PART 3

HANDLING

PART 3

HANDLING

MANAGEMENT OF SYSTEMS

103. Management of the fuel system

(1) Start the engines with the PORT and STBD. FUEL PUMPS switches forward, *i.e.*, PORT to NO.1 ENG. and STBD. to NO.2 ENG. Unequal fuel consumption in flight can be balanced by reversing the above selection or by asymmetric use of power. For single engine running, both systems will feed one engine if both switches are selected accordingly.

(2) In the event of emergency landings with indicated fuel below 400 lb per side, care should be taken to avoid sideslip as this can result in increase of unusable fuel.

(3) No positive indication is given if fuel should fail to transfer from the ventral tank. This could be detected by the ventral tank empty indicator remaining white together with increased fuel consumption from the wing tank systems. Owing to the c.g. moving further aft than normal, the precautions given in Part 4 - Emergency Handling should be observed.

(4) During inverted flight or under negative 'g' conditions the fuel pumps are uncovered and cease to deliver fuel; the air supply to each recuperator inflates the rubber bag, discharging the recuperator contents (39 lb) to the respective engine. On returning to normal flying attitudes, the pumps require approximately 15 sec to recharge the recuperator. During this time they are able to supply the fuel requirements of the engines through a bypass annulus in the recuperator.

(5) In an I.C.A.N. atmosphere at sea level and maximum speed, the recuperators will discharge in 4 sec with maximum reheat and 9 sec in maximum cold running. These times will improve with increase in altitude and decrease in Mach number, and will be increased or decreased in a warmer or colder atmosphere, respectively.

RECUPERATOR DISCHARGE TIMES IN SECONDS

I.C.A.N. ATMOSPHERE

	MAX. REHEAT				MAX. COLD			
ALTITUDE IN FT	700 KNOTS	MACH 1.7	MACH 1.3	MACH 0.9	700 KNOTS	MACH 1.7	MACH 1.3	MACH 0.9
SEA LEVEL	4.0			4.5	9.0			10.0
10,000	4.5			5.5	10.5			13.0
20,000	5.0		6.0	8.0	12.0		13.0	18.0
30,000		5.5	8.0	12.0		13.5	18.0	26.0
40,000		8.5	12.5	17.5		20.0	27.0	39.0
50,000		14.0	19.5	24.5		32.0	45.0	59.0

(6) The booster pumps require an a.c. supply and operate when the air turbine reaches its governed speed. If the a.c. power should fail, the engines will continue to suck fuel assisted by the d.c. pumps but engine and aircraft speed should be kept as low as practicable. Unusable fuel will increase considerably under these conditions. The fuel pressure warning indicators on the auxiliary warnings panel may show white. For recommended action to be taken refer to Part 4 - Emergency Handling.

104. Engine handling - ground running

(1) If j.p.t. should reach 700 deg.C during starts, close the H.P. COCK immediately.

PART 3 HANDLING

(2) Maximum engine speed when ground running is 96 per cent except for essential checks.

(3) With both engines running on the ground at the same speed, 85 per cent r.p.m. must not be exceeded otherwise the brakes may not hold.

(4) If one engine is run on the ground to maximum r.p.m. the other engine must be run at a minimum of 50 per cent r.p.m. to avoid excessive jet pipe temperature on the slower running engine.

(5) Before disconnecting the ground electrical supply one engine must be maintained at 58 per cent r.p.m. for continuance of a.c. electrical power.

(6) No.1 engine must not be ground run by itself unless it is absolutely essential, in which case high-speed running must be kept to a minimum.

105. Engine operating data

(1) At and above I.S.A. conditions, max. engine speed may be expected to be of the order of 100.5% r.p.m. Below I.A.S. conditions, down to minus 30°C, governed speed will be maintained. In flight, governed speed may be reduced as a result of:-

the max. j.p.t. control

the H.P. pump at high forward speed

the fuel flow limiter *(A.C.U. back stop)*

(2) Rapid throttle movements should be avoided at any altitude between 20,000 ft. and 30,000 ft.

(3) The total time for which reheat may be used is 15 minutes per flight. This may be continuous or cumulative and applies to all degrees of reheat.

(4) If selection or cancellation of reheat is made at any altitude below 10,000 ft., the aircraft speed at the time of selection or cancellation must not exceed 300 knots.

106. Engine management for maintenance of electrical power

(1) ◀ On XA847, 853, and XG307 when starting without ▶ ground a.c. supply, the inverter will provide power for operation of the M.R.G., j.p.t. indicators ◀ *(XG307 only - XA847, 853, 856 d.c. supplied)* and ▶ fire detector circuits. If a ground d.c. supply is not being used the inverter will be powered by the aircraft battery until one engine attains a speed of 50 per cent r.p.m. at which speed battery loads ◀ are transferred to the generator. On all aircraft ▶ after any ground d.c. supplies have been disconnected, a drain on the battery will occur if r.p.m. are reduced below 50 per cent; battery steady discharge current rises to a considerable value before any indication of generator failure is given.

(2) During ground running without ground a.c. supply, or during taxying, certain a.c.-operated services

-A.I., and the fuel booster pumps - will be inoperative unless one engine is run at 58 per cent r.p.m. *(fast idling)*. At this engine speed the electrical accessories air turbine attains its governed speed, and the stall warning light goes out. In flight, above 10,000 ft, engine speed will be sufficient to maintain turbine speed with the throttle at IDLING except, perhaps, in the most adverse climatic conditions.

(3) The A.I. equipment requires a five-minute warm-up period and, in operational conditions, must be operative one minute after take-off. If, after the four-minute warm-up from ground a.c. supply, the throttle setting is reduced below 58 per cent r.p.m. the whole of the five-minute warm-up period will have to be begun again. In the operational role, therefore, the fast idling stop on No.2 engine must not be overridden except in an emergency. In the training role the stop may be overridden, although 50 per cent r.p.m. must be maintained if battery discharge is to be avoided.

107. Management of reheat

(1) Reheat is selected by entering the throttle lever into the reheat section of the power control unit, the extent to which the throttle lever is moved preselecting the degree of reheat. After light-up the jet pipe nozzle position indicator will move to correspond with the stage of reheat selected.

(2) A facility for retaining reheat on returning the throttle lever into the throttle control section is incorporated in the design of the power control unit. As the throttle lever is brought back into the cold range, minimum stage reheat will be retained down to about 90 per cent r.p.m; reheat is cancelled when the throttle lever is moved further back from this position.

(3) With the control switches set to AUTO, jet pipe temperature control is automatic in that the fuel supply to an engine is restricted should j.p.t. exceed a predetermined value. Additionally, when running in reheat, a maximum-temperature trip operates to cancel reheat and illuminate a warning on the auxiliary warnings panel if j.p.t. exceeds the maximum allowable by 60 deg.C. The warning indicates that top temperature trip has operated. Reheat stays cancelled until the pilot moves the power lever out of the reheat section and reselects.

(4) If when reheat is selected, (a) reheat fuel fails to light-up, *(nozzle position indicator remaining at pre light-up position)*, or (b) when lit, fails to burn properly or subsequently flames-out, *(reduction in j.p.t. due to nozzles being open)*, the selection must be cancelled manually as described in (2) above.

108. Management of cockpit pressurizing and air conditioning system

(1) Cockpit pressurization is automatic when the switch marked CABIN AIR, on the starboard console, is selected ON. This facility should be selected after starting and should normally be left on for the duration of the flight. After landing the switch should be put off. The ram-air valve may be opened to disperse any residual pressure in the cockpit before opening the canopy.

(2) The CABIN AIR switch must be ON before any air conditioning can be obtained; there is a slight time delay *(10-15 sec)* before air flows into the cockpit. Temperature is controlled by a selector on the starboard console which provides for two modes of operation: automatic or manual. Before take-off the selector should initially be placed to AUTO-WARM, and subsequently adjusted, within the AUTO range, as necessary. The manual facility is intended to be

used should malfunctioning of the automatic equipment occur. In the MANUAL *(red)* sector the pointer is self-centring to a FIXED position and must be held to COOL or WARM until the desired effect is achieved. With either system there will be a time lag of about one minute between selecting and obtaining a new air temperature.

109. Use of engine anti-icing (XG308 - 310)

(1) *General*

With anti-icing in operation, consideration should be given to the resulting loss in thrust and its effect on fuel consumption. There is usually a rise of approximately 20 deg.C j.p.t. and, at full throttle, r.p.m. may fall if the jet pipe temperature control operates.

(2) *Starting and taxying*

If visible moisture *(fog or mist)* reduces visibility to 1000 yards or less and the O.A.T. is below + 5 deg. C, anti-icing must be selected ON immediately after starting and left ON for taxying.

(3) *Take-off*

If icing conditions prevail it is preferable to use anti-icing during take-off, but if runway conditions do not allow this, run the engines at 85 per cent r.p.m. with anti-icing ON for 1 minute immediately prior to take-off to remove any ice previously formed. Select anti-icing OFF before starting the take-off run and select ON again as soon as practicable after take-off.

(4) *Climb*

Climb at the maximum practicable rate of climb. If an alteration in r.p.m. is essential, move the throttles smoothly.

(5) *Level flight*

Should icing conditions be met in level flight, climb or descend out of icing, as continued flight in icing conditions may result in flame extinction. Should flame extinction occur, relight immediately. If this is unsuccessful, a further attempt may be ◀ made within 1 minute; if this also fails, any further attempt to relight may damage the engine. ▶

(6) *Descent*

Throttle the engine to the desired r.p.m. which must not be less than 80 per cent. Descend at the maximum practicable rate of descent. During descent engine speeds in the range 80 per cent r.p.m. and upward may be used, but the maximum anti-icing protection is obtained with the highest practicable r.p.m. If anti-icing has been used on the climb or descent, a period of 2 minutes should elapse before selecting the anti-icing OFF, after leaving icing conditions. Check engine response fully before approaching to land.

(7) *Landing*

If icing conditions persist down to airfield level, engine speed should be kept above 80 per cent r.p.m. if possible until finally committed to a landing. In the event of an overshoot, the throttle should be opened smoothly.

110. Management of autopilot modes

(1) *Pre-flight checks*

Prior to take-off, check:-

(a) MASTER switch ON
(Check doll's eye indicator)

(b) ATT. HOLD/I.L.S. switch ATT. HOLD

(c) PITCH and ROLL AND YAW channel switches OFF

(d) A/P engage switch OUT

(e) THROTTLE SERVO DISENGAGED

Note...
The above switching procedure is most important in that it ensures that any malfunction whilst the undercarriage is down is confined to ± 1 deg. tail plane authority.

(2) *Use of autostabilizer*

(a) In flight, the autostabilizer should not be selected on whilst in close proximity to the ground or to another aircraft, e.g., formation flying, lest there be a latent malfunction which will then become effective.

(b) Handling with autostabilizer engaged is improved particularly at medium to high altitude and on the approach.

(c) The autostabilizer should normally remain on throughout the sortie, including the approach and landing. On descent with autostabilizer engaged, I.A.S. should not exceed 400 knots below 1000 ft.

(d) In order that immediate instinctive action will be taken to correct actuator runaway should this occur, the aircraft must not be flown 'hands off' at altitudes below 10,000 ft with autostabilizer engaged.

Note...
If, when flying with autostabilization, an aircraft oscillation occurs coincident with an instrument power supply change-over (indicator white), switch OFF the master switch. This is because a break in one line of the 3-phase input to the instrument transformer will cause the essential instruments to change-over to the stand-by inverter but the autostabilizer will not, by itself, reject the partially disrupted main supply.

PART 3 HANDLING

STARTING, TAXYING AND TAKE-OFF

111. External checks

(1) Check the outside of the aircraft systematically for signs of damage and for security of doors and panels.

(2) Check that the nose and main undercarriage ground locks are removed, check the oleos for extension and leaks, the tyres for cuts and creep and the brake leads for security and leaks.

(3) Check that all covers, plugs, intake guards, and aileron and tail-plane trailing-edge guards are removed.

(4) Ensure that the armament safety break plug is removed and stowed in the pocket of the pennant.

◀ (5) Check fire extinguisher over temperature discharge indicators show green. ▶

112. Internal checks

(1) On entering the cockpit carry out the instructions given in para. 96.

(2) Then:-

(a) Rudder pedal adjuster — Adjust for leg reach

(b) Ascertain that the ground electrical supply, a.c. and d.c., is switched on

(c) Cockpit lighting — As required

▶◀

(3) Cockpit checks

◀ Undercarriage DOWN button	IN (UP button override knob horizontal)
Feel cut-out switch *(not XA847)*	IN
Artificial horizon switch *(if fitted)*	NORMAL ▶
Instrument master switch	ON

PART 3 HANDLING

Cockpit - lower left side

Canopy operating handle	UP
Ram air valve	CLOSED and locked
Canopy jettison handle	Fully down
De-mist lever	OFF (rear)
◀Anti-icing lever	off (rear)
Throttle servo *(if fitted)*	DISENGAGE▶
U/c emergency lever	Fully forward (safety wire unbroken)
◀V.H.F. sets *(if fitted)*	ON
I.L.S. *(if fitted)*	MASTER OFF. chan. as req'd▶

Cockpit - middle left side

Throttles	Fully forward, H.P.COCKS CLOSE
◀S.W.P. air test switch *(not XG307)*	Press to test SWP and attention lights. Press MUTE switch to cancel attention lights
Feel cut-out switch *(XA847)*	IN

Cockpit - left front

Ventral tank jettison handle	Fully in▶
U/c position indicator	3 greens - alternate bulbs - day/night switch
Feel cut-out indicator	Black
Autopilot trim indicator ◀*(if fitted)*▶	Central
Combined trim indicator	Check trims over full range

◀ Triplex heater switch	ON
Canopy blower switch	As required
Cockpit altitude	Check altimeter
Cabin air switch	ON
Cockpit temperature selector	As required
Navigation lights	As required
Alt. and gen. circuit breakers	Check setting
Inverter normal/stand-by switch	NORMAL (guarded)
Brake accumulator pressure	2000 lb/in^2 min
Fuel switches	Both back (PORT No.2, STBD. No.1) A.W.P. indicators black. Both forward (Port No.1, STBD. No.2) A.W.P. indicators black. Leave both switches forward
Camera master and dull/bright switches *(if fitted)*	ON
Autopilot *(if fitted)*	
Master switch	ON
Autostabilizers	ON
I.L.S./ATT HOLD	ATT HOLD
Rebecca *(if fitted)*	ON
Aerial selector switch	O/R
Tacan *(if fitted)*	ON. Select channel and, if in beacon range check DIST and BRG ▶

PART 3 HANDLING

Control column

Autopilot engage switch	OFF
◀ Feel switch *(if fitted)*	IN ▶
Armament safety trigger catch	SAFE
Brake lever	ON, parking catch engaged

Note...

◀ *(1) On XA847, 853 and XG307 if d.c. ground supply only is available, M.R.G. instruments and the fire detection system will be supplied by the inverter when the INSTRUMENT MASTER switch is ON; the FLIGHT INST. SUPPLY indicator will show white.* ▶

◀ *(2) If fitted the oxygen warning light on the standard warning panel has no significance as the circuit is not complete.* ▶

113. Starting the engines

(1) *Engine start*

◀ Confirm or set: ▶

Brakes	ON
◀ Battery switch	ON ▶
Instrument master switch	ON (Supply indicator Black)
Standard warnings mute button	Flight position (pushed in)
◀ J.P.T. control switches	AUTO ▶
H.P. cocks/throttles	Idle/fast idle
Fuel switches	PORT - NO. I ENG. STBD - NO. 2 ENG. ◀ fuel pressure warnings black ▶

No. 1 and No. 2 engine start master switches	ON
No. 1 and No. 2 engine ignition switches	ON
No. 1 engine starter button	Press for 2 sec and release
No. 1 J.P.T. indicator	If 700°C is reached, close H.P. cock

(2) *Checks after starting No. 1 engine*

(a) J.p.t.	625°C at idling
(b) Fire warning	Out
(c) Oil pressure warning	Black above 45% r.p.m.
(d) Hydraulic warning No. 1	Out at slow idle
(e) Flaps and air brakes	Test
(f) No. 1 throttle	Return to idle

(3) *Starting No. 2 engine*

(a) No. 2 engine starter button	Press for 2 sec and release
(b) No. 2 j.p.t.	If 700°C is reached, close H.P. cock

(4) *Checks after starting No. 2 engine*

Repeat (2) (a) to (c)

Hydraulic warning No. 2	Out
Turbine underspeed	Black
Ground supply	Disconnect
Alternator failure warning	Black above 58% r.p.m.

PART 3 HANDLING

S.W.P. and A.W.P. .... Increase r.p.m. on No. I engine and check all warnings out

WARNING
If J.P.T. exceeds 700 deg.C during start, close the H.P. cock immediately.

114. Failure to start

(1) *Starter fails to operate*
Check switches, wait one minute and repeat starting drill.

(2) *Starter operates but engine does not turn*
Wait one minute and then make a further attempt. Up to six attempts may be made as the heat factor is not involved.

(3) *Engine rotates but fails to light-up*
H.P. cock/throttle .... H.P. COCK CLOSED

Wait one minute and make a second attempt, if possible ensuring waste fuel has drained. If second attempt fails, wait 45 minutes before making a further attempt.

Note...

(1) The H.P. cock must be closed immediately it is seen that the engage will not light up. The H.P. cock should be closed before the r.p.m. reduce to 10%.

(2) Sub-para (3) above. If the H.P. cock is closed as in Note (1) there will be no necessity to 'blow through' the engine. If, however, it is suspected that excess fuel has accumulated, wait until sufficient draining has taken place and repeat the starting drill.

(3) Failure of an engine to start due to a starter system fault may be classified as an 'A' or 'B' failure. An 'A' failure occurs when the 10-amp fuse blows at any time during the air cycle, or when combustion of the starter fuel does not take place and the starting system shuts down after 1¾ or 3¼ sec of operation. A 'B' failure occurs when combustion is initiated in

the combustion chamber but is not sustained for the normal 5 to 7 sec; it is usually recognised by a momentary loud discharge of exhaust gases from the exhaust pipe, followed by shutting down of the starting system.

115. Checks after starting

Canopy	Check light on. Close and make sure light is out when locked. Check mechanical indicators
Instrument supply indicator	Black
Flight instruments	Attitude indicator erected, Mk.5 FT compass set. Altimeter set.
Autopilot *(if fitted)*	(Doll's eye) Black
Brake pressure	3000 lb/in^2
Cabin air switch	ON
S.W.P.	Check all warnings out and then test
A.W.P.	R.H. TEMP.TRIP. warnings out. All indicators black
Armament safety break	Have the plug connected

116. Checks before taxying

Powered flying controls	Functional check
Flying controls trimming	Functional check. Observe trim indicators when trimmed to zero
Air brakes	Functional check. Observe position indicator shows IN and LOCKED
Flaps	Functional check. Observe position indicator
V.H.F.	Select frequency required
V.H.F. set selector switch	As required

PART 3 HANDLING

Canopy blower switch	ON
Cabin air switch	ON
Temperature controller	AUTO
Face/feet air diffuser control	As required
Throttle servo	DISENGAGE
Mk. 5 FT compass	Synchronize. Check heading by E2B. Check annunciation
◀ Rebecca *(if fitted)*	ON and check functioning. If not required switch OFF
Tacan *(if fitted)*	On if required ▶

117. Taxying

(1) Check that chocks are removed and release the wheel brakes lever. Differential braking should be checked during taxying, but heavy braking and sharp turns must be avoided when the fuel tanks are full, otherwise there is a possibility of fuel vented from the tanks entering the auxiliary air intakes.

(2) Owing to the high centring force of the nose wheel, large amounts of power and brake pressure are required to break-out initially and to begin a turn when taxying. Once the break-out has been achieved, turning is simple, but care should be taken to prevent locking the inner wheel. With the fully-powered flying controls, no adverse effect is felt in high cross- or tail-winds and taxying is simple under these conditions.

(3) No surging should be experienced when taxying under cross-wind conditions.

(4) During taxying, the generator and alternator supplies should be maintained by setting No. 2 engine throttle lever at the 'fast idling' stop, or above if necessary.

(5) The canopy must always be closed, and locked whilst taxying.

PART 3 HANDLING

118. **Checks before take-off**

Nesa windscreen heating switch	ON
Triplex ▶◀ windscreen heating switch	ON
Canopy blower	ON
Flaps	UP
Air brakes	IN and locked
Trim	Rudder - neutral Ailerons - neutral Tail plane - take-off incidence
Autopilot *(if fitted)*	Master switch - ON
Autostabilizers	ON
Att. hold/I.L.S.	ATT. HOLD.
Control column switch	OFF
Throttle servo	DISENGAGE
Fuel contents and fuel pressure warning	Final check
Voltmeter *(if fitted)*	28 volts (white)
Fuel switches	Both forward
Instruments	
Mk.5FT compass synchronized	
Altitude indicator erected	
Other instruments normal	
Pitot heater	ON
Instrument supply indicator	Black
S.W.P. lights	Out
A.W.P.	No warnings
Oxygen	Contents Pressure gauge Flow check

PART 3 HANDLING

Canopy	Closed and locked warning light out
Harness	Tight and locked
Hydraulics	Warnings out Check controls for full and free movement

119. Take-off

(1) Align the aircraft on the runway and apply the brakes.

(2) Set G.M.Mk.5FT compass to runway heading.

(3) Move No.1 throttle to parallel No.2 and smoothly open both throttles together to maximum cold thrust as the brakes are released. At 100% r.p.m. check that j.p.t. exceeds 650°C otherwise the take-off must be abandoned due to low thrust. In conditions where temperature, runway length or runway surface is such that single engine failure would be critical, select maximum reheat on both engines at the commencement of take-off.

(4) Take off is made with flaps up and stick forward of neutral. The nose wheel does not rise easily of its own accord, and speed should be increased to 145 knots before raising by an easy pull on the control column. The unstick will follow at about 160-165 knots. Violent backward movement of the control column must be avoided at unstick as this can lead to damage in the tail bumper area.

(5) Take-off with flaps down is not recommended because of the possibility of one flap blowing up following a hydraulic failure and because the nose wheel raising speed is increased to the same order as the unstick speed at forward c.g.'s, *i.e.* without ventral tank or with ventral tank empty. In emergency if distance is critical, reheat may be used.

(6) (a) The take-off should be abandoned if one engine

should fail at or below 130 knots; action should be:-

Throttles	Back to idle/idle
Brake parachute	Stream
Wheel brakes	Employ maximum braking technique
Transmit R/T call	'Barrier! : Barrier!'

This procedure should bring the aircraft to a standstill in about 2400 yds, at a take-off weight of 34,000 lb in Temperate Maximum Sea Level conditions on a wet runway. The brake parachute has been proved up to 220 knots although the weak link is designed to fail at about 200 knots streaming speed.

(b) If an engine fails above 130 knots, continue the take-off without altering the power setting; action should be:-

Throttles	Leave at existing setting
Undercarriage	Up as soon as possible when airborne
Failed engine throttle	H.P. cock closed
Fuel switches	Both to good engine

(7) The aircraft is stable immediately on take-off and is easily controlled provided that a light touch is used in the aileron sense. The undercarriage should be retracted as soon as the aircraft is clear of the ground and the operation takes place with noticeable jolting of the airframe and slight tendency to irregular lateral rolling if main undercarriage retraction is slightly unsynchronized.

(8) If speed exceeds 220 knots during undercarriage retraction, a further increase in time to 'lock up' may be expected. Placard speed for undercarriage is 250 knots.

PART 3 HANDLING

HANDLING IN FLIGHT

120. Checks after take-off

At a safe height

◀(1)	Brakes	Apply fully until undercarriage is locked up ▶
(2)	Undercarriage	All lights out
(3)	All warning lights	Normal
◀(4)	Ventral tank *(if fitted)*	Doll's eye black ▶

Note...

(1) *The G.M. Mk.5FT compass should only be resynchronized when in steady cruising flight.*

(2) *If, at any time during flight, the FLIGHT INSTR. SUPPLY indicator changes to white (inverter supply), the A.I. must be switched OFF to prevent damage to this equipment.*

121. Safety speeds

Height cannot be maintained at speeds below 140 knots on one engine.

122. Climbing

(1) After take-off the aircraft accelerates rapidly if the angle of climb is shallow, and for optimum climb to altitude the speed should be increased to 400 to 450 knots before increasing the climbing angle to maintain this speed at full power *(cold)*.

(2) Apart from small initial trim adjustments the aircraft remains in trim on the climb and holds the initial trimmed speed without difficulty.

(3) (a) The recommended climbing speed is 450 knots/Mach 0.90. The Mach 0.9 climb can be held without difficulty, but care is needed to avoid exceeding speed into the Mach 0.95 region if the small transonic trim change is to be avoided during the climb.

(b) For a Mach 0.9 climb above the tropopause, reheat should be engaged at 25,000 ft; normally, for acceleration to supersonic flight reheat is engaged at the tropopause.

(c) Climbing at speeds below Mach 0.9 is not recommended, as below the minimum drag speed there is a loss in climb performance.

(d) Climbing at speeds in excess of Mach 0.94 will also result in increased fuel consumption from the increased transonic drag.

(4) The top temperature controllers are designed to hold engine jet pipe temperature limits constant on the climb at a fixed throttle setting. Periodic checks should be made to ensure that these units are functioning correctly, and j.p.t's should be controlled manually in the event of top temperature control malfunction.

(5) The cockpit temperature can be adjusted, within the AUTO range of the selector, as becomes necessary. The 6 o'clock position is recommended for the initial climb setting soon after take-off.

123. General flying

(1) (a) The aircraft is easy to trim throughout the flight envelope. There is a small nose-up trim change with increase in power, and a corresponding nose-down change with decrease in power, but otherwise the aircraft trim conditions are reasonably symmetrical at subsonic and supersonic speeds. Transonically, in the range between Mach 0.94 and 0.98, there is a small nose-down trim change on acceleration and a corresponding nose-up trim change on deceleration. This is barely noticeable in 1 g flight but becomes more noticeable when making the transition under increased normal acceleration.

(b) With the relatively large amount of sweep back, the rolling moment due to yaw is higher than on more conventional aircraft, and this characteristic is noticeable when correcting for directional displacement in roll or at low speed. It is not in any way embarrassing.

(c) Certain aircraft exhibit directional asymmetries requiring increasing amounts of rudder trim as the Mach number is increased beyond transonic values.

(2) The controls are fully power-operated and irreversible. Artificial 'q' feel plus spring feel is applied to the rudder and tail-plane controls, and plain spring feel to the ailerons.

(3) Tail-plane feel and response is satisfactory and pleasant at all speeds throughout the flight envelope and remains pleasant and positive below the normal landing speed and up to the highest permissible Mach number.

(4) Rolling manoeuvres *(refer to Part 2 - Limitations)*

(5) The rudder is smooth and satisfactory in operation at all speeds, and feel forces are high at transonic and just subsonic speeds. The aircraft is stable directionally, and little reference to rudder control is required above low indicated speeds; certain aircraft, however, may exhibit directional asymmetries as indicated in (1) (c) above. Some reduction in damping occurs transonically necessitating increased co-ordination of controls in manoeuvring flight.

(6) The trimmers are all smooth and relatively insensitive, so that there is no tendency to over-trim, with the exception of the case indicated in (1) (c) above.

(7) The air brakes are fully variable up to the full deflection of 50 deg.; their use is limited to speeds below 650 knots/M = 1.3 *(large fin)*. At high speeds operation of the air brakes is accompanied by a nose-down trim change and initial displacement in roll, and by slight buffeting.
buffeting.

(8) *Change of trim*

Undercarriage down	Slight nose-down
Undercarriage up	Slight nose-up
Flaps down	Little change
Flaps up	Little change

(9) (a) A small nose-up trim change occurs with increase in power, otherwise there are no further trim changes up to Mach 0.95.

(b) In 1 g flight a nose-down trim change occurs at Mach 0.96 - 0.97 which increases, untrimmed, from 5 to 10 lb pull force at transonic speeds. Further trim changes up to the limiting Mach number are negligible.

(10) Coincident with the transonic trim change, mild buffet can be detected which disappears beyond Mach 1.0. This is more pronounced but still moderate in the ventral tank configuration. A similar order of buffet is induced by increase in normal acceleration, but only below Mach 1.0.

(11) Slight buffet is noticeable in the clean configuration, and with wheels and flaps down, below 200 knots.

(12) Stability and control at low speeds of the order of 250-200 knots are satisfactory, and the aircraft may be flown satisfactorily with restricted manoeuvring down to 145 knots with flaps down and 150 knots with flaps up. Owing to the high induced drag in this

configuration, a considerable proportion of the available power is required to maintain height under these conditions. Severe turbulence causes no deterioration in control other than a slight tendency to over-correct laterally at high speed, and to slight Dutch Roll in the landing configuration.

◀124. **Stalling**

Note...
Intentional stalling is prohibited. The following information is given to cover the case of an inadvertent stall.

(1) *Stalling in 1g flight*

(a) *Undercarriage and flaps up:*

Stalling tests have shown that the aircraft is prone to enter an incipient spin from the 1g stall but that adequate warning is available. In the gun pack configuration with or without a ventral tank, air brakes IN, at an altitude of 40,000 ft, the characteristics appear as follows:-

225 knots	- Slight buffet begins
170 knots	- Buffet becomes moderate
145 knots	- Buffet is considerably reduced. Sink rate increases
135-115 knots	- Lateral and directional wallowing becomes more pronounced as speed is further reduced. Up to this point recovery is immediate on moving stick forward
115-110 knots	- Yaw develops rapidly to the point where it cannot be held with rudder, followed by wing drop and entry to the spin. At this stage, moving ▶

the stick forward will probably not prevent spin entry.

With ventral tank and missile pylons, with or without missiles, the stall characteristics are similar. Adequate warning of approach to the stall is given with slightly more pronounced buffet from 230 knots down to the stall.

With ventral tank fitted, air brakes OUT, tests indicate that the characteristics are similar but with some increase in buffet amplitude and with the sink rate increasing at a speed approximately 10 knots higher. Due to the high rate of sink at low I.A.S. and the comparatively large height losses incurred in recovery, speed should not normally be reduced below the minimum speed limitations *(Part 2)*.

(b) *Undercarriage and flaps DOWN, air brakes OUT*

Stall approaches down to 120 knots have shown continuous mild to moderate buffet from the approach speed 175 knots down to 120 knots, in contrast to the reduction of buffet experienced at 145 knots in the undercarriage and flaps up, air brakes in, configuration. As speed is reduced below 150 knots the rate of sink increases and at low altitude this should constitute a warning of the approaching stall.

From a low speed condition at low altitude recovery can be effected with little or no loss of height by opening up to maximum reheat, leaving the flaps down, retracting air brakes and raising the undercarriage as speed increases past 150 knots; the aircraft should be accelerated to a safe speed *(175 knots)* without any deliberate change of pitch attitude.

(2) *Stalling under g*

Note...
In all manoeuvring flight below 200 knots, care should be taken to maintain sufficient engine r.p.m. to enable maximum rate application of full power as required.

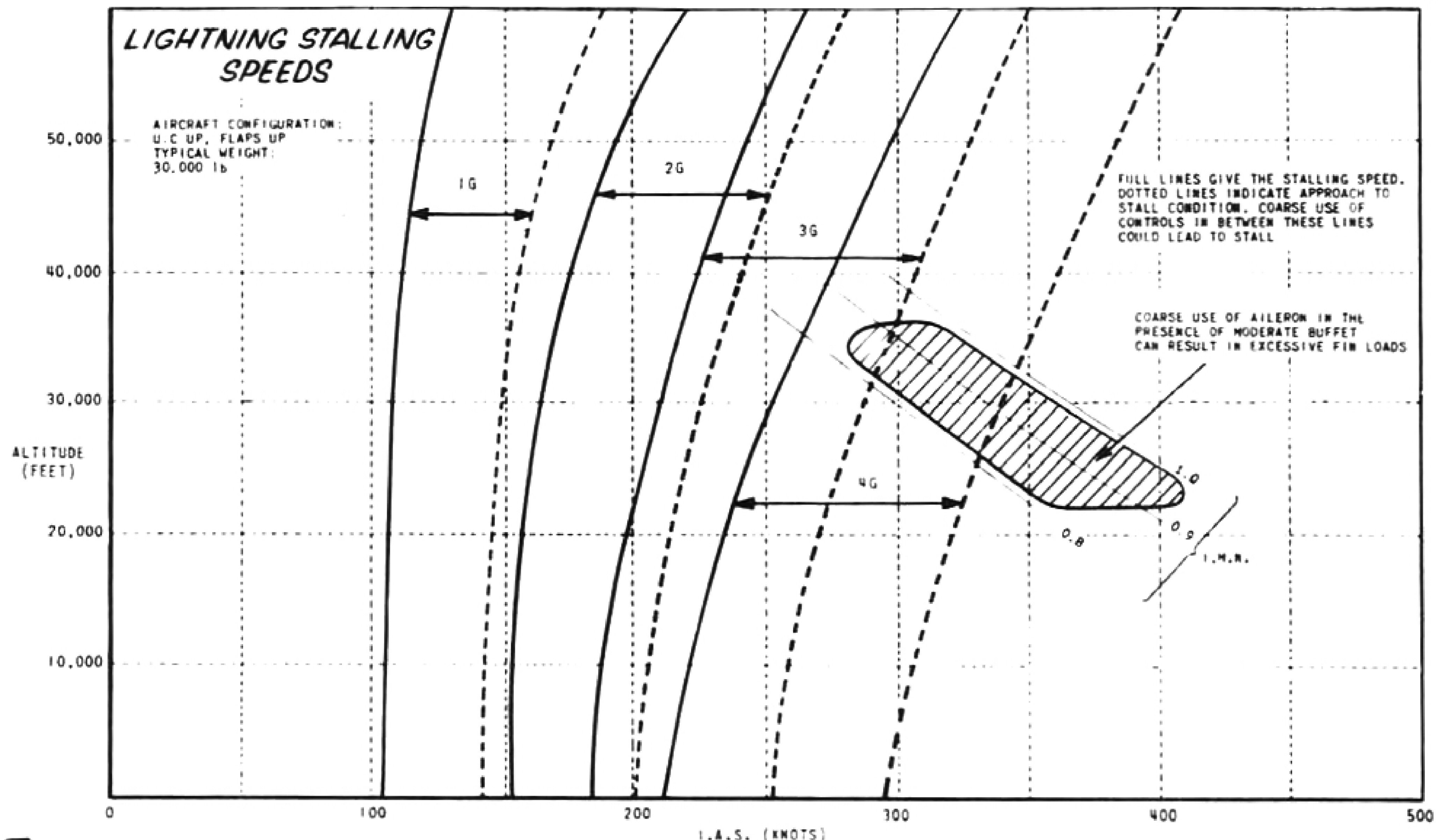
(a) *Undercarriage and flaps up:*

In the configuration ventral tank, gun pack, and **air brakes IN, commencing at 45,000 ft/0.9M, speed** loss is rapid with application of g even using maximum cold thrust. A good buffet margin exists and some lateral rocking occurs as g is increased. At the stall, the aircraft rolls fairly smoothly into or out of the turn and recovery is immediate on relaxing g.

With air brakes **OUT**, or with missile pylons with or without missiles, under similar conditions as above a good buffet margin exists and the lateral rocking characteristics are present. There is little warning, however, of the rather violent 'flick' rolling manoeuvre which typifies the 'g' stall. Although recovery is rapid on relaxing controls the aircraft should not be flown beyond the lateral rocking stage.

(b) *Undercarriage and flaps DOWN, air brakes OUT:*

In turning flight there is some warning of the approaching stall in the form of increased buffet and wing rocking; in turbulent conditions, however, this might not be noticeable. The aircraft finally tends to roll slowly into, or out of, the turn. Recovery can be achieved by relaxing g; response to aileron is sluggish in this condition and should be assisted by the use of rudder.



LIGHTNING STALLING SPEEDS
AIRCRAFT CONFIGURATION:
U.C UP, FLAPS UP
TYPICAL WEIGHT:
30,000 lb
1G
2G
3G
4G
FULL LINES GIVE THE STALLING SPEED. DOTTED LINES INDICATE APPROACH TO STALL CONDITION. COARSE USE OF CONTROLS IN BETWEEN THESE LINES COULD LEAD TO STALL
COARSE USE OF AILERON IN THE PRESENCE OF MODERATE BUFFET CAN RESULT IN EXCESSIVE FIN LOADS
1.0
0.9
0.8
I.M.N.
50,000
40,000
30,000
20,000
10,000
ALTITUDE (FEET)
0
100
200
300
400
500
I.A.S. (KNOTS)

PART 3 HANDLING

(c) The accompanying graph shows stall approach speeds and stalling speeds at different altitudes for normal accelerations up to 4g at a typical weight of 30,000 lb. Any coarse use of control at speeds within the band formed by the broken and continuous lines could lead to a stall.

Particular attention is drawn to the shaded area where full aileron rolls in the presence of moderate buffet can result in excessive fin loads. *(Reference should be made to the rolling limitations and to para.128).*

125. Spinning

Note...
Intentional spinning is prohibited. The following information is given in case of an inadvertent spin.

Spinning from unaccelerated flight is unlikely except in the event of gross mishandling. Under g, however, a lesser degree of mishandling will produce a stall from which a spin is quite possible. For this reason care should be taken to avoid stalling under g. Spin entry and characteristics are similar for both forms of entry.

(1) *Spin entry and characteristics*
At the stall the aircraft yaws markedly, and then rolls, the nose dropping during the roll. It hesitates in a fairly steep nose-down attitude, then continues in a spin which becomes increasingly oscillatory, particularly in roll. The rate of rotation is low, a turn taking 6 seconds, and each complete oscillation takes 2/3 of a turn. The height loss is about 1000 ft per turn during the first two turns. Providing external reference is available, there is normally little difficulty in establishing the direction of rotation, but the oscillations may cause confusion. Recovery action has so far invariably produced recovery within two turns, but height loss during the ensuing dive is high; during a two turn spin and recovery to level flight it is unlikely to be less than 8000 ft and may reach 15,000 ft.

(2) *Spinning with missiles fitted, with or without air brakes OUT*

In this configuration the recovery standard is as good as for the clean aircraft although there are some minor changes in the character of the spin. There is less variation in pitch attitude and the spin is slightly flatter. Oscillations in roll, yaw and pitch do not occur in the same phase relationship and the roll oscillation in particular tends to build up after the first turn.

(3) *Recovery action*

(a) Apply full anti-spin rudder *(i.e. opposing the yaw)*.

(b) Centralize the ailerons and move the stick just forward of central.

(c) Maintain this until rotation ceases *(which will normally be within 1 turn but may take up to 3)* checking ailerons central and that full rudder is applied in the correct sense *(refer to Note 2)*.

(d) When rotation ceases, centralize the controls, and ease out of the ensuing dive when the speed reaches 170 knots.

(e) The spin may become very oscillatory. If at any time doubt or confusion exists about the direction of rotation, or if the above action does not stop the spin within 3 complete turns, centralize the controls. This will either effect recovery or put the aircraft into a more stable,

◀ easily recognisable spin. Once this is positively identified, normal recovery action as at (a) (d) above can be taken.

(f) Height loss during the pull-out is high, and if the rotation has not stopped by 15,000 ft the aircraft should be abandoned.

Note...

1. *Rudder forces are very high: over 200 pounds will be needed to obtain full rudder.*

2. *The use of aileron during spin or recovery should be avoided, since its effects are varied and unpredictable. In general, out-spin aileron will increase the degree of oscillation and more than ¼ may delay or prevent recovery. In-spin aileron will mask the recovery point by inducing roll, and overall height loss is thereby increased.*

3. *The use of full forward stick on recovery is not recommended since it produces an uncomfortable bunt which again increases the height loss.*

4. *The above information applies to the clean aircraft with and without ventral tank and with and without missiles. Spinning characteristics with flaps and/or undercarriage down are unknown but it is recommended that the same recovery action be used and that flaps and undercarriage should be retracted as soon as possible. Owing to the 150-knot pressure switch it may be necessary to operate the undercarriage-UP override in this case.*

5. *The M.R.G. may topple, and the indications of the attitude indicator and compass should therefore be treated with reserve until they can be checked.* ▶

PART 3 HANDLING

126. High-speed flying limitations

The aircraft is very easily capable of exceeding its air speed and Mach number limitations, and care should be taken to avoid exceeding the current limits of 700 knots/Mach 1.7 with air brakes in and 650 knots/Mach 1.3 with air brakes out.

127. High-speed flying characteristics

(1) At all speeds subsonically in 1 g flight, the aircraft is smooth and straightforward to fly.

(2) (a) Transition from subsonic to supersonic flight can be achieved in the operational configuration in cold thrust from sea level to 45,000 ft, and up to 52,000 ft in reheat. There are no changes in flight characteristics transonically other than the slight nose-down trim change and very slight buffet *(para.122)*. These characteristics are more pronounced with the ventral tank, but are still moderate. The aircraft remains stable directionally and longitudinally through this stage, but damping is reduced and a slight deterioration in precise controllability results. Above Mach 1.0, and up to and in excess of design Mach limits, conditions are improved, and stability and control are smooth and satisfactory. Normal accelerations, which can be applied within the limits set down in Part 2, are limited only by the gradual decrease in tail plane effectiveness with increase in Mach number. Aileron control remains crisp and precise to limiting Mach number where 180 deg./sec is still available. Rolling manoeuvres are, however, restricted *(Part 2 - Limitations)*.

(b) Throttles may be closed to IDLING at any speed within the allowable flight envelope.

(c) During reduction of speed transonically under normal acceleration, trim change appears as a small nose-up pitch, at Mach 0.98, of approximately + ½g. This change is progressive in 1 g flight and is only noticeable as a mild pitch under 'g' in the narrow speed bracket Mach 0.98 -0.96.

(3) Air brake operation is accompanied by a small nose-down trim change and only slight roughness up to the limiting speeds. Above these speeds, trim changes occur and the directional stability is reduced. The limits of 650 knots/Mach 1.3 with the large fin and 650 knots/Mach 1.2 with the small fin must be observed.

128. **Flight conditions involving high structural loads**

(1) *General information*
High structural loads are incurred in certain manoeuvres and flight conditions. The aircraft has been designed to withstand these but excessive repetition of high loads will reduce its useful life through fatigue damage. Therefore, the aircraft should not be subjected unnecessarily to the following flight conditions:-

(a) Repeated application of high g

(b) Low level/high speed flight, particularly in turbulence.

(c) Certain rolling manoeuvres *(refer to sub para. (2)-(4))*. For this reason, rolling limitations are imposed.

Note...
At high g, the slip-ball (if fitted) is less sensitive to sideslip than at 1g and even small displacements of the ball should be corrected.

PART 3 HANDLING

(2) *Aircraft with two or no missiles*

During rapid rolls at high g, roll-yaw inertia coupling tends to produce higher than normal loads. This is particularly true at the speed/height combination of 0.8M to 0.95M and 20,000 ft to 35,000 ft where the high angle of attack, signified by buffet, produces sideslip and hence fin load; the amount of sideslip increases with higher rates of roll and higher g.

In the region of 1.2M to 1.4M, adverse yaw - due to aileron application - becomes pronounced particularly at high I.A.S. *(500-650 knots)* and under applied g. This produces sideslip and, therefore, high fin loads and appreciably reduces the normal rolling capability of the aircraft. Extension of the air brakes aggravates the situation: their use *(within the limitations)* should be kept to a minimum in these circumstances.

Rudder should be used to decrease the sideslip; if g also is reduced, rolling response will be improved and the fin loads further reduced.

(3) *Aircraft with single missile*

(a) High load regions are similar to those in sub para.(2), with an additional fin load due to the yawing moment of the single missile: this is particularly marked at high g. If the sideslip loads due to the single missile and full aileron rolling are additive, *i.e.* rolling away from the missile, particularly high fin loads can be produced in the region 1.2M to 1.4M.

The situation will be aggravated if the air brakes are extended: their use in these circumstances *(within the limitations)* should be kept to a minimum.

(b) Indications that asymmetry is becoming excessive are given by:

The inability to correct the yaw, despite a large rudder pedal force.

A marked change of lateral trim.

(c) The loads should be reduced by minimising side-slip and reducing g.

(4) *Firing and breakaway*

(a) If only one of two missiles is fired and then a rapid breakaway performed, high fin loads will be produced. The aircraft will yaw and, due to the sweep back, will have a strong rolling tendency. If aileron is applied to oppose this roll, even higher fin loads may result.

(b) The loads should be minimised by correcting sideslip with rudder and reducing normal acceleration to between 1g and 3g.

(5) *Autorotation due to inertia coupling*

Moderate rates of roll at less than 1g can produce autorotation; that is, rotation which does not cease on centralizing the controls. Should this condition occur, only the minimum amount of aileron should be used to stop the rotation with the rudder kept central and the control column in the position for 1g flight.

PART 3 HANDLING

CIRCUIT PROCEDURE AND LANDING

129. Approach and landing

(1) *Checks before landing*

Before joining the circuit, check fuel. Until familiar with the aircraft, fuel conditions in the circuit should not be less than 500/500 lb. An indicated fuel reading of 400/400 lb is sufficient for an overshoot, circuit, and landing with no allowance.

Reduce speed and check:-

Brake pressure	3000 lb/in^2
Air brakes	OUT
Undercarriage	DOWN (3 green lights)
Flaps	DOWN

Note...
Rudder feel is reduced when the undercarriage is selected DOWN.

(2) During the turn on to the final approach, which should be made at approximately 190 knots, a relatively large proportion of the total cold power will be required to maintain speed, depending upon the amount of height that is lost in the turn.

(3) When lined up on the final approach, speed should be reduced progressively and should not drop below 170 knots until within 200-300 yards of the airfield boundary, and the boundary should be crossed at approximately 165 knots, commencing the 'round out' before throttling fully back. At this point nearly full negative tail-plane travel will be required to trim out the approach angle and hold-off. Using this technique, the touchdown will be smooth and should occur between 155-145 knots.

(4) A flat approach angle, not exceeding 3 deg., should normally be adopted to avoid the possibility of tail bumper damage which can result from flaring-out at the recommended speed but from a too-steep approach, or from a too-low approach speed.

(5) At touchdown both No.1 and No.2 engines should be throttled to slow idling, the nose wheel lowered firmly on to the runway with forward stick, and the brake parachute handle pulled. After a delay of approximately 1½-2 sec, the parachute will be felt as a sudden deceleration accompanied by a slight weather-cock action, depending on the wind direction, and tendency for the nose to rise. The brake parachute should NOT be streamed before touchdown.

(6) It is not necessary to correct the initial nose-up pitch with brake parachute operation unless there is a strong cross-wind. Under these conditions the weather-cock can be more easily controlled if the nose wheel is held firmly on the ground by full forward stick. Weather-cocking can normally be controlled with coarse use of rudder.

(7) With brake parachute only, speed will normally be reduced to 20 knots in approximately 2000 yards without use of wheel brakes, and irrespective of runway surface conditions.

PART 3 HANDLING

(7)	Ejection seat and canopy safety pins	Fitted
(8)	Armament safety break	Before leaving the cockpit order the ground crew to remove the safety break plug

Note...

On days when the engines have not been ground run prior to flight, check hydraulic accumulator capacity after shutting down No.2 engine following the first flight of the day; displace the stick to check that a minimum of 5 feel strokes can be obtained on the ailerons and 3½ on the tail plane before the accumulators become exhausted. A stroke is defined as displacement from neutral to one extreme and back to neutral, and the rate of displacement should not exceed 1 stroke in 5 sec.

(8) With maximum use of Maxaret wheel braking together with the tail parachute, average landing distances of about 1100 yards are obtained on dry concrete.

(9) With maximum Maxaret wheel braking only and no brake parachute, distances of less than 1800 yards are obtained on dry concrete.

(10) In the most adverse condition of flooded runway with cross-wind and no brake parachute, maximum distances of as much as 2500 yards have been required.

(11) Wheel brakes should not be used on any account before the aircraft has touched down.

(12) The parachute is jettisoned on the runway when a LOW taxying speed is reached. It is not profitable to attempt to taxy under power with the parachute streamed as this may damage the parachute.

130. Instrument approach

Let down	◀ 350 knots/0.9 Mach ▶
G.C.A.	220 knots. Undercarriage and flaps down. 175 knots on final to visual.

131. Going round again

(1) On a visual approach a minimum of 400/400 lb fuel, which allows about 4 minutes of flying, should be available for this possibility.

(2) Open the throttles smoothly as required and raise the undercarriage *(acceleration to maximum thrust can be attained in 5 sec from 60 per cent r.p.m. or above)*. The aircraft will accelerate quickly but flaps should not be raised until 180 knots is reached, in order to reduce any tendency to sink.

Trim changes with retraction of undercarriage and flaps are not excessive.

(3) In the event of a severe fuel shortage the final turn may be made without flap at 200 knots and, therefore, at reduced power, and flaps may be lowered immediately after the final turn.

(4) 'Roller' landings are not recommended owing to the possibility of overstressing the tyres by excessive rolling speed.

132. Flapless landing

A flatter approach, at 185 knots, should be made for a flapless landing with touchdown at 165 knots. Under these conditions tail bumper clearance is reduced, extra care should therefore be taken during the round-out. The landing run will be increased by about 200 yards on that for a normal landing.

133. Checks after landing

(1)	Brake parachute	JETTISON
(2)	Flaps	UP
(3)	Air brakes	IN and LOCKED
(4)	Stop No. 1 engine	

Note...
Maintain No. 2 eng. throttle lever at the 'fast idling' position.

134. Checks after taxying

(1)	No. 2 eng. throttle lever	H.P.COCKS CLOSED
(2)	Fuel pump switches	OFF
(3)	Battery switch	Off
(4)	Parking brake	On
(5)	Chocks	In position
(6)	All electrical switches	Off

PART 3 HANDLING

(7)	Ejection seat and canopy safety pins	Fitted
(8)	Armament safety break	Before leaving the cockpit order the ground crew to remove the safety break plug

▶◀