircraft at higher speeds becomes unpredictable.

70. **High speed flying—Characteristics**

(a) *Sea level to 15,000 ft.*

(i) As speed increases there may be a slight change of longitudinal trim, and, at the maximum speed or mach number, slight intermittent buffeting may occur. If a rapid longitudinal oscillation develops at or near the I.A.S. or mach number limitation, speed should be reduced as soon as possible until the oscillation ceases.

(ii) The airbrakes are effective at high I.A.S. but their use is accompanied by noticeable buffeting especially when fully out is used with three-position airbrakes.

(b) *15,000 to 25,000 ft.*

As speed is increased buffeting commences at about 0.77M and increases in strength as the speed rises. If the limitation of 0.79M is exceeded there is a tendency for lateral unsteadiness to develop.

(c) *Above 25,000 ft.*

(i) Up to about 35,000 ft. warning of the approach of severe compressibility effects is given by a nose-up change of trim which occurs at about 0.84M to 0.85M. Below this speed the first symptoms are given by slight buffeting which commences at about 0.78M to 0.8M. At about 0.81M the buffeting increases in intensity and at 0.83M a slight nose-

down change of trim occurs, followed by a nose-up change at about 0.85M. The lateral trim becomes sensitive at these speeds and lateral unsteadiness may be encountered.

(ii) Above 35,000 ft. warning of the approach of severe compressibility effects is given by lateral unsteadiness and a tendency for one wing, generally the starboard, to become heavy at about 0.84M. At about 45,000 ft. the wing starts to get heavy at slightly lower speeds, between 0.82 and 0.83M. Below these speeds the symptoms are much the same as in (i) above.

(iii) Above 35,000 ft. if the aircraft is accelerated past the speed at which a wing becomes heavy, any wing drop that occurs is usually accompanied by aileron snatching and loss of aileron effectiveness, making it difficult to restore lateral level. At the same time elevator effectiveness falls off markedly and severe buffeting sets in. Should control be lost, great care must be taken to avoid overstressing the aircraft during the subsequent recovery at the lower altitudes when the I.A.S. may be high. Use of the tail trimmer during recovery should be avoided, but extreme care must be taken if it has to be used.

(iv) The behaviour under compressibility will vary between aircraft and is also likely to vary on individual aircraft depending on the C.G. position and the external condition of the aircraft. Although the wing heaviness case is given as being the most critical from the point of view of possible temporary loss of control, other effects such as strong nose-up or nose-down changes of trim, lateral rocking and directional instability may be noticed. As soon as compressibility effects become marked, irrespective of the altitude but particularly at the highest altitudes, speed must be reduced, as the consequences of still further increasing the speed are unpredictable and may be serious. The remarks in this paragraph apply both to the clean aircraft and when wing tip tanks are fitted.

(v) Recovery from mild compressibility conditions is best made by throttling back to not less than 6,500 r.p.m. and easing the aircraft out of the dive, care being taken to avoid high G which will aggravate matters.

(vi) If loss of control is experienced the engines must be throttled right back and the airbrakes extended and the control column held hard back. On aircraft fitted with three-position airbrakes the mid-position should be selected. On no account may the fully out position be used. About 10,000 ft. may be lost before the mach number has fallen to a figure at which control can be regained. During the recovery G loads must be kept low. Use of the tail trimmer during recovery should be avoided, but extreme care must be taken if it has to be used.

(vii) At all heights, if the engine power is high, only a shallow dive is needed to reach the limiting speeds.

NOTE.—With wing tip tanks fitted the compressibility effects described above will occur at slightly lower mach numbers and even lower if they are badly fitted. If complete loss of control occurs recovery may be more difficult.

71. Cruising

Cruising data is given in para. 99 (b), which gives fuel consumption, airspeed and engine settings for best range, fast cruise, and best endurance, at various weights.

72. Descent

(a) Descent data, for a normal descent and a glide descent are given in para. 100.

(b) *Checks before let-down or joining circuit*

Mk. 4B Compass	Magnetic
Canopy internal de-mist	As required

Radar	As required
Fuel check	Isolating switches NORMAL
	H.P. cocks on and locked
	Contents
	L.P. pumps as required
	Fuel pressure warning lights out
	L.P. cock and pump circuit-breakers made.
Harness	Tight and locked — check with crew.
Tailplane	Check for "live" circuit on tail trim switch and cut-in button.

CIRCUIT AND LANDING PROCEDURE

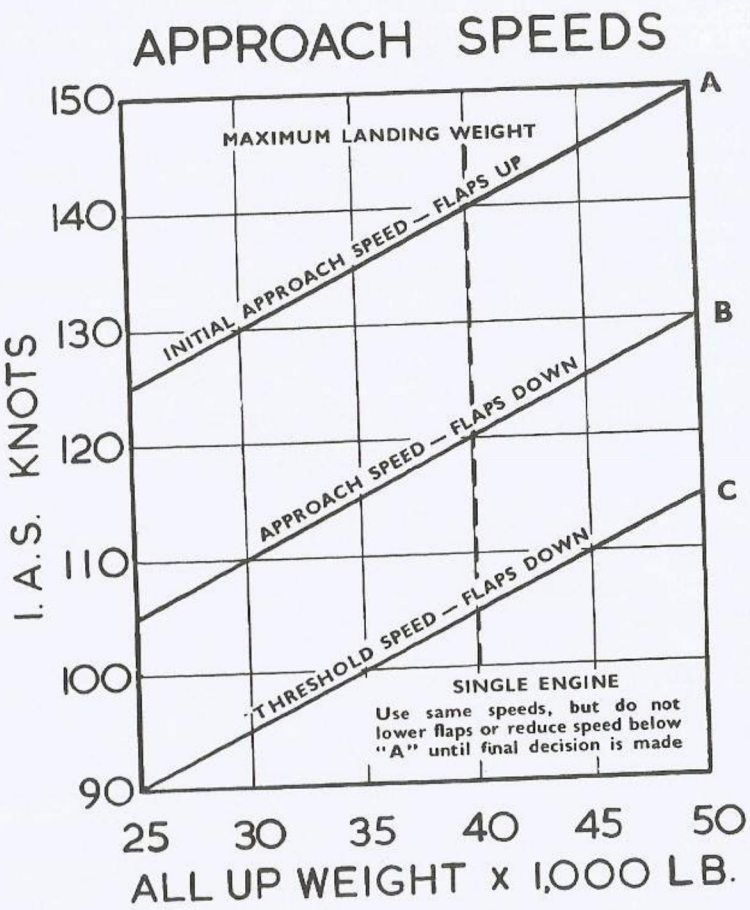
73. Approach and landing

(a) *Checks before landing*

Brakes	Pressure 2,000 lb./sq. in. min. and off
Airbrakes	IN
Undercarriage	Down below 190 kts. Check three green lights
Fuel	Contents — all L.P. cocks and pumps ON
Harness	Tight and locked

(b) Approach speeds are shown on the chart overleaf. On the crosswind leg keep the speed at A, turn on the final approach, lower flaps and reduce speed to B. When the decision to land has been made reduce speed progressively to cross the boundary at C.

(c) Until the decision to land has been made, the r.p.m. must be kept above 4,500 and an exaggerated nose-up attitude avoided. On throttling back the thrust and speed reduce slowly and the engines should be throttled fully back before reaching the airfield boundary so that the touch-down is made with the least amount of residual thrust.



APPROXIMATE ALL-UP WEIGHTS (lb.)

Crew only	**23,000**
Full fuselage tanks	**34,000**
Full fuselage and tip tanks	**38,000**
300 gallons remaining	**25,500**

NOTE.—No bombs are included in these weights.

If landing at a C.G. forward of 21 inches the threshold speed *must not be below 105 knots*. This can only happen if bombs are hung up and the fuel drill is not correctly followed.

74. **Crosswind landing**

A crosswind landing presents no special difficulty, and the "crab" technique is recommended. If the crosswind is gusting strongly the threshold speeds should be increased by the value of the crosswind component.

75. **Braking**

(a) After lowering the nosewheel on to the runway, the brakes may be applied continuously but should be used with care while the speed is high, to avoid locking the wheels. The pressure can be increased as the speed falls off but care will still be necessary to avoid locking the wheels, especially on a wet runway.

(b) Every effort should be made to avoid overheating the brakes, and braking should therefore be judicious according to the length of the runway. Landings involving heavy braking should not be made at intervals of less than ten minutes and if, while taxying after such landings, heavy differential use of the brakes is made, the time interval should be doubled.

76. **Instrument approach**

The following speeds, flap and approximate power settings, are recommended for use during instrument approaches with the undercarriage down. The figures apply, specifically, to an aircraft without wing tip tanks at about 32,000 lb. A.U.W. The effect of empty wing tip tanks on the r.p.m. required will be very small.

	R.P.M.	Flaps	Airspeed Knots
Downwind	6,200	UP	140
Base leg and final	6,200	UP	140
Glide path	5,800	UP	125
Three miles finals	5,800	DOWN	115

In icing conditions the undercarriage should be left up until about seven miles finals; the r.p.m. are then kept below 6,000 for the maximum length of time.

NOTE.—When the glide path is intercepted and flap is lowered, the aircraft tends to maintain height unless the airspeed is kept at 140 knots until the flaps are fully down.

77. Going round again

(a) A minimum of 150 gallons of fuel, which allows about five minutes flying, should be available for this eventuality.

(b) Open the throttles smoothly to 7,000 r.p.m. and check that symmetrical power is being obtained; raise the undercarriage and flaps. It is advisable to check that the tailplane actuator is operating before raising the flaps. The aircraft will accelerate quickly and any tendency to sink is easily held. There is a strong nose-down change of trim during the last half of the flap travel, and it should be anticipated by progressive application of nose-up trim as the flaps retract.

(c) Practice "roller" landings are not recommended, particularly with two-position ram engines (pre-Mod. Avon 175), because of the possibility of compressor stall and engine surge while opening up from the fully throttled position, especially in crosswind conditions. If in emergency it becomes necessary to go round again from the runway, the following precautions should be observed:—

(i) When opening the throttles particular care must be taken up to 4,500 r.p.m. and some difference in response from each engine should be anticipated.

(ii) Keep the nose-wheel on the runway until the engines have reached 7,000 r.p.m.

(iii) Check at 7,000 r.p.m. that symmetrical thrust is being obtained before opening the throttles further.

78. Checks after landing

Brake pressure	Minimum 2,000 lb./sq. in.
Generators	Charging
Flaps	Select UP
All heaters	OFF
Canopy demisters	Both OFF
Trims	Neutral
Master safety switches	OFF—Check with crew
Flaps	Check up
Unrequired V.H.F. set	OFF
Cabin air switches (Mod. 5)	Off
Cabin heat control	COLD (Pre-Mod. 5) HOT (Post-Mod. 5)
Fuel booster-pumps	As required
D.V. panel	Open
All radar	OFF

NOTE.—At night, all cockpit lighting OFF. Use taxy lights as required.

79. Stopping the engines

(a) Stop the engines by closing the H.P. cocks while the engines are at idling r.p.m. Leave on at least one L.P. cock for each engine until the engines stop.

(b) *Checks after stopping the engines*

Parking brake	On
Bomb doors	OPEN
H.P. cocks	OFF
Engine master start switches	OFF

L.P. cocks and pumps	OFF
V.H.F.	OFF
Flap pin	In
Rudder lock	In
Ejection seats	Safety pins in position
Brakes	Off — When chocks in position
Intercomm. and battery isolating switches	OFF
Oxygen	OFF

NOTE.—Whenever the aircraft is parked out in the open for any long period, i.e., overnight, the tail plane is to be left in the fully nose-down trim position. This will prevent condensation forming on the exposed part of the actuator jack, with the consequent risk of icing on a subsequent flight.

ASYMMETRIC FLYING

80. Single engine flying

(a) When closing down an engine in flight deliberately, No. 5 inverter should first be stopped and the generator switched off. The engine should then be stopped by closing the throttle and then shutting the H.P. cock; one L.P. cock should be kept on.

(b) The aircraft has a very good single-engine performance and the rudder trimmer is powerful enough to trim out all foot loads at normal cruising speeds. At 7,400 r.p.m. a single engine will maintain a speed of about 330 knots in level flight below 5,000 feet.

(c) *Use of electrics*

When flying on one engine (or if a generator fails) some electric load must be shed so as to conserve the battery. It will normally be sufficient merely to stop No. 5 inverter. If it is desired to use the Gee or Rebecca, No. 4 inverter may be started after switching off all other non-essential electric loads. When using only one generator the tail plane actuator should be used as little as possible.

81. Relighting an engine in flight

(a) Engine relighting is practicable at heights up to 20,000 feet and at speeds up to 200 knots. Relighting becomes progressively more certain with reduction of altitude and airspeed; therefore relighting above 15,000 feet is not recommended. Successful relighting is more certain if high energy ignition (engine Mod. 174) is fitted.

(b) Ensure that the H.P. cock is closed, then:—

(i) Reduce speed to 200 knots or less until the windmilling r.p.m. are 1,000-1,200.

(ii) Ensure that at least one L.P. cock and pump switch is on and that the fuel pressure warning light is out.

(iii) Check that the master starting and ignition switches are on.

(iv) Close the throttle fully.

(v) Keeping the H.P. cock closed, press the relight pushbutton.

(vi) After 3 seconds move the H.P. cock to the fully open position.

(vii) When the r.p.m. start rising, release the relight button.

(viii) When the r.p.m. have stabilized at the correct idling r.p.m. for the particular altitude, the engine may be opened up slowly to the desired figure.

(ix) If the engine r.p.m. fail to build up within 30 seconds of opening the H.P. cock, the relight button should be released and the H.P. cock closed immediately.

(x) A further attempt may be made after descending to a lower altitude; an interval of about two minutes should be allowed to let the engine dry out.

82. **Single engine landing**

Maintain a speed of at least 150 knots while positioning the aircraft with the flaps up. Lower the undercarriage in the normal position on the circuit. Maintain speed A given on the approach speed chart until the final decision to land is made at 600 feet A.G.L. or above, then lower the flaps and reduce speed to cross the airfield boundary at the speed recommended for a normal landing.

83. **Going round again on one engine**

(a) This can be done comfortably provided that the speed is at least that given in line A on the approach speed chart.

(b) Raise the undercarriage and carefully increase the power to 7,000 r.p.m. on the live engine, taking care to maintain directional control and allowing the speed to build up to 140 knots. The aircraft should be climbed away at this speed. Unless power is increased carefully, control will be lost.

PART IV
EMERGENCY HANDLING

84. **Engine failure on take-off**

(a) The safety speed is 140 knots.

(b) At weights below about 33,000 lb. if corrective action is taken quickly, control may be maintained at speeds as low as 125 knots and the aircraft will accelerate and climb away comfortably from this speed. It may be necessary to throttle back the live engine sufficiently to maintain directional control.

(c) Raise the undercarriage, trim as necessary and build up speed to 150 knots.

(d) Close the H.P. cock and throttle of the failed engine.

(e) Switch off the L.P. cocks and pumps of the failed engine.

85. **Engine failure in flight**

In the event of engine failure in flight the immediate action should be to close the throttle and H.P. cock. If failure is due to an obvious mechanical defect put off the relevant L.P. pumps and cocks and stop No. 5 inverter. Do not attempt to relight. If failure is due to a flame-out put off the L.P. pumps but leave one L.P. cock open. Shed all non-essential electrical load, and in any case No. 5 inverter, until the engine has been relit.