

PART 1
CHAPTER 2—FUEL SYSTEM
Contents

	Para
CONTROLS AND INDICATORS	1
DESCRIPTION OF THE SYSTEM	
General	2
Fuel Tanks	3
Fuel Tank Capacities	9
Fuel Transfer	10
Fueldraulic Booster Pump	16
Fuel Pressure Monitoring	19
DC Transfer Pumps	20
DC Transfer Pump Monitoring	21
Wing-to-Wing Transfer	22
Fuel Contents Gauges	25
Air-to-Air Refuelling (AAR) System	28
Ground Refuelling	32
Ventral Tank Jettison (F Mk 3 and T Mk 5 Only)	37
Ventral Tank Emergency Transfer (F Mk 6 Only)	38
Overwing Fuel Dumping (F Mk 6)	42
MANAGEMENT OF THE SYSTEM	
Before Engine Start	44
Starting and After Start Checks	45
In Flight	48
After Flight	51
MALFUNCTIONS OF THE SYSTEM	
Fuel Pressure Warnings	52
Wing-to-Wing Transfer Cock Failure	57
Fuel Contents Gauge Failure	60
Ventral/Flap Transfer Failure (F Mk 3 and T Mk 5)	62
Ventral Transfer Failure (F Mk 6)	63
Mk 44 Valve Failure (F Mk 6)	66
Fuel Venting	68
Illustrations	Fig
Controls and Indicators—F Mk 3 and F Mk 6	1
Controls and Indicators—T Mk 5	2
Fuel System	3

CONTROLS AND INDICATORS

1. Details of the controls and indicators of the fuel system for the F Mk 3, T Mk 5 and F Mk 6 are listed

in Tables 1, 2 and 3 respectively. Fig 1 illustrates the cockpit positions of the F Mk 3 and F Mk 6 items, and Fig 2 the T Mk 5 items.

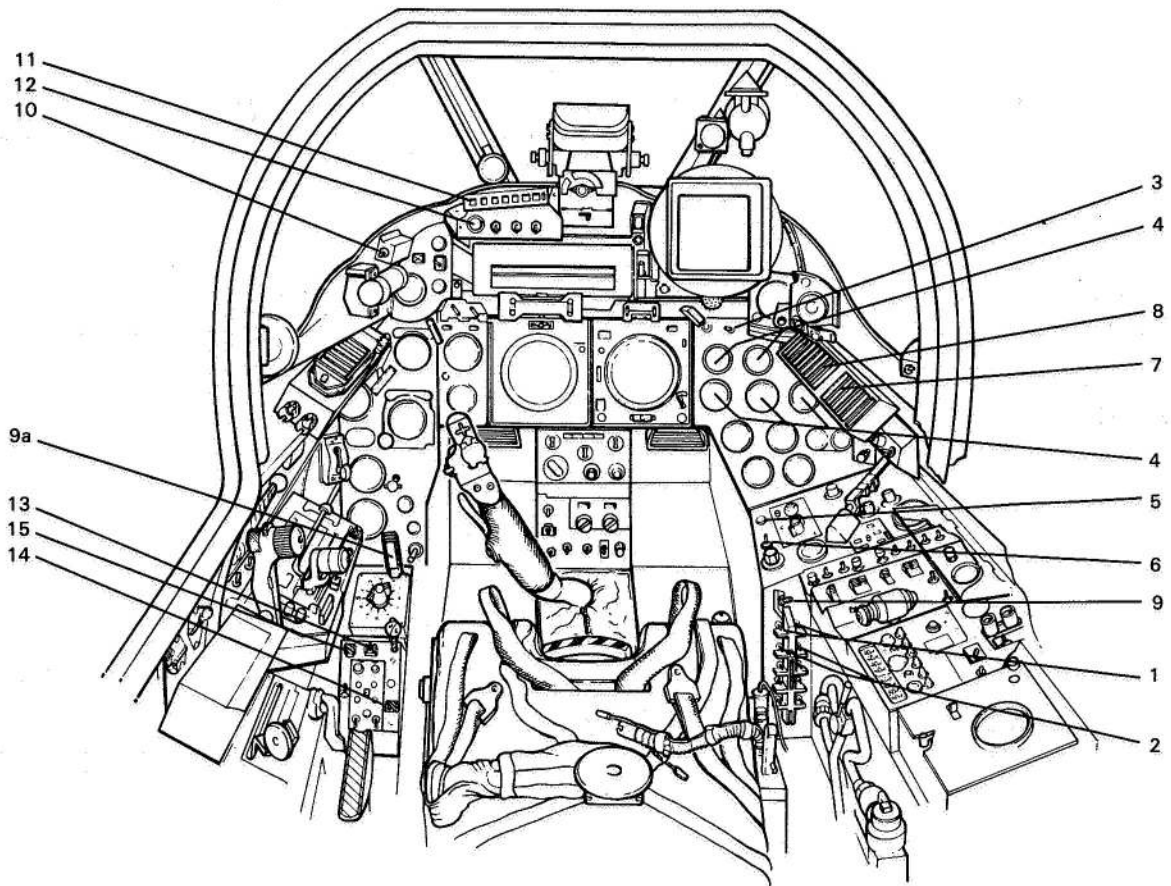
Table 1 — Fuel System Controls and Indicators — F Mk 3

Item No	Item	Marking	Remarks
1	LP fuel cocks (2)	FUEL COCK No 1, FUEL COCK No 2	Lock toggle switches in the on (up) position. Ganged switches
2	DC pumps switches (2)	DC PUMPS PORT, DC PUMPS STBD	Up for on. Ganged switches
3	Wing-to-wing transfer switch	TRANSFER — P/off/S	Three-position switch
4	Fuel contents gauges (3)	MAIN (2), VENTRAL	Capacitor gauges
5	Flap tanks contents button	FUEL CONTENTS T/E	—
6	Gauge test switch	GAUGE TEST — FULL/EMPTY	Spring-loaded to centre (off) position
7	Fuel pressure warnings	FUEL 1, FUEL 2	On when fuel pressure less than 5.75 ± 0.75 PSI
8	Fuel pressure warnings	PUMPS P, PUMPS S	Appropriate caption on when: 1. Both DC pumps in one wing failed or uncovered 2. One pump uncovered and other failed
9	Vent valve heating	PITOT HEATER — NORMAL/ OFF/STANDBY	No vent valve heating in OFF or STANDBY
9a	Ventral tank jettison handle	—	Black and yellow striped
10	AAR switch	FL REFUEL/NORMAL	—
11	AAR panel	Captions: WG PRT, FLP PRT, OW PRT, VEN, OW STB, FLP STB, WG STB	OW PRT and OW STB captions inoperative
12	Probe lighting switch	PROBE LIGHT — ON/OFF	Inoperative unless NAV LTS set to ALL ON or TIPS
13	Ventral tank emergency transfer switch	VENTRAL TANK — EMERGENCY TRANSFER	Inoperative
15	Overwing tank jettison switch	OVERWING TANK — JETN/OFF	Inoperative

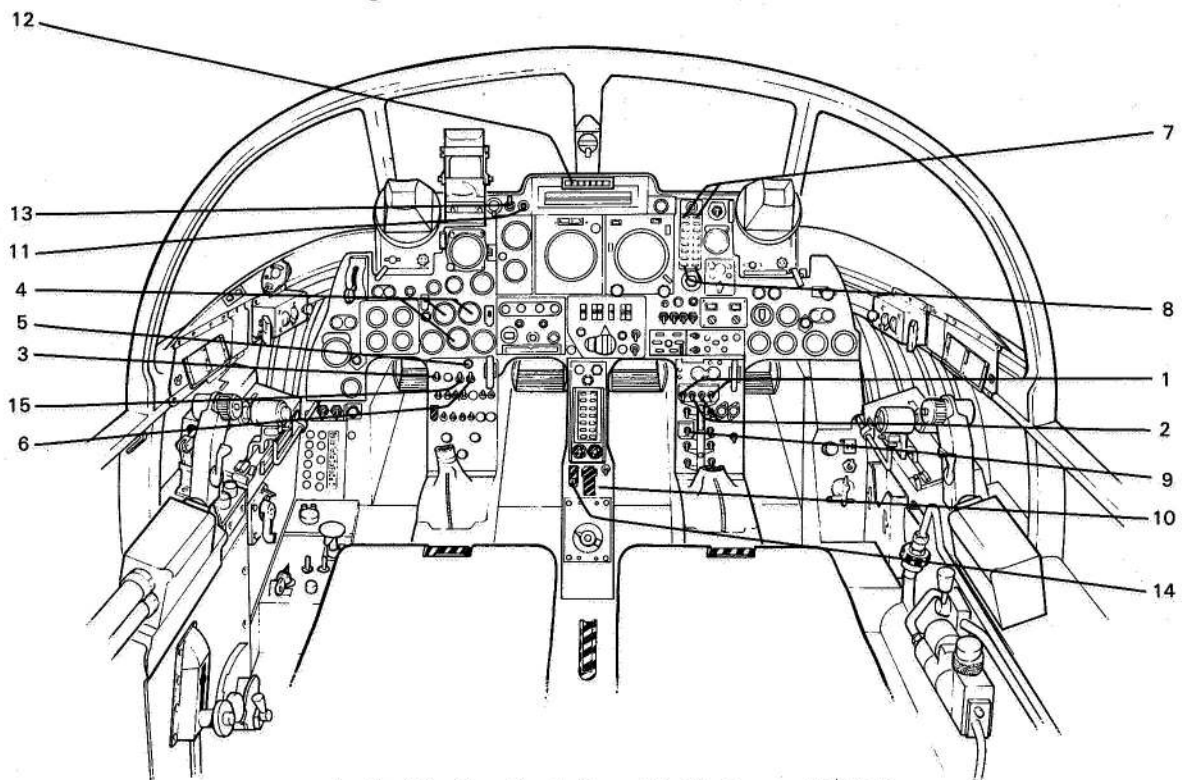
Table 2 — Fuel System Controls and Indicators — T Mk 5

Item No	Item	Marking	Remarks
1	LP fuel cocks (2)	PORT No 1 ENG COCK, No 2 ENG STBD COCK — OPEN	Up for OPEN. Ganged switches
2	DC pumps switches (2)	FUEL PUMPS — PORT No 1 ENG, No 2 ENG STBD — ON	Up for ON. Ganged switches
3	Wing-to-wing transfer switch	FUEL TRANSFER — PORT/off/STBD	Three-position switch
4	Fuel contents gauges (3)	MAIN (x2), VENTRAL	Capacitor gauges
5	Flap tanks contents button	FUEL CONTENTS T/E TANK	—
6	Gauge test switch	FUEL TEST — FULL/EMPTY	Spring-loaded to centre (off) position
7	Fuel pressure warnings	FUEL 1, FUEL 2	On when fuel pressure less than 5.75 ± 0.75 PSI
8	Fuel pressure warnings	PUMPS P, PUMPS S	Appropriate caption on when: 1. Both DC pumps in one wing failed or uncovered 2. One pump uncovered and other failed

continued



1-2 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1-2 Fig 2 — Controls and Indicators — T Mk 5

Table 2 — Fuel System Controls and Indicators — T Mk 5 — *continued*

<i>Item No</i>	<i>Item</i>	<i>Marking</i>	<i>Remarks</i>
9	Vent valve heating	PITOT — ON/OFF/STANDBY	No vent valve heating in OFF or STANDBY
10	Ventral tank jettison handle	DROP TANK JETTISON — PULL HANDLE	Black and yellow striped
11	AAR switch	FLIGHT REFUEL — OFF/ON	—
12	AAR panel	Captions: WG PRT, FLP PRT, OW PRT, VEN, OW STB, FLP STB, WG STB	OW PRT and OW STB captions inoperative
13	Probe lighting switch	PROBE LIGHT — ON/OFF	Inoperative unless NAV LIGHT switch to STEADY or HI FLASH
14	Overwing tank jettison switch	O/WING TANK JETTISON	Inoperative
15	Ventral tank emergency transfer switch	VENTL TRANS — NORMAL/EMERGY	Inoperative

Table 3 — Fuel System Controls and Indicators — F Mk 6

<i>Item No</i>	<i>Item</i>	<i>Marking</i>	<i>Remarks</i>
1	LP fuel cocks (2)	FUEL COCK No 1, FUEL COCK No 2	Lock toggle switches in up (on) position. Ganged switches
2	DC pumps switches (2)	DC PUMPS PORT, DC PUMPS STBD	Up for on. Ganged switches
3	Wing-to-wing transfer switch	TRANSFER — P/off/S	Three-position switch
4	Fuel contents gauges (5)	MAIN (2), O/WING (2), VENTRAL	Capacitor gauges
5	Flap tanks contents button	FUEL CONTENTS T/E	—
6	Gauge test switch	GAUGE TEST — FULL/EMPTY	Spring-loaded to centre (off) position
7	Fuel pressure warnings	FUEL 1, FUEL 2	On when fuel pressure less than 5.75 ± 0.75 PSI
8	Fuel pressure warnings	PUMPS P, PUMPS S	On when: <ol style="list-style-type: none"> Both DC pumps in one wing failed or uncovered One pump uncovered and other failed
9	Vent valve heating	PITOT HEATER — NORMAL/off/STANDBY	No vent valve heating in OFF or STANDBY
10	AAR switch	FL REFUEL/NORMAL	—
11	AAR panel	Captions: WG PRT, FLP PRT, OW PRT, VEN, OW STB, FLP STB, WG STB	—
12	Probe lighting switch	PROBE LIGHT — ON	Inoperative unless NAV LTS switch set to ALL ON or TIPS
13	Ventral tank emergency transfer switch	NORMAL/EMERG TRANSFER/OFF	Guarded from NORMAL to EMERG TRANSFER and from EMERG TRANSFER to OFF
14	Overwing fuel dump switch	FUEL DUMP/OFF	Guarded switch
15	Overwing tank jettison button	O/WING TANK JETTISON	Operates only after FUEL DUMP is selected

DESCRIPTION OF THE SYSTEM

General

2. Internal fuel is carried in integral tanks in the wings and flaps. External fuel is carried in a ventral tank and, in the case of the F Mk 6, in overwing tanks if fitted. The left and right fuel systems are independent of each other, the left system supplying No 1 engine and the right system No 2 engine; the ventral tank feeds equally to each system and there is provision to balance the two systems through a wing-to-wing transfer system if fuel asymmetry occurs. Fuel is transferred to the collector box in the outboard section of each wing by a combination of gravity feed, DC pump pressure, air pressure and, in the case of the F Mk 6 ventral tank, by air pressure and AC pump pressure. Fuel is delivered to the engine and reheat fuel systems from the collector box by a fueldraulic pump.

Fuel Tanks

3. *Wing and Leading-Edge Tanks.* Each wing tank comprises a leading-edge tank and a two-compartment main tank. The outboard compartment of each main tank serves as a collector box from which LP fuel is delivered to the engine HP pumps and reheat pumps via fueldraulic pumps and the LP cocks.

4. *Flap Tanks.* Flap tank fuel is transferred to the main tanks by air pressure at 7 PSI.

5. *Ventral Tanks — F Mk 3 and T Mk 5.* In the F Mk 3 and T Mk 5 the jettisonable ventral tank supplies fuel to both main tanks under air pressure at 13 PSI.

6. *Ventral Tank — F Mk 6.* In the F Mk 6 a larger, non-jettisonable ventral tank is fitted, the fuel being transferred to the wing tanks by an AC pump supplemented by air pressure. The AC fuel pump takes its power from the 200-volt AC busbar and is therefore inoperative after AC failure. The tank has three compartments: a forward hatch tank, a centre tank and a rear tank. The hatch tank is removable and interchangeable with a fuel/gun pack containing two Aden guns, ammunition and fuel. The centre tank carries the fuel and air connections to the fuselage and contains the AC pump plus the refuelling and fuel transfer system.

7. *Overwing Tanks — F Mk 6.* The F Mk 6 can be fitted with two overwing tanks, the fuel being transferred to the main tanks under air pressure plus gravity. The fuel may be dumped from the overwing tanks providing air pressure is available; without air pressure the dumping rate is very slow.

8. *Fuel Tank Venting.* All tanks are vented outward and inward, outward venting being prevented during

negative-g flight. All vent valves are heated by a 28-volt AC supply, the heaters being controlled by the pitot heater switch. With the switch in the NORMAL position the vent valves are heated; in the OFF or STANDBY positions, vent valve heating is not available. To avoid fuel asymmetry an interconnecting pipe between the left and right wing tanks ensures that the air pressure in both tanks remains equal if a wing tank vent valve fails.

Fuel Tank Capacities

9. The usable fuel tank capacities for the F Mk 3 and T Mk 5 are shown in Table 4, and for the F Mk 6 in Table 5.

Table 4 — Fuel Tank Capacities, F Mk 3 and T Mk 5

Tank	Capacity—Gallons	Capacity—Pounds	
		AVTUR 8.0 lb/gall	AVTAG 7.7 lb/gall
Main and leading edge	2 x 320	2 x 2560	2 x 2464
Flap	2 x 33	2 x 264	2 x 254
Ventral	1 x 250	1 x 2000	1 x 1925
Total fuel	956*	7648	7361

*Approximately 7 gallons/side extra gauged fuel available when mod 2459 is embodied.

Table 5 — Fuel Tank Capacities, F Mk 6

Tank	Capacity—Gallons	Capacity—Pounds	
		AVTUR 8.0 lb/gall	AVTAG 7.7 lb/gall
Main and leading edge	2 x 255 325	2 x 2600	2 x 2503
Flap	2 x 33	2 x 264	2 x 254
Ventral	1 x 610*	1 x 4880	1 x 4697
Total fuel	1326	10,608	10,210
Overwing	2 x 260	2 x 2080	2 x 2002

*When guns are fitted, ventral tank capacity is reduced to 535 gallons.

Fuel Transfer

10. A diagram of the fuel system is shown at Fig 3. With AC and DC power, and air pressure available, fuel transfer to the main tanks and collector boxes is automatic. As the fuel level drops by 120 to 160 lbs, Mk 44 valves in the main tanks open to allow fuel from the ventral and flaps tanks to flow into the main tanks; they close to stop fuel transfer to the main tanks if the main tanks are full. The Mk 44 valves incorporate non-return valves to prevent reverse flow.

536
8
10

11. *Overwing Tank Transfer (F Mk 6 Only)*. In the F Mk 6, when overwing tanks are fitted, the fuel feeds under air pressure to the main tanks when the Mk 44 valves are open. The overwing tanks are divided into compartments, the feed from the tanks being arranged to ensure that CG limits are not exceeded. As each tank becomes empty, a low-level float switch closes a refuel/shut-off cock in the tank; the AC pump in the ventral tank starts when both low-level float switches have closed.

12. *Ventral Tank Transfer (F Mk 6 Only)*. If overwing tanks are fitted, both the overwing tank low level float switches must operate before ventral tank fuel can be transferred. If overwing tanks are not fitted, the Mk 44 valves control ventral tank transfer. In either case, ventral fuel transfers to both main tanks under AC pump and air pressure. The rear tank of the ventral empties first, followed by the hatch and centre tanks together. When the ventral tank is empty, a low level float switch turns off the AC pump, closes the Mk 47 transfer valve in the centre tank and opens the flaps tanks' Mk 27 valves.

13. *Ventral Tank Transfer (F Mk 3 and T Mk 5)*. In the F Mk 3 and T Mk 5, the ventral tank fuel transfers under air pressure once the Mk 44 valve opens. When the ventral tank is empty, a Mk 7 fuel/no air valve closes and electrically opens Mk 27 valves in the flaps tanks, allowing flap fuel to feed.

14. *Flaps Tanks Transfer (All Marks)*. When the ventral tank is empty the Mk 27 valves open to allow flap fuel to transfer to the main tanks under air pressure. Fuel transfer rate from the flap tanks is slow, and with the flaps lowered up to 200 lb of fuel per tank may be trapped and unusable until the flaps are raised.

15. *Wing Tanks Feed (All Marks)*. Fuel from the inboard compartment of the main tanks feeds by gravity into the collector tanks (outboard compartments). In addition, two DC transfer pumps in each wing feed fuel from the inboard compartments and the leading-edge tanks respectively to the collector tanks to sustain a good fuel level for the fueldraulic pumps.

Fueldraulic Booster Pump

16. The fueldraulic booster pump system is designed to ensure a sufficient supply of vapour-free fuel to the engines through the full range of engine settings, at all altitudes and attitudes. A fueldraulic pump is fitted in each collector tank to supply fuel to the associated engine and reheat systems.

17. Each independent system has an engine-driven hydraulic supply pump which uses fuel drawn from the engine low pressure fuel system as a medium. The

supply pump is of a fixed cam-plate type; consequently its output varies in direct proportion to engine speed. The output of the supply pump drives the fuel booster pump, also with a fixed cam-plate, so that booster pump output is also proportional to engine speed.

18. The booster pumps are double-ended and are fitted in such a manner that one end is always immersed in fuel. Thus, in negative-g conditions, fuel pressure is maintained at a safe value. However, note that for air turbine lubrication reasons, negative-g flight is not to exceed 15 seconds.

Fuel Pressure Monitoring

19. A pressure switch downstream of each fueldraulic booster pump operates to bring on the appropriate FUEL 1 or FUEL 2 caption on the AWP if the difference between tank pressure and pump delivery pressure falls below 5.75 ± 0.75 PSI. If reheat is in use when the pressure switch operates, reheat is automatically tripped.

DC Transfer Pumps

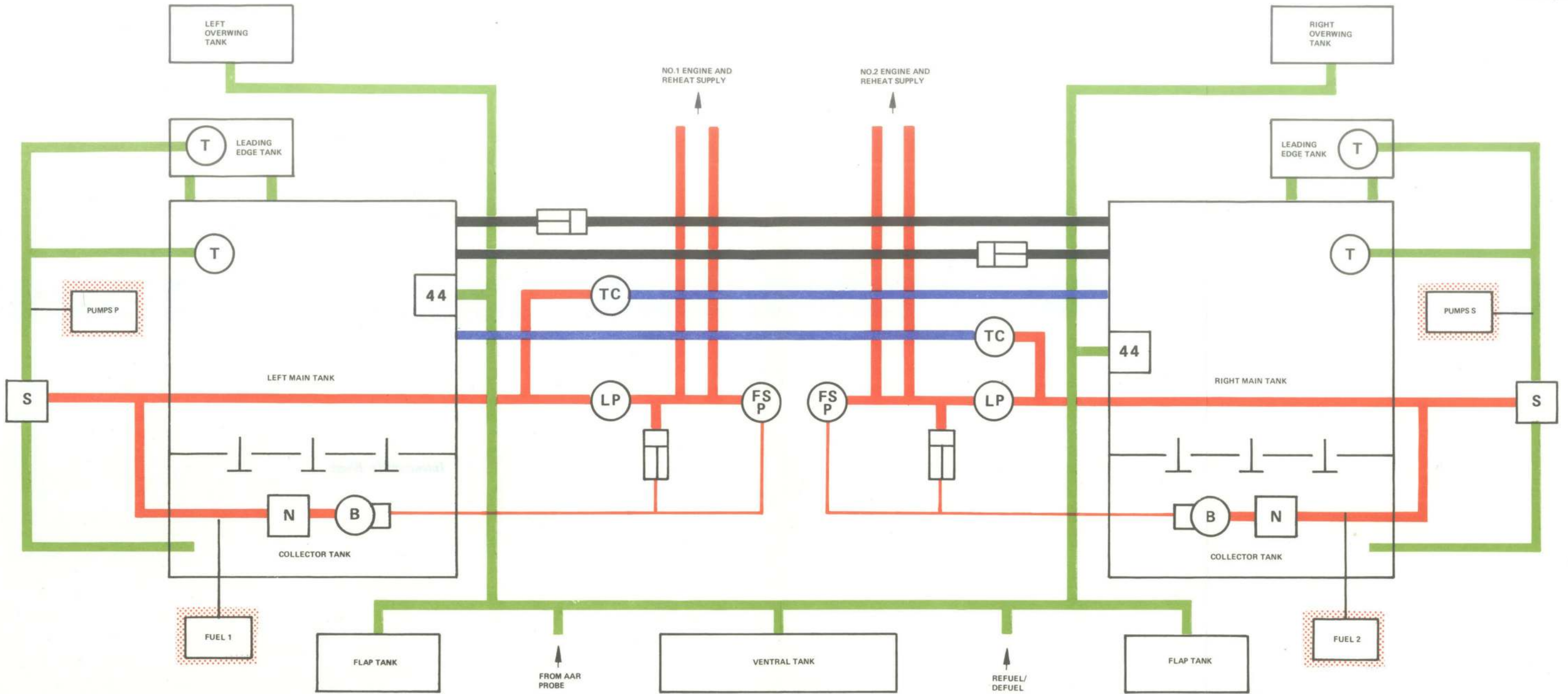
20. Two DC-powered transfer pumps are fitted in each wing, one in the leading-edge tank and one in the main tank, to transfer wing fuel to the collector tank. Each pair of pumps is controlled by one DC pump switch (see Tables 1, 2 and 3). If a booster pump is not running or has failed, a pressure-sensitive shuttle valve diverts the output of the DC pumps into the engine feed line.

DC Transfer Pump Monitoring


21. If both DC pumps in one wing fail, or if one pump fails and the other is not covered with fuel, the associated PUMPS P or PUMPS S caption on the AWP comes on, indicating that fuel is not being transferred from the leading edge and main wing tanks to the collector tank by the DC pumps. Fuel can be transferred to the collector tank by gravity if a nose-up attitude is maintained.




Wing-to-Wing Transfer

22. In conditions of fuel asymmetry, fuel may be transferred to the low side by the wing-to-wing transfer system. A wing-to-wing transfer switch, positioned and labelled as shown in Tables 1, 2 and 3, controls two isolating cocks in separate fuel transfer lines (see Fig 3). When P (PORT) is selected the isolating cock in the right wing is opened and fuel is transferred to the left fuel system from the right under right fueldraulic booster pump pressure or DC pumps pressure. A selection to S (STBD) similarly transfers fuel from the left fuel system to the right. An associated indicator light shows only that a transfer selection has been made and can come on either when a cock is closed and the



— MAIN FUEL SUPPLY
— FUEL DRAULIC PUMP SUPPLY
— FUEL TRANSFER/REFUEL/DEFUEL
— WING-TO-WING TRANSFER
— BALANCE PIPES

S SHUTTLE VALVE
44 Mk 44 VALVE
N NR/SUCTION VALVE
 NRV

 FUEL DRAULIC BOOST PUMP
 TRANSFER PUMP
 TRANSFER COCK

 FUEL DRAULIC SUPPLY PUMP
 LP COCK

1-2 Fig 3 - Fuel System



Intentionally Blank

transfer switch is to P or S or when a cock is moving. Therefore monitor the fuel gauges to ensure transfer is taking place. When the transfer switch is returned to the central (off) position, the indicator light goes out momentarily, comes on again for 2 or 3 seconds, and then goes out.

23. *Rate of Transfer.* If the fuel hydraulic booster pump on the side from which fuel is being transferred is operating, the rate of fuel transfer is approximately 210 lb/minute at 100% RPM or 160 lb/minute at 85% RPM. If the engine on the high fuel side has been shut down, or if booster pump on the high side has failed, fuel is transferred providing the DC pumps are operating; in this case the rate of transfer is approximately 75 lb/minute.

24. If the DC pumps alone are transferring fuel, there may be up to 400 lb of fuel which cannot be transferred in straight and level flight.

Fuel Contents Gauges

25. Capacitor fuel gauges are fitted as shown in Tables 1, 2 and 3. In the F Mk 3 and T Mk 5 there are two MAIN gauges and a VENTRAL gauge. In the F Mk 6, in addition to the two MAIN gauges and one VENTRAL gauge, there are two O/WING gauges to indicate the associated overwing tank contents. In all marks, the MAIN gauges indicate the contents of the main and leading-edge tanks; flap tanks contents are indicated as an increased reading on the associated MAIN gauge when the FUEL CONTENTS T/E button is pressed.

26. A gauge test switch, spring-loaded to the centre (off) position, is used to check the serviceability of the contents gauges. When FULL or EMPTY is selected, all gauges register full scale or zero respectively.

27. The gauges require 115-volt AC power and only operate when the instrument master switch is on. If the normal AC power supply fails, the gauges continue to operate from the standby inverter supply.

Air-to-Air Refuelling (AAR) System

28. Air-to-air refuelling (AAR) is made through a detachable probe fitted below the left mainplane. AAR is controlled by the AAR switch and monitored by the dimmable AAR panel captions, the captions coming on when the AAR switch is selected to FL REFUEL and going out when the associated tank is full. The switch and panel position, and a list of the applicable captions, are given in Tables 1, 2 and 3.

29. Setting the AAR switch to FL REFUEL has the following effects:

- a. Air pressure is released in the ventral tank, flap tanks and, in the F Mk 6, the overwing tanks.
- b. In the F Mk 6, the AC fuel pump is switched off.
- c. All refuelling valves are energised open and, in the F Mk 6, the Mk 39 refuel/emergency transfer valve in the ventral tank is opened.
- d. The captions on the AAR panel come on to indicate which tanks are not full.

30. As the tanks fill during AAR, the captions go out and the associated fuel gauge shows full. After breaking contact with the tanker, reselect NORMAL on the AAR switch to restore normal fuel transfer.

Note 1: In the F Mk 6, the ventral tank emergency transfer switch is not to be set to EMERG TRANSFER during AAR.

Note 2: It is possible to lose the ability to transfer ventral and flap tank fuel in the F Mk 3 and T Mk 5 aircraft if the air pressure relief valve malfunctions after AAR.

31. For night AAR, a probe lighting 2-position switch labelled PROBE LIGHT — ON is provided. There is no power supply to the probe lighting unless the NAV LTS switch is set to ALL ON or TIPS (F Mk 3 and F Mk 6) — STEADY or HI FLASH (T Mk 5).

Ground Refuelling

32. A pressure refuelling point, under a panel on the left side of the fuselage, permits simultaneous refuelling of all tanks including the ventral tank and, in the F Mk 6, the overwing tanks when fitted. Opening the panel operates a microswitch which changes the fuel electrical circuit from its flight condition to the ground refuelling condition. The microswitch, together with the fuel level switches in the tanks, controls the operation of the refuelling valves and the tank indicator lights.

33. In the F Mk 6, refuelling of the ventral tank is via a Mk 39 refuel/emergency transfer valve which is energised open when the refuelling panel microswitch operates.

34. All tanks are depressurised prior to refuelling by setting the BATTERY switch on and selecting FL REFUEL on the AAR switch for at least 30 seconds. The switch is returned to NORMAL when depressurisation is complete.

35. Above the refuelling panel there are seven 'tank full' indicator lights which come on when the panel is removed and go out individually when the associated tank-full float switch operates.

36. In the F Mk 6, if the aircraft is partially refuelled with overwing tanks fitted, the fuel is usually distributed fairly evenly amongst all tanks. In this condition the fuel feeds in the normal sequence and the CG should remain within limits.

Ventral Tank Jettison (F Mk 3 and T Mk 5 Only)

37. When pulled, the ventral tank jettison handle (see Tables 1 and 2 for cockpit position) releases the ventral tank. When the ventral tank is jettisoned, the VENTRAL fuel gauge freezes at the value indicated at the time of jettison.

Ventral Tank Emergency Transfer (F Mk 6 Only)

38. In the F Mk 6, a ventral tank emergency transfer three-position switch, with positions marked NORMAL/EMERG TRANSFER/OFF, is on the left console. It is guarded against inadvertant selection from NORMAL to EMERG TRANSFER; a second guard prevents accidental selection from EMERG TRANSFER to OFF.

39. When overwing tanks are fitted, if either of their low-level float switches fails to operate as the overwing tanks empty, ventral fuel does not transfer. By selecting the ventral tank emergency transfer switch to EMERG TRANSFER, the AC pump in the ventral tank is started, the Mk 47 (normal transfer) and Mk 39 (emergency transfer) valves are opened and fuel then transfers to the main tanks. However, with a failed overwing tank low-level float switch, ventral fuel may feed into one or both overwing tanks when EMERG TRANSFER is selected, whence it feeds normally into the main tanks.

40. When overwing tanks are not fitted, selecting EMERG TRANSFER opens the Mk 39 valve only, and fuel transfers to the main tanks at a reduced rate.

41. The OFF position of the switch prevents operation of the ventral tank pump during servicing with AC ground power connected.

Overwing Fuel Dumping (F Mk 6)

42. A guarded, two-position OFF/FUEL DUMP switch is on the left console of the F Mk 6. Fuel is dumped through a pipe running from the bottom of the centre compartment to the aft end of each overwing tank. The pipes are sealed by a blanking cap held in position by a hinged lever connected by two explosive bolts. When FUEL DUMP is selected, the explosive bolts of both tanks fire to free the lever which hinges open under the influence of a spring. Air pressure then dumps the fuel overboard, the transfer in the tank to its centre compartment following the

normal sequence. From full, the tanks take approximately two minutes to empty, and a further two minutes for residual fuel and vapour to clear.

43. If a malfunction occurs, it is possible for dumping to continue from the ventral tank via the overwing tanks. In this situation set the AAR switch to FL REFUEL on the approach to land thus stopping ventral transfer and safeguarding against fuel spillage on hot brakes after landing.

MANAGEMENT OF THE SYSTEM

Before Engine Start

44. Before engine start note the fuel contents, particularly the ventral contents and, in the F Mk 6, the overwing tank contents (if fitted). Press the FUEL TANKS T/E button and check the MAIN gauges increase appropriately showing the contents of the flap tanks. Select the fuel gauge test switch to EMPTY noting datum readings for each gauge. It is important to note any error during the EMPTY check and apply it to the indicated fuel amounts when checking the fuel transfer sequence in flight.

Starting and After Starting Checks

45. Start the engines with both LP cocks and both DC pumps switches on (up). Check that the FUEL 1 and FUEL 2 captions go out by 38% RPM.

46. *Ventral Tank Pressure Check (F Mk 6)*. A fuel pressure gauge is fitted at the left side of the centre compartment of the ventral tank in the F Mk 6 to allow groundcrew to check the serviceability of the ventral AC pump and tank pressure before flight. During the checks after starting, with AC on line, the groundcrew make a check of the ventral transfer pressure *before* fuel starts to transfer into the main tanks. Note that if overwing tanks are fitted, EMERG TRANSFER is selected to start the AC pump during the check. With the pump running the pressure gauge should read a minimum of 38 PSI.

47. Before take-off, carefully note the ventral (or overwing tanks, if fitted) gauge reading and compare with that noted during the internal checks. Under normal operating conditions the ventral (or overwing) contents should have decreased by 200 to 400 lb.

In Flight

48. Out-of-balance main tank contents are corrected by selective switching of the wing-to-wing TRANSFER switch to the low side, ie, selecting P (PORT) decreases right main tank contents. When an engine is shut down, consider carefully whether or not transferring

fuel is wise, depending on the emergency which caused the engine shutdown and the fuel available to the remaining engine without transfer. If it is considered necessary to transfer fuel, select the TRANSFER switch towards the side feeding the live engine. Leave the FUEL PUMPS switch of the shut-down engine ON so that the DC pumps on that side continue to run to provide wing-to-wing transfer pressure when the fueldraulic booster pump has stopped or is at a low output level. Engine and fuel management during low level diversion is discussed in Part 4, Chapter 2.

49. With the aircraft in straight and level flight, both DC pumps are uncovered when the fuel level in the main tank of the shut-down engine has fallen to approximately 400 lb gauged fuel. This fuel transfers only if the LP cock on the failed side is open and the fueldraulic booster pump is being driven by the windmilling engine.

50. *Flight with Low Fuel Contents.* When landing with indicated fuel less than 400 lb/side, avoid side-slip since this can result in an increase in unusable fuel.

After Flight

51. If the wing-to-wing transfer system has not been used in flight, it is checked after landing as follows:

- a. After No 1 engine shut-down, note the fuel contents and select the TRANSFER switch to P (PORT).
- b. When the fuel gauges confirm that fuel has transferred to the left tanks, select the switch off for 5 seconds and then select S (STB).
- c. After No 2 engine shut-down, check that fuel has transferred to the right tanks and then select the TRANSFER switch off.

MALFUNCTIONS OF THE SYSTEM

Fuel Pressure Warnings

52. *FUEL 1 or FUEL 2 Caption.* A FUEL 1 or FUEL 2 caption indicates either failure of the fueldraulic booster pump or lack of fuel in the collector tank on the associated side.

- a. *Fueldraulic Booster Pump Failure.* After booster pump failure the DC pumps are capable of supporting engine operation via the shuttle valve up to 40,000 feet, 0.9M and 85% RPM. If it is necessary to transfer fuel from the side having only DC pumps, set the corresponding engine to idle before transfer begins.
- b. *Empty Collector Box.* The collector box remains topped-up under gravity feed as long as the aircraft is in a nose-up attitude. In nose-down attitudes, the collector box is emptied at a rate corresponding to

engine demand unless output from the DC pumps (and, in particular, the leading-edge tank pump in a nose-down attitude) is sufficient to replenish it.

53. *PUMPS P or PUMPS S Caption.* A steady PUMPS P or PUMPS S warning signifies a pressure drop in the combined DC pumps output pipe. While this could indicate the simultaneous failure of both pumps, it is more likely to indicate the uncovering of one pump owing to fuel movement in the tanks following the failure of the other pump. The situation may be diagnosed as follows:

<i>Flight Condition</i>	<i>Probable Situation</i>
1. Level acceleration, or High nose attitude without acceleration	Front pump uncovered, rear pump failed
2. Nose-down attitude with no acceleration, or Rapid deceleration	Front pump failed, rear pump uncovered

a. *Condition 1.* With the front pump serviceable as diagnosed in Condition 1, no special action is required; stopping the acceleration or re-adopting a nose-down attitude re-immerses the serviceable pump to provide a continuous, if reduced, supply of fuel to the collector box. In any event, the collector box is being supplied by gravity feed.

b. *Condition 2.* With the front pump failed, as diagnosed in Condition 2, if the nose-down attitude or rapid deceleration is maintained, the collector tank empties and, since there is no DC pump pressure or gravity feed to provide an alternative fuel supply, the associated FUEL caption comes on and the engine flames out. Therefore, immediately a Condition 2 failure is diagnosed, throttle the affected engine to idle and adopt a 7° nose-up attitude for at least 15 seconds to allow the collector tank to refill under gravity. This action extinguishes the PUMPS warning if the rear pump is working but it must be repeated at intervals during recovery if the risk of flame extinction on that engine is to be avoided.

54. *Wing-to-Wing Transfer.* The output of a single DC pump is limited. It is incapable of sustaining simultaneous collector tank replenishment and wing-to-wing transfer. If a PUMPS warning appears whilst fuel transfer is in progress from the affected side, transfer should be stopped. Any fuel remaining on the side with a PUMPS warning may not be recoverable.

55. *Shuttle Valve Malfunction.* After fueldraulic booster pump failure the low pressure fuel system is supplied directly by the two DC pumps via the shuttle valve (Fig 3). If one DC pump fails in this situation, the remaining pump may provide enough pressure to

hold the shuttle valve over instead of allowing it to close and permit the engine to be fed from the collector box by HP pump suction. In this event, if the collector box has previously emptied and the fuel hydraulic pump system has not been reprimed by DC pump output, the engine will flame out if the supply to the DC pump is interrupted (eg by a change of aircraft attitude or velocity). This situation is resolved by deliberately shutting down and relighting the engine.

56. *Combined FUEL and PUMPS Warnings.* There is an immediate danger of engine flame out when the FUEL and PUMPS captions on one side come on together. Pressure in the delivery line to the engine has dropped below 5.75 ± 0.75 PSI and the DC pumps are not replenishing the collector box or supplying fuel directly to the low pressure fuel system via the shuttle valve. Move the throttle to idle and adopt a 7° nose-up attitude for at least 15 seconds to replenish the collector box. If the PUMPS warning goes out the failed DC pump can be diagnosed in the method described in para 53. However, it is advisable after a combined warning to recover with the affected throttle at idle, and at an altitude below 12,000 feet if possible. If the engine flames out it may be relit at low altitude for landing. The combined failure drill and the cold relight drill are given in the FRC.

Wing-to-Wing Transfer Cock Failure

57. *Indicator Light.* After any malfunction of the wing-to-wing transfer system the transfer indicator light should be ignored. Fuel gauge readings are the only reliable indications of whether or not transfer is taking place.

58. *Cock Failed Open.* If a wing-to-wing transfer cock fails in the open position, constant cross transfer occurs and undemanded fuel asymmetry results. Stop the increasing asymmetry by selecting cross transfer in the opposite direction and balance the fuel by use of differential throttle.

59. *Cock Failed Closed.* If a cock fails in the closed position, cross transfer from that side is impossible. If the fuel contents on the side with the failed cock are high, balance can only be corrected by use of differential throttle.

Fuel Contents Gauge Failure

60. *Power Failure.* If the electrical power supply to a gauge fails, the pointer freezes at the reading indicated at the moment of failure. Operating the GAUGE TEST switch (FUEL TEST switch in T Mk 5) brings no response from the failed gauge(s).

61. Other types of failure, such as an internal short circuit in a tank sensor unit, may result in a gauge

reading incorrectly or falling to zero or below, even though it indicates correctly when tested.

Ventral/Flap Transfer Failure (F Mk 3 and T Mk 5)

62. Failure of the ventral and flap tanks to transfer results in an aft movement of the CG and progressively worsening longitudinal stability as fuel is used from the wing tanks. As soon as the failure is recognised, check that the AAR switch is to NORMAL (OFF, T Mk 5) and restrict handling to gentle manoeuvres only. If the condition persists, land before the CG moves beyond the aft limit. The full drill and the CG limits are given in FRC.

Ventral Transfer Failures (F Mk 6)

63. *AC Pump Failure.* After AC failure, or after a mechanical failure of the ventral tank AC pump, the transfer rate of ventral tank fuel under air pressure is reduced. Select EMERG TRANSFER to open the Mk 39 valve and increase the flow. The engine demand is balanced by the transfer rate at economical cruise power settings.

64. *Ventral Transfer Failure.* If complete ventral transfer failure occurs, the fault is usually a failure of the Mk 47 valve to open. Having ensured that the AAR switch is to NORMAL, select EMERG TRANSFER to open the Mk 39 valve; the flow rate is then the same as after an AC pump failure. If the fuel fails to transfer after selecting EMERG TRANSFER the CG moves rapidly aft as fuel is used from the wing tanks. Use gentle manoeuvres only, reduce speed below 250 knots and make a precautionary landing. The full drill is in the FRC.

65. *Transfer Pressure Failure.* The failure of transfer air pressure in the F Mk 6 is noticeable only during prolonged use of reheat. Transfer rate is slightly lower than normal.

Mk 44 Valve Failure (F Mk 6)

66. If a Mk 44 valve fails to close because of high level float switch malfunction when the wing tank is full, ventral tank fuel is lost overboard through the wing tank vent (within approximately 10 minutes). If such venting occurs, set the ventral tank emergency transfer switch to OFF to stop the AC pump and close the Mk 47 valve. As the level in the wing tanks drops, select NORMAL to top up with ventral fuel.

67. If selecting the ventral tank emergency transfer switch to OFF does not close the Mk 47 valve, fuel is still transferred overboard by air pressure. In this case select the AAR switch to FL REFUEL to depressurise the tank and top up by selecting NORMAL on both switches when there is space available in the wing tanks.

◀ **Fuel Venting**

68. If, during or after start-up, fuel is observed to be venting from the overwing tanks, or under pressure from any other source, or onto the wheelbrakes area, both engines are to be shut down immediately. If

venting occurs from the overwing tank vents while taxiing, immediately shut down the No 1 engine, raise the flaps and shut down the No 2 engine as soon as practicable. Abnormal venting from any other source while taxiing is to be checked by a servicing specialist prior to flight. ▶

RESTRICTED

Intentionally Blank

RESTRICTED

This file was downloaded
from the RTFM Library.
Link: www.scottbouch.com/rtfm

Please see site for usage terms,
and more aircraft documents.

