PART III

MANAGEMENT OF SYSTEMS AND EQUIPMENT

A.L.1 Page 58 Para. 90 (a)

90. Management of fuel system

(a) *Use of fuel system*

The fuel drill on page 59 is to be used for all sorties. If a full fuel load is not required, the integrals must be filled for every sortie and used in accordance with the fuel drill, any adjustments to the fuel load being made by varying the contents of the fuselage and wing tip tanks. The use of the integral tanks only for start-up and taxy is to minimise fuel venting from these tanks.

(b) *Use of L.P. cocks, transfer cocks and L.P. pumps—both drills*

(i) Before starting the engines check the operation of the L.P. cocks aurally leaving them ON and set the transfer cocks to NORMAL. Then check the operation of the L.P. pumps aurally and against the appropriate fuel warning light, leaving all but the integral tank pumps OFF for start-up.

(ii) Leave the L.P. cocks on throughout the flight, and control the use of fuel by the transfer cocks and L.P. pumps in accordance with ~~pumps in accordance with one of the following tables as appropriate~~. the fuel drill on Page 59 A1

NOTE.—When an overload tank is in use, check its cocks and pumps aurally before start-up and leave the combined cock and pump switches OFF until the fuel is to be transferred to No. 3 tank. The use of overload fuel is covered in (f) below.

~~**LOW LEVEL FUEL DRILL—BELOW 10,000 FT.**~~ A1

CONDITION	TANK POSITION					
	Integrals		No. 3	No. 2	No. 1	Wing tips
	Cocks	Pumps	Pumps	Pumps	Pumps	
1. Start-up and taxy	ON and NORMAL	ON	OFF	OFF	OFF	Full
2. Take-off and climb	ON and NORMAL	ON	ON	ON	ON	Full
3. When No. 1 tank reads 3,500 lb., No. 2 tank reads 2,000 lb. and the integral tanks show a drop (switch off relevant pumps when figures reach those quoted)	ON and NORMAL	OFF	ON	OFF	OFF	Feeding
4. When No. 3 tank reads 3,500 lb. keep No. 1 and 3 tank contents equal	ON and NORMAL	OFF	As reqd.	OFF	As reqd.	Empty
5. When No. 1 and No. 3 tanks read 1,000 lb.	ON and NORMAL	ON*	OFF	OFF	OFF	Empty
6. When integrals read 500 lb.	ON and TRANSFER	ON	ON	OFF	OFF	Empty
7. When integrals are empty keep No. 1 and No. 3 tank contents equal	ON and NORMAL	OFF	As reqd.	OFF	As reqd.	Empty
8. When No. 1 and No. 3 tanks read 500 lb.	ON and NORMAL	OFF	ON	ON	ON	Empty

*NOTE. ~~When flying in temperatures below freezing, prove the feed from one integral tank before selecting the other~~. A1

~~HIGH LEVEL FUEL DRILL ABOVE 10,000 FT.~~

CONDITION	TANK POSITION					
	Integrals		No. 3	No. 2	No. 1	Wing tips
	Cocks	Pumps	Pumps	Pumps	Pumps	
1. Start-up and taxy	ON and NORMAL	ON	OFF	OFF	OFF	Full
2. Take-off and climb	ON and NORMAL	ON	ON	ON	ON	Full
3. When No. 1 tank reads 3,500 lb., No. 2 tank reads 2,000 lb., and the integral tanks show a drop (switch off relevant pumps when figures reach those quoted)	ON and NORMAL	OFF	ON	OFF	OFF	Feeding
4. When No. 3 tank reads 3,500 lb.*	ON and NORMAL	ON	OFF	OFF	OFF	Empty
5. When integrals read 500 lb.	ON and NORMAL	OFF	ON	OFF	OFF	Empty
6. When No. 3 tank reads 3,000 lb.	ON and TRANSFER	ON	ON	OFF	OFF	Empty
7. When integrals are empty	ON and NORMAL	OFF	ON	OFF	ON	Empty
8. Keep No. 1 and No. 3 tank contents equal	ON and NORMAL	OFF	As reqd.	OFF	As reqd.	Empty
9. When No. 1 and No. 3 tanks read 500 lb.	ON and NORMAL	OFF	ON	ON	ON	Empty

*NOTE.—If while flying on integrals only, the contents in No. 3 tank rise to more than the figure given at 4 above, switch No. 3 tank pumps ON and the integral tank pumps OFF until the figure is regained.

(c) *General*

(i) Deviations from the correct fuel drill can readily result in aft C.G. positions which may be excessive in the interdictor role. 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 3,500 lb. before transfer has been completed. When the level in No. 3 tank falls steadily below 3,500 lb., 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.

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

(iv) When No. 1 and No. 3 tank 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 500 and 600 lb. respectively. Normally this surge will not be dangerous, as with the levels in No. 1 and No. 3 tanks so low, No. 2 tank will be on as well, but the fact should be remembered if it is necessary to vary the fuel drill. The recuperators will maintain fuel pressure for short periods.

(d) *Use of integral tank transfer cocks*

(i) The integral tank transfer cocks must be left at NORMAL (shut), except when transferring fuel to No. 3 tank. Otherwise, with the cocks at TRANSFER, the recuperators are ineffective (see para. 3 (b)) and at the same time, the fuel line between the tip tanks and the integral tanks is "open". With the integral and No. 3 tanks full, this could lead to fuel feeding from the tip tanks into the integral tanks and out through the integral tank vents.

(ii) If an engine fails and cannot be re-lit, the integral fuel on that side can be used for the other engine by selecting TRANSFER and then using the integral fuel through No. 3 tank.

(iii) When transferring fuel, as the integral tank L.P. cock will be closed (see para. 5 (a)) another booster pump on that side must be on to feed the engine.

(e) *Reserve fuel*

The last 1,250 lb. in No. 2 tank is the minimum safe allowance for a circuit, an overshoot and a landing. The surge in No. 2 tank does not become dangerous until the level has fallen to 400 lb. but even below this level all fuel can be used provided that all manœuvres or attitudes which might lead to fuel surge are avoided. In this condition do not rely on the recuperators to compensate for fuel surge caused by mishandling the aircraft.

(f) *Use of overload fuel*

When the bomb bay overload tank is full it is important to use this fuel as early as possible. During the cruise after the wing tip tanks are empty, use No. 3 tank until it is down to 2,500 lb. and then switch on the overload tank pumps and open the cocks. When the No. 3 tank contents gauge reads 3,500 lb. switch off the overload tank pumps and cocks. Repeat this procedure until the overload tank is empty. As there is no contents gauge for the overload tank the only indication that it is empty will be when the No. 3 tank contents gauge shows a steady decrease in contents when the overload tank pumps are on. Therefore, when transferring fuel make a frequent check of No. 3 tank contents gauge, and when this shows a steady drop switch off the overload tank pumps and continue the fuel drill in the normal manner.

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(g) *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, engine r.p.m., type, temperature and condition of the fuel, the head of fuel in the tanks and it may also vary between aircraft.

(iii) The H.P. pumps are designed to operate with a positive inlet pressure; booster-pump failure will cause the H.P. pumps to obtain fuel by gravity feed and suction only, which may result in a reduction in fuel delivery to the engine. When operating in these conditions, a change in r.p.m. and loss of thrust may be experienced due to swirl vane movement. If the fuel pressure at the engine inlet is sufficiently low, cavitation of the engine pump will occur causing further loss of thrust and reduction in r.p.m. In an extreme case, engine surge will be experienced as low as 15,000 feet and flame extinction could occur at altitudes 5,000 to 10,000 feet above this depending on the conditions listed at (ii) above.

(iv) If a booster pump fails, throttle the affected engine to " idling " immediately, wait for the r.p.m. and j.p.t. to stabilise and then switch on another booster pump on the same side. Accelerate the engine carefully; satisfactory operation and freedom from compressor stall will be shown by the r.p.m. and j.p.t. rising together. If, however, the j.p.t. and r.p.m. do not stabilise normally, the engine should be shut down and relit as described in para. 120. Fuel from the tank with the failed pump, excepting the integrals, may be used for the other engine.

(v) If the distribution of the fuel is critical, descend to below 20,000 feet and feed the engine by gravity and suction from the tank with the failed pump. The L.P. cocks in the remaining tanks serving the affected engine will have to be closed to prevent gravity and suction feed from these tanks. Cruising r.p.m. should be obtained up to 20,000 feet, but careful engine acceleration will be required to ensure satisfactory operation. When recuperators are fitted, the one serving the affected engine will discharge and will not recharge under gravity feed.

NOTE.—If suction feed has been necessary, or has occurred inadvertently, the fact must be reported so that the H.P. pump can be examined.

(h) *Use of different fuels*

If Avon Mod. 687 is embodied, AVTAG, AVTUR or J.P.4 may be used without adjusting the engines. Pre-Avon Mod. 687, the same fuels may be used, but the engines will have to be adjusted accordingly (see also NOTE 2 to para. 84).

91. Management of the electrical system

(a) *Battery control*

(i) *Aircraft battery*

(i) From the time that the battery isolating switch is switched ON until the generator(s) 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 bettery can cope with these demands. An external battery is only required when it is anticipated that the time 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 provided that the aircraft battery is not below 22 volts. on load

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(ii) *External battery*

Whenever an external battery is plugged in or removed, both the battery switch and the aircraft battery isolating switch must be off, and the aircraft battery must remain isolated when an external battery is in use. The battery is always to be plugged in or removed by moving the 3-pin adaptor complete.

(b) *Generator control*

(i) Before starting the engines, ensure that the generator field circuit-breakers are made and switch on the generators.

(ii) Make periodic checks on the ground and in flight to ensure that the generators are functioning correctly. If a generator fails switch it off. Then check and, if necessary, reset the appropriate field circuit-breaker and, after a short pause, switch the generator on again. If the warning light remains on switch off the generator and leave it off.

(iii) When a generator has failed or when flying on one engine, No. 5 inverter must be switched off and electrical consumption reduced to a minimum to prevent overloading the remaining generator.

(c) *Inverter control*

(i) During the starting procedure, when the port master starting switch is put on, check that the No. 3 inverter starts up. It will be heard to cut in, No. 2 inverter failure indicator will show white and the output of No. 3 inverter will be shown on the phase-failure indicator (if fitted). When the starboard master starting switch is put on, check that No. 2 inverter failure indicator changes to black to indicate that No. 2 inverter has cut in.

(ii) Run both No. 4 and No. 5 inverters on every flight, whether the radar equipment is used or not, to eliminate corrosion brought about by lack of use. However, before switching on No. 5 inverter, the voltmeter should be reading ~~27.5~~ 28 volts.

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(iii) In order to protect the radar equipment from voltage and frequency surges, allow at least 30 seconds for the radar inverters and their associated regulating equipment to stabilise before switching on the individual services supply switches. On no account must these inverters be started with the individual supply switches on.

(iv) If any of the inverters fail, attempt to regain the supply by re-setting the appropriate circuit-breaker if this has tripped. However, before doing this with either of the radar inverters, ensure that the individual supply switches are off. It should also be remembered that if No. 3 inverter has failed, there will be no supply to the radar cooling motors, or to No. 5 inverter regulator cooling motor.

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92. Management of the air-conditioning pressurising and demisting systems

(a) *Air-conditioning and pressurising systems*

(i) Before starting the engines, ensure that the engine air switches are OFF and test the mixing valve over its full range. After starting the engines, switch ON the engine air switches and set the mixing valve as required but see (ii) below.

(ii) There is no restriction on the ground in the use of fully HOT but if any other selection is required, this is restricted to a maximum of 10 minutes and the engines must not exceed 5,000 r.p.m. continuously. If or when the 10 minute limit is reached, either select the mixing valve to fully HOT or switch OFF the engine air switches until the aircraft is airborne. In the air there is no restriction in the use of the mixing valve.

(iii) After landing, set the mixing valve to HOT, switch off the the engine air switches and open the D.V. panel to relieve any residual cabin pressure before the entrance door is opened.

(b) *Demisting systems*

(i) Check the canopy drying cartridges on entering the cockpit and the operation of the canopy sandwich demister motor during the pre-start checks.

(ii) Close the D.V. panel and switch ON its heater before take-off; in flight keep the panel closed at heights where pressurising is obtained. After landing switch off the

heater and open the panel to relieve any residual cabin pressure before the entrance door is opened.

(iii) The canopy internal demister must not be used on the climb; switch it on at the start of a descent and switch it off again immediately demisting is complete.

93. Engine handling

(a) Operate the throttles smoothly at all times and avoid slam accelerations.

(b) At all times during flight, avoid using engine r.p.m. lower than 4,500. Acceleration to full power from 4,500 r.p.m. can be obtained within 5 seconds; accelerations from below this figure take considerably longer and care must be taken when opening up again otherwise it is possible to stall the compressor, particularly when the speed is low and the aircraft is sinking.

(c) While the A.C.U. is designed to operate at all altitudes its action and, therefore, engine acceleration deteriorates progressively with altitude and care is required when increasing power at high altitudes, especially for the early stages of throttle opening at low I.A.S. Too rapid throttle opening may cause surge which may lead to severe overheating or flame out. If surge occurs the throttle(s) must be closed and speed increased before another attempt is made to open up the the engine(s) using a slower throttle movement.

(d) When using maximum r.p.m. at low forward speed in extremely cold air at high altitudes, there is a risk of surge followed by flame-out. This risk can be obviated by reducing r.p.m. according to variations in *indicated* air temperature altitude as follows:—

Altitude correction factor
Reduce r.p.m. from 7.950 by 15 r.p.m. for each 1,000 feet above 30,000 feet.

Indicated air temperature correction factor
Reduce r.p.m. from 7.950 by 20 r.p.m. for each 1° C. below —60° C. I.A.T.

NOTE.—If the aircraft is flying above 30,000 feet but the indicated air temperature is higher (warmer) than the above limit, the temperature correction factor may be used in the same ratio and subtracted from the altitude correction factor, thus maintaining optimum conditions but not exceeding 7,950 r.p.m.

Example

Altitude, 40,000 feet ..	Reduce r.p.m. from 7,950 to 7,800.
Indicated air temperature, — 55° C.	Increase r.p.m. by 100, *i.e* to 7,900.

94. Management of the engine anti-icing system

(a) *General*

With anti-icing in operation all throttle movements must be made smoothly and at least 10 seconds allowed to elapse after switching OFF anti-icing before making any throttle adjustments. There is a loss of thrust and economy and usually a rise of approximately 20° C. in the j.p.t. At full throttle, *e.g.*, on take-off, this rise in j.p.t. may necessitate a reduction in r.p.m. to maintain j.p.t.'s within the limitations. Ground accelerations will be slower than normal, and there is slightly less margin from surge.

(b) *Start-up, taxy and take-off*

If visible moisture reduces visibility to 1,000 yards or less and the ambient air temperature is below + 5° C., switch ON anti-icing *after* starting the engines. Taxy and, if the runway length is sufficient, take off with anti-icing on. With anti-icing on the take-off distance may be increased (refer to O.D.M.). If this precludes the use of anti-icing on take-off, run the engines with anti-icing ON at 7,000 r.p.m. for one minute immediately before take-off and switch OFF anti-icing before starting the take-off run. As soon as practicable after take-off, switch ON anti-icing and leave it on until clear of icing conditions.

(c) *In flight*

(i) The protection given by the anti-icing system is not adequate for continuous flight in icing conditions. Should icing conditions be met, switch ON anti-icing immediately and clear the icing region as quickly as possible. Wait 2 minutes after clearing the icing conditions before switching anti-icing OFF.

(ii) Whenever anti-icing is switched ON, r.p.m. must be maintained at 7,200 r.p.m. or above, or in the lower range, between 5,800 and 6,600. However, for maximum protection in the lower range 6,100 r.p.m. is the best setting. If conditions necessitate changing the r.p.m. from the lower to the higher range or vice versa, the throttles should be moved smoothly through the interim range. On no account may r.p.m. be reduced below 5,800 r.p.m. until committed to land.

(iii) For descent and landing involving the use of anti-icing down to airfield level, the times of undercarriage and flap operation should be modified as necessary so that the above engine r.p.m. settings are maintained.

(iv) If the recommended r.p.m. figures are not maintained and icing is moderate to severe, flame-out may result. If this occurs, an immediate relight on one engine (see para. 120 (a)) may be attempted; if this fails, and conditions permit, the normal relighting drill should be carried out. It should be noted that if icing conditions persist down to ground level, it may not be possible to obtain a relight due to ice formation in the engine.

95. **Starter loading**

(a) After checking that the MASTER STARTING switches are off, unlock and open the starter fairings. Each breech cap is then 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 may any work be carried out on the starter while the engine is turning.

NOTE.—Until modified starter fairings are available, do not fly the aircraft with live cartridges fitted if engine anti-icing is to be used.

PART IV

HANDLING

STARTING, TAXYING AND TAKE-OFF

96. **Safety check**

Before commencing the external checks carry out the following safety check.

All ejection seats	Safety pins in position
Master jettison switch	OFF
Canopy and hatch jettison switches	OFF
Battery isolating switch	OFF
Undercarriage safety switch	Down
Wing clearing safety switch (B.(I)6)	Off
Armament safety plug (B.(I)6)	Removed

97. **External checks**

Systematically check the outside of the aircraft for signs of damage and for the security of panels, filler caps, doors and hatches. The engine intakes must be free from obstruction, the starter fairings secure, the fuel drain pipes protruding and undamaged and the jet pipes free from distortion. The pressure head cover and static vent plugs must be removed. The following specific checks must also be made.

Hydraulic accumulators	Min. pressure 1,350 lb./sq. in.
Hydraulic ground/flight cock	Wired in FLIGHT position