

PART 3

Chapter 2 — HANDLING IN FLIGHT

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1 Climbing*(a) Best rate of climb*

(i) Climb at full throttle, within the limitations, at the speed appropriate to the configuration, maintaining this speed until the recommended Mach number is reached.

(ii) The recommended climbing speeds are:

Clean or two pylons with drop tanks or rocket

launchers 430 knots/0.85M

Four pylons with drop tanks or rocket launchers 370 knots/0.82M

(iii) Above 20000 feet it is important to maintain the recommended Mach number to avoid a considerable reduction in rate of climb.

(b) Normal climb

If maximum rate of climb is not essential set 7950 RPM using the same speeds as above.

2 Engine handling

(a) *On the climb*

(i) High speeds at low altitudes may reduce maximum RPM by as much as 100. This coupled with the effect at Part 3, Chapter 1, para 5 (a) may cause the RPM at the start of the climb to read as much as 150 less than the static ground figure. This condition disappears as the climb progresses.

(ii) Maximum RPM may also be reduced if the top temperature controller comes into operation. On some engines the temperature controller reaches the limit of its control at altitudes above 40000 feet when climbing at full throttle. It therefore becomes necessary to close the throttle slightly to maintain JPT below 690°C.

(iii) During a climb at full throttle RPM increases gradually but must not be allowed to exceed 8150 RPM. When climbing at intermediate power it is necessary to close the throttle gradually as altitude is gained to maintain 7950 RPM.

(b) *In flight*

(i) At intermediate throttle settings differing combinations of air-speed and ambient air temperature may cause the selected RPM to vary. It is then necessary to adjust the throttle to maintain a constant figure.

(ii) The idling RPM increases with altitude and with increasing airspeed.

(iii) Negative G must not be applied for more than 10 seconds.

(iv) It is recommended that movement of the throttle should be smooth and progressive. Rapid throttle opening should be avoided at speed below 200 knots above 30000 feet otherwise surging may occur. If surging occurs, throttle back and increase IAS.

(v) At low altitudes maximum power can be obtained within 5 seconds if RPM are above a minimum of 4500 and at high altitudes within about 10 seconds from idling.

(vi) Rapid closing of the throttle at high indicated airspeeds may cause damage to the engine and should be avoided.

3 Flying controls

(a) *Ailerons (in Power)*

The ailerons are light throughout the speed and Mach number range giving a high rate of roll, but see para 12.

(b) *Elevator (in Power)*

(i) The force required for any manoeuvre depends on the distance the control column is displaced from the 'zero load' position and is completely independent of airspeed. It follows, therefore, that when large elevator deflections are required, eg at low airspeeds and very high Mach numbers, the stick forces are relatively heavy; at high airspeeds however, since only small deflections are usually required, the stick forces are light. The control is light, effective and should be used cautiously until its characteristics are known and its effectiveness appreciated. However, elevator effectiveness is somewhat limited by jack stalling, which occurs when the air load on the elevator equals the jack output force and restricts movement of the control column rearwards. For this reason the aircraft is limited to 0.88M in the ground attack role. Depending on the tailplane angle and CG position jack stalling may occur when manoeuvring above this speed and for this reason particular care should be taken when flying in the ground attack role at high IMN; if jack stalling occurs the tailplane trim must be used as a means of control and speed should be reduced.

(ii) Longitudinal control is sensitive at aft CG, ie at high and low fuel states and particularly when outboard stores are carried. Use of the tailplane interconnection aggravates the sensitivity and for this reason the interconnection should be off for take-off and landing and at high speed/low level.

(c) *Rudder*

The rudder is light at low airspeeds and becomes progressively heavier as speed increases. The application of rudder produces a strong rolling tendency.

(d) *Trimmers and tailplane*

NOTE: Care must be taken not to operate the tailplane trim switch inadvertently during manoeuvres as this may result in excessive G being applied.

(i) The aileron tab trimmer must not be used whilst the controls are in Power, and it should be locked in the neutral position. The aileron spring feel trim should normally be used to counteract any out-of-trim forces which may occur in Power. It must not be used when flying in Manual.

(ii) The tailplane trimmer should be used in the normal manner. When manoeuvring, the stick forces are light and little use of the trimmer is required. The full-power elevator tends to mask any out-of-trim forces which may be present. Always trim out the stick force when practicable (but see para 10 **WARNING**); if this is not done and inadvertent Manual reversion occurs the stick force may be too heavy for the pilot to hold. If the normal tailplane trimmer fails, use the standby control; this operates at about one-third the speed of the normal control. If both trimmers fail, the aircraft can be controlled throughout its speed range with full nose-down trim but with full nose-up trim, the elevator is not sufficiently powerful to stop the nose rising at speeds in excess of approximately 420 knots.

(iii) *Follow-up tailplane*

The tailplane gives an improvement in manoeuvring capabilities above 0.90M. Handling characteristics are otherwise normal, but it should be noted that the tailplane remains fully operative with the elevator in Manual. It is not, however, of much assistance, since stick movements in Manual are usually small and within the neutral dead movement of the follow-up mechanism. The tailplane interconnection can be selected on at any speed provided the aircraft is trimmed for hands-off flight before the selection is made. If the control column is held away from the trimmed position at the moment the interconnection is switched on, the tailplane immediately moves from its trimmed position to align itself with the position of the elevator. When flying with the interconnection on, if the control column is moved away from the trimmed position the tailplane automatically follows-up; when the control column force is relaxed, the tailplane reverts automatically to the trimmed position. These tailplane movements are shown on the trim indicator. The interconnection must be off for all ground attack manoeuvres.

(e) *Airbrake*

(i) The airbrake may be used throughout the speed range. Its use may cause the hydraulic warning light and audio warning to come on momentarily.

(ii) Selection of airbrake causes moderate buffeting and a momentary nose-down change of trim which reverts to a moderate nose-up trim change when the airbrake is fully extended. Correcting the out-of-trim forces at high airspeed may lead to over-controlling.

(f) *Flaps*

(i) *At high Mach number*

Lowering the flaps produces a nose-down change of trim, the intensity of which increases with the amount of flap extended and with speed. If the Mach limitation for the use of flap is inadvertently exceeded, the nose-down change of trim, combined with the normal nose-down trim change experienced at 0.90M onwards may result in longitudinal control being severely restricted due to elevator jack stalling.

(ii) *At high airspeed*

If the IAS limitations for the use of flaps are inadvertently exceeded, the flap angle is limited according to the air load to prevent damage, but sufficient flap will be extended to create a strong nose-down change of trim. This can result in elevator jack stalling and tailplane actuator clutch slip. In this event not only is longitudinal control lost but the aircraft cannot be trimmed nose-up by either the main or the standby systems. In extreme cases, the air loads may then force the tailplane to move in opposition to the actuator thereby causing an additional nose-down change of trim.

WARNING: If longitudinal control is reduced or lost as indicated in (i) and (ii) above, the flaps must be raised and speed reduced. When the flaps are raised the nose-up trim change is very strong.

(iii) *At low airspeed*

With full flap, below 250 knots, lateral rocking may occur but is easily controllable: raising the flaps to 60° reduces this tendency.

(g) *Changes of trim*

Increase and decrease power	...	...	Nil
Landing gear down	...	...	Transient nose-up, slight nose-down when locked down
Landing gear up	...	...	Slight nose-up (see Part 3, Chapter 4, para 2 (c))
Flaps down	...	...	Initially strong nose-down during first 38° (particularly above 200 knots) becoming negligible
Flaps up	...	...	Initially negligible but becoming strong nose-up from 38° upwards
Airbrake out	...	...	Low speed — negligible High speed — transient nose-down, nose-up when fully extended
Airbrake in	...	...	Low speed — negligible High speed — initially sharp nose-down, negligible when retracted

4 Flying with external stores

(a) *With drop tanks on inboard and outboard pylons*

The handling characteristics with inboard drop tanks are similar to those of the clean aircraft. With four full tanks, longitudinal control is sensitive particularly on take-off, on the climb and at high altitude. Due to the light stick forces care must be taken not to over-control. At high airspeeds, only very light stick forces are required to exceed the maximum permitted g. With fuel in the outboard tanks manoeuvres in the rolling plane must not exceed 360° to avoid the build-up of excessive rates of roll. When outboard drop tanks are carried, buffet may commence at approximately 0.84M at sea-level. With increasing altitude the onset of buffet may be delayed to 0.88M and the intensity decreases. Buffet may be accompanied by mild lateral rocking. This buffet damages the ailerons and should be avoided.

(b) *With bombs*

Because of the possibility of elevator jack stalling above 0.90M the aircraft should not be committed to dives which will result in this speed being exceeded unless adequate height allowance is made.

(c) Pressure errors

The presence of a drop tank or rocket launcher on the port outboard pylon has a material effect on the pressure error resulting in under-reading of the pressure instruments; for example the altimeter under-reads by about 1000 feet when flying at about 540 knots at low level. (See Part 5, Chapter 2, para 1).

5 Flying for endurance

The recommended speed band is 220-250 knots depending on the configuration (see Recovery Data tables on Flight Reference Cards).

6 Flying at reduced speed

Fly at 170-200 knots using 23° (2 notches) flap. RPM are approximately 6600-6700 and full power can be achieved within 2 seconds.

7 Flying in turbulent conditions

The recommended speed for flight in turbulent conditions is 300 knots/0-80M.

8 Stalling

NOTE: Because the rate of descent is very high and it is possible to induce an inadvertent spin when the aircraft is fully stalled, stalling practice is not to be commenced below 25000 feet nor continued beyond the buffet stage.

(a) Pre-stall buffet speeds, throttle fully closed, are:

At max landing weight — 18500 lb

Landing gear and flaps up	...	...	...	...	140 knots
Landing gear down and flaps up	...	...	...	...	140 knots
Landing gear and flaps down	...	...	...	...	130 knots

NOTE: The above speeds decrease by approximately 5 knots per 1000 lb reduction in weight.

(b) The pre-stall buffet speeds increase slightly with increasing altitude up to 30000 feet but by about 10 knots between 30000 feet and 40000 feet.

(c) Use of the airbrake increases the buffet but does not affect the stalling speeds or other characteristics.

(d) Under typical approach conditions, the buffet speeds quoted above are not appreciably affected, but the height lost during recovery is reduced.

(e) (i) Although the aircraft must not be deliberately fully stalled in flight, the characteristics are described here to assist pilots who inadvertently enter the fully stalled condition.

(ii) If the control column is held back, after the buffet stage is reached, a nose-up change of trim occurs, and though it varies in degree from aircraft to aircraft, counteraction may require full forward stick movement. There is little tendency for a wing to drop. Relaxation of the forward pressure on the control column at this point leads to a further reduction in forward speed accompanied by a very high rate of descent. In this condition the elevator is relatively ineffective and response is slow. A spin or spiral may develop and in any case, considerable height will be lost. The ailerons are effective near the stall but large deflections cause the aircraft to yaw in the direction of the down-going wing and increase the possibility of a spin or spiral developing.

(f) Outboard stores seriously affect the stall characteristics, particularly the time taken for recovery after initiating recovery action. This feature is aggravated if inboard stores are also carried.

9 Low speed flying

Low speed flying is permitted under the following conditions, with no underwing stores or with two empty drop tanks on the inboard pylons:

(a) With flaps and landing gear retracted, the aircraft may be decelerated at constant altitude at a minimum altitude of 10000 feet to the initial onset of buffet or to a minimum speed of 140 knots whichever occurs earlier.

(b) With flaps and landing gear extended the aircraft may be decelerated at constant altitude using 6900 RPM at a minimum altitude of 10000 feet to the initial onset of buffet or to a minimum speed of 130 knots whichever occurs earlier.

10 G-stalling

WARNING: Care must be taken to ensure that the stick force is never completely trimmed out when G is being applied at high Mach numbers because, as speed falls through 0.91M when the trim changes to nose-up and the elevator and tailplane become more effective, a sudden increase in G may result. This is particularly important below 10000 feet when manoeuvring near limiting G and/or black-out threshold.

(a) G-stalling is subject to the over-riding restriction of +7G (+3G with fuel in outboard tanks).

(b) During turns and pullouts, adequate stall warning is given by buffeting at all heights. If the backward pressure on the stick is continued inadvertently after the stall warning, a momentary pitch-up and a sudden increase in G may result. It may occur when G is applied at speeds above 0.90M in the height band 25000 to 30000 feet. However, if pitch-up occurs it is possible to maintain some degree of longitudinal control. Buffeting is considerable and wing dropping may occur.

(c) Little effort is needed to produce buffet or to reach limiting G.

11 Spinning

(a) Intentional spinning is prohibited. The following information is provided to acquaint pilots with the spin characteristics and recovery actions in case the aircraft is spun inadvertently. Generally, the aircraft is most reluctant to enter a spin accidentally unless coarse use is made of the ailerons during manoeuvres within the buffet. Under these conditions an erect spin is more likely to occur than an inverted spin but the latter may result from a poorly executed loop, a stall turn type of manoeuvre, or when full aileron rolling manoeuvres are performed and the stick is moved appreciably back. It is therefore recommended that these spin-prone conditions be avoided.

(b) *The erect spin*

The attitude is oscillatory during the first 3 to 4 turns but thereafter should settle down with the nose some 50° below the horizon and each turn taking about 3 seconds. The stabilised rate of descent is 20000 to

25000 feet per minute when the flight path approaches the vertical and the height loss per turn may vary from 1000 to 1500 feet.

(c) *Erect spin recovery*

(i) The aircraft recovers readily within 1 to 2 turns when the consolidated recovery action is taken, ie full rudder to oppose the yaw and the stick held fully forward, aimed at the white datum, thus ensuring the ailerons are neutral.

(ii) The standard recovery is relatively insensitive to elevator position or tailplane setting. However, the elevator position does affect the steepness and rate of rotation of the spin, both increasing with forward movement of the stick. The main reason for holding the stick forward is to remove any chance of the spin restarting in the opposite direction.

(iii) The effect of ailerons is critical and if any significant aileron is applied to oppose the roll, the aircraft may not recover until the ailerons are centralised. If the aircraft appears reluctant to recover from the spin full aileron should be applied in the direction of the roll, ie away from the foot applying the rudder. The ailerons are the most effective control in the spin and can overcome the rudder under any condition.

(iv) As a last resort the aircraft will usually recover if the controls are abandoned. The effect of altitude is not marked but recovery appears to improve with decreasing altitude. The height required to regain level flight from the time auto-rotation ceases may be in the order of 6000 to 10000 feet.

(d) *The inverted spin*

(i) As in the erect spin the attitude initially is very oscillatory and the nose pitches above the horizon several times before the spin stabilises. This occurs after 3 to 4 turns with the nose some 45° below the horizon and each turn taking about 3 seconds. The height lost per turn is about 1500 feet.

(ii) Due to the marked upside-down sensation there is no difficulty in recognising that the spin is inverted; the direction of yaw is clearly discernible. It is emphasised that in the inverted spin the indications of yaw and roll are in opposite directions whereas in the erect spin they are in the same direction. The acceleration should average - 1 to - 2G.

(e) *Inverted spin recovery*

(i) The spin should stop within 1 to 2 turns when the rudder is fully applied to oppose the yaw and the stick moved fully forward, aimed at the white datum, ie ailerons neutral. The rudder, which is the most powerful control in the inverted spin, must be applied and maintained in a determined manner as the footloads are moderately high and this recovery requires full rudder deflection. The seat harness and rudder pedals should always be suitably adjusted to enable full rudder to be applied.

(ii) As in the erect spin the use of ailerons in the direction of roll is favourable to recovery and if the spin shows no signs of stopping, the stick should be fully moved laterally in the direction of the roll, ie towards the foot which is applying the rudder. When aileron is used to assist recovery the spin develops into a rolling motion with a rapidly increasing airspeed. At this stage the ailerons should be centralised since if the deflection is applied for too long the aircraft may be driven back into an inverted spin and a severe flicking motion may result. It is important to aim at a clean recovery in the first instance as abortive recoveries may lead to the aircraft spinning more determinedly in a steeper attitude and at a higher IAS. Abandoning the controls will not lead to recovery as the rudder tends to be blown in a pro-spin direction.

(iii) Tailplane trim position does not have any marked effect on the spin or the recovery. However, the recovery is improved by having the stick fully forward to reduce the rate of rotation. Holding the stick fully forward also has the additional advantage of making it easier to apply full aileron, and reducing the possibility of the aircraft entering an erect spin after recovery.

(f) *Consolidated spin recovery action*

The following recovery action, which covers both the erect and the inverted spin, should be taken when any unusual manoeuvre occurs:

(i) Centralise the controls and take no further action until a recognisable spin develops.

(ii) Apply full rudder to oppose the direction of yaw as observed visually or indicated by the turn indicator.

(iii) Hold the stick fully forward against the white datum on the instrument panel.

- (iv) Centralise all controls immediately autorotation ceases.
- (v) If the aircraft does not recover apply full aileron in the direction of roll and jettison wing stores.

NOTE 1: It cannot be over-emphasised that there is only one optimum recovery action; if the aircraft does not recover, recheck actions.

NOTE 2: Be ready to centralise the ailerons when and if the spin reverts to a downward roll, the latter being associated with a rapidly increasing airspeed.

NOTE 3: It is important to resist the instinctive tendency to move the stick away from the direction of the roll. When drop tanks are fitted, aileron position is particularly critical during recovery.

NOTE 4: Landing gear and flaps should be raised if down and engine power reduced to idling although it is not considered that these factors will appreciably affect the recovery.

NOTE 5: If recovery has not been achieved by 10000 feet the aircraft should be abandoned.

12 Inertia cross-coupling

(a) Experience has shown that the aircraft is not generally prone to any significant inertia cross-coupling effects. The following information is provided to give the conditions under which it may be possible for inertia cross-coupling to occur, its effects and the action to be taken in this event.

(b) Inertia cross-coupling may be induced by continuous full aileron rolls at high altitude, particularly if the control column is moved fore and aft from the trimmed position.

(c) The effects of inertia cross-coupling are likely to be violent gyrations in roll, pitch and yaw which can lead to loss of control and possibly severe structural damage. These effects may occur without warning or may be preceded by buffet, sideslip and G variations.

(d) If inertia cross-coupling is experienced, the controls should be centralised smoothly. This can best be done by releasing any applied pressure and allowing the controls to centralise. If then the rate of roll does not appear to be decreasing, it is probable that the aircraft is entering a spin which may be inverted or erect. If this occurs, and is confirmed by instrument indication, the appropriate spin recovery action should be taken.

13 Flying at high airspeed

(a) When flying at high airspeed all control movements must be smooth and progressive to avoid over-controlling, particularly when flying at aft CG and/or in turbulent air. Use the tailplane trimmer carefully. Take care not to exceed the G limitations in harsh manoeuvres.

(b) The maximum rate of roll increases with airspeed up to 420 knots; at higher speeds, however, the rate of roll progressively decreases due to jack stalling. Normally maximum rate of roll is not required.

14 Flying at high Mach number

(a) General

The maximum speed obtainable in level flight at full throttle is 0.94M. The aircraft will reach sonic speed in a 30° to 40° dive at full throttle. When outboard tanks are carried speed is limited to 0.88M or the onset of buffet if earlier. Transonic dives should not be started below 25000 feet because the height loss during recovery may be considerable.

(b) Trim changes

(i) As speed increases to about 0.90M there is a progressive nose-up change of trim. Between 0.90M and 0.94M a nose-down trim change followed by a nose-up trim change occurs, the aircraft being almost back in trim again by 0.96M. At higher speeds as the aircraft becomes supersonic the trim changes to slight nose-down.

(ii) When outboard drop tanks are carried, a mild nose-down trim change occurs between 0.87M and 0.88M. This is accompanied by buffet and possibly mild lateral rocking.

(c) Changes in stick force, and tailplane and elevator effectiveness

(i) As speed is increased beyond 0.92M the elevator becomes less effective. This is particularly evident at transonic speeds when even large elevator deflections have a delayed and reduced response. The tailplane may be used to assist in manoeuvring although its effectiveness is somewhat reduced.

(ii) Since the effectiveness of the elevator decreases as Mach number increases, greater deflections are required to manoeuvre. Consequently, the stick forces increase.

(d) *Transonic flight*

Practice transonic flights should be made by putting the aircraft into a 30° to 40° dive with the tailplane interconnection on. Set the trim at zero otherwise the full range of tailplane movement is not available for recovery without using the trim switch. At 0.97M a very slight wing drop may occur which can easily be counteracted with aileron; if the dive angle is too shallow the aircraft reaches a maximum speed of 0.97M, at which speed the elevator is not effective enough to increase the angle of dive.

(e) *Recovery from transonic dives*

During recovery the throttle should be closed. The airbrake may be used; its extension causes moderate buffeting and nose-up change of trim. It is not very effective in reducing speed. Recovery can be made without using the tailplane trim but jackstalling may occur. Normally the tailplane should not be trimmed more nose-up than 0°, as a nose-up trim change occurs as speed falls below 0.95M.

15 Aerobatics

(a) Until experience is gained, the following speeds are recommended:

Roll	...	...	...	...	350 knots
Loop	...	...	...	...	425 knots
Roll off the top	...	...	...	...	450 knots
Vertical roll	...	...	...	...	500 knots

(b) It is recommended that until experience is gained loops are started between 10000 and 15000 feet.

16 Descending

The two recommended forms of descent are as follows:

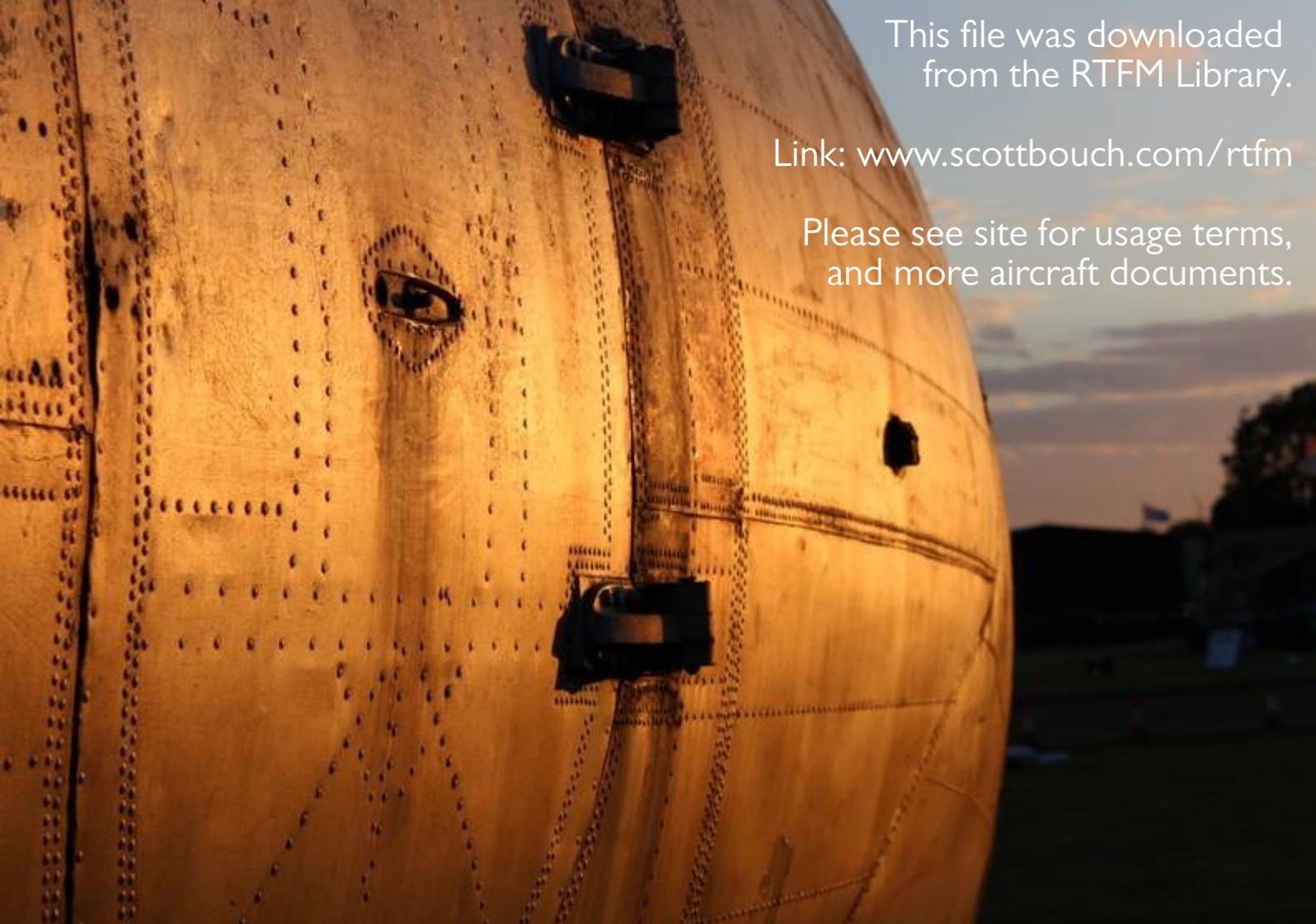
(a) *Range/rapid descent*

Set 6500 RPM and, with the airbrake out and the flaps up, descend at *0.90M/400 knots.

(b) *Instrument descent*

Set 6500 RPM and, with the airbrake out and the flaps at 23°, descend at *0.90M/300 knots.

*But see Mach number limitations when carrying outboard stores.



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