

PART III**HANDLING****LIST OF CHAPTERS**

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Note

All check lists referred to in this part are detailed on the Flight Reference Cards.

PART III—HANDLING

Chapter 1—STARTING, TAXYING AND TAKE-OFF

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1 Preliminary checks

(a) Make a systematic check for obvious damage, loose panels, condition of surfaces, oleos for equal/correct extensions, tyres for creep, excessive wear or cuts, brake leads for damage or leaks.

(b) Carry out the External, Internal and Pre-start checks listed in the Flight Reference Cards. Strict adherence to these checks ensures that no item is missed and that the minimum amount of checking remains to be done after starting the engines.

NOTE: When reference is made to the flap configuration selected it is made in the order—wing flap/aileron droop/tailplane flap. Therefore the abbreviation 15-10-10 indicates that 15° wing flap, 10° aileron droop, and 10° tailplane flap have been selected.

2 Starting the engines

(a) Start the engines using the drills in the Flight Reference Cards.

(b) If the throttle is moved from ground start to ground idling before the RPM and TGT have stabilised, the engine may decelerate to a level at which it is necessary to shut down.

(c) The maximum permitted TGT for starting is 600°C (pre-mod Spey 3119) or 535°C (post-mod Spey 3119). Temper-

atures approaching this limit should only be reached under extreme cold starting or tailwind conditions and are not to be regarded as normal. Normal starting temperatures should be of the order of 450°C. If it is obvious, during a start, from the rate of rise that the limit will be exceeded, close the HP cock before the limit is reached.

(d) Tailwind starting

(i) Tailwind starts should be avoided whenever possible.

▶◀ When tailwind starts are unavoidable the HP cock should be opened to the GROUND START position as soon as a positive LP shaft rotation is indicated. It should be noted that, pre-mod 1121 the LP rotation light will flash whatever the direction of rotation and, post-mod 1121 only when the rotation is in the correct sense.

◀ (ii) If the HP cock is opened too early or the tailwind is excessive an abnormal TGT which, in certain cases may be very low, may be seen. If this occurs or flames issue ▶ from the jet pipe, close the HP cock. Before a second start is attempted the engine must be given a dry run and care should be taken on the next attempt not to open the HP cock until the LP rotation light has flashed for at least 5 seconds. If a second attempt is unsuccessful reposition the aircraft into wind.

3 Functional checks

(a) Whilst carrying out the functional checks in the Flight Reference Cards the use of the tailplane flap and aileron droop standby selectors should be restricted to the minimum required for a brief functional check of their operation. This avoids an excessive drain on the emergency battery.

(b) Tailplane trim checks

(i) Uncouple trim switches on the control column and check that there is no tailplane movement when each of the switches is moved separately for 5 secs to the nose-up and nose-down positions. Release the port side switch and allow it to re-engage.

(ii) Select full nose-up or nose-down trim with the switches coupled and check that the tailplane indicator movements are in the correct sense and at a rate of 1.0°/sec approximately.

(c) *Autopilot checks*

(i) Select Mach hold or barometric height hold, check AP MI shows RDY.

(ii) Engage the autopilot, check AP MI shows ENG.

(iii) Check that the control column locks in the pitch plane but retains freedom of movement in the rolling plane. (As the autopilot engages, a small snatch may be felt on the control column).

(iv) Null the heading indicator on the IFIS and engage the heading hold. Check there is no freedom of movement in the rolling plane.

(v) Note the tailplane angle.

(vi) Trim nose-up, allowing the stick to move. The tailplane limit switches will trip and the autopilot disengage. Check AP warning on SWP and the AP MI shows RDY. Press the ICO reset button and cancel the SWP warning. Check that the stick returns to the centre and note the new tailplane angle which should be approximately $1\frac{1}{2}^{\circ}$ more nose-up. Check AP MI shows ENG.

NOTE: The heading switch returns to OFF automatically during this check.

(vii) Repeat by trimming nose-down noting a new tailplane angle of $\frac{3}{4}^{\circ}$ more nose-down. Re-engage the heading hold and rotate the heading pointer until the limit switch trips and disengages the autopilot. Check that the stick moves in the same direction as the heading pointer. Repeat for the opposite direction.

4 Taxiing

(a) (i) *Pre-mod* E92

Confirm that the brake pressure gauge indicates 4000 PSI. Depress the foot pedals fully, select the parking brake off and release the foot pedals noting that the parking pressure is released. Depress the foot pedals and check that 1665 PSI is applied at each wheel.

(ii) *Post-mod* E92

Confirm 4000 PSI on triple pressure gauge and that there is 1665 PSI on the emergency handbrake gauge. Depress foot pedals and release emergency handbrake, checking that 1665 PSI is registered at each wheel and that the handbrake gauge indicates zero.

(b) Taxi forward and test the brakes. A moderate application of power is required to get the aircraft under way. When the aircraft is moving, idling RPM are sufficient to maintain a normal taxiing speed. The anti-skid units do not operate below 15 knots, therefore harsh braking during taxiing causes unnecessary tyre wear and possible locking of the wheels.

(c) The nosewheel steering is engaged by pressing the nose-wheel steering button and should normally be used for all manoeuvring. The maximum nosewheel deflection is 50°. Differential braking may be used for steering and is necessary for turns of small radius. After initiating the turn with the nosewheel steering, release the button and apply brake as required in the direction of the turn. On completion of the turn, re-align the rudder bar and nosewheel before re-engaging the nosewheel steering.

(d) At high AUV, full deflection may not be achieved and a lag in nosewheel response is pronounced. The aircraft becomes more difficult to turn on nosewheel steering alone. Considerable care is then required when lining-up with the catapult. If other hydraulic services are used during taxiing a temporary loss of nosewheel steering may occur.

◀(e) *Airfield arrester gear*

There are no limitations on trampling airfield arrester gear.▶

5 Checks before take-off

Carry out the checks listed in the Flight Reference Cards.

6 Engine checks before take-off

(a) Align the aircraft with the runway centre-line and with the nosewheel straight, carry out the engine checks listed in the Flight Reference Cards.

(b) Slam accelerations may be made. The acceleration times may vary considerably due to a number of variable factors, but accelerations from ground idling RPM to 2% less than max. RPM can normally be obtained within 10 seconds, BLC on or off. It is not possible to hold both engines at maximum power against the wheelbrakes.

7 Take-off considerations

WARNING: Before any sortie, V-STOP, V-GO, unstick and safety speeds for the relevant AUV should be obtained.

(a) *V-STOP, V-GO speeds*

(i) V-STOP and V-GO speeds are detailed in Tables 2 to 5. V-STOP is the maximum speed at which the take-off can

be abandoned and the aircraft stopped in the runway length remaining. V-GO is the minimum speed from which the take-off can be continued successfully if an engine fails. Provided V-STOP is greater than V-GO, only V-STOP need be considered when abandoning a take-off. If V-GO is greater than V-STOP, a speed-band exists in which an engine failure will result in the aircraft entering the overshoot area or engaging a wire or barrier.

(ii) If an engine failure occurs at or below V-STOP, the take-off should be abandoned.

(iii) If the take-off is continued after an engine failure, the unstick speeds should be increased by 10 knots for an unblown take-off and 15 knots for a blown take-off.

(iv) If an emergency occurs which would make it unsafe to become airborne, the take-off should be abandoned even if V-STOP has been exceeded. If there is no arrester gear or barrier it may be necessary to eject.

(b) *Crosswind*

The maximum recommended crosswind component is 25 knots. If there is a significant crosswind (5 knots component) or marked turbulence is expected after take-off, all three autostabilisers should be set to APPROACH. As the aircraft becomes airborne the "into wind" wing lifts, the amount increasing with increasing crosswind component. This should be anticipated and gentle but firm corrective action taken. Corrective action induces some adverse yaw which can be eliminated by use of rudder. For every 10 knots crosswind component, increase unstick speed by 5 knots.

(c) *Asymmetric loads*

For every 1000 lb. asymmetric wing load, increase unstick speed by 2 knots. Refer to Fig. 3 for trim settings.

8 Take-off, general

(a) Before take-off, after completion of the engine checks, release the brakes and engage the nosewheel steering.

Acceleration is good. Use the nosewheel steering for directional control until the rudder becomes effective at approximately 80 knots. In conditions of no crosswind it is seldom necessary to use nosewheel steering, as 80 knots is achieved quite quickly. Once released, the nosewheel steering should not be re-engaged. The speed at which the nosewheel can be raised progressively increases as CG is moved forward. This becomes significant at CGs forward of 18 inches aft of datum (27% SMC) in the 30/20/20 blown configuration. ODM unstick speeds take account of this characteristic. In the above conditions there will be little, if any, indication of tailplane effectiveness until the unstick speed has been reached.

(b) (i) Start to raise the nosewheel 20 knots before unstick speed. After the nosewheel has been raised, avoid an excessive nose up attitude and allow the aircraft to fly off at the appropriate unstick speed for the AUV. The aircraft tyre limitation is 180 knots groundspeed. Acceleration after an unblown take-off is good, and care should be taken not to exceed the undercarriage speed limitation.▶

(ii) ▶◀

◀(iii) When safely airborne, retract the undercarriage, followed by the flaps and the aileron droop and tailplane flap both selected together. The undercarriage retracts▶ quickly and some slight vibration may be felt from the rotating nosewheel. Neither undercarriage nor flaps retraction causes any significant change of trim.

WARNING: Manual braking of the wheels, either during the retraction or when fully up, can lead to a failure of the undercarriage pre-shortening mechanism which may lead to a partial collapse of the oleo on landing. Manual braking must only be applied with the undercarriage locked down. Braking of the wheels after take-off should be left to the automatic braking system. If a failure of this system is detected after the undercarriage has been selected up, the wheels should either be left rotating in the wheelbays, or if circumstances permit, the undercarriage should be recycled and the brakes applied manually with the undercarriage down and locked. Rotation of wheels in the wheel bays causes no physical damage but is undesirable, particularly in wet, muddy or slushy conditions.

(iv) After the aircraft has been cleaned up, carry out the after take-off checks and establish the initial climb.

◀NOTE: If, following an UP selection of the undercarriage, the correct indications are not obtained, the undercarriage position should, if possible, be checked visually before any further selection is made. Damage may be caused if an undercarriage that has not retracted into its housing is cycled. ▶

(c) *Unblown safety speeds (ISA conditions)*

(i) At an A UW of 46,000 lb. the aircraft unsticks at approximately 160 knots in the flap configuration 15-10-10 and the aircraft climbs on one engine. At 165 knots with the undercarriage down, the rate of climb is 500 ft./min. (approx.), increasing to 1000 ft./min. when the undercarriage is raised.

(ii) If an engine fails after unstick, at any A UW, the aircraft will continue to accelerate so long as the undercarriage and flap/droop configuration are retracted.

(d) *Blown take-off (ISA conditions)*

(i) Up to 48,000 lb. A UW, clean aircraft or with *empty* 2 × 250 gal. slipper tanks fitted, the unstick speed is 142 knots at sea level. Thereafter add 2 knots/1,000 lb. A UW.

(ii) Up to 50,000 lb. A UW, with *full* 2 × 250 gal. slipper tanks fitted, the unstick speed is 152 knots.

(iii) Using the same technique as in the unblown case, fly off at the unstick speed.

(e) *Blown safety speed*

At an A UW of 48,000 lb. the aircraft unsticks at 142 knots at ISA + 10°C. When safely airborne retract the undercarriage and flap/droop configuration. If, during retraction, an engine fails and the aircraft has accelerated to 174 knots, it will continue to accelerate and climb away; this is the safety speed for these take-off conditions. For other safety speeds see Table 1.

Table 1—blown safety speeds

A UW lb.	Temperature °C	Safety speed kts.
42,000	ISA to ISA + 30	165
47,000	ISA to ISA + 30	172
51,000	ISA to ISA + 30	180

Table 3—V-GO speeds (knots)
Configuration: 15-10-10, Unblown take-off

Temperature °C		15°C			25°C			35°C		
		Zero	10K	20K	Zero	10K	20K	Zero	10K	20K
Runway Length	AUW lb.									
	45,000	129	114	92	140	128	112	151	140	128
	47,500	150	140	126	158	149	139	165	158	150
2,000 yds.	50,000	166	159	150	172	166	159	178	172	166
	45,000	80	80	80	104	82	80	122	108	80
	47,500	118	100	80	133	120	96	146	135	118
2,500 yds.	50,000	145	132	112	155	146	130	163	156	145
	45,000	<80	<80	<80	<80	<80	<80	80	<80	<80
	47,500	<80	<80	<80	96	<80	<80	118	99	<80
3,000 yds.	50,000	112	90	<80	130	113	88	145	132	113

Reference: 15-10-10, Unblown take-off, V-GO speeds

Table 4—V-GO (knots) (Sea level) single-engine unstick speed (152 + 15) knots

Configuration: 30-20-20, blown take-off

With full 250 gallon tanks

Temperature °C	5°C			15°C			25°C		
	Zero	10K	20K	Zero	10K	20K	Zero	10K	20K
Headwind	Auw lb.								
Runway Length	35,000	100	86	118	108	100	127	119	110
	40,000	116	108	127	119	108	—	—	—
	45,000	—	—	—	—	—	—	—	—
2,000 yds.	35,000	< 80	< 80	97	< 80	< 80	108	96	82
	40,000	93	< 80	106	96	< 80	—	—	—
	45,000	—	—	—	—	—	—	—	—
2,500 yds.	35,000	< 80	< 80	< 80	< 80	< 80	84	< 80	< 80
	40,000	< 80	< 80	< 80	< 80	< 80	—	—	—
	45,000	—	—	—	—	—	—	—	—
3,000 yds.	35,000	< 80	< 80	< 80	< 80	< 80	—	—	—
	40,000	< 80	< 80	< 80	< 80	< 80	—	—	—
	45,000	—	—	—	—	—	—	—	—

Where V-go not shown, rate of climb < zero (u/c down)

Table 5—V-GO (knots) (sea level) single engine unstick speed—(142 + 15) knots

Configuration: 30-20-20, blown take-off

Without 250 gallon wing tanks or with empty 250 gallon wing tanks

Temperature °C		5°C			15°C			25°C		
		Zero	10K	20K	Zero	10K	20K	Zero	10K	20K
Runway Length	AUW lb.									
	35,000	88	< 80	< 80	102	90	< 80	112	104	90
	40,000	102	90	< 80	112	103	90	123*	114*	106*
2,000 yds.	45,000	113*	103*	86*	—	—	—	—	—	—
	25,000	< 80	< 80	< 80	< 80	< 80	< 80	85	< 80	< 80
	40,000	< 80	< 80	< 80	< 80	< 80	< 80	100*	85*	< 80*
2,500 yds.	45,000	< 80*	< 80*	< 80*	—	—	—	—	—	—
	35,000	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80
	40,000	< 80	< 80	< 80	< 80	< 80	< 80	< 80*	< 80*	< 80*
3,000 yds.	45,000	< 80*	< 80*	< 80*	—	—	—	—	—	—

Where V-go not shown, rate of climb < zero (u/c down)

*Rate of climb with empty 250 gallon wing tanks < (u/c down)

Whilst the ambient temperature has negligible effect on the safety speed, the time to reach a safe speed after unstick will increase with increases in temperature. The maximum increase between ISA and ISA + 30°C is approximately 8 seconds.

9 Catapult launch

(a) General considerations

(i) The aircraft's optimum catapult performance, together with the highest degree of safety, is achieved when the hands-off, in-trim technique is used. This avoids the danger of over-controlling which can result from the powerful longitudinal control combined with high inertia in pitch. To achieve this a predetermined tailplane angle is set, which ensures an in-trim condition approximately 1 second after launch. The tailplane angle required is dependent on CG position, AUV and end speed. With the correct tailplane angle set a satisfactory hands-off launch can be made for 5 seconds or more but, due to possible inaccuracies in setting the correct tailplane angle and also in achieving accurate launch speeds, the pilot should take control shortly after launch as detailed in para. (c).

(ii) *Configuration.* The calculated trim settings are for the aircraft in the blown, 45-25-25 configuration at full power with a minimum thrustmeter reading of 2.0 (temperature corrected as shown in Fig. A) and a minimum blow pressure of 50 PSI. Autostabilisation and aileron gearing should be at HIGH SPEED unless conditions are particularly turbulent. Note that pitch autostabilisation is essential and the aircraft must not be launched without it.

(iii) *Tailplane trim settings.* These are given in Fig. 1 (without underwing tanks) and Fig. 2 (with modified wing tanks). When using the curves, MLS is defined as 118 knots up to 42,000 lb, thence increasing linearly by 2 knots/1,000 lb. Trim should be set to the nearest $\frac{1}{4}^\circ$ and at weights below 42,000 lb or above 48,000 lb trim should be set $\frac{1}{2}^\circ/5,000$ lb less negative than the figure derived from the graphs. Trim settings for a configuration which includes only one 250 gal. underwing tank should be taken as midway between the value for the clean aircraft and that for the two-tank configuration.

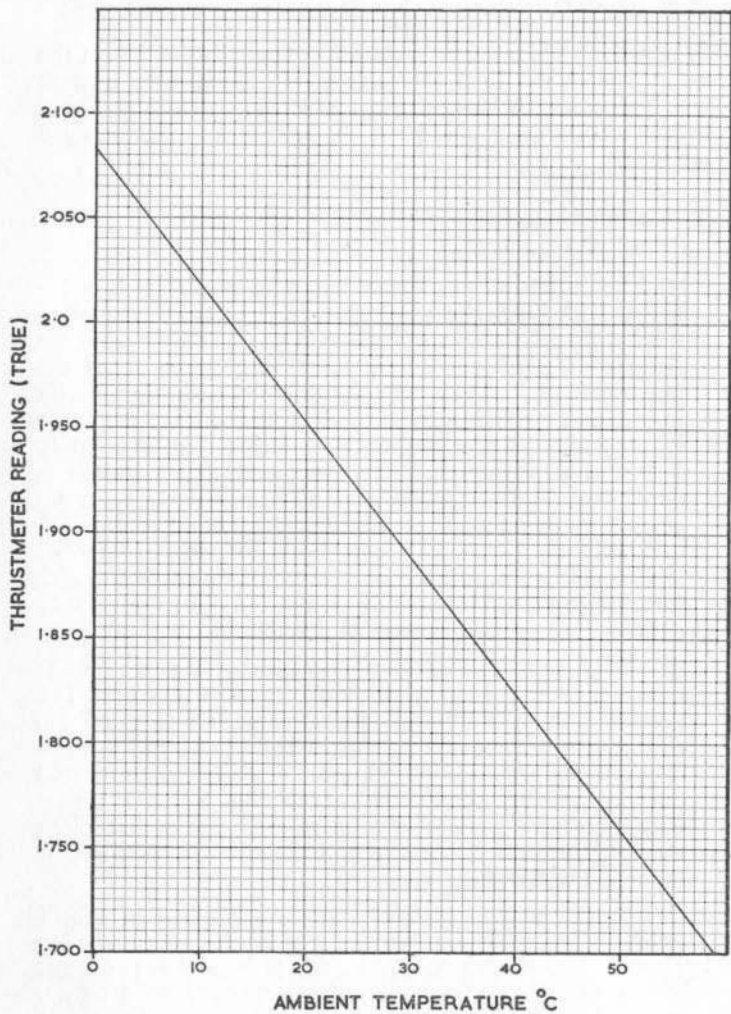


Fig. A—Minimum thrustmeter readings (true)
◀ at maximum RPM, blow on ▶

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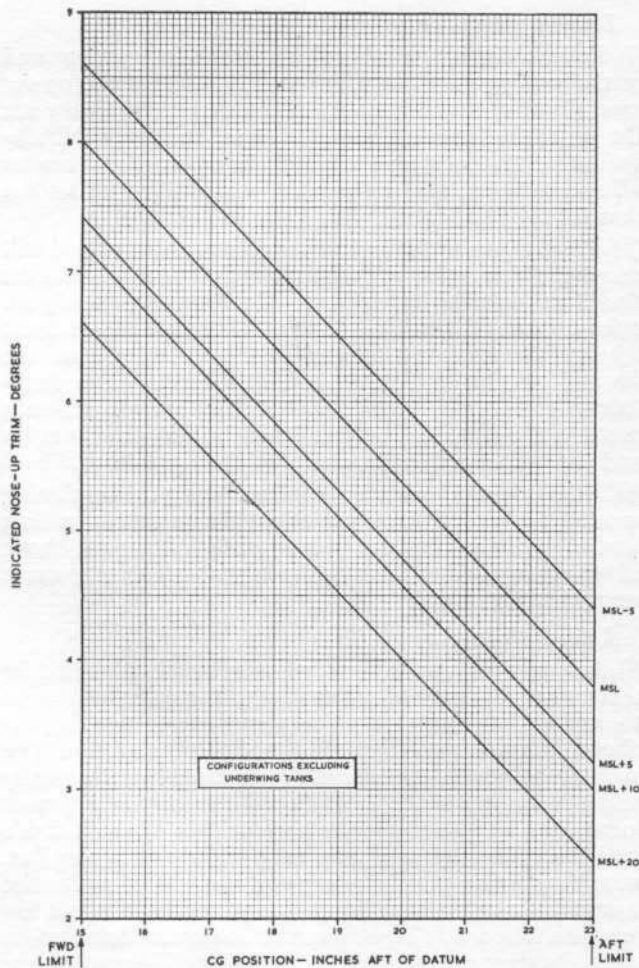


Fig. 1. Tailplane trim without UW tanks

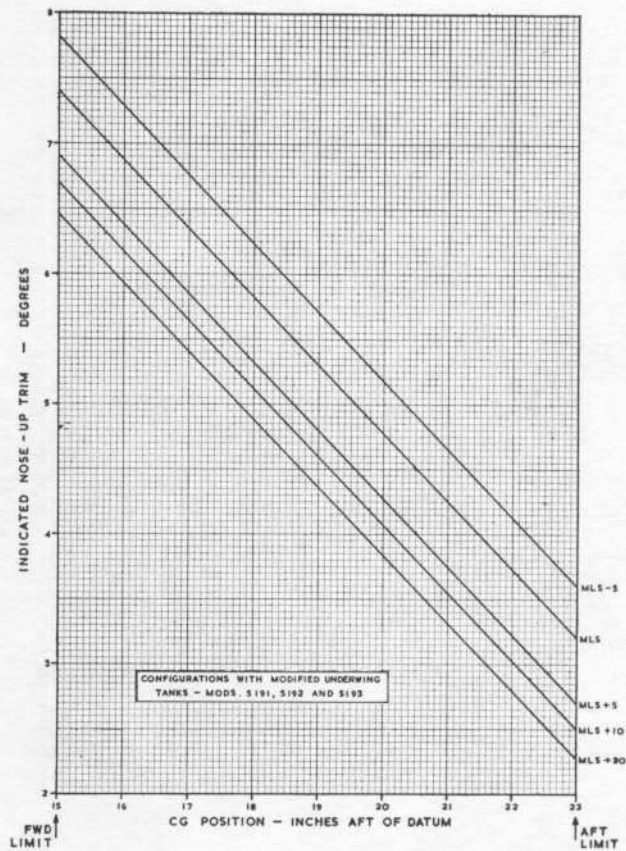


Fig. 2. Tailplane trim with UW tanks

(iv) *Stability*. In all stores configurations except with underwing tanks the aircraft is longitudinally stable up to the limiting incidence (approx. 29 units ADD). With underwing tanks fitted the stability is reduced and the aircraft becomes neutrally stable in pitch above about 24 units ADD.

(b) *Launch procedure*

(i) Follow closely the catapult director's instructions and as the loading chocks are approached control the power carefully to ensure that contact is made gently. Carry out the catapult Take-off checks given in the FRC's. Before acknowledging the check board confirm brakes off and blow on, and exercise the controls fully. Confirm that the tailplane returns to its original setting.

(ii) Prior to launch, the aircraft will be tensioned and will adopt the correct launch attitude with its tail skid on the deck (see WARNING below). On receiving the signal, open up smoothly to full power. Complete the catapult take-off checks given in the FRC's ensuring that the HP and LP RPM and TGT are within limits. Give the 'ready to launch' signal; adopt the correct catapult posture, positioning the left hand behind the throttles and the right hand, palm open, on the right thigh.

WARNING: If the brakes are applied during the tensioning procedure the aircraft may not adopt the correct launching attitude. If the brakes are subsequently released a shock load will be applied to the hold back gear which may cause a premature break out.

(c) *Launch technique*

(i) A hands-off launch is essential but control should be taken smoothly soon after launch and the attitude brought to, and maintained at, a value about one to two degrees above the value seen when tensioned on the catapult. The attitude at which the aircraft is to be flown, normally corresponds with the bottom of the aircraft symbol located on or just above the horizon line of the attitude indicator, although this may vary slightly with parallax, according to the pilot's sitting position. With an in-trim launch little or no stick input is required for the first few seconds. Any stick input required to correct for random or inadvertent out-of-trim should be applied gently since the aircraft is very sensitive in pitch; a large backward stick movement to correct a nose-down change of attitude could result in over-rotation and stall.

(ii) It should be noted that with underwing tanks fitted the aircraft becomes neutrally stable at the higher incidences. Hence if, with tanks on, the aircraft is launched out-of-trim in the nose-up sense, the incidence continues to increase until corrective action is taken. With the recommended trim settings and normal tanks-on launch speeds, this divergence in incidence should always be relatively slow and therefore easily controlled. At the reduced launch speeds permitted as an operational necessity, a more rapid divergence could be encountered in the event of an over-trim, but this can be safely controlled by experienced pilots.

(iii) Care should be taken not to exceed 23 units ADD. A safe incidence during the immediate post-launch phase is assured by not exceeding an attitude of about 4° more nose-up than the tensioned value. The audio signal should be monitored closely since it provides useful rate information.

(iv) At minimum launch speeds some sink may occur.

(v) If, due to crosswind or an asymmetric configuration, wingdrop occurs immediately after the launch it should be corrected with rudder and not with aileron.

(vi) When settled in the climb, the natural nose-up trim change with increasing speed can be compensated by first retracting flap and droop to 30-20-20, then raising the undercarriage and then the remainder of the flap and droop.

(vii) *Launching below MLS*

When, under conditions of extreme operational necessity, the aircraft is launched below MLS, post-launch incidences up to 26 units ADD must be expected, with a height loss of about 15 ft. The optimum attitude for flying the aircraft is 4° above the tensioned attitude. Control movements should be made very gently and no attempt should be made to correct the initial nose-down nod that is experienced immediately after launch.

(d) *Rudder and aileron trim settings*

If catapulting with an asymmetric external stores loading ◀ the trim settings for rudder and aileron given in Fig. 3 ▶ should be used.

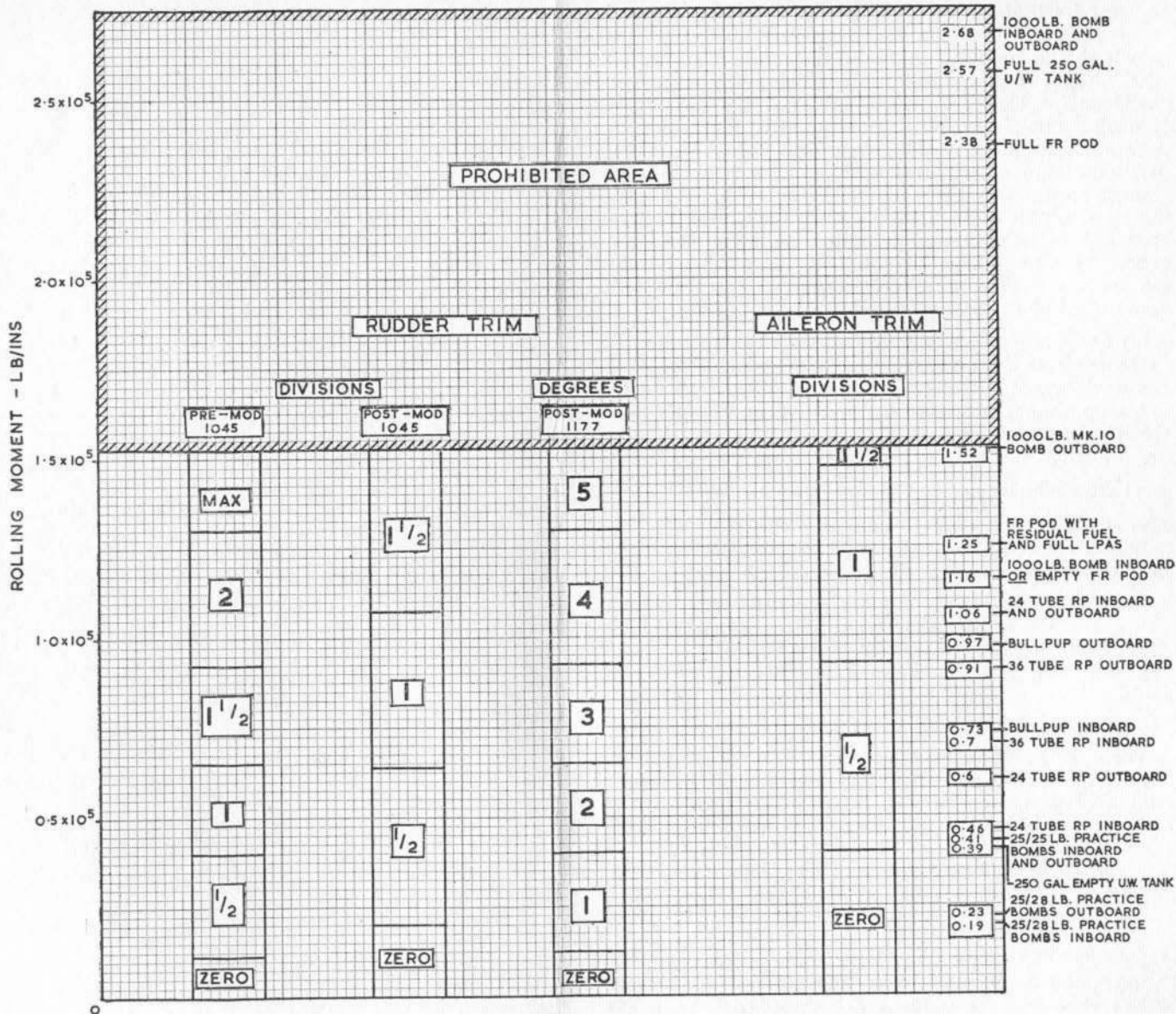


Fig. 3—Aileron and rudder trim for catapulting with asymmetric stores

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10 Checks after take-off

Carry out the checks listed in the Flight Reference Cards.

11 Engine failure during take-off

(a) If an engine fails during take-off the relevant V-STOP and V-GO speeds will indicate whether the take-off should be abandoned or continued.

(b) Take-off abandoned

If an engine fails during take-off and take-off is abandoned, ◀close both throttles, and close the HP cock of the failed engine, lower the arrester hook, extend the airbrakes and apply the wheelbrakes. Close the HP cock of the live engine. The arrester hook takes 2-3 seconds to lower, ▶ therefore the selection must be made 300 yards before the wires. Aim for the centre of the wires and assist engagement by releasing the wheelbrakes and pulling the stick back. If the hook fails to engage a wire, re-apply the wheelbrakes, steer for a clear grass area and, if necessary, retract the undercarriage.

(c) Take-off continued

If the take-off is continued there is a definite yaw towards the dead engine but moderate application of rudder is ◀sufficient to keep straight. Fly off at the two engine unstick speed plus 10 knots unblown, 15 knots blown, correct any tendency to roll with gentle use of aileron. Foot load is moderately heavy until the rudder has been retrimmed. When airborne, raise the undercarriage at a safe height and, if necessary, jettison stores. Select flaps and droop up. (If unblown, retain 15-10-10 until the ADD indicates below 18 units and then select flaps and droop up). ▶

(d) Safety speeds are detailed in paras. 8(c) and 8(e).

12 Engine failure after take-off

◀(a) If the engine fails after take-off, the aircraft will climb away if the safety speed has been reached. Raise the undercarriage as soon as it is safe to do so and, if necessary, jettison stores. Select flaps and droop up. (If unblown, retain 15-10-10 until the ADD indicates below 18 units and then select the flaps and droop up). Moderate application of rudder is required to prevent yaw. ▶

◀(b) If safety speed has not been reached, land ahead if practicable; if not practicable, jettison stores, raise the undercarriage, flaps and droop as described in sub-para (a) and climb away. If necessary—*Eject*. ▶

PART III—HANDLING

Chapter 2—HANDLING IN FLIGHT

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1 Climbing

Climb at full power, within the TGT limitations, at 400 knots converting to 0.82M. Acceleration after take-off is good. The climbing speed should be established during the initial climb to 2,000 ft. The aircraft is stable in the climb up to about 32,000 ft. and speed control and trimming are good. Above 35,000 ft. speed control becomes more difficult. When minimum time to height is not essential a reduced power climb should be made, to conserve engine life.

2 Engine handling in flight

◀(a) Engine acceleration (pre-mod Spey 3514) may become progressively slower with increasing height; this is accentuated when the engine is cold, particularly after a cold relight. ▶

At 35,000 ft. a slow acceleration to maximum RPM normally takes about 25 seconds. Acceleration times improve with an increase in airspeed or a reduction in height.

(b) Cruising conditions

The LP RPM give a fairly accurate indication of the percentage thrust being used. For equal thrust and fuel flow it is recommended that the LP RPM are matched for cruising.

(c) Relighting

See Part III, Chap. 4, para. 8.

3 Flying controls

(a) Ailerons

(i) Spring feel provides an increasing force with stick displacement. Some adverse aileron yaw is experienced when aileron is applied; this is more marked when the ailerons are drooped. Aileron forces are light and response is good but deteriorates above 0.9M, and at low speeds when the ailerons are drooped.

(ii) Selection of low-speed aileron gearing when ailerons are drooped serves to improve control response at low speeds. Low-speed gearing must not be used above 300 knots as the rates of roll achievable can cause inertia coupling.

(b) Tailplane

Aircraft response to tailplane is sensitive, and pitch auto-stabilisation should be used to prevent over-controlling. The Q-feel mechanism ensures that the control column forces increase with an increase in airspeed and spring feel ensures that the stick force is proportional to displacement of the stick. When manoeuvring at high airspeed it should be noted that only small tailplane angles are required to achieve limiting G values.

(c) Rudder

(i) The Q-feel ensures that the rudder forces increase with increase in IAS. Rudder response is adequate for all normal manoeuvres. In asymmetric flight the forces are moderate but are reduced when the airbrake is extended (Chap. 4, para. 2(d)).

(ii) There are no limitations on the use of rudder trim. However, to avoid exceeding design limitations, further rudder angle must not be applied with the pedals after full trimming has taken place, except at low speed.

(d) *Airbrakes*

(i) The airbrakes are powerful in effect and take approximately 6 seconds for full movement. Full extension at high speeds causes considerable buffet.

(ii) Use of high power with airbrake more than half open may lead to skin cracking (pre-mod 1044).

(iii) During airbrake operation at high IAS, the airbrake position indicator may move erratically and, due to the momentary reduction of hydraulic pressure within the GS system, the following may occur:

The fuel inlet pressure and proportioner failure magnetic indicators may show temporarily cross-hatched, particularly if jettisoning fuel. The flowmeter may indicate zero.

NOTE: When flying on one engine the use of airbrakes decreases the foot load resulting from asymmetric power. Conversely, closing the airbrakes increases the rudder forces required for balanced flight. Therefore, when overshooting on one engine, the increase in foot load as the airbrakes close should be anticipated.

4 Autostabilisation

(a) The undamped stability characteristics of the aircraft make the use of autostabilisation essential if other than gentle manoeuvres are to be executed smoothly. Although the undamped stability of the aircraft is better at low altitudes, due to the dutch rolling characteristics of the aircraft in the approach configuration, autostabilisation is essential to ensure accurate control. Also at high speed, low level, pitch autostabilisation is essential for accurate height keeping and to avoid induced oscillations. High speed flight should not be attempted below 100 ft. with the tail-plane autostabiliser engaged because of the possible height loss should the autostabiliser malfunction.

(b) Either yaw autostabilisation or the yaw damper must be on at all times. The yaw damper is primarily a standby system and should not normally be used with the yaw autostabiliser, otherwise its life will be shortened.

(c) It can be seen from the above that, unless circumstances demand otherwise, all available autostabilisation should normally be used during flight.

5 Tailplane trimming

(a) The all-moving tailplane is trimmed by the datum shift method, in that the angle of the tailplane is varied whilst the control column always takes up the central (neutral) position when the tailplane stick forces are trimmed out. This neutral position of the control column is constant irrespective of the trim setting, thus when a stick force is trimmed out, the control column should be allowed to return to neutral as the trimmer is operated.

Continued on next page

(b) The tailplane trimmer is powerful and as the stick forces about the neutral position are light, accurate trimming is best achieved by operating the trimmer using short blips.

(c) Whenever the normal tailplane trim switch is released ensure that it returns to the central position.

(d) *Tailplane trim runaway*

If a runaway occurs, oppose it by moving the control column and by using the normal trim switch. If the normal trim switch is ineffective, try the standby trim switch. If at high speed, reduce speed as quickly as possible. If the trim runaway is nose-up, enter a steep turn to avoid an excessive nose-up attitude. If this proves ineffective instruct the observer to remove fuse F7/CQ and, thereafter, use standby trim. Yellow triangles on the adjacent fuse holder cover point to the correct fuse.

6 Trim changes

<i>Condition</i>	<i>Trim change</i>
Increase/decrease of power ...	Negligible
Undercarriage down ...	Very slightly nose-up
Extension of flaps/aileron droop/tailplane flap, blow on (levers operated together)	15-10-10 selected, slight nose-down 30-20-20 selected, slight nose-up 45-25-25 selected, slight nose-up
Blow off	Nose-up (marked at low airspeed)
Airbrakes out (low altitude, high IAS)	Slight yaw, then slight to moderate nose-up The degree of trim change increases with speed
Airbrakes in	Slight to moderate nose-down

At high Mach No. the trim change on airbrakes extension becomes negligible or slight nose-down.

7 Aileron droop and tailplane flap—emergency operation

(a) *Indications*

Failure of either aileron droop or tailplane flap, or both, to operate when selected.

Either service running away.

(b) Immediate action

Make a momentary up or down selection on either the aileron droop or tailplane flap standby selector. This isolates the normal actuators and prevents further movement of the surfaces.

(c) Considerations

The normal selector will be inoperative. The reset button must not be used to revert to the normal actuators. If any aileron droop or tailplane flap is selected separately, a trim change results, becoming severe if the separation exceeds 5°. Apparent small differences in flap/droop synchronisation may occur due to inaccuracies in the indicators.

WARNING: If the separation exceeds 10°, full tailplane movement plus full trim movement is insufficient to counteract the trim change, and longitudinal control of the aircraft may be lost until the separation is reduced.

(d) Subsequent actions

The aileron droop and tailplane flap can be lowered subsequently by the standby controls. This action uses the emergency battery, therefore the standby controls should be used with economy. Aileron droop and tailplane flap should be selected alternately in small steps to avoid excessive trim changes.

8 Rudder trim failure

If the rudder trim actuator "runs away", speed must be restricted to 300 knots at which speed the foot load is moderate and, if released, will not cause excessive yaw and thus overload the fin. At higher speeds excessive fin loading will occur. There is no standby rudder trimmer.

9 Rudder Q-feel failure

Indications

The starboard flying control hydraulic system may have failed. Rudder feel becomes light.

Considerations

The fin strength may easily be exceeded at high speed by only light rudder loads.

Action

No more than usual rudder deflections should be used. Yawing manoeuvres must be avoided.

10 Flying at reduced airspeed

Prolonged flight at reduced airspeed is most comfortable if it is carried out at 250 knots with a flap configuration of 15-10-10 selected and blow on. The autostabilisers should be set to APPROACH and the aileron gear-change selected to low speed (fully up). The use of blow is limited to 45 minutes per sortie. Approximately 85% RPM will be required, giving a fuel flow of about 100 lb./min.

11 Low-speed handling and stalling

(a) Deliberate stalling is prohibited. The approach to the stall, from straight and level flight, is permitted in the 0-0-0 configuration. It must not be continued beyond the ADD steady note, or the onset of buffet or intake banging, whichever is the earlier.

(b) *Minimum flying speeds*

The minimum permitted speed in the landing circuit is the datum speed for the relevant weight and configuration. Slow flying practice may be carried out in the landing configuration at the corresponding datum speeds minus 5 knots on either two engines or one engine observing the A_{UV} and blow limitations. It is recommended that slow flying practice be carried out in the following height bands:

Two engines (blow on)	5—15,000 ft.
One engine (blow on)	5—7,000 ft.
One or two engines (blow off)	Sea level—15,000 ft.
One or two engines (blow off, flapless configuration)	5—15,000 ft.
Two engines (blow on, flapless configuration)	5—15,000 ft.

NOTE 1: For blown configurations a minimum pressure of 20 psi must be available but see Chap. 3, para. 6, Notes.

NOTE 2: Above 15,000 ft. the handling characteristics and the blow effect are not representative. The minimum heights quoted are a safety consideration. This is relaxed in the unblown case to permit carrier approaches to be practised ashore.

(c) *Effects of blow on low speed handling*

(i) In the full landing configuration the stalling speed is dependent upon the amount of blow pressure available and occurs at 28-29 units on the ADD indicator (18-19° wing incidence). Behaviour at the stall varies but usually consists of a mild pitch up and wing drop. The stall is preceded by a region of very poor lateral control at ADD indications above 24 units.

(ii) At a given airspeed, reducing blow pressure has the effect of increasing wing incidence, thereby reducing the margin above the stall. Conversely, increasing the blow pressure reduces the wing incidence and increases the stall margin. Thus to maintain the stall margin at a given IAS, the blow pressure should be maintained as high as possible. For example, at a constant IAS, at 20 units ADD (approx. 10½° wing incidence) the effect of reducing the blow pressure from 30 PSI to 15 PSI will be to increase the incidence to approx. 22 units ADD reading.

◀(d) *Aerodynamic lateral imbalance in the launch configuration*

(i) Aerodynamic lateral imbalance, caused by a break-away of the airflow over the inboard surface of the wing, can occur in the launch configuration at high incidence. It has three progressive stages which can be classified as follows:

1. *Wing heavying*—A progressively increasing rolling movement as incidence is increased. The wing can be held up by applying aileron.

2. *Wing lowering*—A more rapid increase in rolling moment than in wing heavying, leading to wing drop. Corrective application of rudder or aileron will limit degree of wing drop. Having regained full control the incidence can be increased further before entering the next stage.

3. *Wing drop/incipient pitch up*—A sharper, more positive, moment often accompanied by pitch up. Recovery can only be effected by prompt forward movement of the control column, to reduce incidence.

The above definitions apply to level flight conditions; they are accentuated in banked/accelerated flight.

(ii) Onset of wing heavying normally occurs at an incidence 4°-5° above that achieved during a heavyweight airfield take-off or 2° above the incidence expected during▶

◀ a catapult launch at MLS. Increasing the incidence a further 2° brings the aircraft to the wing drop stage; normal recovery action is effective.

(iii) Carriage of underwing tanks causes a more sudden breakaway than with clean wings, and modified underwing tanks (mod 5193 and 5191 or 5192) produce a more sudden breakaway still.

(iv) The most likely occasions on which lateral imbalance will occur are:

Following accidental over-rotation after launch.

Following an over-trimmed launch.

During clean-up and acceleration after an engine failure. ▶

(e) *Stalling characteristics*

The following details are for information only:

(i) 30,000 ft. *clean aircraft with or without stores, AWW 42,000 lb.*

Aircraft trimmed at 200 knots, engines at idling RPM. As speed is reduced below 200 knots, both tailplane and aileron response deteriorate slightly. At approximately 190 knots (ADD 21 units) mild buffet begins and as the speed decreases the buffet increases rapidly to moderate intensity. At 170 knots (ADD 24 units) some wing rocking occurs which can be checked by use of rudder but not by ailerons, which are ineffective. As the speed decreases below 160 knots (ADD 26 units) the ailerons become effective again and the aircraft descends rapidly in heavy buffet. Normal recovery action is effective.

(ii) 6,000 ft., *blown 45-25-25 configuration, under-carriage down, AWW 40,000 lb.*

With full power on both engines the airbrakes buffet masks any natural stall warning. At 5 knots below datum speed there is some slight deterioration in control response. As speed is further reduced the rate of descent increases. At 5-10 knots below datum, control response becomes sluggish and the aircraft becomes difficult to trim and fly accurately. Small disturbances to the flight

path require large control movements to correct, and it is easy to over-control. At 30 knots below datum (ADD 29 units) a sharp wing drop and mild pitch-up occurs. Normal recovery action is effective. In the single-engined, blown 30-20-20 configuration, behaviour is similar.

(iii) 6,000 ft., unblown 45-10-10 configuration, under-carriage down, $\frac{1}{2}$ airbrakes, AUW 40,000 lb.

At approximately 15-20 knots below datum (ADD 27 units) a sharp wing-drop occurs without warning.

12 G-stalling

WARNING: Speed must not be reduced nor G applied beyond the ADD steady note or the onset of buffet or intake ◀banging or the limiting G. At speeds below 300 knots▶ buffet warning is reduced.

(a) As G is increased beyond a certain value buffet is induced. At high altitude it occurs at approximately $1\frac{1}{2}$ G (15-16 units ADD), but varies with AUW and Mach No. The onset of buffet is clearly defined throughout the speed range and its intensity increases with G until wing rock or wing drop occurs at approximately $\frac{1}{2}$ G beyond the onset of buffet (16-17 units ADD). The wing rock characteristic may become more marked at lower altitudes. In all cases recovery is immediate upon reducing G.

(b) At Mach 0.88 to 0.93, buffet is present in straight flight and an increase of G increases its intensity and eventually leads to mild wing drop. At speeds above 0.93M high G forces can be applied without buffet but the speed reduces rapidly.

(c) At low altitude below 300 knots, the onset of buffet is less marked and the increase in G is negligible. Due to the reduced Q-feel and the attendant light stick forces, care should be taken not to exceed the ADD audio limits.

13 Spinning

◀**WARNING:** Intentional spinning is prohibited.

(a) Normal swept-wing spin-recovery techniques are effective. A rate of descent of approximately 20,000 ft./min.▶

◀ can be expected and both engines may flame-out, with consequent loss of flying control power.

(b) *Consolidated Spin Recovery Action.* In the case of a condition of high and rapidly increasing angle of attack, or an incipient spin, the control column should be pushed positively forward (if necessary against the stops). Should there be no reduction of angle of attack and a spin develops, the following full spin recovery action is recommended:

(i) Apply full opposite rudder and, with the ailerons neutral move the control column progressively forward. The initial movement should be restricted to half the available travel and if incipient spin recovery action has previously been taken it may be necessary to move the control column *back* to achieve this position. An inverted spin may result if the control column is moved too far forward.

(ii) Close the throttles. Retract undercarriage, air-brakes, flaps and droop, and jettison external stores.

(iii) The spin is very oscillatory and in the latter stages of recovery the rotation rate may increase. Full recovery action must be maintained until rotation has finally ceased. Centralise the rudder immediately the rotation stops and allow the airspeed to increase to 250 knots before easing out of the dive.

(iv) If the aircraft does not appear to be responding to the recovery action, apply aileron in the direction of spin (i.e. away from the foot applying the rudder).

(v) If the aircraft is not under control at 15,000 feet AGL—*Eject.* ▶

14 Aerobatics

(a) Aerobatic manoeuvres must conform to the limitations laid down in Part II.

(b) *Rolling Manoeuvres*

WARNING: When full aileron is used, the rate of roll starts gently but increases rapidly. To avoid the effects of inertia cross-coupling (see para 15), abrupt reversal of roll should be avoided and the rolling limitations in Part II Chap. 1 must be observed. ▶

◀(i) *General.* As aileron is applied, slight adverse yaw is experienced; this should be accepted. The rudder should not be used coarsely in an attempt to control the yaw, or to keep the nose up when the wings are vertical. Use of rudder and/or tailplane to maintain an accurate flight path, following coarse use of aileron to initiate a rolling manoeuvre, can result in either excessive side-slip, negative-G, or a combination of both; any of these may lead to unpredictable manoeuvres with the risk of structural damage to the aircraft. At speeds above 500 knots manoeuvres should be carried out carefully because the adverse yaw becomes marked and the rudder is powerful in effect.

(ii) *360° Rolls in 1G Flight.* 360° rolls may be performed in 1G flight. Once the roll has been started no fore or aft movement of the control column must be made. Slight yaw and barrelling may be experienced; this should be accepted without correction. Subsequent correction to height should be made when the wings are level. If external stores are carried, the second half of a 360° roll must be completed with gentle and reduced use of aileron.

(iii) *Rolling at more than 1G Flight.* Simultaneous coarse application of tailplane and aileron must be avoided as this induces severe cross-coupling. Loss of control of the aircraft will almost certainly follow. To avoid the effects of cross-coupling, apply G and then the required amount of aileron. Subsequent alterations to the flight path may then be made by using the tail-plane and aileron together so long as the controls are used gently. It is emphasised that any increase in G should be made carefully.

(c) *Looping manoeuvres*

(i) Half loop manoeuvres only are permitted. ▶

(ii) The maximum entry altitudes (1013 mb. set) using a minimum entry speed of 530 knots can be obtained from Fig. A overleaf. The conditions set out are applicable to any external stores configuration and any stores in the bomb bay with the bomb bay doors open or closed. It can be seen that in ISA conditions at 48,000 lb. AWW the maximum entry altitude is 3,000 ft. and the minimum entry speed is 530 knots.

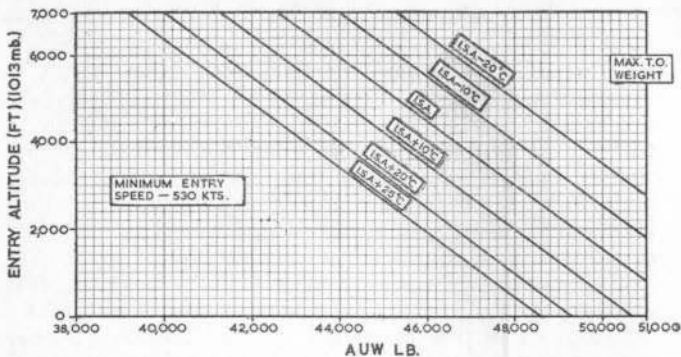


Fig. A—Maximum entry height for looping manoeuvre

NOTE: For altimeter settings above 1013 mb. add 30 ft./1 mb. For settings below 1013 mb. subtract 30 ft./1 mb.

(iii) The half loop should be performed either:

With the strike sight indicating a $7^\circ/\text{sec}$. pitch rate
or

By pulling the 4G accelerometer reading on entry and holding this until the ADD steady note is reached.

Continued on next page

(vi) Extension of the airbrakes at high IAS causes a noticeable nose-up change of trim with marked transient yaw and rapid deceleration.

(vii) Under ISA conditions at SL and 500 knots in the clean configuration about 91 % RPM will be required, giving a fuel flow of about 210 lb./min. With underwing tanks and other stores this increases to approximately 92 % RPM and 250 lb./min.

17 Engine failure in flight (clean)

(a) Mechanical

If an engine fails due to obvious mechanical causes, shut down the engine as follows:

Close the HP cock fully

Close the engine master cock

Switch off the generator of the affected engine

Manage the fuel as in Chap. 4, para. 3.

Do not attempt to relight

(b) Flame-out

If a flame-out occurs, a relight may be attempted immediately, while the RPM is decreasing, by pressing the relight button and moving the throttle to the ground idling position. If no relight occurs within 20 seconds, release the button and close the HP cock. Allow the engine to drain for one minute before proceeding with the Relight Procedure given in the FRC's.

(c) Double flame-out

Immediate actions

Press both relight buttons for 20 seconds.

Subsequent actions

If the immediate relight attempt is unsuccessful, switch off all unnecessary services.

Descend below 25,000 ft., reduce speed to 250 knots and carry out the normal relight procedure. If a relight is unobtainable, glide to a suitable area and abandon the aircraft.

Considerations

Provided that both engines are windmilling and control movements are kept to a minimum a sufficient degree of

control is afforded by the flying controls hydraulic systems at a minimum gliding speed of 250 knots. In any case the RPM should not be allowed to fall below 13%.

18 Descent

The airbrakes are very effective and allow steep descents to be made without increasing airspeed.

19 Flight in severe turbulence

The recommended speed for crew comfort considerations is 400 knots.

20 Flight in rain

The windscreen wiper provides reasonable vision in all but the heaviest rain. It must not be used on a dry windscreen or above 350 knots. The windscreen clearance air jet system may be used up to 250 knots at engine speeds below 90%.

21 Flight in icing conditions

(a) Engine and intake anti-icing

Flight in icing conditions should be avoided. Engine and air-intake anti-icing is fitted and should be used.

(b) Airframe anti-icing

Airframe anti-icing is not fitted. In emergency, use of wing and tailplane blow (by selecting 15-10-10) gives considerable protection from leading-edge icing. The speed limitation in this configuration is 280 knots.

(c) (i) Take-off and climb

In icing conditions, switch on the engine air-intake anti-icing and check the indicators. Climb as rapidly as possible and leave the anti-icing switched on until the aircraft has been in clear air for one minute.

(ii) Level flight and descent

If icing is encountered switch on the engine air-intake anti-icing and check the indicators. If flight in icing conditions is likely to exceed five minutes maintain not

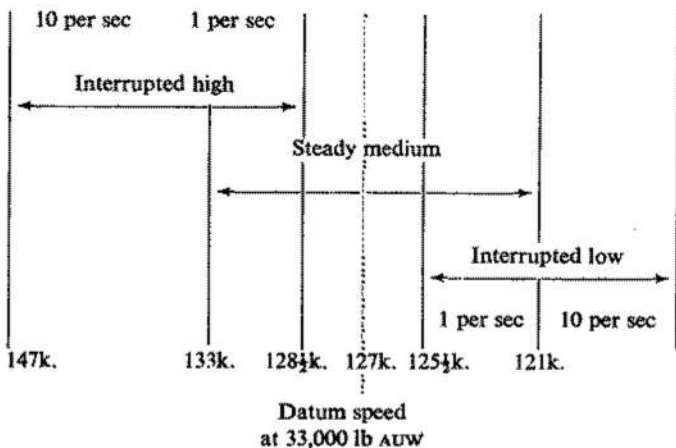
less than 0.8M and a minimum of 80% RPM. The anti-icing should be switched off after one minute in clear air. Flight in icing conditions at less than 0.8M and 80% RPM may result in an abnormal rise in TGT. If this occurs close the throttle to ground idle until the TGT falls, then select not less than 80% RPM. If a flame-out occurs an immediate relight may be carried out.

◀ **WARNING:** If the MI indicates O/P No. 2 anti-ice valve should be switched off to prevent overstressing of the duct. ▶

22 Airstream direction detector

(a) Audio tone pattern

With the aircraft in the 45-25-25 configuration, at 33,000 lb. AUW, the audio tone pattern is correctly set up when it corresponds to the speeds shown below. An allowance for weight variation must be made at the rate of 2 knots per 1,000 lb.



(b) *Calibration*

(i) To check the audio pattern and ADD indicator are correctly set up, the aircraft must be flown in the following conditions to ensure correct IAS/incidence relationship:—

Configuration: 45-25-25

Clean wing or pylons*

Undercarriage down

Full airbrake

Blow on

Weight: 35,000-37,000 lb.

Power: As necessary to maintain an indicated BLC pressure of 35 PSI.

Height: Commence at 2,500 ft. or below.

(ii) Smooth air conditions are essential and G must not be applied. Fly at approximately 2,500 ft. and reduce airspeed to about datum speed, then set up and maintain an accurate ADD indication of 20 units in a steady controlled descent; check that the rate-of-descent is approximately 700 ft./min. and that the steady audio note is obtained. Observe the reading of the deck landing ASI. When the ADD is correctly set up, this reading, corrected for instrument error only, and not for position error, should be within ± 3 knots of the calculated datum speed for the weight. When it is not, the ADD cannot be used as a stall warning device and must be adjusted on the ground ◀ in accordance with AP.101B-1202-1B. ▶

*If the ADD is calibrated with wing tanks on, the steady note should be obtained when the deck landing ASI, corrected for instrument error only, is reading within $\mp \frac{0}{8}$ knots of the calculated datum speed for the weight.

PART III—HANDLING

Chapter 3—CIRCUIT PROCEDURE AND LANDING

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1 Fuel allowance

An overshoot, circuit and landing requires approximately 500 lb. of fuel.

◀2 Joining

(a) Carry out the joining checks listed in the Flight Reference Cards.

(b) At the "break" position select $\frac{1}{2}$ airbrakes and turn downwind. When lowering aileron droop and tailplane▶ flap to the landing configuration, the selector should be moved only one stage at a time and the extension of droop and tailplane flap checked at each stage.

3 Downwind

(a) *Blown*

When the airspeed has reduced to 225 knots lower the undercarriage then, at 200 knots, select the configuration to 30-20-20. The airspeed will decrease to approximately 160 knots. Increase the RPM if required and carry out the "checks before landing".

(b) *Unblown*

When the airspeed has reduced to 225 knots lower the undercarriage and select the flap configuration to 30-10-10. Throttle back to 83% RPM. The airspeed will decrease to about 175 knots. Carry out the "checks before landing".

(c) An application of wheelbrakes during a down selection of the undercarriage must be avoided. A specific check should be made to ensure that no pressure is indicated at the brakes after the undercarriage is down. If pressure exists, the undercarriage should be recycled to eliminate it.

4 Checks before landing

Carry out the checks listed in the Flight Reference Cards.

5 Datum speeds

The datum speed is the correct speed for the approach and landing. It varies for different configurations and weights as shown in the following table.

<i>Flap configuration</i>		<i>Datum speed (knots)</i>
<i>Two engines</i>		<i>at 33,000 lb. AWW*</i>
45-25-25	Blow on	127
30-20-20	Blow on	130
0-25-25	Blow on	139
45-10-10	Blow off	139(Carr) 146(Airfield)
0-10-10	Blow off	158 (Airfield only)
<i>One engine</i>		
30-20-20	Blow on	133
45-10-10	Blow off	139(Carr) 146(Airfield)
0-10-10	Blow off	158 (Airfield only)

*For other weights adjust speed by 2 knots/1,000 lb.

Minimum blow pressure of 20 PSI must be available. The datum speeds above, approximate to the ADD steady note except for the two engines, 45-10-10, blow off, carrier

approach at 139 knots when the ADD note will indicate low speed and should be ignored. The aircraft is then to be flown referring to the ASI. In the 30-20-20 configuration the minimum permissible blow pressure is 15 PSI. In this configuration much larger throttle movements may be necessary to reduce any excess speed during an approach and care must be taken to ensure that the minimum blow pressure is maintained. ▶

6 Approach and landing with blow (Normal max. AUW 39,000 lb.)

NOTE 1: If the blow pressure is below approximately 30 PSI (ISA) it will not be possible to fly at both 20 units ADD and the calculated datum speed, since 20 units will then equate to some higher airspeed depending upon the actual blow pressure available. The aircraft should therefore be flown at the airspeed corresponding to 20 units.

NOTE 2: If the blow pressure available is below 20 PSI, an unblown approach should normally be made. However, if it is essential for recovery purposes to carry out a blown landing, the AUW should be reduced to the minimum practicable and the aircraft flown at the airspeed which equates to 20 units ADD.

(a) The turn onto the final approach should be made at 10 knots above datum speed (at approximately 20 units ADD) with $\frac{3}{4}$ airbrakes extended. Control response deteriorates in the landing configuration and, in turbulent conditions, care is required to prevent overcontrolling during corrections to the flight path. All control movements should, as far as possible, be made slowly and smoothly. When the glide path is intercepted select full airbrakes and reduce speed progressively to the datum, maintaining a minimum blow pressure of 20 PSI (approx 83% RPM) and observing the ADD limitations. Alterations to the power setting should normally be of the order 2% RPM and time allowed for these changes to take effect. Large power changes result in difficulty in establishing the datum speed quickly and accurately.

(b) Landing

(i) The no-cut technique should be adopted, the aircraft being flown on at the datum speed. The aircraft can be flared at these speeds but power should not be reduced appreciably before touchdown. If the throttles are closed before touchdown the resultant loss of blow causes a rapid sink, accompanied by a pitch up and possible wing drop. ▶

(ii) If the throttles are closed quickly immediately after touchdown, a slight increase in aircraft attitude results. After touchdown when sufficient runway length is available and/or the wind strength is significant, brake wear is reduced by holding the nose clear of the runway until the speed has decreased to 110 knots. Lower the nose gently at this speed, aiming to place it gently on the runway at approximately 95 knots. Nosewheel steering may be engaged as soon as all three wheels are firmly on the runway. From a landing at 33,000 lb. at datum speed and commencing braking at 90 knots, the application of 300/500 PSI brake pressure to each wheel results in a landing run of approximately 1,900-2,000 yards.

(iii) The anti-skid units normally prevent the wheels locking when excessive pressure is applied but, unless the shortest possible landing run is required, more gentle use of the brakes is recommended. If excessive brake pressures are used, tyre wear is increased. With the skid units operating, the landing run may feel slightly rough. The units need to be "spun-up" after touchdown and do not operate at maximum efficiency until the aircraft is firmly on the ground. They do not prevent scuffing of the tyres if brakes are applied immediately after the aircraft has landed. On both wet and dry surfaces with the anti-skid units operating, it is possible to scuff the tyres and/or lock the wheel if maximum brake pressure is continuously applied. If slip or skid is felt, or if difficulty is experienced in keeping straight, release the brakes momentarily. Continuous application of brake during slip or skid can lead to wheel locking with consequent scuffing and possible bursting of tyres.

(iv) At weights above the normal maximum landing weight of 39,000 lb., the minimum runway length should be 3,000 yards and, to avoid the possibility of bursting a tyre, the maximum use of aerodynamic braking should be made.

7 Approach in turbulent conditions

In turbulence, increase the datum speed by 5 knots. Control is improved by selecting the flap configuration 30-20-20 and using the appropriate datum speed plus 5 knots.

8 Approach and landing with an asymmetric store

(a) *Landing*

(i) Arrested landings in the 45-25-25 configuration may be made with underwing stores cleared for asymmetric carriage. A longer straight-away should be flown and care taken to avoid late corrections when lining up.

(ii) At approach speeds with asymmetric stores the aircraft has a tendency to overbank and yaw. These rolling and yawing moments should be fully trimmed out at the datum approach speed. The normal datum speeds should be used but care must be taken not to allow the speed to fall below these values. Turns away from the store require a moderately large application of rudder.

(iii) Under conditions of large ship movement and/or turbulence the available aileron and rudder deflection may be insufficient to allow the mirror glide-path to be maintained. If this occurs, the attempt to land should be abandoned and a further attempt made at a higher approach speed. If control is still inadequate divert, or jettison the asymmetric store.

(b) *Bolting*

At very low airspeed, e.g. prior to unstick, the aircraft has a tendency to yaw towards the store. If a "bolter" occurs this yaw should be anticipated and a gentle correction made.

9 Crosswind landings

(a) The maximum recommended crosswind component is 25 knots, but until experience is gained in handling the aircraft under crosswind conditions, normal operation should be limited to a 20 knot component. The crab technique is recommended. In turbulent crosswind conditions, control will be improved by using the flap/droop configuration 30-20-20.

(b) *Final approach*

Allow a slightly longer final approach than normal in order to stabilise the airspeed and drift. The final correction, to line up with the runway before touchdown, should be made firmly and smoothly. Gentle use of aileron is sufficient to counteract any tendency to roll.

(c) Landing

Immediately after touchdown lower the nose gently to the runway. In crosswind conditions there is a marked tendency for the "into wind" wing to lift if a nose-up attitude is maintained. After lowering the nose the nosewheel steering *must not* be engaged until the aircraft is firmly on the ground and the rudder bar is central. Sufficient rudder control is available to cater for the initial crosswind landing run and nosewheel steering need not be engaged until the speed has reduced to approximately 90 knots. The wheelbrakes should not be used until all three wheels are firmly on the ground

10 Approach and landing (without blow) (Normal max. AUV 39,000 lb.)

(a) Carry out the checks detailed in the Flight Reference Cards, but with the blow selected off and a flap configuration of 45-10-10. If the ADD is not switched off it reads in the low sector at datum speed.

(b) Make a wide circuit and long final approach. This eliminates the necessity for excessive bank in the circuit and allows ample time for the airspeed to be reduced. Complete the turn onto the final approach at 20 knots above datum speed. The airspeed will be in the region of 165-170 knots and, even with $\frac{3}{4}$ airbrakes extended, decreases comparatively slowly.

(c) A normal landing should be made. After touchdown use aerodynamic braking to reduce airspeed to below 120 knots before applying the wheelbrakes. The landing run is increased. At 33,000 lb AUV only moderate braking (1000 PSI/side) is required to stop within 2,500 yards in nil wind conditions at ISA. In the same conditions at 39,000 lb AUV the normal landing run will be almost 3,000 yards, decreasing to approx 2,200 yards if maximum braking is used. In crosswind conditions, when it may not be possible to use aerodynamic braking, the nosewheel should be lowered after touchdown and the airspeed allowed to decrease to below 120 knots before the brakes are applied.

11 Engine failure in the approach configuration (blown) (with or without wing tanks)

(a) If an engine fails in the blown configuration, loss of thrust and a reduction in blow pressure produces an immediate increase in incidence and a possible loss of speed of about 5 knots. Some height will be lost in regaining the new datum speed and in raising the flap configuration to

◀ permit an overshoot. At an AUV of 34,500 lb. an engine failure can be accepted during a normal blown approach, down to 200 ft., and still permit an overshoot or landing in ISA conditions. The height loss increases by approximately 25 ft. for each 10°C increase in ambient temperature above ISA. The rate of climb at 150 knots with undercarriage down is approximately 800 ft./min. At 39,000 lb. AUV an engine failure can be accepted down to 250 ft. The aircraft maintains height at datum speed in the blown configuration so long as the airbrakes are retracted. During the following recovery actions particular attention should be paid to keeping a 20 units ADD indication during each recovery phase. ▶

(b) Immediate actions if above safety height

If it is necessary to overshoot, ease the stick forward to increase speed to datum speed + 5 knots. (This new speed will be the datum speed for an equivalent single-engined approach). Open the throttle of the live engine to full power, at the same time closing the airbrakes. As the airbrakes close, the footload required to oppose yaw will increase. Select undercarriage up.

Raise the flap configuration to 30-20-20 initially; as the new datum speed is reached, rotate the aircraft to level flight.

As speed increases, raise the configuration to 15-10-10 and climb away.

(c) Immediate action if below safety height

To land, ease the stick forward to maintain at least the original datum speed. Open the throttle fully on the live engine, at the same time closing the airbrakes. Anticipate the yaw which increases as the airbrakes close. Do not raise the undercarriage.

(d) Subsequent actions

If it is apparent that a landing can be made on the runway or in a reasonable undershoot area, the approach should be continued. At least the original datum speed should be maintained. If it is unlikely that a landing can be achieved, an early decision to abandon the aircraft will have to be made.

◀12 Engine failure in the approach configuration (unblown) (with or without wing tanks)

If an engine fails in the unblown configuration some yaw results but the foot load required to counteract it is fairly light if the airbrakes are, at least, half out. At an AUV of 38,000 lb. in ISA conditions the height and speed loss should not exceed 200 ft. and 5 knots; below 38,000 lb. the expected height loss should not exceed 150 ft., decreasing with decreasing weight. The height loss increases by approximately 25 ft. for each 10°C increase in ambient temperature above ISA. During the recovery to level flight, 22 units ADD should not be exceeded. ▶

Immediate actions

Open the throttle of the live engine, retract the airbrakes and re-establish the datum speed. As the airbrakes retract, the foot load to oppose the yaw increases and becomes moderate; it should be anticipated. On regaining the datum speed, use the airbrakes as required and land.

13 Flapless landings

(a) The aircraft handles quite satisfactorily in the flapless configuration and landings may be made 0-25-25 (BLC ON) or 0-10-10 (BLC OFF).

NOTE: Deck landings in the flapless configuration with BLC off are not possible because of the high wind speed required over the deck.

The datum speeds for both carrier and airfield landings are detailed in the Flight Reference Cards and these speeds correspond to the ADD steady note.

(b) *Tailplane trim settings*

More nose-down trim is required than for a normal ◀approach, thus limiting the remaining nose-down tailplane movement. However, sufficient tailplane move-▶ment remains to permit an overshoot. The worst case likely to be encountered is with underwing tanks fitted in the 0-25-25 configuration with blow on. Up to 4° nosedown trim will be required at the limiting speed of 200 knots, thus reducing the nose-down tailplane movement to 4°.

NOTE: When extending the airbrakes at 200 knots full forward stick may be required.

(c) *Circuit*

After selecting the landing configuration the circuit should be flown at 10 knots above the approach speeds. De-

celeration is slow in the flapless configuration and care in speed control is required to achieve the correct approach speed. At no time should the aircraft be flown at less than the ADD steady note.

14 Instrument approaches

The settings given in the Flight Reference Cards are for the normal approach configurations. The datum speeds are the basic speeds and must be adjusted for weight.

15 Overshooting

(a) Open the throttles fully, selecting airbrakes in. Raise the nose and, when climbing, raise the undercarriage. At a safe height raise the flap configuration, in stages, observing that droop and tailplane flap movements are synchronised. ◀Carry out the After Take-off checks given in the FRC's.▶

(b) If an further circuit is intended, the aircraft can be climbed away in the landing configuration with the airbrakes closed.

16 Deck landing (blown)

WARNING: If full power is applied at, or just before, touch-down when carrying out normal twin-engined deck landings into the Mk. 13 arrester gear, a significant increase in the total energy to be absorbed by the gear will result and may cause the engaged unit to be tracted to the full extent of its pull-out. This is likely to overload and cause a failure of the unit. Approach power is to be held until a positive retardation is felt following wire pick-up when the power is to be cut to idle. This warning is not applicable to single-engine landings.

WARNING 2: It is dangerous to attempt to take a very late wave-off because this may result in an inadvertent hook-on with full power applied. If this occurs there will be a very large increase in the energy input into the gear and the maximum G-loading on the aircraft is likely to be exceeded.

(a) (i) In the 45-25-25 configuration the aircraft is pleasant to fly on a deck-landing approach. It has a good view and positive stability in all axes. Speed control and alignment are straightforward but require some anticipation.

(ii) The large aileron deflections attained with droop cause adverse aileron yaw (yaw towards the downgoing aileron). This requires co-ordinated use of rudder and aileron which, in turn, ensures a more rapid response when making alignment corrections.

(iii) During an approach the BLC pressure is normally between 30 and 38 PSI depending upon the ambient temperature and the RPM in use. The use of full airbrakes is recommended; this requires more thrust and thus maintains higher BLC pressures. Full airbrakes give rise to noticeable airbrakes buffet which increases as power is increased. Increased airbrakes also require more nose-up trim.

(iv) Reduced speed approaches (datum-3 knots) entail no significant problems but speed control becomes slightly more difficult. The ADD audio will be in the low sector and read about 21 units.

(b) At about 35,000 lb. AWW, approximately 87% PRM is required to maintain the datum speed with full airbrake in use. The use of full airbrakes causes an increase in buffet but the increase in RPM required to offset the extra drag results in slightly higher blow pressures.

(c) The bleed valves open at approximately 83% RPM. Small throttle movements at and below this setting cause the blow pressure to decrease rapidly. This leads to a moderate but definite nose-up pitch, a deterioration in speed control and an immediate loss of height. Care should therefore be taken not to reduce RPM immediately prior to touchdown. A distinct change in engine note occurs when the power is reduced below approximately 83% RPM with the engine bleed valves open; this is useful as a warning of impending low blow pressure.

(d) After landing the aircraft pitches nose down and should a bolter occur it may be difficult to rotate the

aircraft during the deck run and the nosewheel may not raise, particularly if the nose has pitched down during the landing. If this occurs, the aircraft will still fly off after a bolter but in a flat attitude. When attempting to raise the nosewheel only small rearward stick movement from the trimmed approach position should be made. This ensures that the tailplane will be close to the position required for flight after leaving the deck. Care must be taken not to apply excessive back stick as this delays tailplane response and may result in excessive nose-up rotation after leaving the deck. In IMC the aircraft should be rotated to the same attitude as used for the launch. ▶

(e) With a 1000 lb. asymmetric store on an outer wing station an approach and landing can be made at datum speed without difficulty. It will be necessary to carry full opposite aileron trim and approximately $\frac{1}{2}$ opposite rudder trim.



17 Deck landing (unblown)

(a) Configuration 45-10-10 (with or without external tanks).

(b) It is important to establish the final approach speed as soon as the final turn has been completed, since throttle movements to control the airspeed are likely to be larger than normal. Control of speed becomes more difficult if the approach is made at speeds higher than datum. The ADD audio will be reading in the low sector (approximately $21\frac{1}{2}$ units ADD). ▶

(c) There is a deterioration in lateral control. Nevertheless control is adequate for all normal manoeuvres. If the ship is 'fishtailing', lining up may be difficult and large corrections to line up in the latter stages of an approach should be avoided.

(d) The aircraft pitches forward on touchdown. If a bolter occurs, the advice in para. 16(d) should be followed. On becoming airborne over the forward end of the angle it will be necessary to correct the roll caused by the 'cliff edge' effect.

18 Deck landing without tailplane blow

(a) If a tailplane blow failure occurs the aircraft is to be landed in the 30-20-20 configuration. This is because the tailplane trim required during an approach, with a tailplane blow failure, in the 45-25-25 configuration, places the tailplane at or near its maximum lift position and further nose-up trim or rearward stick movement could result in a marked reduction in tailplane lift and therefore a loss of tailplane effectiveness.

(b) In the 30-20-20 configuration at datum speed (130 knots at 33,000 lb. AUV) there is adequate margin between the maximum lift tailplane position and the trimmed approach position to allow adequate control during the approach phase. However a bolter at this datum speed is likely to be hazardous as it will be impossible to raise the nosewheel during the deck run. Furthermore, large rearward movements of the stick will stall the tailplane and the recovery from this situation and the rotation required on leaving the deck will invariably involve a large loss of height. (See para. 16(d)).

(c) At AUV's of 35,000 lb. and below, the nosewheel raise speed is approximately 140 knots therefore a datum approach speed of 139 knots (at 33,000 lb. AUV) should be used whenever possible. If the wind-over-the-deck conditions demand a lower entry speed into the wires, the datum speed may be reduced to a minimum of 130 knots (at 33,000 lb.).

◀ **WARNING:** As the datum speed is reduced below 139 knots it will become increasingly more difficult to carry out a bolter.

(d) When landing in the 30-20-20 configuration, much larger throttle movements are necessary to reduce excess speed on the approach. Unless care is taken there is a danger of reducing the blow pressure to below the 15 psi allowed in this configuration, when throttling back. This must be avoided and full airbrake should be used to assist in maintaining high approach power settings and, therefore, blow pressures above the minimum. ▶

19 Checks after landing

Carry out the checks after landing listed in the Flight Reference Cards.

20 Shut-down procedure

Carry out the sbut-down checks listed in the Flight Reference cards.

PART III—HANDLING

Chapter 4—ASYMMETRIC FLYING

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1 Stopping one engine

WARNING: Flight in icing conditions must be avoided owing to lack of anti-icing protection on the dead engine.

For asymmetric flying:

Close the HP cock

Switch off the generator on the failed side

Manage the fuel as in para. 3.

2 Single-engine flying

(a) (i) In the clean configuration and with all standards of engines, the aircraft may be flown on one engine throughout the full flight envelope.

(ii) With blow on, practice single-engine flying is limited to below 7,000 ft. and to 45 mins. cumulative time in any one sortie.

◀(iii) In the single-engined approach configuration the AUV must not be more than:

Ashore — 36,000 lb at ISA reducing linearly to
34,000 lb at ISA + 25°C

Afloat — 35,000 lb at ISA reducing linearly to
34,000 lb at ISA + 25°C ▶

(iv) For minimum practice speeds in the approach configurations refer to Chap. 2, para. 11(b).

(b) Flying controls

(i) The single remaining flying control hydraulic system will fulfil all normal demands, but the power of the PFCU's is reduced and response to a sudden demand is slower.

(ii) The flying control integration valves permit General Services hydraulic pressure to be applied to either of the flying controls systems in the event of a failure of the system driven by the live engine. Integration of the hydraulic systems should take place in emergency only. Speeds are then limited to 350 knots or 0.6M.

(c) *Services lost*

(i) *Port engine stopped*

Roll autostabiliser on the port aileron

Pitch and yaw stabilisation

Autopilot on the port aileron and tailplane.

NOTE 1: A windmilling speed of at least 13% ensures that the port hydraulic system remains operative therefore the above services may not be lost.

NOTE 2: The standby yaw damper remains available and must be switched on if the port hydraulic system is inoperative.

(ii) *Starboard engine stopped*

Roll autostabiliser on starboard aileron

Standby yaw damper

Autopilot on the starboard aileron

Q-feel

NOTE 1: See Note 1 above.

NOTE 2: Spring-feel is retained in the tailplane and rudder.

(d) *Handling*

With the port engine stopped, the standby yaw damper must be switched on (but see notes 1 and 2 above). It is not possible to trim out all the foot load on the rudder during the circuit and landing. Foot load varies with speed and configuration but does not exceed approximately 90 lb. using full rudder at circuit speeds. Extending the airbrakes tends to decrease the foot load required to maintain balanced flight. Approximately $\frac{1}{4}$ rudder is required to maintain datum speed with half airbrake extended. Due to foot loads prolonged asymmetric flight under circuit conditions is tiring, pre-mod 1045; post-mod 1045 the foot loads can be trimmed out. Do not exceed the trim limits detailed in Ch. 2, para. 3(c)(ii).

3 Fuel management

Use the fuel from the dead-engine side by opening the inter-tank-transfer valves and then switching off the FNA valves on the live-engine side. Re-open the FNA valves on the live-engine side before the contents of any master tank

on the dead-engine side drops to 75 lb.; then immediately close the inter-tank-transfer valves. Any fuel remaining on the dead-engine side is now unusable.

4 Single-engine circuit and landing (blown)

◀ **WARNING:** For maximum weights refer to para. 2(a) (iii). ▶

(a) Circuit

Fly the downwind leg at 1,000 ft. AGL in the normal way, with flap configuration 30-20-20, blow on, maintaining at least 15 PSI blow pressure (approx. 89% RPM). Lower the undercarriage. Adjust the speed by use of airbrakes, aiming to turn crosswind at 10 knots above datum speed.

(b) Approach datum landing

(i) Make a gentle turn onto a long straight approach. Select about $\frac{3}{4}$ airbrakes when on the sight glide path. Adjust the airbrakes position to give the correct datum speed and follow the sight glide path. Engine RPM should not be reduced below about 89% which will maintain the minimum permissible blow pressure of 15 PSI. Because ▶ high engine RPM are required to maintain blow pressures, datum speed should be established early as it is difficult to reduce speed at later stages without the attendant low RPM and low blow pressures.

(ii) A normal power-on landing should be made.

5 Overshoot (blown)

(a) The aircraft will overshoot on one engine in the flap configuration 30-20-20, blow on, at the datum speed, provided the airbrakes are fully in and the undercarriage retracted. Below 35,000 lb. AUV the aircraft has a touch and go capability in ISA conditions.

(b) The speed must not be allowed to fall below the correct datum speed on the approach, or during an overshoot, otherwise the subsequent climb performance is adversely affected. Moderate yaw occurs as power is increased and the airbrakes retracted; this should be anticipated.

(c) *To overshoot, proceed as follows:*

Open the throttle fully on the live engine

Close the airbrakes

Raise the undercarriage

Climb initially at datum speed.

6 Single-engine circuit and landing (unblown)

(a) *Circuit*

Fly the downwind leg at 1,000 ft. AGL with the flap configuration 30-10-10, blow off, maintaining at least 89% RPM. Lower the undercarriage. Adjust the speed by use of airbrakes. Select the flap configuration to 45-10-10, aiming to turn crosswind at 10-15 knots above datum speed.

(b) *Approach and landing*

ALW (i) Make a gentle turn onto a long straight approach. Select $\frac{1}{4}$ airbrake when on the sight glidepath. Adjust the airbrake position to give the correct datum speed and follow the sight glidepath. Reducing speed in the unblown configuration is difficult and datum speed should be got as early as possible on the approach. Excessive reductions in RPM settings are likely to cause high rates of descent. If full airbrake is extended to control the speed, buffet will increase. This is slightly uncomfortable and distracting. It is recommended that the use of air brakes should be limited to $\frac{3}{4}$.

(ii) A normal power-on landing should be made, taking care not to apply the wheelbrakes at speeds in excess of 120 knots.

7 Overshoot (unblown)

(a) The aircraft will overshoot on one engine in the flap configuration 45-10-10 at datum speed with the undercarriage down. As power is increased and the airbrakes retracted, the aircraft yaws rapidly unless prompt corrective action is taken. The foot load required to oppose the yaw is moderate and should be anticipated.

(b) The aircraft will touch and go on one engine in ISA conditions and the same observations as in (a) apply.

(c) The speed must not be allowed to fall below the correct datum speed on the approach, or during the overshoot, otherwise the subsequent climb performance is adversely affected.

8 Relight procedure

(a) Immediate relights may be obtained up to 40,000 ft. Cold relights should be possible up to a minimum of 25,000 ft. Engine acceleration may be assisted by increasing forward speed. To ensure a reasonable chance of relighting, descend to below 25,000 ft. and adjust speed to 250 to 300 knots. During relight the TGT should be monitored carefully until the engine has accelerated satisfactorily from idling. To confirm a complete relight has been obtained the engine should be accelerated to full power before selecting the required RPM.

(b) Check the engine master cock is on. Press the relight button and open the HP cock to the ground-idle position. Light-up should occur within 10 secs. and idling RPM achieved in approximately 45 secs. When the RPM or TGT start to rise, release the relight button. Switch on the generator. When the engine runs satisfactorily, open up slowly to the desired RPM. If no relight is achieved after 20 seconds, release the relight button and close the HP cock. Alternatively, if a relight is achieved but, after one minute the engine appears unlikely to pull away, close the HP cock. Wait at least one minute before making a second attempt, to allow excess fuel to drain.

(c) *During the relight, check:*

TGT	Not above 600°C (535°C Spey 3119)
Oil pressure MI	To HIGH when RPM are increased.
Fire warning light	Out
Flying controls pressure	3300 PSI

9 Deck landing, single-engine (blown)

(a) Configuration 30-20-20, blow on. Maximum AUV 35,000 lb. at ISA, reducing linearly to 34,000 lb. at ISA + 25°C.

(b) Fly the circuit normally, aiming to be downwind 10-15 knots above datum speed. Datum speed should be established as soon as possible after rolling out of the final turn onto the final approach. With $\frac{1}{2}$ airbrake extended, approximately 92% RPM is required during the final approach; the

speed should be monitored carefully and large reductions in throttle setting avoided to prevent large reductions in blow pressures. Careful throttle handling is required to maintain blow pressures in excess of the recommended minimum of ◀15 PSI. Full rudder trim and a small foot pressure are▶ necessary to maintain balanced flight during the approach. To minimise the delay in obtaining maximum available thrust in the event of a bolter when carrying out single-engine deck landings full power on the live engine is to be applied at the instant of touchdown. It is to be cut to idle only when a positive retardation is felt.

(c) Under ISA + 25°C conditions at the maximum AUV of 34,000 lb. an overshoot is possible at any stage of the approach without loss of height provided that the aircraft is rotated positively to achieve a reading of 21 units on the ADD indicator. With airbrake retracted, full rudder trim and about $\frac{3}{4}$ rudder deflection is necessary to stop the aircraft skidding. With $\frac{1}{2}$ airbrake and the undercarriage down the aircraft will climb at 150 knots. After raising the undercarriage and retracting the airbrake increase to 160 knots and retract the flaps and droop in stages.

PART III—HANDLING

Chapter 5—AIR TO AIR REFUELLING

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1 Air to air refuelling, receiver role

(a) Air to air refuelling in the receiver role is permitted, within the height band 2,000 to 35,000 ft. and speed range 230-290 knots, against Scimitar, Sea Vixen, Buccaneer and Victor tankers by day and night. The tankers must be equipped with Mk. 20A, B, C or E pods or Mk. 17 hose drum unit fitted with collapsible drogues. ▶

(b) Checks before contact

Select air to air refuelling switch ON (OFF for dry contacts). Observer check overload fuel transfer switches OFF.

If the refuelling switch is not set on until after contact is made, high surge pressures will be experienced when it is set on.

(c) Approach and making contact

◀ **WARNING:** Engine malfunctioning may occur if the drogue is allowed to approach the engine intakes. ▶

(i) Making contact below 20,000 ft. is straightforward at the recommended speed of 260 knots. When the tanker is ready, smoothly fly the aircraft towards the drogue in a slight climb, with an overtaking speed of 2-3 knots. To reduce any tendency to follow the small random move-

ments of the drogue it is advisable not to focus on the drogue but to look through it at the tanker aircraft. Last-minute corrections to the flight path are usually unnecessary and should be avoided as they are likely to impose heavy loads on the drogue after contact.

(ii) Above 20,000 ft. making contact becomes progressively more difficult with increasing altitude and this increases the risk of damage due to the drogue striking the radome. When approaching the drogue for contact above 20,000 ft., control is easier if the ROLL and YAW channels of the autostabilisers are selected to APPROACH. In the event of a missed contact, throttle back and ease back about 5 yards, then make another approach.

(d) *In contact*

(i) Whilst in contact, normal formation flying techniques should be employed. With a Sea Vixen tanker, fly at the normal trailing position of the hose; with a Scimitar tanker it is more comfortable to fly at about 4 ft. below this position in order to take the receiver's tailplane out of the tanker's jet wake.

(ii) *Fuel contents indications*

The pounds remaining indicator "winds up" while refuelling is taking place and indicates total contents at any time. While receiving fuel, check the fuel contents gauges at an early stage to ensure that fuel is being received in each of the four master/slave tank combinations. In the event of a refuel valve failure it is not possible to get fuel into the affected master/slave combination. If wing tanks are carried, they fill automatically after all internal tanks are full. The fuel contents for the wing tanks may be monitored from the observer's cockpit. When all tanks are full, the amber light by the hose reel comes on.

NOTE: Mod 956 is intended to obviate out-of-balance between fuselage tanks whilst receiving fuel. Pre-mod 956 out-of-balance may occur if probe/drogue contact is broken before the main fuselage tanks are full.

(e) *Breaking contact*

When refuelling is complete, withdraw slowly by reducing power. Take care to fly slightly below the trailing line of the hose. This is important in order to avoid the danger of the receiver's radome being struck by the drogue after withdrawal. If the receiver aircraft disengages from the drogue before the hose reaches the fully trailed position, heavy loads will be thrown on the brake mechanism. This can

result in the loss of the hose on either this or subsequent withdrawals. Therefore on withdrawal, every effort should be made not to exceed 3 knots opening speed. This will ensure that the hose winds out to full trail before disengagement occurs. If the withdrawal is not very slow, premature disengagement can occur without either the receiver or the tanker pilot being aware of it. Emergency breakaway practices are not to be carried out.

When clear, select:

- Air to air refuelling switch ... OFF
 Overload fuel transfer switch ... ON (if appropriate)

(f) *Refuel valve failure*

It is possible for a single refuel valve failure to occur, resulting in one set of fuselage tanks failing to receive fuel. Subsequent engine demand could empty the affected tanks. Since the automatic shut-off of the fuel-no-air valve cannot be relied on, two proportioner cells could run dry and air would be admitted to the engine fuel system.

(g) *Action in the event of a refuel valve failure*

(i) If a refuel valve failure occurs, the FNA valve of the affected tank should be closed and the inter-tank transfer valves opened, before the tank runs dry. This ensures that the affected proportioner cells are supplied with fuel from the adjacent master tank.

(ii) *Further considerations*

With the inter-tank transfer valves open it is possible that the other pair of main tanks may go out-of-balance due to a difference in heads of fuel. If this occurs, the fuel gauges must be monitored carefully and a reasonable balance maintained by closing the appropriate FNA valve.

2 Air to air refuelling, tanker role

NOTE 1: To avoid damage to the hydraulic pump seal due to cold soaking, when a two-bladed turbine is fitted, the master switch should be selected on for ten minutes in every sortie, providing there is sufficient internal fuel for complete safety i.e. enough to allow for transfer to the pod.

◀NOTE 2: 1100 lb of fuel is transferred to the pod when the master switch is selected on. ▶

(a) *Carriage limitations (hose stowed)*

Speed: 450 knots up to 0.8M.
 380 knots between 0.8M and 0.90M.

Rolling: Moderate rates of roll may be used so long as 60° bank is not exceeded and the indicated G is not less than +1G and not more than +3G.

(b) Carriage limitations (hose trailing)

The hose may be trailed in level flight only.

Minimum speed: 230 knots

Maximum speed: 290 knots up to 25,000 ft. decreasing linearly to 250 knots at 40,000 ft.

To prevent fuel venting, fuel should not be transferred from the aircraft system into the pod tank when the aircraft is in a climbing attitude.

3 Checks

(a) Pre-flight checks

Check the refuelling panel as follows:

FUEL GONE counters	...	...	Zero
WIND/TRAIL switch	...	...	Wind
FUEL JETTISON switch	...	...	Off
EMERGENCY TRAIL/HOSE RELEASE	...	...	Central
POD FUEL LEVEL indicator	....	...	Max
FUEL SELECTION dials	...	...	Zero
Circuit breakers	...	...	Made
REFUEL LTS—DAY/NIGHT switch	...	...	As required
EMERGENCY signal switch...	...	...	Off
MASTER switch	...	...	On
TRANSFER SYSTEM MI	...	...	Arrow to REFUELLING

The following lights should be illuminated:—

HYDRAULIC POWER FAILURE light

BRAKE-ON light

HOSE-IN light

Red signal light

Press to test the HIGH fuel pressure light and the amber and green signal lights. Select the MASTER switch off.

TRANSFER MI NORMAL.

(b) Checks after take-off

Wing tanks transfer switch	...	...	ON
MASTER switch	...	...	ON (at not less than 230 knots)
HYD POWER FAIL light	...	...	Out (if on, hose must not be trailed)
Red signal light	...	...	On
White HOSE-IN light	...	...	On
Blue BRAKE-ON light	...	...	On
TRANSFER SYSTEM MI	...	...	REFUELLING

Select the master switch off to allow the pod to be used as a normal underwing tank.

4 Trailing the hose

◀ Select the MASTER switch on. Select TRAIL and fly at 230-250 knots. Check the following lights:

BRAKE-ON light	...	...	Out
HOSE-IN light	...	...	Flashes intermittently, then out
Red signal light	...	...	On

(b) At full trail, the red light goes out and the amber light comes on. Maintain speed between 250 and 280 knots whilst making contact and whilst passing fuel. If the red signal light goes out before the tanker crew is ready for contact use the EMERGENCY SIGNAL switch to retain the red light until ready.

WARNING: When either a wind or trail selection has been made the operation of the hose and drogue must be completed before a re-selection is made, otherwise the drogue and hose assembly may be lost. ▶

5 Transferring fuel

(a) Select the amount to be transferred or MANUAL on the selector dials on the control panel and check that the POD FUEL LEVEL indicator shows MAX. Two minutes must elapse between switching on the master switch and commencing fuel transfer, to allow the fuel integrators (fuel gone counters) to warm up.

(b) Check that the emergency signal switch is off. The amber light shows, giving the receiver aircraft clearance to make contact.

(c) Smooth flying is necessary at this stage to enable the receiver pilot to make a successful contact.

(d) The contact is normally felt in the tanker. When the hose has wound in 5 to 7 ft. the amber light goes out, the green refuel light shows and, provided the receiver aircraft has the flight refuelling switch on, fuel transfer begins.

(e) If the high fuel pressure warning light comes on, press the light in an attempt to reset the system. If the light remains on, signal to the receiver to break away. Reset the system and allow the receiver to make another contact. If the fault persists, refuelling must be discontinued.

(f) When the pod is empty, flow to the receiver ceases, the green light is replaced by the amber light and the pod fuel level magnetic indicator shows MIN. When the pod is approximately half refilled the MIN indication disappears and flow to the receiver recommences. The green light then replaces the amber light. If the receiver is not in contact, the pod fills completely and MAX shows on the pod fuel level magnetic indicator.

◀(g) The rate of fuel transfer is approximately 1,150 lb./min. for the first four minutes, thereafter 900 lb./min.▶

(h) If it is necessary to discontinue refuelling, switch on the EMERGENCY SIGNAL. The red stand-off light comes on and the receiver aircraft must break contact immediately.

6 Breaking contact

When fuel transfer is complete, indicated by the green light going out, the amber light illuminating and the fuel selection dials reading zero, switch on the EMERGENCY signal. When the receiver breaks contact, the pod re-fills and MAX shows on the magnetic indicator. Withdrawal of the receiver can usually be felt in the tanker.

7 Winding in the hose

(a) Select the WIND/TRAIL switch to WIND. The hydraulic POWER FAILURE light comes on. The hose takes about 15 seconds to wind in.

(b) When the hose is stowed, the blue BRAKE light and the HOSE IN light comes on. Switch off the EMERGENCY SIGNAL and MASTER switches and set the FUEL SELECTION dials to zero.

(c) The pod now functions as a normal underwing tank.

(d) If the hose does not wind in when selected, relieve the air load on the drogue by reducing speed to a safe minimum, switch to TRAIL for 5 seconds and then switch to WIND again.

◀ Tanker Role Malfunctions ▶

8 General ▶

(a) If the brake light comes on whilst the hose is trailing, indicating that the hose is not fully trailed, refuelling should not normally take place. In this condition, during contact, the hose winds in but does not retrail and contact may be broken.

(b) If the hose parts, switch off the master switch immediately, to prevent loss of fuel.

(c) *Hose jettison*

If the hydraulic POWER FAIL and BRAKE lights come on when the hose is trailed, or being trailed, the hose cannot be wound in; it must be jettisoned before landing. Select TRAIL and EMERGENCY TRAIL. The BRAKE light cycles on and off until the hose is fully trailed when the amber light comes on and the brake light goes out. Set the FUEL SELECTION dials to zero and at a speed of 230 knots select HOSE RELEASE, to jettison the hose. Switch off the EMERGENCY SIGNAL and MASTER switches.

◀9 **Failure of pod supply valves to open**

If this occurs the only fuel available for transfer will be that already in the pod. Diagnosis of this condition can only be made by reference to the pod tank fuel contents indicator which will quickly show MIN and fail to move through black, at mid-level, to MAX. The green light (on the multi-light indicator) may or may not illuminate depending on whether the cause of the defect is mechanical or electrical.

10 Hydraulic failures

(a) *Hose stowed*

The hose must not be streamed if the HYD POWER FAIL warning light is on.

(b) *Hose streamed*

(i) If failure occurs during contact, fuel will stop flowing. The green light will go out, the emergency red, hydraulic failure and amber lights will come on. (The blue brake light will come on if the hose is not at full trail.)

(ii) Attempt to wind in the hose normally. If the hose fails to wind in, select the master switch to OFF; depending upon the actual failure that has occurred, the hose may wind in.

(iii) If the hose cannot be wound in, re-select the master switch to ON and jettison the hose (see sub-para. (e)).

11 Drogue breaks off

(a) If the drogue breaks off the hose will be quickly wound in (approx. 3 secs.). ▶

(b) Provided the reception coupling is retained the hose will be stowed normally, the BRAKE ON light appearing on completion. Select all switches OFF.

(c) If the complete drogue assembly breaks off, or the hose parts, the hose will probably wind in before any action can be taken. Immediately the failure is apparent select the master switch to OFF. Some internal damage may occur in the pod.

12 Receiver nozzle lodged in coupling

Select fuel counters to zero; this will minimise loss of fuel from the pod. It may be possible to wind in the hose normally; if not it should be jettisoned.

13 Hose fails to trail fully

If, following an attempt to trail the hose, the amber light fails to appear thus indicating that the hose has not trailed fully, select WIND and then make a further attempt to trail. If the hose will not trail fully, no attempt at contact should be made, as a whip may develop in the hose with the associated risk of breaking off the receiving aircraft's probe.

14 Hose fails to wind in

If the hose fails to wind in, reduce airspeed to a suitable minimum before making a further attempt. If this is unsuccessful alternate applications of positive and negative G may assist in winding in.

15 Pod fuel jettison (hose stowed)

Set the master switch on and operate the jettison switch. When the pod tank fuel indicator shows MIN, switch off the jettison and master switches. If the master switch is not switched off, the pod will refill from the aircraft tanks.

16 Failure of fuel to flow following normal contact

If, following an apparently normal contact and the appearance of the green light, no fuel is transferred to the receiver, then:

1. The receiving aircraft should check all relevant switches.
2. The fault may be a 'soft' contact, and the receiver should withdraw and make a further contact.
3. If fuel still fails to transfer, a fault in the pod is probable and no remedial action is possible. ▶

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