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MELBOURNE.

ANSETT

AIRLINES OF AUSTRALIA

DOUGLAS DC 9
FLIGHT STUDY GUIDE

1979

CONDITIONS OF ISSUE

The information contained in this Study Guide is designed to help crew members to a better understanding of the aircraft. It is primarily to help the pilot undergoing conversion to the type, but also contains reference material of use to the established pilot.

It must be clearly understood that this Study Guide contains material of a general nature. For specific drills and values, reference must be made to the Operating Manual.

Should there be any differences between this Study Guide and the Manual, the Operating Manual must take precedence at all times.

RECORD OF BULLETINS

As certain Bulletins will be issued in conjunction with this Study Guide each Bulletin on receipt, must be immediately inserted, and the date and signature affixed in the appropriate column of this page.

Checks will be made at varying intervals to verify that these Bulletins are completed.

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1. INSTRUCTOR PILOT INFORMATION:

1.1. GENERAL:

Everything that the student is taught must be directly applicable to airline operation and no information should be disseminated which is not directly concerned with flight safety, passenger comfort and operational efficiency. All flight manoeuvres used for training should be limited to those in the training program.

A student may be apprehensive at the start of jet transition and the instructor must attempt to allay these fears and build confidence early in the training. In conjunction with related manoeuvres, the instructor should discuss jet aircraft incidents and show that many of the errors committed were avoidable through complete understanding and respect for the jet aircraft's characteristics.

It is the responsibility of the instructor to conduct detailed briefings to ensure understanding of the subject matter prior to flight. Flight time is too costly to allow initial description of a procedure or manoeuvre while airborne. Briefings should be conducted in an atmosphere conducive to learning, making maximum use of available training aids, such as cutaways, diagrams and blackboards.

1.2. DAILY PRE-FLIGHT BRIEFINGS:

Prior to each flight the instructor will spend adequate time briefing on specific training procedures and manoeuvres to be accomplished on that flight. Each item will be briefed in detail to avoid unnecessary repetition in flight, allowing maximum utilisation of flight time.

1.3. DAILY POSTFLIGHT BRIEFINGS:

Immediately following each flight, the instructor will hold a critique and also brief on the next day's flight. The student's progress will be reviewed to determine if a re-direction of the instructor's efforts is required to obtain the best results.

1.4. INSTRUCTOR NOTES:

Familiarity breeds complacency and the instructor must always approach his flying duties with caution and respect. He must continually remain alert and expect the unexpected. Experience dictates that he follow these simple rules.

a. Plan the ground training program to keep ahead of the in-flight presentation.

b. Carefully outline each training period before flight and brief adequately. Give 60 minutes of flight training for each hour flown. Plan each days program so that each manoeuvre leads into the next manoeuvre.

c. Obtain weather briefing and file the clearance.

d. Recheck the computed take-off data, gross weight and C.G.

1.4. INSTRUCTOR NOTES: ' (Cont'd)

e. Perform an exterior check emphasising hydraulic systems, brakes and tyres before and after each flight.

f. Have one student occupy the observers seat at all times to maintain a clearance watch on the left side of the aircraft and to monitor the instruction being given to the other pilot.

g. Do not allow more persons in the cockpit than are necessary.

h. Guard the controls at all times and be prepared to prevent or correct any rudder misapplication.

i. Be "ready" on the brakes during all taxiing.

j. Have "control" in all three axes prior to verbal command "I've got it!".

k. Return all controls, switches, and circuit breakers to their normal position at the completion of every manoeuvre before proceeding to the next.

l. Alternate the students often enough to prevent fatigue.

m. Stop if any difficulty is experienced while the student is steering during taxi. Normal turns cannot be made from the right hand seat.

The instructor, check instructor or check pilot will be the pilot in command of training or check flights and will be responsible for the safety of the flight.

2. GROUND OPERATION:

2.1. EQUIPMENT LOCATION AND WALKAROUND:

The instructor shall complete an external and interior familiarisation walkaround with each student. The Instructors Walkaround Guide should be used for this purpose. The interior cabin and aft accessory section inspection should include the location of all emergency exits and equipment.

The student should operate at least one cabin door and one emergency exit. The forward passenger and ventral stairs should be operated by all students at least once during their training.

2.2. COCKPIT FAMILIARISATION:

Familiarise the student with all circuit breaker panels as well as the operation of the pilots seats, rudder pedal adjustment, jump seat and cockpit windows. Have the student adjust his seat vertically so that he can see along the flat top of the glare shield, and horizontally so that the max. thrust position of the throttles is reached with the arm nearly extended. Now adjust rudder pedals so that full throw is reached without extending the foot. The location and operation of all controls, switches and instruments should be thoroughly reviewed so that the pilot can locate any switch or control immediately when asked to do so by the instructor. Next, the instructor should discuss the radio and navigational equipment and associated test procedures.

2.3. CHECK LIST FAMILIARISATION:

Use initial acceptance 1st flight of day, thereafter the intransit.

The instructor and the student should thoroughly review and exercise the various normal check lists.

Certain cockpit checks such as the pre-start, after start, and some emergencies should be known well enough to be accomplished by the student following the recommended scan pattern and without reference to the check list. After completion of the items, the check list should then be read to insure that no items have been overlooked.

This philosophy results in considerable time saving, insures that the student knows the cockpit and the operating procedures and is not merely following the check list as a guide, but as a true check. The general objective regarding all cockpit checks and use of the check list is to accomplish the various items of the check and then read the check list. Checks have been constructed to minimise the number of items to be accomplished whilst the aircraft is moving and during the approach and landing, therefore as many items as possible have been placed in the "After Start" and "Descent" checks.

2.4. ENGINE STARTING:

The instructor should point out to all students that it is the responsibility of the Captain to issue all commands on the interphone for the starting sequence. It is important to use the proper phraseology on the interphone to be assured that ground personnel fully understand what is said above the high noise level during engine start. Strict compliance with the engine starting procedures outlined in the DC-9 Operating Manual is required. The instructor should point out the importance of both crew members monitoring engine instruments and systems during the starting process. As soon as the engine has indicated normal "light off" and the starter switch has been released, monitoring of the temperatures and pressures of that engine can be delegated to the instructor and the next engine starter switch actuated. In training call each parameter.

2.5. CROSS-BLEED STARTS:

Normally all engines will be started from the APU or from an external air source. If difficulties are experienced with either source, a cross-bleed start of either engine can be made from the one already started. Increase thrust on the operating engine until there is 36 psi duct pressure after obtaining a ground clearance to increase thrust. Use this air source to start the remaining engine.

2.6. OVER-LAPPING STARTS:

In line operations, over-lapping engine starts are accomplished to speed up departure. After the student has demonstrated proficiency in starting engines, he should be shown over-lapping starts.
Immediately after starter release on the first engine, air can be used to start the second engine. Even though the first engine has not yet reached idle, the second engine can now be started. Watch the EGT's, be prepared to "cut" engines.

Co-pilots should monitor stabilised EGT on engine already started.

2.7. BATTERY STARTS:

The engines can be started using battery power if there is an adequate source of air. The ignition system and the air conditioning pack valves can operate on battery power with the EMERG power Sw. on, EGT is available and N_1 and N_2 indication will function because independent engine driven tachometer generators supply electrical power to the indicators. The fuel flow system is powered by 400 cycle alternating current and will not function.

2.8. START CONTROL SWITCHES:

When held in the START position, the engine start control switches open the manifold shut-off valves to the starter of the selected engine.

Raise only the cover of the start control switch for the engine to be started and close it before starting the next engine. This will prevent rotating the wrong engine.

The start control switch should be released to 35% N_2. In the event of over-temperature during start, the Captain may continue to motor the engine. Normally, the start control switch is released before the maximum of 40% N_2.

If the start control switch is inadvertently released, do not normally re-engage. Wait until N_2 has stopped rotating and observe the starter limitations before attempting to restart. N_1 will also be stopped, unless a strong wind continues N_1 rotation.

2.9. START LEVERS:

The start lever has a spring loaded pin which locks the lever in the cut-off or idle position. To move the lever depress the locking pin with the thumb and at 20% N_2 indication, while depressing the lock pin move the start lever with the thumb and forefinger, quickly upwards to the idle position, checking that the locking pin positively engages.

2.10. EGT, FUEL FLOW, N_1 AND N_2:

Approximately 20% N_2 rotation provides the best fuel/air ratio for starting. However, N_1 must have begun to move in order to provide the necessary air to support combustion. The only cockpit indication of N_1 rotation is motion of the N_1 tachometer. Therefore, do not move a start lever to idle position until observing N_1 tachometer motion, even if this is beyond 20% N_2. Fuel flow must not exceed 1100 PPH on introduction of fuel - normal indication is 800 PPH approx.

EGT must be monitored until stabilised. The EGT describes a definite starting pattern. This pattern follows the engine start fuel flow schedule. As the start lever is advanced to idle, the fuel flow after the initial surge as the P & D valve closes is at a maximum, then increases with RPM to a maximum before dropping to idle fuel flow. If no fuel is indicated because the A.C. power to the fuel flow indicators is disconnected, a normal start can still be made by observing EGT and RPM.

The rate of EGT increase is indicative of danger. A sudden and extremely fast increase in EGT usually means the EGT limits will be exceeded and the start should be discontinued before the EGT reaches the limit. With a slowly increasing EGT, it can be allowed to go to the limit before shutting down.

2.11. REASONS FOR TERMINATING START PROCESS:

1. If manifold pressure returns rapidly to near normal with start valve open light on (starter shaft is sheared). Return start switch to off immediately.

2. If no rotation within 10 seconds, turn switch off. Check C/B. It may be necessary to use Manual operation of start valve.

3. Place start lever off if -

   a. F/F 1100 PPH. or more
   b. EGT above 350°/420° (increasing rapidly).
   c. No light off in 20 seconds.

2.12. COMMON ERRORS:

1. Releases and re-actuates the engine start control switch.

2. Advances the start lever too slowly from CUTOFF to IDLE. This shows a lack of knowledge of the lever function.

3. Holds the start control switch in START above 35% N_2.

4. Does not monitor N_1 rotation.

5. Takes hand off start lever while starting engine and does not monitor EGT.

6. Does not observe oil pressure.

7. Does not check annunciator panel for CSD and other annunciators which operate during start (F/O Duty).

3. TAXI:

Taxiing the DC-9 aircraft is accomplished basically as in other aircraft. Certain techniques, however, are peculiar to the DC-9 because of the jet engines, swept wings, landing gear locations, nose wheel steering sensitivity, and rudder pedal steering.

The student must become aware of the proximity of obstacles, the effects of excessive noise, and the destructive force of the jet engine exhaust blast.

Although the visibility from the cockpit is very good, wing tip clearance is difficult to judge. Taxi on the centreline (put the inboard foot on the centreline when taxiing straight).

Although the DC-9 engines develop relatively high thrust at idle it will usually be necessary to increase RPM to approx. 40% N_1, to break away from the parked position except at light weights on a level tarmac where a smooth breakaway can be accomplished by slowly advancing the throttles until the aircraft starts to roll. When at the desired taxi speed, reduce power to idle. Caution must be used not to exceed 55% N_1 unless it is firmly established with ground personnel that the use of higher power will not cause property damage. If it is necessary to turn shortly after brake release, prevent blasting of adjacent aircraft and personnel by allowing the aircraft to gain enough momentum to carry it through the turn at idle thrust.

The delay of the jet engine response plus the lack of noise level change to throttle movement can easily lead to excessive breakaway power.

The "wing tip/tail/nose clearance" diagram should be reviewed with the student, pointing out that the wing tip being aft of the centre of turn will actually move outward somewhat when making a short radius turn. It must also be remembered the wing and tail are in very different planes and clearance of the wing tip does not necessarily mean clearance for the tail. To ensure adequate tail clearance the nose should be no closer than 4 ft. to any obstruction when doing a full 180° turn.

The long wheel base must be considered during turns. The main landing gear is approximately 54 feet aft of the cockpit and the centre of turn is always in line with the main landing gear. This means the pilot is always outside of the centreline in a turn and must overshoot the desired centreline when entering a turn. When making sharp, slow turns the need for additional thrust should be anticipated. If turning on full lock back off the nose wheel steering about 1 inch to prevent nose wheel scrubbing. Differential thrust may be used with caution if necessary.

3.1. NOSE WHEEL STEERING SENSITIVITY:

Nose wheel steering is very effective and the control motion is much less than the required in other aircraft. To make smooth turns, firmly hold the wheel and "pressure" it in the desired direction. Use the same firm hold while steering the aircraft out of the turn. If the nose wheel steering is released during a turn, the turn will abruptly stop. Before stopping, centre the nose wheel. The full lock capability of the A/C is reduced from 82° to 74° with the right hydraulic system inoperative. This effect should be demonstrated at least once during taxi.

3.2. RUDDER PEDAL STEERING:

Rudder pedal steering, usable from either pilot position, is provided (10/12° either side of neutral). This steering capability is used during takeoffs and landings, as well as taxiing. Nose wheel steering will override this feature and will normally be used during all except minor turns.

NOTE: Because of tyre scrubbing and chock moving, when checking the rudder during pre-start or taxi, have student hold nose steering wheel firmly.

CAUTION

WHILE RIDING IN THE RIGHT SEAT, THE INSTRUCTOR HAS ONLY RUDDER STEERING CAPABILITY. BE PREPARED TO STOP AS YOU MAY NOT BE ABLE TO TURN.

3.3. BRAKES:

Braking action of the DC-9 is excellent and positive with a smooth response. No new or special techniques are required or need demonstration. Rough application can subject the landing gear to very high structural loads. Brakes should not normally be used in a turn.

Before entering a turn the taxi speed should be such as to permit completion of the turn without brake application. If braking is necessary use the outboard brake.

The JT8D-7 fan engines have relatively high idle thrust and this combined with light weights causes the aircraft to accelerate to high taxi speeds. Continuous riding of the brakes to prevent this is undesirable since very little air cooling of the brakes takes place when they are in constant contact. Intermittent brake usage provides a cooling period between applications. Allow the aircraft to accelerate, then brake to a very slow taxi speed, release the brakes smoothly and repeat the sequence. DO NOT RIDE THE BRAKES!

Hot brakes are difficult to detect and could affect RTO ability.

3.4. COMMON ERRORS ASSOCIATED WITH TAXIING:

1. Use of excessive thrust on breakaway at ramp.
2. Failure to keep aircraft moving while in a turn.
3. Taxiing too fast.
4. Rough braking and rough nose steering techniques.
5. Taxiing off centreline.
6. Riding brakes during taxi - will result in overheated brakes.

   DO NOT RIDE BRAKES.
7. Excessive use of brakes in a turn.
8. Undershooting turn and putting the inboard wheel off the taxiway.

4. TAKE OFFS:

During the pre-flight briefing period, the maximum gross weight for existing conditions shall be checked by each student. The data used shall be the latest available and should be rechecked prior to the actual take-off, where conditions have changed. It should be determined by the instructor that the student fully understands how the following are determined:

1. Computations and chart usage:

   a. Speeds - V_1, V_R, V_2.

   b. Runway or climb-out limitations.

   c. Anti-ice procedures.

The flaps will be lowered to the desired take-off setting when cleared from the tarmac area.

Lowering the flaps helps to prevent foreign object ingestion. The taxi pre take-off checklist will not be read until the checks up to and including the flight instruments have been accomplished.

During taxi out, each item of the Taxi Pre Take-off Check should be completed. When the take-off data is read, the pilot should cross check gross weight, both airspeed bugs are set at correct V_2, both EPR bug settings at correct value and stabiliser trim setting. This is a Captain responsibility.

4.1. STABILISER TRIM SETTING: (Complete one take-off with 3 units of mis-trim)

Stabilisers have occasionally been mis-set for take-off. During normal pre take-off procedures the stabiliser trim should be set carefully according to the C.G. and rechecked prior to take-off. The DC-9 has sufficient elevator effectiveness to allow the pilot to overcome a stabiliser mis-trim condition as long as the trim is set within the green band, but an incorrect setting may prevent the aircraft from achieving the engine out take-off flight path. With a full forward C.G. and the stabiliser set on the forward edge of the green band, it may not be possible to unstick the aircraft until V_2 has been reached requiring up to 75 lbs pull force. With the stabiliser mis-set either nose up or nose down, the pilot may not have any indication of mis-trim prior to rotation.

WARNING

IF THE AIRCRAFT DOES NOT RESPOND AS ANTICIPATED AT V_R WITH NORMAL CONTROL COLUMN FORCES, ASSIST WITH STABILISER TRIM.

4.1. STABILISER TRIM SETTING: (Cont'd)

With a forward C.G. and the stabiliser mis-trimmed nose-down but in the green band, an increased pull force will be required to obtain sufficient elevator for rotation at V_R or as high as V_2. If the take-off is runway limited and a heavy pull force is required at rotation, use some nose-up stabiliser trim to assist. Fortunately, after take-off, increasing speed and flap retraction will alleviate the nose-down out of trim condition.

If the C.G. is aft and the stabiliser is mis-trimmed nose-up but in the green band, the aircraft will rotate at V_R very quickly and considerable nose-down elevator after lift-off may be required to stop the pitch-up.

4.2. TAKE-OFF THRUST SETTINGS:

The aircraft is certificated for setting thrust either statically prior to brake release or while rolling after brake release. The same take-off EPR setting is good for both static and rolling. The approved flight manual provides only one take-off thrust chart for setting take-off EPR from 0 to 60 knots.

The EPR used for take-off is the maximum permitted not the maximum available. Reference in this manual will be to maximum EPR rather than take-off EPR. The engine has the capability of producing very high levels of thrust in cold temperatures but is flat rated to 14,000 lbs. Required EPR for take-off will be achieved at significantly less than full throttle.

The take-off N_1 setting (approx. 92%) is used as a cross check of EPR and will change with increased airspeed. Use EPR for thrust setting and do not retard the throttles for N_1 variation unless N_1 or other engine parameters exceed the operational maximums allowable.

Do not waste time and fuel trying to accurately set thrust or to check engine performance prior to brake release. Advance both throttles to the vertical position and allow the engines to accelerate & the bleed valves to close. This minimises thrust asymmetry, caused by differences in individual engine acceleration and aids in preventing overshoot of the desired thrust setting. Release the brakes and during the start of take-off roll further advance the thrust levers smoothly to take-off EPR. Make final take-off power adjustments between 40 to 80 knots, at the same time checking engine performance. The first officer makes the final thrust adjustments using the lower portion of the throttles. The Captain keeps his hand on the throttles to the V_1 speed.

NOTE: Crosscheck take-off EPR with N_1. Observe thrust setting limitations - maximum and minimum.

If max. EPR is set very quickly and then brakes released, there will be an "apparent" ram increase in EPR which is actually the last portion of the engine acceleration and EPR must be reduced to the correct value. Since the first airspeed indication is 60 knots, a practical upper limit for final readjustment of take-off EPR is 80 K.

4.2. TAKE-OFF THRUST SETTING: (Cont'd)

Take-off performance is based on static thrust settings. Once the throttles are set for take-off thrust, do not re-adjust them, except to maintain an operational limit on N_1, N_2, or EGT.

4.3. TAKE-OFF WARNING SYSTEM:

When both the throttles are advanced to just forward of the flap quadrant, an intermittent horn will sound if the spoiler handle is out of detent, the stabiliser trim is not in the "green", the slats are not extended or flap is more than 15°. The warning will not sound if flaps are retracted.

NOTE: Any time the take-off warning horn sounds before V1 speed is reached, the take-off must be abandoned and the cause of the warning determined and corrected before a further take-off is made.

Dependent on the speed when the take-off was rejected, a check of thermal plug integrity may be required.

4.4. NORMAL TAKE-OFF:

Both the rolling and standing start take-offs are normal and will be taught. However, the rolling take-off should be considered as the more desirable and used whenever possible. Release the brakes smoothly and slowly for static take-off.

1. Do not waste valuable runway length aligning the aircraft with the runway centreline. If the aircraft is not aligned at the start of the roll, steer toward alignment while accelerating. Once aligned, strive to MAINTAIN THE AIRCRAFT EXACTLY ON CENTRELINE WITH WINGS LEVEL. Adherence to these criteria will automatically aid the pilot when contending with an engine out or correcting for a cross wind. Starting early in the training, the instructor will insist that the student stay on the centreline with wings level.

2. Nose wheel steering should be used for initial alignment and when aligned revert to rudder pedal steering. Quick inputs on the rudder should be avoided. The rudder steering is very effective and any input changes should be made smoothly and comparatively slowly to avoid heading changes.

3. After initial alignment, the Captain's hand will come off nose wheel steering and hold the control column forward. Only moderate pressure is necessary to retain good steering and a smooth riding nose wheel.

4. Final thrust adjustments should be completed by the co-pilot between 40 and 80 knots to assure proper thrust.

5. During take-off roll, the crew should carefully monitor all engine and airspeed indications. When the Captain is flying, although the co-pilot will call the V speeds to him, he is responsible for checking his own speeds and executing the rotation at the proper speed. During the course of instruction the instructor should intentionally omit to call out 'Rotate' to determine if the student is monitoring the speeds.

   If the F/O is flying, the Captain will perform those duties normally performed by the F/O.

4.4. NORMAL TAKE-OFF: (Cont'd)

6. At V_1 speed the Captain will place his right hand on the control column. When approaching V_R, forward wheel pressure should be relaxed so as to have no wheel pressure as V_R is reached. At V_R, start a slow smooth rotation and continue to rotate through lift off to 16° nose up attitude. This rotation will result in lift off prior to V_2 and generally results in speeds in excess of V_2 + 10 on a normal 2 engine take-off. The rate of rotation and V_R speeds are based on the loss of an engine at V_1, at maximum gross weight and lifting off at the optimum point on the runway.
Therefore, the climb out speed exceeds V2 on 2 engine take-offs. As a guide for the proper rotation rate it requires approximately 3 seconds from start of rotation to lift off and an additional 3 seconds to reach a 16° body angle. Lift off occurs at a body angle of 8° for all flap settings.

7. The aircraft should attain V_2 approximately 25 ft above the runway or 2 seconds after lift off. Depending on gross weight holding a body angle of 16° will result in an airspeed of V_2 + 10 to V_2 + 20 kt during initial climb with both engines operating.

   THE LANDING GEAR WILL BE RETRACTED ONLY WHEN A POSITIVE RATE OF CLIMB IS INDICATED ON THE FLIGHT INSTRUMENTS. Because of ground effect the rate of climb indicator and the altimeter may not show a positive climb until the aircraft is 35 to 50 ft above the runway.

   Gear retraction temporarily increases the aircraft drag while the gear doors are open. Undue haste in retracting the gear is neither necessary nor desirable, however take-off performance is based on initiation of gear retraction within 3 secs. of lift off.

8. Continue climb to 800 ft. at 16° nose up body angle. At 800 ft. raise flaps and slats to the retraction schedules. If manoeuvring is necessary or desirable accelerate first to the minimum manoeuvring speed. When operating at a speed less than the minimum manoeuvre speed, limit banks to 15°. After reaching minimum manoeuvring speed you are protected to at least 45° bank although 30° banks should not normally be exceeded.

   At light weight, holding V_2 + 10 kt will result in a body angle which pilots and passengers may find uncomfortable. For this reason a 16° maximum body angle is used during the take-off climb. Allow the aircraft to accelerate and with wings level, retract flaps/slats on speed schedule. Accelerate to the desired climb or manoeuvring speed maintaining obstacle clearance. The body angle may also be limited by reducing to climb thrust as soon as practical after reaching 800 ft, but any climb limitations must be followed.

4.4. NORMAL TAKE-OFF: (Cont'd)

The pilot should establish a body angle of 16° after lift-off. On two engines this will result in a speed of V_2 + 10 to V_2 + 20 and V_2 speed if operating on one engine. Airspeed and body angle must be frequently cross-checked and body angle adjusted if necessary to maintain a minimum of V_2 speed. Since the body angle will be higher than for propeller aircraft pilots will probably not hold the proper body angle at first allowing the airspeed to increase. Stress that the target attitude for one or two engine operation is 16°. The scat system should be used during take off and the student instructed to fly to the "BIRD".

Flap/Slat Retraction Schedule:

After reaching 800 ft. on straight climb out select flap to zero when speed has increased as follows:-

Flap 15 - V_2 + 10
Flap 5 - V_2

When flap is at zero and speed has accelerated a further 25 kts. retract slats by selecting both flaps and slat levers to "Up". At these speeds the bank angle is limited to 15°. 30° bank turns can be made at the minimum manoeuvring speed. To obtain this speed add 10 kts to the straight climb out speeds.

e.g. On a 15° flap take-off and a typical V_2 of 130 kts -

Straight Climb Out - 15° bank max.

V2	Retract Flap	Retract Slat
130K	140	165

Manoeuvring - 30° bank max.

T/O Flap	Flap Retracted	Slat Retracted
V2 + 10 (140K)	150	175

CAUTION

DO NOT RETRACT SLATS WHILE MANOEUVRING

When retracting the take-off flap from 15° the lever should be placed to zero without pausing at the 5° position. After reaching 800 ft flap is selected to zero and power reduced to MCL.
MCT = MCL from SL to 1500' + above 20000'.

CAUTION

THE INSTRUCTOR WILL MAKE THE FIRST TAKE-OFF WITH THE STUDENT FOLLOWING THROUGH ON THE CONTROLS

4.4. NORMAL TAKE-OFF: (Cont'd)

NOTE: Do not walk the rudder. Hold steady rudder pressure and wheel positions, changing only to maintain a wings level attitude on the runway centre line particularly during lift-off.

Effects of Improper Rotation -

1. Late Rotation -

   The result of a late rotation is the use of additional runway and a climb out profile lower than predicted. Late rotation also tends to cause faster rotations.

2. Early Rotation and Over Rotation -

   Rotating to take-off attitude too soon will extend the take-off roll, using additional runway or will result in an early lift off which will result in a lesser climb rate and a lower profile than predicted.

   Over-rotation adversely affects take-off performance. The nose high attitude causes an increase in drag, delaying acceleration to lift off speed. This could trigger the stick shaker. Over-rotation and early rotation usually are closely associated.

   Tail strikes can occur either from over-rotation or an early fast rotation. Tail skid contact occurs at a body angle of 11.5^{o} at lift off.

Common Errors - Take-off:

1. Use of nose wheel steering for directional control to V_r.
2. Rough nose wheel steering.
3. Uses nose steering instead of rudder pedal steering when aligned.
4. Uses too much runway aligning aircraft in take-off position.
5. Wastes time and fuel with extended engine run-up at take-off thrust prior to brake release.
6. Too sudden brake release. Release brakes smoothly.
7. Does not monitor airspeed indicator for V_1, V_r, and V_2.
8. Does not keep wings level.
9. Over-rotates at V_r. This may actuate the stick shaker. To correct, lower the nose to normal take-off attitude and continue with a normal take-off procedure.
10. Rotates late.
11. Rotates insufficiently resulting in a flat climb out and lack of obstacle clearance.

4.4.1. TAKE-OFFS IN STANDING WATER, SLUSH OR WET SNOW:

Wet runway tests were conducted to verify that take-offs can be safely accomplished in water depths up to the ½ inch limit. DC-9s are equipped with the Chine B nosewheel tyres which are certified to ½ inch of standing water, slush or wet snow.

Significant water ingestion during the take-off roll is accompanied by EPR fluctuation. If these fluctuations reach or exceed .10 EPR a compressor stall is evident and may be audible to the flight crew. EPR reduction of this magnitude has an effect on aircraft performance. Depending upon prevailing conditions, aircraft speed and runway remaining, the crew should respond accordingly.

Two operating procedures should be observed during take-off in standing water, slush or wet snow to ensure stabilised engine operation during take-off roll:

1. Engine ignition should be turned 'ON' and remain on until the aircraft has been cleaned up and the throttle setting reduced for climb.

2. At approximately 70 kt during take-off roll nosewheel hydroplaning starts. Above this speed no forward pressure should be applied to the control column. This will reduce the intensity of the spray from the nosewheel.

3. The APU should be left on to guard against loss of all electrical power in the event of engine flame out.

4.5 INSTRUMENT TAKE-OFF:

During training take-offs shall be given the student having him go on instruments just after rotation. The climb-out procedure shall be completed on instruments.

The purpose of this manoeuvre is to emphasise that the technique concerning rotations, lift-off and climb-out is the same under all flight conditions.

4.6. ENGINE FAILURE AFTER V1:

Before training starts on this manoeuvre, the student should be proficient in normal take-offs and shall have completed engine cuts in flight as laid down in "Engine Out & Rudder Control Familiarisation" P.36 - 39.

The purpose of this manoeuvre is to teach the student the correct procedures to follow for maximum aircraft performance if an engine was lost after being committed for take-off.

The student should be carefully instructed to keep the nose of the aircraft directionally straight during simulated engine failures. Any tendency of the student to anticipate the engine failure should be thoroughly discouraged. By maintaining directional control with whatever control force is necessary, the student will automatically and properly compensate for the engine failure condition. It is important that all pilots realise the necessity and importance of applying sufficient rudder in engine-out conditions so that the excessive yaw angles are avoided. Any time the swept-wing aircraft is yawed, a strong rolling or banking tendency develops which must be compensated for by opposite aileron control to keep the wings level if corrective rudder is not applied. Conversely, when sufficient rudder is applied during engine-out conditions, there is practically no requirement for any aileron control application. This fact can be used as a means of judging whether sufficient rudder has been applied during engine-out operation. The amount of rudder required under these conditions varies only with airspeed and thrust on the other engine.

There is no need to vary the rudder angle when rolling into or maintaining a turn, particularly when it is done smoothly; the rudder should be kept in one position unless thrust or airspeed changes. The turn and bank instrument and the Ball in the H.D.I. can be used for an indication of sideslip or yaw and can be cross checked against the aileron requirement in engine-out conditions. The ball should be close to centre, with ailerons neutral.

Due to engine location and rudder pedal steering, loss of thrust does not present a control problem. Sufficient rudder is available to handle any engine-out condition under adverse crosswinds. Recognition of power loss is dependent on recognition of a decrease in performance and/or a power loss as indicated on the engine instruments. Flight crews must be trained to be conscious of engine instrument readings at all times and, in particular, during take-off. Flying the correct take-off profile on all take-offs with regard to airspeed will automatically compensate for a recognition problem.

4.6. ENGINE FAILURE AFTER V_1: (Cont'd)

Engine failure after being committed (V_1) does not present much of a directional control problem because the DC9 has ample rudder control to handle any engine failure yaw, plus full legal crosswind conditions.

The instructor will retard a throttle between V_1 and V_R. The student will apply rudder as necessary for runway alignment. It is not necessary to reposition the aircraft on the exact runway centre line. The instructor will call "Engine Failure" only after the gear is selected up.

At the start of rotation, the rudder pressure should be increased to compensate for the steerable nose wheel leaving the ground.

CAUTION

DO NOT ROTATE UNTIL REACHING V_R, AND THEN ROTATE AT THE SAME RATE AS ON TWO ENGINES. DUE TO SLOWER ACCELERATION ON ONE ENGINE, A HESITATION SPEED INCREASE WILL BE OBSERVED. THIS IS DUE TO STATIC SYSTEMS ERRORS AND IS NOT APPARENT DURING TWO ENGINE ACCELERATION. BECAUSE OF THE DRASTIC REDUCTION IN THRUST, A SIGNIFICANT INCREASE IN REQUIRED RUNWAY LENGTH RESULTS AND IS PLANNED FOR. ALSO, AFTER BECOMING AIRBORNE, THE NORMAL PERFORMANCE IS GREATLY REDUCED. THE TWO ENGINE PERFORMANCE IS APPROXIMATELY 6 TIMES THAT OF THE SINGLE ENGINE PERFORMANCE.

Normal rotation should result in reaching V_2 shortly after becoming airborne and an attitude of 13° to 16° will be required to maintain V_2 to 500 ft. At 500 ft reduce attitude 3°, accelerate in level flight, and then raise the flaps and retract slats on schedule. As flaps retract increase pitch attitude approx. 3° for 15° flap take-off to prevent sinking. Continue accelerating in level flight to the single engine climb speed (V_{CL}) and then climb at this speed to 1500 ft. After clean up, the engine failure and after take-off check lists should be completed. It should be pointed out that, weather permitting, the pilot should immediately return and land, after climb to 500 ft, manoeuvering and climbing with slat or flaps and slats extended. Identification, Phase II and the Pre-landing should be completed as the downwind leg is entered.

CAUTION

PARTICULAR CARE SHOULD BE TAKEN TO AVOID ANY LARGE LATERAL CONTROL INPUT WHICH WILL RAISE THE SPOILERS DURING THE ROTATION AND INITIAL CLIMBOUT. ANY UNNECESSARY DRAG WOULD ADVERSELY AFFECT THE RATE OF CLIMB PERFORMANCE. MAINTAIN CONSTANT HEADING, USING RUDDER. AILERON SHOULD BE USED TO CORRECT SMALL OUT OF WINGS LEVEL STATE. CORRECT RUDDER, WHEN HOLDING A STEADY HEADING, WILL BE INDICATED BY ZERO LATERAL INPUT.

Don't oscillate the rudder or control wheel. If changes are required strive to make them smooth and well co-ordinated.

When stabilised on speed during climb, rudder trim may be used to reduce the pedal force while pedal displacement remains the same. Rudder trim may be used when established on climb. Trim should be adjusted to 5° - 6° only and left constant rather than attempt to keep constantly in trim, particularly during acceleration and flap retraction.
Changes in trim which result from speed and thrust changes should be controlled with rudder until the aircraft is established on climbout when fine trimming can be carried out.

4.6. ENGINE FAILURE AFTER V_1: (Cont'd)

If speed is 2 to 3 kt less than V_2 after establishing the initial target attitude of 16° do not change attitude until speed is stable. V_2 speeds average 1.28 Vs and there is therefore ample margin for controllability. For obstacle clearance engine out maintain not less than V_2 and not above 16° pitch attitude to 500 ft or until clear of obstacles. V_2 is close to best angle of climb speed. If failure occurs after take-off at a speed higher than V_2 hold 16° pitch attitude but not less than V_2.

4.6.1. CURVED TAKE-OFF:

When departure from an airport calls for a curved flight path after take-off, the procedure is as follows:-

1. If no engine failure occurs, a 15° banked turn will be commenced at the threshold or the nominated point. Flap retraction will be carried out to the appropriate Flap/Speed schedule. The turn will be continued until the desired heading and altitude is reached. NOTE: A 10° - 15° bank angle is required off some runways.
2. If an engine failure occurs, proceed as follows:-
   a. Establish the aircraft in straight ahead climb with correct rudder input and wheel level.
   b. At threshold, or the nominated point, commence the turn using aileron only. Rudder input should be constant, and 15° of bank used.
   c. During turn maintain constant rudder input. Check wheel is level and speed V_2 to V_2 + 5. If the bank angle does not remain constant with zero lateral input, the rudder input is incorrect.
   d. Use the flight director in the Speed Command mode during the turn. The speed command will call for wings level, but the pitch attitude should be used to give V_2 speeds.
   e. Continue turn until reaching the desired heading, Continue climb to the clean up height (if necessary) retract flap/slat on schedule as required.
   f. The engine shut down procedure (Phase 1 & 2) should be carried out after the aircraft is established down wind or after clean up. If fire or severe vibration is present the shutdown should be carried out during the turn.

4.7. ENGINE FAILURE RECOGNITION:

Under adverse conditions on take-off, recognition of an engine failure on fuselage mounted jet engines may be difficult because -

1. There is no audible detection of an engine loss.
2. Thrust asymmetry from loss of an engine is small.
3. A crosswind can mask the thrust asymmetry of the loss of an engine.

Close, reliable crew co-ordination is necessary for early recognition. The Co-pilot will call out any indication of engine problems. The call will be specific malfunction or "Engine Failure" with no attempt to identify location initially.

The initial portion of each take-off should be performed as if an engine failure has occurred. In the event of an actual failure, the flight profile then will be the same normal profile commonly used. Even in the event of an unnoticed engine failure occurring after V_1, the profile and procedure still will be correct and safe.

Instructor Caution:

Close the throttles slowly in simulated failure, reset to 40% N_1 and be prepared to restore thrust on the engine cut should the second engine malfunction or the take-off approach critical conditions. Opening the throttle until the red gear light goes out closely approximates 40% N_1. The instructor will closely monitor the pilot's technique on practice engine cuts during take-off and be particularly alert for any over-control laterally or any excessive delay in applying the proper rudder correction.

NOTE: Be alert on engine cuts at V_R for pilots who tend to over-rotate.

4.7. ENGINE FAILURE RECOGNITION: (Cont'd)

Common Errors:

1. Anticipates engine failure and applies wrong rudder.
2. Tries to correct with aileron instead of rudder. Wings must be level with zero lateral input.
3. Oscillates rudder and control wheel.
4. Rotates early.
5. Rotates late. Remember obstacle climb path.
6. Fails to make good scheduled one engine flight path.
7. Does not recognise the engine failure.

4.8. ABORTED TAKE-OFF - (SIMULATOR AND AIRCRAFT):

Aborted take-offs will be practised in the simulator. The condition shall be presented by inducing an engine failure before V_1 is attained. When practised in the aircraft failure will be called by the instructor at least 25 kt. below V_1.

In the aircraft, while taxiing, give the student practice in manual spoiler extension and simultaneous brake application and associate this training with the aborted take-off.

During briefing thoroughly discuss manual spoiler extension.

When the pilot makes the decision to abort the take-off, the following action must be rapidly initiated:

1. Brakes - Max. Braking)
2. Thrust Levers - Idle) Immediately and simultaneously
3. Spoiler Handle - Pull Up, aft & up (Manual extension)
4. Reverse Thrust - Apply as directional control will permit. (Max. EPR if necessary). Use both RT levers for simplicity (except in training).

   Hold the nose wheel in firm contact with the runway with forward pressure on the yoke.

5. Engine failure procedures - After stopped.

NOTE: Reverse the operating engine with caution, particularly on a wet runway or in crosswind conditions.

Common Errors on Aborted Take-off:

1. Slow reaction.
2. Fails to use brakes immediately.
3. Forgets spoilers or does not operate them correctly.
4. Tends towards use of nose wheel steering.

4.9. SIMULATED MAX. GROSS WEIGHT TAKE-OFF:

Refer to the appropriate chart.

4.10. CROSSWIND TAKE-OFFS:

There is no training manoeuvre that can substitute for an actual crosswind take-off. Even though the swept wing aircraft tends to heel downwind more than a straight wing in the crosswind, the take-off technique is similar to that used in other aircraft. Keeping the aircraft on the runway centreline with the wings level will correct for the crosswind. The instructor will keep a record of the highest crosswind component encountered during training.

Steering and Rudder Techniques -

After the aircraft is aligned on the runway further use of the nose wheel steering should not be necessary as adequate control is available through the rudders which also operate nosewheel steering through 10-12° either side of neutral. There is a tendency to walk the rudder if it is allowed to return the neutral position. Corrections should be made around the offset neutral position required to control the crosswind.

Lateral Control -

Correct for the anticipated wing down condition caused by a crosswind by pre-setting a fixed amount of lateral control into the crosswind prior to brake release. Use the pre-set position as a new zero wheel position, and make necessary corrections from this preset position as needed to keep the wings level. With changing speed and wind conditions the new zero may be shifted slightly. Avoid large wheel oscillations.

Smooth rudder control inputs combined with small lateral control inputs about the preset position will result in a normal take-off with no over-controlling directionally or laterally.

Rotation and Take-off -

During rotation hold the control wheel in the displaced position to keep the wings level during lift-off. The aircraft is in a sideslip with crossed controls at this point. A slow smooth recovery from this sideslip is accomplished after lift-off.

Common Errors (Crosswind) -

1. Relaxes crosswind corrections during rotation.

2. Wing rocking because he oscillates lateral control from zero wheel position instead of holding a pre-set position when attempting to hold wings level.

3. Fails to recognise wings level.

BULLETIN No. 12
(Section 4 – insert to face page 20)

TAKE–OFFS

This Bulletin supersedes Bulletin No. 9 which should be removed and destroyed. Changes have been made where indicated.

Aircraft Handling in Windshear Conditions During the Ground Roll and After Lift–Off.

If a tailwind increase occurs during the take–off ground roll, an indication to the pilot may be a slower than normal increase in indicated air speed as the aircraft accelerates. If the tailwind increases at the same rate as the aircraft is gaining speed, indicated airspeed will remain constant. As the aircraft exits the shear while continuing the take–off roll in a constant tailwind, an increase in IAS will again be observed.

Because of the tailwind, IAS will now be lower than the ground speed and additional distance will be required to accelerate to the scheduled V_1 and V_R speeds. It is considered that under standard day conditions at sea level, all engines operating, a tailwind increase of at least 20 – 30 kt can be sustained without exceeding the scheduled take–off field length. If available runway length exceeds the scheduled take–off distance, a stronger tailwind increase can be sustained.

If any of these conditions are encountered on take–off when runway length is a problem, the aircraft has an additional lift–off capability if the rotation is continued close to tail skid contact. Since a higher pitch attitude will reduce lift–off speed, it is important to continue the rotation after unstick to an attitude higher than normal to preclude loss of lift as the aircraft exits the ground effect. The pitch attitude must not be reduced until a positive rate of climb has been achieved and then some of the climb capability can be traded for cautious acceleration. Airspeed, Altitude and Rate of Climb must be constantly monitored.

If obstacle clearance is not a problem and undershoot shear conditions are suspected after take–off, some initial climb rate may be sacrificed to obtain better speed margins. An initial climbout speed of V_2+25 will provide better climb performance to penetrate sustained downdraught areas.

It is not considered desirable to accelerate on the runway beyond normal rotation speeds (due increased distance required). Acceleration airborne in a shallow climb with gear retracted will be better than acceleration on the ground if higher speed margins are being sought prior to encountering anticipated windshear.

It should be noted that as long as the airspeed does not fall below the stick–shaker speed when in an undershoot or downdraught environment, the aircraft should not be accelerated to a higher speed until loss of altitude can be prevented. This may require holding a body angle attitude that is significantly higher than the original climbout attitude.

Maintain a continuous full panel scan during the initial climb when close to the ground for earliest possible detection of windshear. Proper attitude and speed control are mandatory to minimise any rate of descent.

5. AIR WORK:

5.1. CLIMBING TURNS - SIMULATOR & AIRCRAFT: (210/250/285/310K)

The student can be introduced to the technique of precise turn control, accurate roll out on desired heading, smooth level off at desired altitude and maintenance of constant speed during this period of flying.

Training value is obtained from climbing turns in the following areas.

1. Develops smoothness in the use of lateral controls.

2. Utilises principles learned in attitude flying such as:

   a. Precise and smooth level off.
   b. Control of climb airspeed by attitude while power is constant.

3. Introduces the student to the technique of thrust and speed control.

Execute this manoeuvre utilising 30° bank turns rolling from one turn to the other. Give the student the desired climb airspeed and power setting. Emphasise proper attitude flying principles in airspeed control and in levelling off. Initially, have the student step climb while climbing at the desired airspeed.

Instructor Tips:

1. Determine that the student understands principles of attitude flying, and then point out the use of these principles.

2. Emphasise the use of a steady pressure on controls until the desired results are obtained. Don't move them; pressure them.

5.2. TURN RATE AND RATE OF ENTRY:

Turns should be entered at a consistent and constant roll rate. This can be achieved by always using the same control input. 30° of control wheel deflection is recommended and the turn should be established at 30° of bank. Smoothly roll from one turn to the other using 30° control wheel input. Roll out on desired heading can be achieved accurately by using the same 30° control deflection leading the desired heading by 1/5 of the bank angle, e.g. 30° bank, roll out 6° ahead. Constantly stress the need to concentrate on attitude. For every configuration of flight a specific attitude should be established and maintained if accurate work is to result.

5.3. LEVEL OFF AT CONSTANT SPEED:

Have the student level off at various altitudes maintaining constant speed. Vertical speed should be reduced over the last 1000 ft. to less than 1000 FPM.

5.3. LEVEL OFF AT CONSTANT SPEED: (Cont'd)

Initially the student will probably use nose down trim to level off. Emphasise that if speed is to be held constant there will be no change of trim irrespective of the thrust used or the vertical speed. Note the pitch attitude necessary to hold steady altitude and point out that if speed were increased pitch would have to be decreased and vice-versa.

5.4. POWER CONTROL:

Power control is considerably different on a jet compared with a prop aircraft. Throttle movement is much greater and more frequent. During manoeuvring flight the student should be taught to fly with one hand constantly on the throttles. Specified thrust settings are rarely used and desired speed is maintained without reference to EPR or N1 values. This technique is most desirable as it reduces the number of instruments the pilot is required to scan. It is necessary to develop a feel for the correct thrust through throttle position and, to an extent, "seat of the pants" feel for a state of equalibrium between desired speed and thrust. Initially the student should be shown that at average gross weights (39,000 kg) selection of 1.35 EPR will maintain any desired speed in level flight. Train away from dependence on thrust instruments as soon as possible. Stress use of the throttle to vary speed and pitch to vary flight path. Demonstrate the use of MCL to accelerate and idle thrust to decelerate.

As the desired speed is approached (10K above) during deceleration, show firstly spin up to approximately 50% N_1, then as desired speed is approached (5K) increase thrust to maintain speed. During acceleration thrust reduction from MCL should commence approximately 10K below desired speed. Show that thrust response to throttle movement is non-linear particularly as the throttle approaches the normal maximum power position. Small throttle movement - large EPR increase. Draw attention to the fact that maximum thrust levels can be easily exceeded due to the almost complete absence of engine noise. Watch EPR and N_1 values.

5.5. INSTRUMENT SCAN RATE:

Instrument scan must be quick, constant and follow a regular pattern. It is important to establish as early in training as possible the need for good, fast scanning. Inability to maintain desired flight path or speed or a variable attitude is evidence of a slow scan rate or pre-occupation with or fixation on a given instrument.

Recommended scan is ATTITUDE, HEADING - ATTITUDE, SPEED - ATTITUDE, VERTICAL SPEED and ALTITUDE. Note that attitude is referenced every time another parameter is referenced. Together with a sound knowledge of required pitch attitude for various configurations, development of good scanning is essential if the student is to quickly and comfortably establish confidence in handling the aircraft.

5.5. INSTRUMENT SCAN RATE:

Common Errors -

1. Overcontrolling laterally when changing angle of bank & direction.

2. Initially, forgetting basic rules of attitude flying. During climb, attempting to control level off with power rather than attitude.

   STRESS HERE LEVEL OFF WITH ATTITUDE AND CONTROL AIRSPEED WITH POWER

3. Not starting to level off soon enough.

5.6. NORMAL TURNS - 30° BANK 250 KTS. (5000 - 15000 FT):

After levelling off at a specific altitude, have the student smoothly roll into a 30° bank at 250 kts. using 45° of lateral input. Point out that a specific attitude will maintain altitude. Constant pressure on the control wheel rolling into and out of the turns will give the desired constant roll rate, with smooth entry and recovery. Scanning from the horizon to the rate of climb to the altimeter and back to the horizon is necessary to maintain altitude and steady bank angle.

5.7. STEEP TURNS (ALTITUDE 5000 - 15000 FT.):

This manoeuvre is done at a 45° bank angle at 250 kts. in the clean configuration without the use of stabiliser trim.

With the power set for stabilised straight and level flight at approximately 250 kts. in trim and on the desired altitude, smoothly roll into a 45° bank. Again, use constant lateral pressure to obtain a constant roll rate. As the aircraft rolls through 30° bank, increasing back pressure on the wheel and increase in pitch (approx. 3°) is required to account for the apparent increase in weight due to G force (refer load factor - bank angle chart). This need should be anticipated even before it shows on the instruments. At the same time, a small increase in power will be required to prevent a speed bleed. Again the horizon indicator is the primary instrument for this manoeuvre but must be used somewhat differently since pitch angle of the horizon becomes inaccurate during the turn, induced by gyro precession. It should be used for instantaneous pitch corrections with reference to the altimeter and rate of climb for reaction. The IVSI is good for general trends of climb or dive. The roll out is done at the same constant rate as roll in and the reverse technique used, reducing the thrust and pitch to the values used at entry. The student should start rolling out approximately 10° before the desired heading. Turns should be for at least 180° duration. It is important to hold constant speed otherwise variation in stick force and pitch will be needed to maintain altitude.

NOTE: It is normal for the compass flag in the CDI to appear occasionally furing a sustained steep turn together with a comparator warning light.

5.8. ELEVATOR CONTROL:

Give the student a feel for increasing stick force with increasing elevator requirements by performing 45° bank turns without retrimming the stabiliser during or after turn entry. For a constant airspeed and constant bank angle, constant stick force and control column displacement is required to hold attitude and altitude. Only small control column movements are required (about the constant stick displacement) to hold altitude. These movements are best made by making small stick force (pressure) changes. Think of flying by pressure changes.

Enter the turn with the aircraft trimmed for level flight. With no trim change, the original trim will still be good for roll-out, if the recovery is made to the same speed and thrust. On roll-out the aircraft will tend to pitch up. Use the elevator to control pitch until stabilised at the original thrust and speed.

Later in training during landing pattern work, the student will automatically trim the stabiliser to maintain zero elevator stick force in turns. Initially, when trim is used in the turn, the student may allow the nose to pitch up on recovery.

5.9. FLIGHT INSTRUMENTS:

An instantaneous rate of climb indicator can be very useful for maintaining altitude. Although the instantaneous rate of climb indicator has considerable lag when performing steep turns, changes in rate of climb can be used to anticipate changes in altitude indication.

Sudden changes in G force can initially give large, false rate of climb indications. Entering a turn the IVSI will give an erroneous indication of climb of approx. 200 FPM, and the reverse on roll out.

The instrument lag may be such that the altimeter will respond as quick or quicker than the rate of climb, especially at high altitude. Know your instruments.

The Artificial Horizon precesses in a turn. The bank angle indication can be used at all times, but the pitch reference changes continuously and should be used only for instantaneous pitch correction. Small changes in indicated nose attitude on the artificial horizon will be required to actually hold a fixed pitch attitude, zero rate of climb and constant altitude.

Common Errors -

1. Enters turn with too rapid or too slow a roll rate.
   a. Rapid roll rate will usually yield altitude loss on entry.
   b. Too slow a roll rate during entry will usually yield altitude gain.
2. Pumps control column (use steady pressure).
3. Fails to add thrust as bank goes through 25-30°.
4. Instrument scan too slow.

5.9. FLIGHT INSTRUMENTS: (Cont'd)

5. Reluctant to make required thrust change.

6. Allows bank angle to change. (This changes the effective lift area as each bank angle change requires an elevator pressure change and a pitch change).

7. Allows speed to vary which results in excessive pitch variation to hold constant altitude.

5.10. SPEED BRAKE USAGE:

With the speed at 250 kt to 275 kt in straight and level flight have the student move the speed brake lever to the full flight up position (30^{o}) noting that initially, there is very little pitch reaction, but that pitch down occurs during the latter part of the movement. The lever should be moved slowly particularly during the latter part of the travel both extending and lowering the speed brake. The control wheel should be centered (not necessarily wings level). Repeat the exercise until the student can extend and retract the speed brakes smoothly and without wing oscillation.

The 210 kt minimum speed with the speed brake extended is twofold. First the stall speed increases 10 kt at 0^{o} flaps and 20 kt at 50^{o}, therefore, they should not be extended with flaps extended. Secondly, if deceleration is desired in the 210 kt regime slats/flaps are far more effective.

CAUTION

ENSURE THAT THE SPEED BRAKE LEVER IS MOVED ONLY TO THE 30^{o} FLIGHT POSITION. IF THE LEVER IS MOVED TO THE UPPER TRACK, EXTENSION OF 60^{o} IS POSSIBLE.

Spoiler and Speed Brake Data -

1. Spoilers cause a loss of lift over the area of the wing ahead of and aft of the spoilers.

2. In flight, when spoilers are used as speed brakes, it is recommended that the speed brakes be used in the full up position. Partially raised speed brakes will be double acting (one side will raise and the other lower), increasing the roll rate. When moving the speed brake lever in flight try to have the wheel centered(not necessarily wings level) to prevent lateral overcontrol, or if deflected, do not vary lateral input while moving speed brake lever.

3. Move the speed brake lever smoothly. A pitch change will occur as the speed brake is moved but is more pronounced during the last 1/3 of extension. This is easily corrected with elevator if the speed brake lever is moved aft slowly in flight. To maintain altitude at constant speed with full speed brake increase pitch attitude 3^{o}.

4. In flight, buffet caused by speed brake operation is very minimal. Its use will cause pitch down which can be easily controlled by elevator, and early air separation from the wing with a resultant increase in stick shaker actuation speed.

5.11. ROLL RATES, LATERAL CONTROL & SPOILER EFFECTIVENESS (5000-15000 FT):

Roll rate training will be done in the simulator in various configurations.

The instructor shall have previously discussed with the student the spoiler/aileron combinations and relationship, and how hydraulic system failures can unbalance the relationship.

This manoeuvre will show the student that the DC-9 has a nearly constant roll rate (under normal conditions) over a very wide speed range. This is due to the increased spoiler effectiveness as the flaps are lowered. Use constant input force and 45° control wheel input. Roll from 30° one way to 30° the other way.

Procedure:

1. Set the bug to Vref 50° plus 50 kt.
2. At a speed of approximately 210 kt clean, use normal aileron input and roll aircraft into a 30° bank in each direction noting the rate of roll compared to the lateral input pressure.
3. Select full speed brake smoothly and repeat rolls above and note somewhat increased roll rates.
4. Lower the speed brakes.
5. Turn off both hydraulic systems and repeat rolls. Note decrease in roll rates with no spoilers.
6. Slow to Bug Speed and make shallow banks. The roll rates are those encountered.
7. Return hydraulic systems back to 3000#.

For Information:

In the landing configuration with the wing flaps fully extended, and the left hand outboard spoiler panel raised 60°, full right wing down lateral trim plus 70 - 80° aileron control wheel rotation, is required to maintain level flight. The right wing spoilers would raise approximately 15°. Full aileron control wheel rotation is approximately 120°. Therefore, about one third normal aileron control remains for manoeuvering if crosswinds are encountered.

The above control abnormality can be relieved by decreasing the wing flap angle during landing. The recommended flap setting for such an abnormal flight condition is 25°.

A pilot at his discretion may choose to land the aircraft with flaps set at a reduced angle which would reduce drag and improve manoeuvering capabilities. This would be especially true if a go-around should become necessary.

5.12. ACCELERATION TO V_{MO}:

This manoeuvre familiarises the student with elevator-stabiliser control characteristics, and demonstrates flight up to V_{MO}. It also familiarises the student with the aircraft performance capabilities in acceleration and deceleration.

Initial Conditions:

Configuration - Clean
Altitude - 10,000 - 15,000 feet.
Airspeed - 200 - 250 knots
Note thrust and stabiliser trim settings.

Procedure:

Use maximum climb thrust (MCL) to accelerate in level flight to 300 knots. Stabilised at 300 kts. Maintain longitudinal trim. Note the thrust and stabiliser trim settings and compare with those at 250 knots.

(Perform turns if desired). Again advance thrust to MCL and maintain longitudinal trim while accelerating to V_{MO} in level flight. Again note the thrust and stabiliser settings.

CAUTION

SMOOTH AIR REQUIRED FOR V_{MO} DEMONSTRATION

Hold altitude and heading within limits during the acceleration (if training area permits).

Manoeuvre at V_{MO} and note "clacker" and overspeed warning light. Then reduce thrust to idle, stabilised at 210 kts in level flight. Time the deceleration clean from V_{MO} to 210 kts. Note the time at 285 kts. This indicates deceleration time to turbulence penetration speed. Note the thrust and stabiliser settings and compare with the two sets previously observed.

Discussion -

Elevator-Stabiliser:

As the airspeed changes reduce pitch attitude to hold the altitude with elevator by increasing stick pressure. Then trim the stabiliser and reduce control pressure to zero while returning the control column to its original position.

The student should note that the stabilizer trim-switch operation required intermittent operation or "beeping" at high indicated speeds and fairly large amounts of trim at low speeds. Because the stabilizer is used to trim out control forces instead of an elevator trim tab, the technique for trimming the aircraft is somewhat different. Remember that the control column is always the same physical position whenever the aircraft is trimmed out, (except when the Mach trim compensator is functioning). This means that as the stabilizer is trimmed, the elevator control should be allowed to move toward the neutral position, thus relieving the out-of-trim control force in such a manner that the aircraft attitude is held constant.

5.12. ACCELERATION TO V_{MO}: (Cont'd)

If the elevator control is held in a fixed position with 10 or 15 pounds of force while the stabiliser trim is operated, the forces will never be relieved and the aircraft will nose up or down. Initially, most pilots are not aware of this subtle difference in trim technique and usually over-trim until they adapt to this particular feature through experience. Use frequent short beeps on the main stab. trim at speeds above 300 kts to minimise the possibility of excessive pitch trim rate and effectivity which can occasionally be detrimental to passenger comfort. Use less frequent longer applications of the trim with large speed changes as this is more effective than "beep" trimming at the lower speeds. The stabiliser is not to be used as a primary flight control, establish the desired attitude with the elevator then trim to relieve control forces as they occur.

Note the position of the stabiliser trim position indicator at the start of the manoeuvre, at high speed, and at low speed. As the airspeed increases, the nose tends to pitch up and the stabiliser trim will normally be positioned nose down when in-trim at high speed.

VMO - Maximum Operating Airspeed:

VMO is indicated by cross hatched pointer (barber pole) on the airspeed indicators, but varies with altitude. At this speed a "clacker" will sound and the overspeed light will illuminate.

This manoeuvre demonstrates that the aircraft can easily exceed VMO in level flight at low and medium altitudes. Failure to reduce thrust to a cruise setting after level-off can result in excessive speeds.

Thrust:

The aircraft decelerates slowly after thrust reduction in level flight. This is due to aerodynamic cleaness, flush antennae, lack of propellers, etc. The kinetic energy contained in a large mass at high speed requires a long time to dissipate and deceleration is slow.

Any residual thrust will only result in a longer deceleration time. Therefore, use idle thrust or minimum thrust required for engine anti-icing.

For any large increase in airspeed, the quickest acceleration with the least fuel used will be obtained with maximum thrust permissible. In training, use MCL.

5.12. ACCELERATION TO V_{MO}: (Cont'd)

Deceleration Times:

The average deceleration times noted will be useful in later operations. Nominally it takes 35 seconds to decelerate from V_{MO} to 285 knots and 110 secs. from V_{MO} to 210 knots in level flight, with no speed brakes raised, and thrust at idle. These lead times will be used in approach planning for reaching clean descent airspeeds, turbulent air penetration speed or flap placard speeds. Using full speed brakes to aid in deceleration will reduce these times by approximately half. Deceleration with speed brakes and slats extended from 280 to 210K = 35 secs. Slats only 280 to 210K = 45 secs.

Common Errors:

1. Poor altitude control. Use elevator to maintain flight path and trim smoothly.

2. Poor speed stabilisation. Too gentle with use of thrust.

5.13. BASIC JET PRINCIPLES (ATTITUDE FLYING AND SPEED CONTROL):

1. Attitude/Speed Control Exercise:

At 210 kt extend slats and decelerate to Vref + 45 kt set 15° flaps and allow aircraft to decelerate to Vref + 25 kt and point out the pitch change during flap extension as well as new attitude at Vref + 25 kt. Lower gear, set flaps to 25° speed Vref + 15, and note the same. Extend flaps to 50° and allow to slow to Vref + 5 while setting up a sink rate of 600-800 ft. per minute. This simulates entering the glide slope on an ILS approach and gives the student a look at the attitude changes and thrust requirements. Follow this with a missed approach to show the effects of power application, rotation and immediate flap retraction, when a missed approach is executed. Continue with flap retraction schedule until clean and 210 kt. This exercise demonstrates both attitude and speed control with variable power and constant power.

2. Flap Extension:

The initial flap extension will cause a ballooning effect. Simultaneous with initial flap extension ballooning should be resisted with forward stick followed by trimming. The pitch attitude should be decreased by approximately 3° during initial extension to hold altitude then as speed decreases pitch attitude should slowly increase to hold level.

The effect during further flap extension is much less marked. During flap retraction the opposite effect will be encountered but usually 2 engine acceleration is so rapid that there is less need to vary pitch attitude. During SE acceleration increase pitch 2 to 3° to prevent altitude loss.

5.14. USE OF SPEED COMMAND:

During circuit work the student should be taught to reference the SLOW/FAST scat indicator when flying the "bug plus" speed applicable to the gross weight and flap setting. For take-off the FD system is set to the SC mode and the aircraft should be flown to the pitch attitude command of the "yellow bird". Refer to diagram 4 of Appendix 2 for the Vs variable on which the scat is based.

5.15, APPROACH TO STALL & FULL STALL DEMONSTRATION: (MINIMUM OF 10,000 ft. ABOVE TERRAIN)

Prior to this exercise it should be determined that the student is fully conversant with the stick shaker, the supplementary stall recognition system and the relationship between the stick shaker and the S.S.R.S. speeds.

The instructor shall demonstrate a full stall and recovery prior to the student practising the manoeuvre. The student is not to proceed further into the stall than the stick shaker or the stick shaker speed minus 3 kt.

5.15. APPROACH TO STALL & FULL STALL DEMONSTRATION: (Cont'd)

The purpose of this manoeuvre is to familiarise the student with the aircraft handling characteristics in the impending stall region and to stimulate early recognition.

Approaches to stalls shall be practised with the aircraft in the clean configuration, with 25° flaps gear down in a 30° bank and straightaway with the landing gear extended with 50° flaps.

The minimum altitude for stall demonstration is 10,000 ft. above the terrain. If at all possible and with consideration of the terrain the maximum altitude should not exceed 15,000 ft. so that Mach effect will not interfere with the low altitude characteristics.

Conditions:

Altitude - 10,000 ft. minimum above terrain (16,000 ft for SSRS Demo)

Yaw Damper - ON OR OFF

Speed - To stick shaker or the stick shaker speed minus 3 kt.

Airspeed "Bug" - Vref 50° for weight

Vartical Speed - 0 to shallow climb

Ignition - On

Eng.Hyd.Pumps - High

EPR Bug - MCL

CONFIGURATION	AUW kg x 1000	30	32	34	36	38	40	42
	THRUST % N_1	55%						55%
SLATS RETR.	TRIM 1.4 Vs	165	169	174	179	184	190	195
FLAPS UP	S.S. SPEED	122	126	131	135	138	142	145
GEAR UP	S.S.R.S.	118	122	126	130	133	136	140
SLATS EXT.	THRUST % N_1	55%						55%
FLAPS 25°	TRIM 1.4 Vs	120	124	128	132	135	139	142
GEAR DOWN	S.S. SPEED	91	94	97	100	103	106	108
SLATS EXT.	THRUST % N_1	55%						55%
FLAPS 25°	TRIM 1.4 Vs	120	124	128	132	135	139	142
U/C DN. 30° BANK	S.S. SPEED	98	102	105	108	111	115	117
	THRUST % N_1	70%						70%
SLATS EXT.	TRIM 1.4 Vs	111	115	119	123	126	129	132
FLAPS 50°	S.S. SPEED	85	88	91	94	97	99	102
GEAR DOWN	S.S.R.S.	82	84	87	90	92	95	97

5.15 APPROACH TO STALL & FULL STALL DEMONSTRATION: (Cont'd)

Thrust should be set according to the configuration at trim speed plus 20 kt and speed should be bled at 1 kt per second in a shallow climb (0-500 FPM).

Do not trim the stabiliser below 1.4VS or undesirable pitch up during recovery will result. In each instance, the speed bleed shall be gradual to guard against an excessive nose high attitude. (1 kt per second).

At the first indication of stick shaker, power shall be applied (maximum Allowable Thrust) (in training use MCL) simultaneously lowering the aircraft nose to 5° above the horizon or to the horizon with SSRS levelling the wings if in a turn. If the flaps are at any other position than 15°, immediately raise or lower them to the 15° position. Selection of 15° flap reduces the stall speed by approx. 32% and decreases the 50° flap drag by approx 55%.

If pitch up (due to flap extension) is permitted with the application of thrust (particularly at speeds less than Vref), an accelerated stall buffet is likely. The student must be taught to avoid such an occurrence by holding forward pressure on the control column. Hold the aircraft nose on the target attitude during the acceleration. At Vref (Bug Speed) begin rotation to obtain bug + 10 or a maximum of 16°. With a positive rate of climb, retract the landing gear, if extended. Once the recovery has been made, speed shall be allowed to increase to 150 kt prior to climbing back to the initial altitude or commencing the next exercise.

NOTE: Any time the aircraft, when in the Clean configuration and at low altitude, inadvertently gets into a stall buffet, immediately apply max allowable thrust and set 15° flaps for the recovery.

At high altitude DO NOT extend flaps during recovery as this will increase drag and reduce the margin of thrust available for recovery.

Stalling Characteristics:

The DC-9 Series 30 aircraft stalling characteristics are somewhat different with slats closed than with slats opened.

Slats Retracted:

With the slats closed the aircraft is conventional in that pre-stall buffet is quite apparent and as the stall or CL max. is encountered there is a marked "G" break and the nose pitches down. In approaching a stall there is good stability up to the stick shaker. From the stick shaker to the SSRS, lateral and directional instability become apparent. This instability, although easily controllable, makes the pilot "WORK" to maintain wings level. This natural warning is an excellent indication that the aircraft is about to stall.

5.15. APPROACH TO STALL & FULL STALL DEMONSTRATION: (Cont'd)

Slats Extended:

With the slats extended the keynote is stability. The aircraft is very stable up to the stick shaker, however, just prior to SSRS a very slight lateral instability occurs. This lateral activity is not nearly as marked as with the slats retracted. Very light natural aircraft buffet commences after the stick shaker. In the landing configuration the 50° flap buffet completely masks the stall warning buffet. At and below 94 kt IAS in the 50° flap configuration lack of airflow into the ram air duct will cause the aircondition packs to trip off. With the slats opened pre-stall buffet is difficult to detect and there is little or no "G" break or pitch down as the stall or CL max. is achieved. Because conventional pre-stall characteristics are not present with the slats open the SSRS was installed in addition to the stick shaker. With the slats open the stalling characteristics at and beyond CL max. are:

a. very light buffet
b. very light "G" break
c. mild rolling tendency

together with -

d. unmistakeable stall recognition from the SSRS
e. excellent controllability through the stall
f. very good stall speeds

The aircraft behaviour at high angles of attack (CL max.) is excellent. There is -

a. no abrupt roll or pitch
b. excellent controllability about all 3 axis
c. little altitude loss
d. positive recovery

Stick forces lighten beyond the SS speed as the SSRS speed is approached, but are still positive.

As in other aircraft, we are not teaching stalls. Rather, we are teaching approaches to stalls and the recognition and recovery from this impending stall condition. Stall warning is considered to be any warning readily identifiable by the pilot, whether artificial (stick shaker) SSRS or caused by airflow separation (such as stabiliser buffet, aileron buffet, or wing buffet). Recognition is primarily with the stall warning device (stick shaker).

Except to demonstrate the SSRS instructors will go no further into the stall regime than stick shaker or more than 3 kt lower than the speed that stick shaker should actuate. The stickshaker & SSRS will not be deactivated in flight and must be operable for all flights.

It should be emphasised that the SSRS (lights and horn) mark the stall and are the absolute limit at which recovery should be initiated.

5.15. APPROACH TO STALL & FULL STALL DEMONSTRATION: (Cont'd)

If the stall recovery is delayed beyond the SSRS, and the pilot continues to apply back pressure, he could eventually reach a point where the control forces would lighten. Going deeper into the stall would result in pitch up, possibly followed by roll off, and a high sink rate, inevitably resulting in excessive loss of altitude.

In comparing the various flap settings of the Series 30 the 50° flap/slats configuration is the least favourable from the standpoint of pitching moment characteristics.

Effect of C.G.

The aircraft is the most sensitive controlwise at the aft C.G. and the stall speeds are approximately 4-5 knots slower than for a comparable weight at forward C.G.

Recovery was demonstrated from aft C.G. whilst the listed Flight Manual stall speeds were determined at full forward C.G.

Rate of Entry

A distinct advantage of the SSRS is its capability of detecting different entry rates into a stall through measuring the change in angle of attack as a function of time.

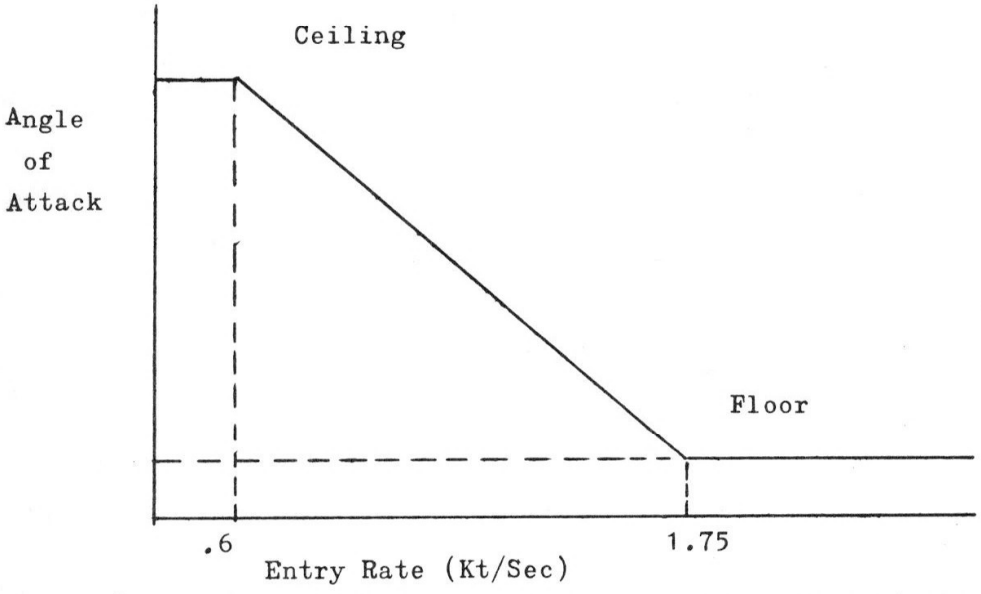
In Douglas flight tests, entry rates were varied from 0 to 5 knots per second. Stall speeds as shown in the FAA Approved Flight Manual were achieved at an entry rate of 1 knot/second and represent V_S or the minimum speed attained. "The greater the entry rate the slower the speed" is the general rule. At higher entry rates, it is possible to obtain minimum speeds as much as 10 knots below the 1G. stall speed, but with an overshoot in pitch attitude.

The SSRS automatically corrects for varying entry rates as depicted in the following chart for 50° flaps/slats extended.

High Altitude (above 25000')

Marked to heavy buffet occurs about 10K ahead of the stick shaker.

5.15. APPROACH TO STALL & FULL STALL DEMONSTRATION: (Cont'd)



The purpose of the "FLOOR" which is the lowest angle of attack the SSRS will trigger, is to avoid nuisance trips during takeoff and landing and yet still provide a safe margin for inadvertent high entry rates.

The "CEILING" was established to prevent a pilot from creeping up to the stall at a zero knot entry rate thus robbing him of any margin of time prior to the full stall.

Flight Controls -

Trim the aircraft to the speeds listed. Pitch control from this point on is maintained with elevators.

Lateral control is maintained with ailerons and spoilers.

Directional control is maintained by keeping wings level with aileron.

Rudder should not be used during stall recovery since positive control is available without it. Further, the rudder is so aerodynamically effective even when the aircraft is stalled that it is easy to overcontrol, thus inducing a yaw which aggravates any rolling tendency. The instructor should caution the student not to use rudder.

During FAA certification recovery from the stall was demonstrated by relaxing the control column thus permitting natural unassisted aircraft recovery. This recovery may be accelerated by using elevator augmentation, however, it is not a requirement.

Deep stall is prevented by powered elevators and greater span elevators which are outside the disturbed airflow.

5.15. APPROACH TO STALL & FULL STALL DEMONSTRATION: (Cont'd)

Flaps:

Flaps are positioned to 15° if stall warning occurs while flaps are retracted. This action will lower the stall speed. If the flaps are extended further than 15° when stall warning occurs, retract to 15°. This action will remove that drag associated with larger flap settings and allow more rapid acceleration. Note that a trim change will occur with flap extension. Use elevator and if necessary a little stabiliser trim to maintain desired attitude.

DO NOT USE SLATS OR FLAPS AT HIGH ALTITUDE (above 25,000 ft.) due to increase in drag and possibility of exceeding flap speed placard.

Landing Gear:

If stall warning entry is made with the L.G. extended, do not raise it until after the recovery has been effected and a positive rate of climb is established.

Thrust:

During the recovery, advance the thrust levers promptly to the "Maximum Power" position - observe resultant EPR indication. The pilot not flying will adjust the thrust to the maximum allowable for the altitude. Normally use MCL in training. Thrust has no appreciable effect on initial buffet or stall speeds and will cause a very slight pitch up.

Speed Brakes:

Speed brakes have an appreciable effect on stall speed. (Refer to diagram 7 in Appendix 2). Therefore, speed brakes are not normally extended in flight at airspeeds below 210 kt. The angle of attack is much higher for the same airspeed with speed brakes up.

Airspeed "Bug"

The bug should be set for Vref 50° for the weight prior to starting these manoeuvres.

Common Errors:

1. The student lowers nose too far below the target attitude then, in order to minimise altitude loss, rapidly raises nose which reactivates stall warning or induces buffet.

2. Does not co-ordinate turn roll out and lowering nose while recovering from approach to stall in a turn.

3. The student does not apply enough thrust. Emphasise last portion of throttle opening provides most thrust.

4. Forgets to call for flap positioning.

5. Attempts to trim below trim speed during entry and recovery.

5.15. APPROACH TO STALL AND FULL STALL DEMONSTRATION: (Cont'd)

6. Calls for gear up before positive climb established.

7. Uses rudder to control lateral instability. Do not use rudder as it may cause abrupt roll off.

NOTE: If the student advances thrust levers beyond the desired thrust setting, the instructor should be alert that engine limitations are not exceeded.

5.16. ENGINE OUT & RUDDER CONTROL FAMILIARISATION:

(Conducted at Minimum Altitude of 15000 ft. above terrain).

Purpose:

This exercise is developed to familiarise the student with engine out yaw tendencies and the handling of this yaw with proper rudder control input. Conduct initially at 250/210 kt before continuing at Vref + 10 kt.

Conditions:

Altitude	-	1500 ft. or higher above terrain
Flaps	-	15^{o}
Gear	-	Down
Airspeed	-	Vref + 10 kt
Yaw Damper	-	On
Thrust	-	As required

With both engines set to equal power, the student shall be instructed to fly the aircraft toward a preselected visual reference point or to maintain aircraft heading. The instructor should now reduce power to idle on an engine.

As soon as the student is able to maintain heading, wings level and form an appreciation of the rate of thrust decay, reduce speed to Vref + 10, set Max. Allowable thrust on both engines, rotate to the take-off attitude 16^{o} and reduce one engine to idle during rotation.

After proficiency has been developed in proper rudder usage, and proper yaw control, co-ordinate the take off engine failure procedure with this exercise. Do not conduct actual take off engine failure practice until this exercise is completed.

Discussion:

At the completion of training, an engine failure should trigger the student into the same sequence of thoughts:

a. Rudder and Aileron to counter thrust asymmetry (Gear up)
b. Attitude, Airspeed, Flight Path
c. Engine Failure procedure.

5.16. ENGINE OUT AND RUDDER CONTROL FAMILIARISATION: (Cont'd)

Flight Instrument Indications of Thrust Loss:

The aircraft nose is the best indicator of the correct rudder pedal input. Apply rudder pedal to return the nose to the desired heading.

Priority for best method of determining the proper rudder application is:

a. Nose - Stop the nose motion by applying rudder to return it to the original heading.

b. Control Wheel - Apply control wheel to maintain constant bank - zero or otherwise. The control wheel will be rotated in the direction of the required rudder pedal. Apply rudder until the control wheel is level. The wheel position can be used as a measure of the correctness of rudder application. If the right hand is down right rudder is needed and if the left hand is down some left rudder is needed.

c. "Ball" - Push the Ball back towards the center with the rudder. As yaw develops from thrust asymmetry, the Ball deflects toward the required rudder pedal. Push the Ball back.

Rudder and Lateral Control:

To counter the thrust asymmetry due to an engine failure, visually observe the aircraft nose start to swing and stop the swing (yaw) with rudder just as if the aircraft were rolling down the runway and was being held on centerline with rudder.

Rudder pedal application should always be smooth and at the same rate as the thrust decay. The pedal force is relatively light and easy to hold and requires approximately 2/3 available pedal.

Under instrument conditions the pilot's scan is centered on the attitude indicator. This results in roll being the first indication of an asymmetric condition and the control wheel being applied first to hold the wings level or maintain the desired bank angle. Then rudder is applied to center the wheel. With the proper rudder applied, no lateral control displacement or lateral trim is necessary. This means the control wheel should be centered (level) when proper rudder is applied. This then retains full lateral control in both directions and helps prevent pilot induced lateral oscillations.

Make turns at a constant airspeed and hold the rudder displacement constant. Do not attempt to co-ordinate rudder and lateral control in turns. Rudder pedal inputs will excite roll due to yaw and induce the pilot to counter his own rudder oscillations with opposite control wheel. Hold the rudder displacement constant in manoeuvring flight, even if slightly incorrect. Make the final rudder correction when wings are again level.

5.16. ENGINE OUT AND RUDDER CONTROL FAMILIARISATION: (Cont'd)

Thrust, Attitude and Airspeed:

If an engine failure occurs at other than MCT or take-off thrust, add thrust on the operative engine as necessary to maintain the original airspeed. At a first setting, the same total fuel flow will be approximately correct, so increase the fuel flow of the operative engine accordingly.

If the failure occurs when at a thrust limit, lower the nose to maintain airspeed as the thrust loss occurs. During the training manoeuvres dropping the nose down about 3 degrees prevents airspeed loss.

When the thrust loss occurs in a turn at minimum manoeuvring speed, the bank angle can be held if the airspeed is maintained. If the student allows the airspeed to bleed off he should realise that the bank angle is now limited and the bank must be decreased.

Autopilot:

If the autopilot is on, and an engine failure occurs, it may disengage due to AC Power interruption. Re-engage, add thrust as required and trim the rudder to center the wheel. It is not necessary to disengage the autopilot while applying rudder trim.

Rudder Trim:

Rudder pedal forces are light and can easily be held by the pilot. Rudder trim can be used to remove the pedal force after displacement is stabilised.

If pedal pressure is held, the pilot tends to lose the feel for the proper displacement and may be making small, but significant changes. To eliminate this, it is best to trim rudder pedal pressure to zero if the pedal displacement is to be held for an extended period of time. The rudder trim operates the rudders through the same control units as the rudder pedals.

Rudder Characteristics (Flaps Up);

A small rudder pedal motion will cause the aircraft to respond quite rapidly and since forces are light, the result is a sensitive rudder control.

If a rudder pedal is depressed rapidly an undesirably large dynamic yaw can result. This type pedal motion and/or the subsequent rapid release of the pedal once applied, or application of the opposite rudder may subject the aircraft to high structural loads, especially at high speeds.

Since the directional system is sensitive and the aircraft response is rapid, any rudder application or rudder corrections for aircraft yaw should be accomplished smoothly and carefully.

5.16. ENGINE OUT AND RUDDER CONTROL FAMILIARISATION: (Cont'd)

Instructors should thoroughly brief their students as to the above.

Common Errors:

1. Wrong rudder
2. Oscillates rudder
3. Attempts to co-ordinate aileron and rudder in turn
4. Attempts to use aileron in lieu of rudder.

5.17. RUNAWAY STABILISER - SIMULATOR OR AIRCRAFT:

A runaway stabiliser and a jammed stabiliser are separate and distinct problems and should not be combined.

This manoeuvre is to familiarise the student with the method of stopping a runaway stabiliser and returning the aircraft to an in-trim condition.

Conditions:

Altitude	-	5000 ft above terrain (minimum)
Airspeed	-	200 - 250 kt
Configuration	-	Clean

With the aircraft in the 220-250 kt speed range set up the problem by requesting a change in airspeed. When the student actuates the trim button, the instructor should hold his in the same direction after noting stabiliser setting and restricting runaway action to 3 units of trim.

Procedure:

Runaway of the main stabiliser trim can be recognised by the aural beep occurring every second and a comparatively fast out of trim motion - ½ degree per second. The aural beep also occurs when the alternate trim is in motion but the rate of trim is much slower - 1/10 of a degree per second and the aural beep occurs every 5 seconds.

Should the main stab trim runaway, resist the out of trim condition on the elevator to maintain flight path and immediately place the stabiliser trim cutout switch to the stop position. Retrim with the alternate trim control. Should the alternate trim runaway (5 seconds beep and slower motion) oppose runaway using primary trim in opposite direction. When in trim again, pull the circuit breakers on the alternate trim motor and use primary trim.

In each case, adjust power as necessary to maintain "in trim" speed.

5.18. JAMMED STABILISER APPROACH AND LANDING:

The jammed stabiliser approach procedures assures landing capability from even the most adverse C.G. conditions and from speeds just above approach speed to V_{MO}.

In a situation where the horizontal stabiliser is jammed and the longitudinal trim is not available, the pilot may be required to fly the approach with a push/pull force which could in some cases not afford sufficient elevator to offset the out of trim condition. To compensate for this, that is to make our elevator more effective, 5 kt must be added to the Vref speed if the stabiliser becomes inoperative during take-off or approach to land and 20 kt if it becomes inoperative during climb, cruise or descent. Do not assume a jammed stabiliser just because the trim switch does not activate trim. Check trim cutout, alternate trim, C/B's and "suitcase handles". Maintain the airspeed of the last in trim flight condition until ready to descend for approach and landing.

If time permits refer to the Inoperative Stabiliser Landing Chart to determine the specific Vref additive to be used for the final approach.

The circuit should be flown to the normal pattern extending downwind so that a turn onto final can be made at 1000 ft above field elevation. As stick forces can be quite high during manoeuvring the co-pilot can assist by holding the control column (not the wheel) with a constant pressure. Constant pressure should be applied and the co-pilot should be cautioned not to apply control forces in an attempt to fly the aircraft.

It is important to maintain a normal sink rate during approach with close control of speed until touchdown. Due to the limited elevator control high sink rates must be avoided.

For a missed approach apply maximum power, rotate, raise the gear with a positive rate of climb, retract flaps to schedule and accelerate to the in trim speed.

The approach and landing will be accomplished with flaps set at 50° and the airspeed bug set to Vref + 5, + 20 kt or as determined from the Inop. Stab. Landing Chart. The final approach will be flown accordingly. In the simulator, the manoeuvre can be practised by inducing a jammed stabiliser condition on the trouble console.

DO NOT ASSOCIATE THIS MANOEUVRE IN TRAINING WITH A RUNAWAY STABILISER. FURTHER, IN THE AIRCRAFT, DO NOT PULL ANY C.B. NOR DEACTIVATE THE STABILISER TRIM SWITCHES. DO NOT CONDUCT IN STRONG WIND OR GUSTY CONDITIONS.

5.18. JAMMED STABILISER APPROACH AND LANDING: (Cont'd)

Procedures:

In the simulator, advise the student that he is on a downwind leg and cleared to execute a jammed stabiliser landing to the airport.

1. Set stabiliser to max of 3 AND mis-trim in both aircraft and simulator.

2. Read the pre-land check list and set airspeed bug to Vref + 5 or 20K.

3. Start decelerating and extend flaps to 15°, flying downwind at not less than "bug" + 25K.

4. Extend landing gear and flaps as in normal approach.

5. Plan turning on final approximately 1000' above field elevation and decelerate to "bug" speed with 50° flaps on final (plus shear and gust additives).

6. Establish normal sink rate.

NOTES: Until ready to start landing descent, maintain speed at which stabiliser jammed.

As the aircraft decelerates, the stick force will build up. If the student desires, help may be given by the instructor who will hold some relieving pressure on control column (not wheel).

Common Errors:

1. Reduces thrust and speed too soon. Maintain trim speed.

2. Does not stabilise soon enough on final approach. Permits high sink rate to develop.

3. Forgets to set bug speed to Vref plus 5 knots or 20 knots.

4. Overcontrols during flare and balloons. Flare should be minimal to prevent tendency to overcontrol with resulting balloon.

5.19. CANYON APPROACH (MIN. 5000' ABOVE TERRAIN):

The purpose of this manoeuvre is to train in the areas of speed and attitude control through changing altitudes and configurations.

Procedure:

Assign a starting altitude and heading.

1. Read and pre-land check list and set airspeed bug to Vref 50°.

2. Extend slats, set flaps to 15° and decelerate to Vref + 25K maintaining altitude and heading. Fly this configuration one minute, using this minute to stabilise on speed, altitude and heading.

3. At end of first minute, gear down, extend flap to 25°, set thrust to 1.1 EPR and decelerate to Vref + 15K. Now start descent maintaining Vref + 15 K.

4. Descend 2000' then level off maintaining speed and configuration for three minutes from start of descent.

5. At the end of time, execute pull-out:

   Max. Power, Flap 15° and rotate to 16° body angle.
   Establish 30° bank.
   With positive climb rate - raise gear.
   Maintain Vref + 25 K or a 16° maximum deck angle.
   Reverse direction and stop turn.
   Level off at original altitude and clean up on Vref schedule.

INSTRUCTOR: At light weights use MCT power.

5.20. ENGINE FAILURE AND ENGINE FIRE:

Simulated engine failure and engine fires can be accomplished throughout the student's flight training. Proper procedures and crew co-ordination should be discussed and practised on the ground prior to start or on taxiing while awaiting take-off clearance. Of prime importance is the crew's ability to function efficiently and without undue haste during Phase 1 portion of the emergency. The student should be cautioned that control of the aircraft is of paramount importance. As the student progresses fire warnings or engine failures can be introduced during take-offs and instrument approaches. On simulated engine fires in the aircraft the Fire Shut-off handle is to be left in the normal position.

CAUTION

THE INSTRUCTOR SHOULD RETARD THE THROTTLE AT A RATE CONSISTENT WITH NORMAL ENGINE DECELERATION. RESET TO 40% N_1 DURING TAKE-OFF OR APPROACH.

5.20. ENGINE FAILURE AND ENGINE FIRE: (Cont'd)

Engine Shut-down and Re-start:

The purpose of this manoeuvre is to have the student become proficient in the inflight engine re-start procedures.

The student shall be required to shut down an engine under simulated conditions of an engine fire. The student shall execute the phase 1 items on the Engine Fire check list, after which the check list shall be read.

CAUTION

DO NOT PULL THE FIRE SHUT OFF HANDLE ON THE AIRCRAFT IN FLIGHT

The engine shall be relighted, following the "AIR START " check list step by step.

INSTRUCTOR CAUTION

ALLOW A COOLING PERIOD OF 1 MINUTE AT IDLE PRIOR TO SHUTDOWN.
IF THE ENGINE IS TO BE SHUT DOWN FROM A SETTING ABOVE CRUISING THRUST, COOL THE ENGINE AT IDLE FOR 2 TO 3 MINUTES BEFORE SHUTDOWN.

5.21. USE OF AUTO PILOT:

As the DC-9 will utilise the auto pilot during most phases of flight it is important that the student have a thorough understanding of the various modes in which it can be operated. It is essential that the sequence of automatic operation in each of the modes be known so that proper monitoring can be achieved. Initial exposure to the autopilot should be conducted during the climb to high altitude. Further training should be accomplished whenever possible even if the time involved is brief, so that the student acquires competency in co-ordinating engagement, thrust and speed control and overall monitoring prior to conducting coupled approaches. It is important to stress that speed, attitude and altitude must be closely monitored. There is a tendency to become preoccupied with the autopilot operation forgetting flight path and speed. During climb for high altitude exercises use the airspeed and mach hold with varied degree banked turns using the turn controller and the CDI HDG control. On reaching altitude use the Vertical speed wheel to set up varied sink rates, finally engaging the altitude hold function. During subsequent periods the altitude pre-select function should be practised on at least three occasions.

6. HIGH ALTITUDE DEMONSTRATIONS:

6.1. GENERAL:

These manoeuvres introduce the student to aircraft flight characteristics at high altitude and in most cases will be the introduction to flight above 25,000 ft. It is most important that the student be thoroughly familiar with high altitude low and high speed buffet, mach trim compensator operation and general handling qualities prior to this period of training, otherwise anxiety may develop.

The need for smooth control inputs should be impressed upon the student in order to avoid loss of altitude or inadvertent stall buffet when manoeuvring at high altitude and mach. Note that very small pitch changes will result in vertical speed changes of 1000 and 1500 FPM.

Conditions:

Configuration	-	Clean
Visual Conditions	-	Clear of Clouds

6.2. LEVEL TURNS:

Altitude	-	30,000 feet or above
Mach	-	.76
Yaw Damper	-	ON or OFF

Perform 180° and 360° turns with 25° to 30° bank angle.

Discussion:

These turns will give the student a feel for longitudinal control and thrust requirements at high altitude at cruising Mach while holding bank angle, airspeed and altitude.

At high altitude turn rate for a given angle of bank + IAS is much less than at low altitude due to the increase in TAS. Therefore, bank angle should be a minimum of 15° to 20° where a significant heading change is desired and accurate tracking is to be maintained. Where a significant change in track is required at cruise Mach No. .76 commence the turn approximately 2-3 miles prior to reaching the fix so as to come out on track at completion of the turn. (Refer Turning radius diagram).

At high altitude, use the altimeter as the primary instrument for holding altitude. The IVSI is sluggish in response and therefore inaccurate.

6.3. MMO AND MTC DEMONSTRATION:

Prior to demonstrating the MTC operation is should be determined that the student is cognizant of the mechanical relationship of the MTC to the longitudinal flight controls of the aircraft and that the MTC operates the elevator and does not trim the stabiliser to preclude aircraft tuck. The aircraft tucks due to a backward shift in the center of pressure on the wing as mach reaches approximately .80. The MTC will be fully extended at approximately .84 mach.

6.3. MMO AND MTC DEMONSTRATION: (Cont'd)

Altitude - 30,000 feet or above (33,000 ft. desirable).

After completion of Level Turns, set throttles for maximum continuous thrust and accelerate to MMO.

If shallow dive is required to reach MMO, establish a 1500 ft/min rate of descent. Increase to 2000 ft/min if required.

As the speed increases through .80 mach note the MTC extension. Hold level flight or constant flight path if descending while placing the MTC to the OVERRIDE position and then relax the control column and allow the aircraft to tuck. Continue acceleration toward MMO observing the aircraft tendency to continue "tuck", then place the MTC control to TEST, return to level flight and place the MTC switch in the NORMAL position. Check the MTC INOP light is out.

When MMO is reached and the warning clacker sounds in level flight, reduce thrust. If MMO is reached in a descent, establish a 1,000 ft/min climb until back at the original altitude then level off at Mach .82/83 If the MMO is reached during descent the recovery to climb may be used to demonstrate the sensitivity of the high speed buffet to slight increase in G force.

High speed buffet could occur in turbulent flight at high altitude due to gusts or in recovering the aircraft following an upset and this manoeuvre will demonstrate to the student the need to avoid other than very mild increase in G force. During the recovery have the student pull a higher than normal G force intermittently during the round out to the climb.

Use brief BEEP trimming to remain in-trim throughout this manoeuvre except during the MTC demonstration when trim is not be used.

Hold heading, be smooth and fly with precision.

6.4. HIGH SPEED BUFFET:

Mach - .82 - .83
Altitude 33,000 feet or above.

At Mach .82 - .83 perform a level turn with a gradually increasing bank angle until high speed buffet is recognised. Do not exceed a bank of 45°.

If high speed buffet does not occur, increase altitude and repeat, or increase "G" force by increasing the control column pull force while in a 30° bank.

Decrease the bank angle when high speed buffet is encountered. Repeat as desired.

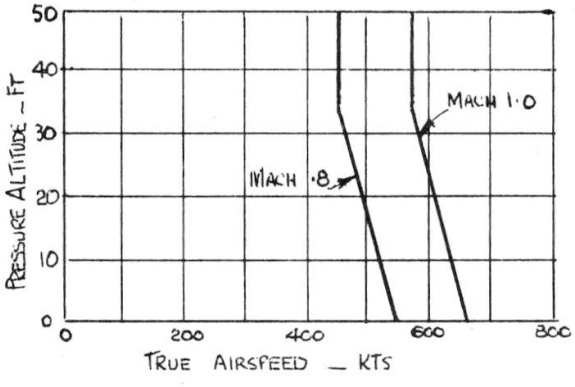
Raise the speedbrakes when in level flight and observe high speed buffet with speedbrakes. Observe roll sensitivity as speedbrakes are raised.

6.5. SWEPT-WING, JET CHARACTERISTICS:

The jet transports have an increased performance envelope as compared to their propellor engine forerunners. This increased performance capability results in normal operations at altitudes and airspeeds where compressibility effects occur. The extra performance which gives normal cruise at high altitudes also provides enough extra thrust to permit climbing to higher altitudes than the optimum for a given weight, and makes the airplace easily capable of exceeding V_{MO} at low and medium altitudes. A general understanding of the effects encountered will aid the pilot in effectively operating the DC-9 aircraft.

High Speed Flight at High Altitude:

Mach number is the ratio of the local air velocity to the velocity of sound. This is a non-dimensional expression of airspeed such that at a speed of mach 1.0 the airspeed equals the speed of sound. As seen by the pilot, Mach is the ratio of his true airspeed to the speed of sound. The speed of sound in air decreases with increasing altitude (decreasing temperature) up to 36,000 feet as seen on the adjoining plot.



Although these aircraft fly at airspeeds below Mach 1.0 (MMO is less than M 1.0); local airflow can reach sonic speeds (Mach 1 or greater) over some portion of the aircraft.

Lift is developed from the decrease in pressure of the air being accelerated over the upper surface of the wing. This accelerated air can reach sonic speeds while the aircraft is subsonic.

The critical Mach number of a wing is that aircraft Mach at which some portion of the airflow over the wing first equals the speed of sound (Mach 1.0). Increasing the airspeed still higher will cause the airflow at some portion to become greater than Mach 1.0. A shock wave forms where the flow returns to subsonic flow as seen in Figures A, B and C:

LOCAL VELOCITIES - TYPICAL JET TRANSPORT

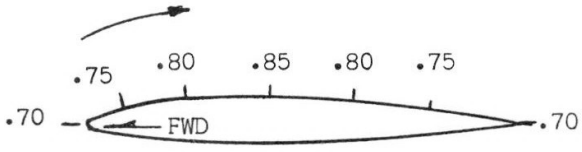


Fig. A MACH .70

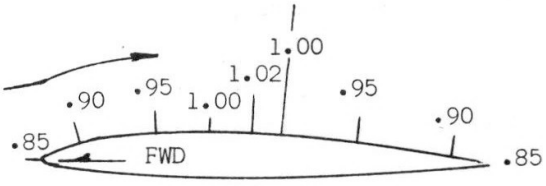


Fig. B MACH .85

Examples of Local Airflow Velocities

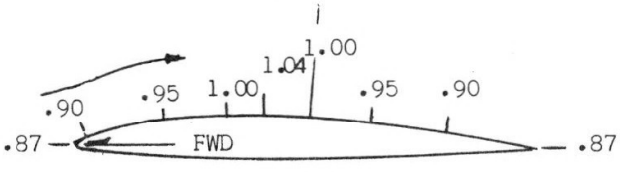


FIG. C. MACH .87

Center of Pressure

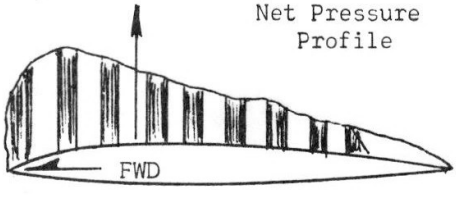


Fig. D MACH .70
Angle of Attack 4.6°

Center of Pressure Shift

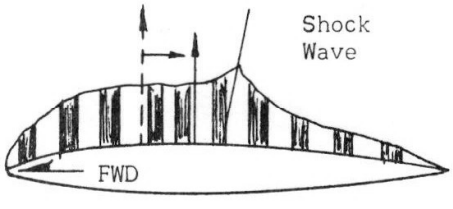


Fig. E. MACH .875
Angle of Attack 2.6°

6.5. SWEPT-WING, JET CHARACTERISTICS: (Cont'd)

From these sketches it can be seen that as speed of the wing continues to increase, the transition from sonic to subsonic flow will move aft on the wing. Thus, the chock wave moves aft with increasing speed and vice versa. This shock wave and its motion can be observed as a shadow on the wing, just forward of the flap, during the shallow dive to M_{MO}. It is most easily seen if flying 90° to the sun and observing the down sun wing. Occasionally the standing wave can also be seen.

The distribution of lift over the airfoil changes with the formation of the shock wave and the center of pressure moves aft as shown in Figures D and E.

At high subsonic flight speeds, basically the lift (lift coefficient - C_L) for a given wing increases with Mach for a fixed angle of attack until separations occur due to increased turbulence aft of the shock wave and then the lift (lift coefficient) decreases. This is shown in Figure F, which also shows a continuing decrease in maximum C_L capability as speed increases.

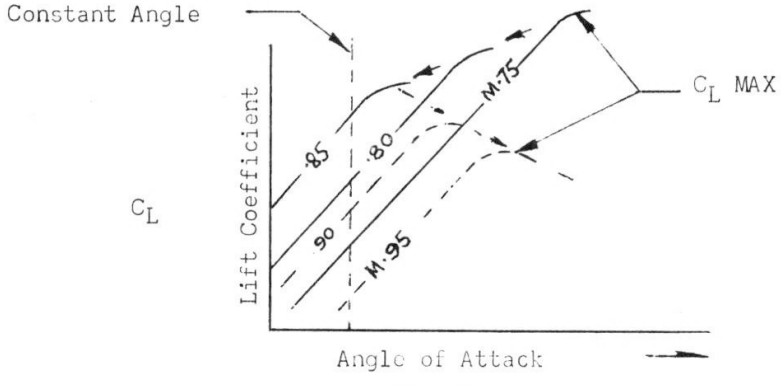


Fig. F

Thus, after the shock wave is well developed, the maximum lift capability continues to decrease with further increase in Mach up to Mach 1.0. To the pilot, this means limited airplane manoeuverability. High speed buffet will occur with any increase in "G" force or bank angle.

Also, as the flight speed increases, the turbulence increases aft of the shock wave. Flow separation finally occurs and buffeting - High Speed Buffet - will be felt in level flight at 1 "G".

With increasing airspeeds above the critical Mach this separation and buffet causes the drag to rise rapidly as shown in Figure G.

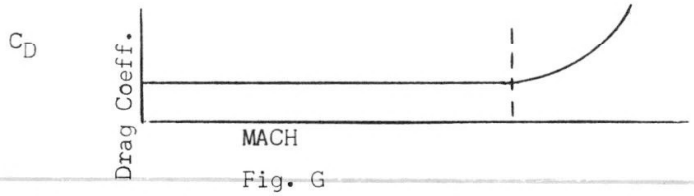


Fig. G

6.5. SWEPT-WING, JET CHARACTERISTICS: (Cont'd)

The Critical Mach of a wing is dependent, among other things, upon the wing sweep and the airfoil shape. The thinner the airfoil section and the more wing sweep, the higher the Critical Mach number. DC9 Mcrit = .75.

The DC9 airfoils are a laminar flow shape selected after extensive testing to give the desired overall performance. It is a compromise to give satisfactory low speed and high speed performance.

The wings are swept to aid in delaying the formation of the shock wave. The component (V_c) of the airflow (V) across the chord of a swept wing is less than the aircraft airspeed as seen in the sketch, Figure H.

V = Aircraft Velocity

V_c = Lift Producing Chordwise Flow

V_2 = Spanwise Flow (Negligible Lift Effects)

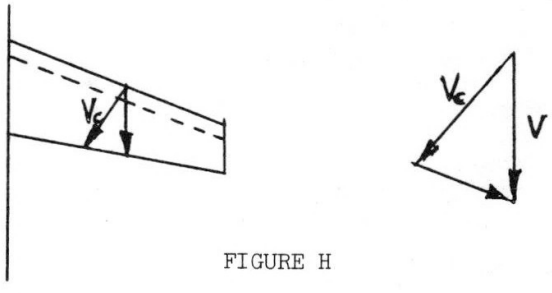


FIGURE H

Low Speed Buffet:

At low speeds the onset of initial buffet and stall are primarily determined by the angle of attack. At high angles of attack, flow separation over the aft section of the wing causes buffet. As the separation proceeds over the entire wing, stall occurs.

There is very little change in low speed initial buffet up to Mach .3, but with increasing Mach the speed of initial buffet continually increases. Thus, for a low indicated initial buffet speed (light weight) very little change takes place up to an altitude of 20,000 to 25,000 ft and increases thereafter. A high indicated initial buffet speed (heavy weight) will start to increase at 10,000 ft. The stall associated with the initial buffet varies proportionally with altitude and therefore the stall margin from initial buffet to stall remains relatively unchanged.

Buffet Boundary:

If high speed buffet and low speed buffet are plotted against altitude and indicated airspeed on the same graph, the two buffet curves will meet in an area where one type of buffet is indistinguishable from the other. This is a buffet transition zone and occurs at the theoretical maximum altitude for the existing aircraft weight. See Buffet Boundary Chart.

The discussion thus far has been for "one G" flight. In manoeuvring flight, greater than 1 "G" will be experienced. A 25° bank will increase the "G" load about 1/10 of a "G". Gust loads will also inc-

6.5. SWEPT-WING, JET CHARACTERISTICS: (Cont'd)

rease the "G". Pilot roughness on the controls can easily add 1/10 of a "G". If this aircraft were at 31,000 altitude at 177 kt IAS and 1.3. "G" were pulled by the pilot, initial buffet would occur. A 73,000 lb aircraft at 1.3 "G" apparently weighs 95,000 pounds. See Buffet Boundary Charts, Appendix 2.

Similarly, at high speed on apparent increase in weight ("G" load increase) or angle of attack will induce high speed buffet at a Mach lower than normal. This is demonstrated by banking the aircraft in level flight at M.82 - .83. Pronounced buffet should occur near normal bank angles.

In the past, the expression "Coffin Corner" has been used in connection with high altitude jet flight. This is a misnomer for the area at which low speed buffet gradually transitions into high speed buffet. These two types of buffet define the "Buffet Boundary" of the aircraft's performance envelope. The buffet boundary charts, Appendix 2, are presented in terms the new student is familiar with, indicated airspeed and altitude. This permits showing both the Mach effect on indicated initial buffet speeds as well as the buffet transition area. High speed buffet is usually presented as Altitude versus Mach number.

Cruise Considerations:

The optimum altitude for the type of cruise desired will be as shown in the Performance Section of the Operations Manual.

For normal short range operations (stage lengths up to 800 N.M.) determine the optimum altitude and be reluctant to accept a clearance more than 2000 to 3000 ft above the optimum.

For long range cruise altitude refer to the Operations Manual.

Maintain the speed at desired Mach. Do not allow the airspeed to fall off. If ambient conditions change and speed decreases, add climb thrust and return to the proper speed. Then reset the thrust for the new conditions. Be alert to small changes and make small corrections.

When changing altitude from the optimum, if possible, select the next lowest. When forced to go higher, recognise the performance limitations being imposed, and the reduced margin for high and low speed buffet.

6.6. DUTCH ROLL (VFR ONLY) 30000 ft AND ABOVE (.72M):

Dutch roll is characteristic of swept wing aircraft. The natural aircraft stability normally damps the dutch roll oscillation. Damping decreases as angle of **attack** increases on most swept wing aircraft, but increases with increased speed or mach number for a fixed altitude. The purpose of this manoeuvre is to show the effect of rudder mismanagement, lateral over control and turbulent air on a swept wing aircraft and develop proficiency in recovering from this undesirable reaction.

6.6. DUTCH ROLL (VFR ONLY) 30,000' AND ABOVE (.72M): (Cont'd)

With flaps retracted, the instructor will place the aircraft in a very shallow climb at .72 to .74 mach. The shallow climb is to keep the airspeed from becoming excessive while rolling and also to prevent large amounts of altitude loss.

The student may be introduced to "Dutch Roll" by asking him to fly straight and level with his feet on the floor, being very careful to maintain wings level with lateral control. The instructor will turn off the yaw damper and excite lateral-directional oscillations by "rudder walking". If the student maintains wings level, the "Dutch Roll" never develops.

After the above practice, the instructor shall induce "Dutch Roll" by applying pressure to the rudder in one direction then in the other direction in a rhythmical fashion.

When inducing "Dutch Roll" for recovery practice, or during recovery, the instructor must be alert to prevent oscillations with a bank angle greater than 15° (desired 10°). Oscillations greater than this may impose excessive loading of the vertical fin and empennage.

There are several methods or techniques for stopping a "Dutch Roll". The easiest and, under most circumstances, the first one to be used is the "YAW DAMPER - ON". In fact, with the yaw damper ON for all normal operation, you will probably never encounter "Dutch Roll".

The manual method of "Dutch Roll" recovery to be taught is to simply keep the wings level. When the aircraft is rolling, the ailerons/spoilers (no rudder) should be used to stop the roll. When the wings are level, apply lateral control inputs in such a way as to oppose the direction of the roll and keep the wings level. Control inputs should be of short duration and removed quickly to prevent exciting the roll further.

Apply equal pressure to both rudder pedals. This will stop rudder action induced by the changing airflow across the vertical fin. When the angle of attack is high and airspeed low, the "Dutch Roll" tendency is more pronounced. Natural Yaw Dampening will be at its best at high IAS.

While "Dutch Roll" may be induced inadvertently at most speeds or in any wing flap configuration, it is <u>not to be practiced</u> during flight training in any configuration or manner other than that described above.

<u>NOTE</u>: Do not use rudder or cross control recovery.

<u>Common Errors</u>:

1. Mis-times initial application of aileron.

2. Uses rudder or cross control technique.

6.6. DUTCH ROLL (VFR ONLY) 30,000' AND ABOVE (.72M): (Cont'd)

Discussion:

Swept wing aircraft are generally subject to a more pronounced roll - yaw coupling than previous straight wing transports. This roll, due to yaw, was referred to as "Dihedral Effect" on straight-wing aircraft. When a swept-wing aircraft with dihedral yaws, not only is the advancing wing at a higher angle of attack (Dihedral Effect), but it also presents a greater span to the airstream. In addition, the retreating wing is less effective due to the change in airflow to a more spanwise direction. The lift differential developed by the swept wings is therefore greater and produces a greater rolling moment than would be experienced with a straight-wing aircraft in a similar situation.

The above characteristics cause a yaw-rolling oscillation to be generated, when properly excited, known as "Dutch Roll". Due to the lesser damping of swept-wing aircraft a sudden gust or a short unco-ordinated rudder deflection most frequently initiates a "Dutch Roll" oscillation.

The vertical fin and rudder (if kept in a fixed, streamlined position), develop opposing forces that tend to offset the yawing movement during a "Dutch Roll". This is a "weather cocking" effect resulting from the local tail angle of attack due to the yawing velocity of the tail. Because of this and the inertia of the aircraft, stabilisation is regained in the form of damped oscillations. As the aircraft recovers from "Dutch Roll", the magnitude of the oscillations gradually decreases. The "weather cocking" effect depends on the size of the fin and rudder and is part of a particular aircrafts design. Pilots can easily assist the vertical fin to damp out the oscillations by movement of the lateral controls as demonstrated during flight training, with the yaw damper inoperative.

One effect not discussed is the altitude effect. Damping is reduced when operating near the buffet boundary, especially at speeds in or below buffet transition area (coffin corner). First, the aircraft is at a high angle of attack where damping is reduced and second, the lower air density at high altitude has less damping effect. Accepting an altitude clearance well above the optimum means accepting decreased Dutch Roll damping if the yaw damper is not operating.

6.7. SEVERE TURBULENCE PENETRATION:

The severe turbulence penetration airspeed is 285K or Mach .79 above 32,000'. Below 15,000' a rough airspeed of 250K IAS may be observed. Stress the relationship of penetration speed to low and high speed buffet. Read the article entitled "Flying in Severe Turbulence" from the BOEING AIRLINER, November - December 1963, and the DC-9 Operating Manual coverage.

6.8. RAPID DESCENT:

These manoeuvres are performed to train the student in the procedure required if a sudden loss of cabin pressurisation occurs. The procedures are designed to bring the aircraft down to a safe operating altitude in the minimum time with the least passenger discomfort in the event that cabin pressure malfunction cannot be corrected.

> CAUTION
>
> THE STANDARD HIGH SPEED PROCEDURE MUST NOT BE USED IF THE STRUCTURAL INTEGRITY OF THE AIRCRAFT IS NOT ASSURED.

The Rapid Descent can be used to desend from medium and high altitudes.

The instructor should positively brief that this is not a panic manoeuvre.

The crew should act promptly to don oxygen masks and evaluate the situation and the aircraft before initiating the descent. Entry into the descent should be without undue haste which will lead to overcontrolling and excessive pitch angles and airspeed.

Initial Conditions - Instructor:

Configuration	-	Clean
Altitude	-	Above 20,000 feet
Mach	-	.76 or higher
Autopilot	-	ON (simulates cruise)

The instructor will announce "Cabin Altitude Rising Uncontrollably" or some similar expression. (In the simulator use the cabin altitude warning light.)

The student will get onto oxygen and interphone (5 secs.), attempt to correct the malfunction by use of the manual pressure control, check the pneumatic crossfeeds are closed and evaluate the condition of the aircraft.

Assume these measures are ineffective and the aircraft is in good condition and initiate the descent.

Descent Procedure - Student:

(a) Announce - "RAPID DESCENT")
(b) Throttles - IDLE) SIMULTANEOUSLY
(c) Speedbrakes - FULL UP)
(d) Autopilot - OFF
(e) Bank (either direction as desired) - UP TO 30°

The bank angle is to facilitate a 1 "G" entry into a dive angle of approximately 10°. Do not trim into the pitch down attitude.

Descend off airways, if possible.

6.8. RAPID DESCENT: (Cont'd)

(f) Wings Level - Wings level as soon as 10° nose down is reached

Roll the Wings level early.

Keep the aircraft in trim.

(g) Airspeed - M.80/330K (Barber Pole - 20K). Not above VMO/MMO

(h) Communication - Interphone. Select the boom/mask selector to the mask position and ensure the speaker volume is at adequate level. Interphone communication is established by moving the interphone switch on the control column to the forward latched position.

(i) Pass. Oxygen Masks F/O - Check downstream pressure above 50 PSI. Operate manually if necessary. Reset selector to auto.

(j) Oxygen Selector - Auto

(k) Communication - F/O - ATC

Report off Airways Descent to Air Traffic Control, if practical during descent. (In any case, after descent).

(l) Altitude calls - F/O - Call at each 5,000' of altitude (25,000'-20,000' etc.) and 2,000' above selected level-off altitude.

(m) Level Off - 13,000 ft. or min. enroute altitude or at an altitude where a 13,000 ft. cabin pressure altitude or lower can be maintained. Start to break descent 2000 ft. above desired altitude with gentle back pressure reducing pitch down attitude by half.

(n) Speed Brakes - DOWN

Lower smoothly as required to level OFF at desired IAS (285K) and altitude commencing 500' to 1000' above.

(o) Thrust - Spin up and increase thrust as necessary to maintain 285 Kts.

(p) Determine new course of action, fuel requirements, and oxygen endurance (NORMAL selection). Advise cabin crew.

(q) Recheck cabin altitude. Monitor oxygen pressures.

Discussion:

With the throttles closed and the auto pilot off, the aircraft should be rolled smoothly into 20° to 30° bank. As the bank passes through 10 to 15° gently lower the nose to 10° down and roll out of the bank as this attitude is achieved. DO NOT TRIM INTO THE DESCENT. Initially with throttles closed there will be little change in speed. Trim will be needed and should be used with care as speed increases. As speed increases it will be necessary to reduce pitch attitude to less than

6.8. RAPID DESCENT: (Cont'd)

10^{o} to maintain target speed of barber pole - 20 K.

The descent should be made to an altitude which permits the maintenance of cabin altitude at 13,000 ft. or lower. Passenger safety forms the basis for this manoeuvre. However, the actual altitude of level-off may be determined necessarily by terrain clearance, minimum altitude which gives range to reach an alternate, or passenger safety.

In training, the student is required to perform the complete procedure, but in actuality this is a team effort and the duties should be split between the crew. The Captain should concentrate on descending to a safe altitude. He should know and be capable of performing all the procedures, and emphasis should be on a smooth, unhurried evaluation and entry into the descent.

If this procedure was not performed in a simulator, practising the entry procedures in the cockpit on the ground can result in the student performing a smooth entry on the first attempt in flight. Static briefing should stress: (a) Mask fitting and proper use. (b) Interphone. (c) Cabin altitude warning. (d) Passenger oxygen.

The entry should be performed with no noticeable change in "G" force, negative or positive.

Structural damage may prohibit using high descent speeds. The airspeed can be selected as necessary to obtain the desired rate of descent. A descent initiated from 25,000' or less could be satisfactorily accomplished at a speed less than the maximum permitted.

While accelerating to the descent speed, again anticipate and start applying light control back pressure 10 knots below the desired speed. Keep the aircraft in trim at all times.

Common Errors:

1. Panics and rushes into the manoeuvre without thinking. (This is not a 'Panic' manoeuvre).
2. Deliberates so long over each step that he would be suffering from hypoxia long before he puts the oxygen mask on.
3. Does not keep the aircraft in trim. (Use stabiliser trim normally in descent to maintain in-trim).

   See Appendix C - Read Reference Material on Oxygen.

4. Overbanks the aircraft upon entry. Anticipate the slower roll rates on entry and roll-out.
5. Trims into the manoeuvre with resulting steep nose down attitude.
6. Forgets to raise speed brakes on entry or forgets to lower them at level-off.
7. Forgets crew co-ordination. This is a team effort.
8. Forgets to notify ATC.
9. Never reaches desired descent speed. The maximum rate of descent is at the highest permitted speed.
10. Does not check that passenger oxygen masks are deployed.
11. Allows speed to get slow due to delay in initiating descent after throttles are at idle and speed brakes are extended.

7. RADIO NAVIGATION:

7.1. AREA DEPARTURE:

The purpose of this manoeuvre is to have the student attain proficiency in executing area departures and particularly to gain proficiency in airspeed and altitude control.

During training, a clearance shall be issued taxiing out. The radios should be properly tuned to conform with the departure clearance and the clearance read back to determine that it is understood.

Like other jet powered aircraft, the DC-9 requires exacting thrust management during an area departure because of its high performance characteristics. Laxity in thrust management can cause serious airspeed overshoots and contribute to improper altitude management. It is therefore recommended, where a number of heading and/or altitude changes are embodied in the departure clearance, that the pilot manage the thrust so as to maintain the speed compatible with the clearance. Maintain 210 kts area departure speed until manoeuvring in the vicinity of the airport and at low level has been completed. If an immediate turn is required after take-off, retract the flaps, leave the slats extended, and turn with a minimum of 160K which is the min. manoeuvre speed for 100,000 lb.

When step climbing is necessary, use 250 kts., where moderate/severe turbulence is encountered, maintain 285 kts. Use normal climb speed (310 kts/M.73) schedule as soon as practical after leaving the airport area to climb to the enroute altitude.

The instructor shall emphasise the importance of precise airspeed and altitude control throughout the departure procedure as well as proper engine thrust management and that the student uses good judgement about when to increase airspeed.

Plan the departure clearance so that the student will be required to cross the first fix at a relatively low altitude and then step climb over additional fixes. Insist on proper airspeed and power management. Point out the importance of altitude anticipation. Once the aircraft is in steady state climb, the F/O may be called upon to adjust power settings.

7.2. HIGH ALTITUDE HOLD:

The purpose of this manoeuvre is to acquaint the student with holding procedures and make him aware of the problems associated with high vs. low holding. Holding at lower altitudes is particularly undesirable because of higher holding fuel consumption and climb out fuel requirements if diversion to an alternate becomes necessary.

7.3. HOLDING PROCEDURES:

All normal holding, high and low, shall be accomplished in the clean configuration. At a speed of approx. 1.53 Vs which results in speeds between 195K and 215K at the normal gross weight spread. (GW +120K).

When approach clearance is imminent, extend slats, flaps to 15° and hold a min. speed of Vref 50° + 25K.

While holding hold a standard rate turn of 3° per second. Do not exceed a 30° bank. Patterns size is 1½ mins. inbound above 14000' and 1 min. inbound 14000' and below.

7.4. D.C.A. HOLDING PROCEDURES:

1. Sea Level through 6000' - 210K
2. Above 6000' through 14000' - 220K
3. Above 14000' - 240K

For training purposes, the instructor shall issue a complete high altitude clearance to a holding fix. The student shall proceed to the fix via the specified route. Speed should be reduced within 3 minutes of the fix ETA so as to be at holding speed over the fix. The aircraft is considered to be in the holding pattern at the time it first arrives over the fix.

Entry from any of the three sectors is to be governed by aircraft heading, not the track. When approaching along or near a sector dividing line, where either of two procedures may safely be used, use the procedure which calls for a turn into the wind if a strong crosswind is thought to exist. This will minimise the effect of drift.

Once established in the pattern, a drift correction angle can be determined along the inbound course to the fix. On the outbound leg of one minute patterns, the drift correction may be tripled. In one and one-half minute patterns, the inbound drift correction may be increased to two and one-half times outbound in order to turn and arrive approximately on the inbound course again. It is not mandatory that the outbound time be decreased for a tailwind, but it may be decreased for this or for any other reason.

These are rules of thumb which are familiar to all pilots, but are restated here to emphasise the necessity of allowing for wind without varying the angle of bank.

7.4. HOLDING PROCEDURES: (Cont'd)

It should be pointed out that care must be taken so as not to exceed the inbound times. Allow for known wind conditions or if wind is not known, assume a no wind condition initially.

Outbound times can then be varied gradually to achieve the desired time on the inbound leg. Thus, adequate separation will be maintained.

The instructor shall emphasise the need for precise altitude control and its effect on the selected airspeed and engine thrust setting. It should be pointed out that high altitude holding is generally accompanied by high wind components. There is no buffer zone in holding patterns, either high or low altitude, except when climbing in a holding pattern. When climbing in a holding pattern, the normal climb airspeed may be maintained.

7.5. DESCENT FROM ALTITUDE:

If while holding high clearance is received for an extended descent in the high structure, it could most effectively be made with the speed brakes extended and at 210 knots IAS. If additional drag were needed the slats should be extended. Under no conditions will flaps and speedbrakes be utilised at the same time. In the lower structure, descents should be made with 15° flaps and Vref + 25K. If additional drag is needed, extend the gear. Higher descent rates can be obtained with slats and flaps than with speedbrakes.

CAUTION

WITH SPEED BRAKES EXTENDED AND AT WEIGHTS APPROACHING MAXIMUM GROSS LANDING WEIGHT A 30° BANK AT HIGHER THAN 1 "G" MAY INDUCE STICK SHAKER. WITH SPEEDBRAKES EXTENDED STICK SHAKER OCCURS 10K HIGHER CLEAN AND 20K HIGHER AT 50° FLAP. SLATS AND SPEEDBRAKES MAY BE USED TOGETHER. SPEEDBRAKES AND FLAPS MUST NOT BE USED TOGETHER.

Descent through icing conditions should be accomplished with all anti-icing devices in operation. Normally, 55% N_1 will be sufficient to provide bleed air requirements for the engines.

If airfoil anti-ice is needed, use enough power to keep Anti-ice Low Temp lights out. Use the speedbrakes to maintain speed or sink when adding thrust for anti-ice.

It should be pointedly emphasised the importance of fuel flow while holding. An exception of this would be if turbulence is encountered while holding.

During holding and/or descent, subject the student to icing problems and to engine failure or fire.

The student should limit his descent during the last 1000' to 500'/minute. Retracting spoilers for this last 1000' (if not previously retracted) will help control the rate of descent.

When arriving at the lower holding altitude, holding may be continued at Vref 50° plus 45 kts. and slats extended.

7.6. I.F. APPROACHES:

7.6.1. GENERAL:

The purpose of this manoeuvre is to develop a high degree of proficiency in executing manual ILS approaches with both engines operative and with one engine inoperative.

It should be emphasised to the student that flying a successful ILS requires maximum concentration and effort. A thorough review and under standing of the approach and missed approach procedures is absolutely essential. Organisation and cockpit management is needed for proper sequencing of crew co-ordination duties.

It should be emphasised that proper scan methods as well as speed and altitude control techniques, are primary requisites for a successful approach to jet ILS Minimums.

7.6.2. CREW CO-ORDINATION PROCEDURES:

Refer to the DC-9 Operating Manual.

7.6.3. LANDING REQUIREMENTS FOR CAT 11 MINIMUMS: CAT 1 = 200 x $\frac{1}{2}$

1. At 700' the aircraft must be in the window of $\frac{1}{2}$ dot localiser and $\frac{3}{4}$ dot G.S.
2. No unusual roughness or excessive attitude changes, due to airborne or ground equipment, occurring after passing the middle marker.
3. At MDA (100'), the aircraft must be positioned:
   a. With LOC needle within the 1/3 of a dot and no crosstracking velocity and aircraft tracking so as to remain within the confines of the runway extended.
   b. The GS needle within one dot deflection and in trim to permit a normal approach, flare and landing.
   c. With IAS $\pm$ 5 knots of programmed IAS, but not less than Vref.

7.6.4. MANUALLY FLOWN. DEVIATION INFORMATION ONLY:

1. Prior to entering ILS Patterns, plan ahead. Anticipate the effect of wind on:
   a. Type of Approach
   b. Drift and speed effect on:
      1. Procedure turn
      2. LOC Needle movement on intercept
      3. Inbound heading
      4. Sink Rate.

7.6.4. MANUALLY FLOWN. DEVIATION INFORMATION ONLY: (Cont'd)

2. Upon entering initial approach area immediately -

   a. Stabilize the:

      1. Configuration
      2. Power
      3. Speed
      4. Pitch

   b. From this point, only small changes should be necessary in the above areas.

3. LOC Intercept -

   a. Have the drift corrected heading in mind before LOC comes alive.

   b. Anticipate speed LOC Needle will move before LOC comes alive.

      1. Cross wind behind you will give fast moving needle and require full 30° bank turn.
      2. If LOC needle stops moving in turn, you stop turning.
      3. Monitor the outer locator for accurate interception of the localiser.

   c. Tie down LOC as soon as possible. Have a heading in mind.

   d. Prove your heading by stepping up scan to see small LOC changes.

   e. Rate of needle movement:

      1. Slow: -5° heading change.
      2. Fast: -10° heading change.
      3. Keep bank angle small (10° maximum).
      4. If needle stops, you stop.
      5. When back on LOC, take out ½ of the heading change.

   f. Realise that drift will possibly change during descent.

   g. Plan to be on speed and configuration at GS intercept.

4. GS Intercept -

   a. SetHDI to target attitude to hold the G.S.

      1. Trim it out.

   b. Check the sink rate.

   c. Check speed (Minor thrust change).

   d. Tie down GS in first mile.

   e. Increase scan to see small GS change.

   f. Correct with small pitch angle changes.

      1. Bracket between +2° and +6° on HDI. (50° flap).
      2. Use Elevator pressures, not trim, for transient pitch reqs.

   g. Do not exclude the LOC.

BULLETIN NO. 6
(Insert to face page 61)

DIRECT APPROACHES — JET AIRCRAFT

In order to standardise the points at which flap and gear selection should be made on direct approaches using a 3° approach slope, when conditions of 1000 ft base and 6 km visibility or better is known to exist at the airport, the following is laid down for guidance:-

MILES TO TOUCH DOWN	HEIGHT ABOVE THRESHOLD ~ ft	SLAT - FLAP - GEAR SELECTION POINT	SPEED ~ kt
12	Above 3000 Descending	clean	reducing
10 to 12	Approaching 3000	slat	210
10	3000	-	190
8	2500	-	Reducing to BUG +45
7	2000	15°	BUG +45
6	1800	GEAR	BUG +25
5	1500	25°	BUG +25
3	800 to 1000	Final Flap	BUG +15
2	700	-	BUG & Additives

The selection of slat, flap and gear at the points listed follow a profile similar to a standard circuit where 25° flap is selected as the turn onto base is commenced and as descent begins from 1500 ft.

The procedure should also be used on practice ILS approaches in the above stated conditions.

Earlier selection of flap, etc., will be necessary when conditions are not stable, i.e. tail wind or wind shear expected on final approach.

Improved overall fuel economy will result and noise levels will be reduced when this technique is followed.

7.6.4. MANUALLY FLOWN. DEVIATION INFORMATION ONLY: (Cont'd)

5. At 500' above the field.
   a. Whatever your scan has been, it must now be doubled.
   b. Only small changes can be tolerated.
   c. It doesnt do any good to make a perfect ILS to 500' then lose it on the way to 100'.

7.6.5. ILS APPROACH - MANUALLY FLOWN:

Aircraft Procedure - 2 Engines:

Assume that a result of ATC vectoring or release from holding, you are cleared for an ILS approach.

1. Both VHF NAV's tuned to the ILS frequency and both CDI's have the front course heading selected. This will allow "fly to the course needle" sensing during either a front or back course approach.
2. Pre Landing check list should be completed before beginning the approach.
3. If joining final approach from procedure turn or holding pattern, maintain speed between 190 and 210 knots.
4. Arrive at 10 NM from the field inbound with slats extended at 190 knots.
5. When the glide slope needle touches the "bulls-eye" pitch into the GS attitude and maintain the glide slope.
6. At 2500' above the field (approx. 8 NM to touchdown) extend flaps to 15^{o}, select gear down and allow speed to bleed to Bug plus 25 knots.
7. At 2000' above the field (approx. 7 NM to touchdown) select flaps to 25^{o} and maintain Bug + 15 knots.
8. At 1500' above the field (approx. 5 NM to touchdown) select flaps to 50^{o} and maintain Bug + additives.

   NOTE: When circling approach is to be made, leave flaps at 25^{o} and maintain Bug + 15 knots during the descent. Retract the flaps to 15^{o} (Bug + 25 knots) as the circuit is commenced.

   When the gear is down and locked, complete the Pre-land checklist. The Captain after checking gear three green lights, scanning the annunciator panel and arming the auto spoiler, will have the First Officer complete the landing check list.
9. Once the glide path is intercepted, a normal descent should be started to stay on the glide path. Control rate of descent with elevators and airspeed with the throttles.

7.6.6. SINGLE ENGINE PROCEDURES:

The approach will be made using normal 2 engine procedures with the following exceptions:

1. Plan a 25^{o} flap landing and set bug to Vref 50^{o} + 10.
2. On approach path, maintain flaps at 25^{o} and fly Bug + 5 knots.

The airspeed is controlled with the throttles. The student should be taught that if he is, for example, above the glide slope, he should nose the aircraft slightly down, by reference to the artificial horizon (HDI) cross checking the VSI for increased sink rate.

7.6.6 SINGLE ENGINE PROCEDURES: (Cont'd)

When back on the glide slope, he should change the pitch of the aircraft by reference to the artificial horizon (HDI) while flying a spot on the HDI which he thinks will keep the aircraft centered on the glide slope. Cross check the sink rate. As in small bank corrections, small pitch corrections should also be stressed.

Once established on final course on the ILS localiser, only small corrections should be made. Normally, a bank angle correction of 5° is desirable and bank angles corrections greater than 10° should normally not be made.

Changes in heading shall be made with ailerons, being careful to avoid overcontrolling. Any attempt to fly a precision localiser approach using rudder to make heading changes will excite a dutch roll condition if the yaw damper is not engaged. It should be stressed that on an engine out approach it will be necessary to change the rudder input every time thrust is changed. Synchronise rudder input and thrust changes to avoid unwanted heading change.

7.6.7. I.L.S. APPROACH - MANUALLY FLOWN:

Flight Director:

The purpose of this manoeuvre is to have the student attain a high proficiency in making the flight director approaches and to implant in the student that on all ILS approaches, the glide path is controlled with elevators by reference to the artificial horizon (HDI) & airspeed is controlled with the throttles.

The instructor shall clear the student for an ILS approach from any specific position. This may be from an enroute position or it may be from a holding pattern. The proper localiser frequency should be selected on both NAV receivers, the same inbound course headings set on both CDI's, RMI's selected to ADF and fail flags and altitude checked. The wing flaps and gear are handled the same as on a normal ILS approach. Normal crew co-ordination procedures are used on all approaches.

1. Complete the Pre-land Checklist and set the airspeed bugs.
2. While being radar vectored toward the final approach course, tune and check all radios.
3. Set Flight Director in Heading mode and, if holding a constant altitude, place altitude hold on. "ALT" will appear in the HDI left annunciator window. In routine line operations the F/O is required to select the same FD mode as the Captain.
4. Select headings, as directed by radar, with the heading selector on the CDI and fly the Flight Director. Engage auto thrust when ready to reduce speed for initial flap extension.

BULLETIN NO. 11
(Insert to face page 63)

7.6.7. ILS APPROACH – MANUALLY FLOWN

Flight Director

To utilise the computed Flight Director command to maintain glide slope and localiser when proceeding visually from the minimum after an ILS approach, the following applies and is added to the existing procedure as item 11.

11. If within tolerance of glide slope and localiser at the minimum, and visibility permits a visual approach to be continued, the Flight Director may remain in the glide slope mode for computed slope guidance through to touchdown.

    NOTE: Glide slope gain programming to $\frac{1}{3}$ occurs when entering the EXT mode at the middle marker.

    Any excursion below the glide path through wind shear from that height will require body angles above that scheduled by the Flight Director to regain the desired flight path.

    NOTE: The First Officer must continue to monitor glide slope raw data and call when outside the listed tolerance.

7.6.7. I.L.S. APPROACH - MANUALLY FLOWN: (Cont'd)

5. After operating in heading mode for a minimum of 5 seconds and final approach clearance has been received, select G.S. Auto. "HDG/VL" should appear in the CDI right annunciator window indicating the Flight Director is in the heading mode but is armed for localiser capture.

6. Speeds and configurations are the same as a normal manual ILS.

7. As Localiser Capture occurs, the CDI right annunciator will show GS/A. Localiser has been captured and now armed for capture of the glide slope.

8. With altitude hold engaged, the HDI left annunciator will show "ALT". When glide slope interception occurs this will show "GS". At this time pitch into the glide slope. Select flap and gear as in the preceeding manually flown ILS procedure.

9. Cross check all navigational instruments for warning flags. Fly the orange aircraft symbol a pencil line below the yellow bird. This will allow small pitch and bank angle changes to be readily apparent.

10. Pushing the auto pilot disconnect button at minimums will cause the SC mode to be displayed on the flight director, making it available in the event of a missed approach. An SC will appear in the HDI right annunciator panel.

7.6.8. I.L.S. APPROACH AUTO PILOT:

The purpose of this manoeuvre it to have the student become proficient in manoeuvring the aircraft throughout an ILS approach by use of the auto pilot and show the student that very small corrections are required when making any type ILS approach. During the auto pilot approach, the flight director system shall be engaged and its indications observed in conjunction with the auto pilot. The auto pilot and flight director computors will not necessarily agree exactly due to design differences.

1. At the start of the approach, radios shall be tuned and set as for a normal ILS. Set inbound localiser front course on Captains CDI. Set inbound localiser front course on First Officer's CDI when not needed for navigational checks.

2. Complete Pre-Land check list and set bugs.

3. With Heading mode switch engaged, select radar headings with Capt's CDI heading selector. Alternatively use the turn knob.

4. Configurations are the same on all ILS approaches.

7.6.8. I.L.S. APPROACH AUTO PILOT: (Cont'd)

5. Before intercepting final approach course, select ILS mode and note auto pilot annunciator shows "V-L Armed" and "GS Armed".
6. As localiser capture occurs, auto pilot annunciator shows "V-L CAP" and "GS Armed". Heading switch returns to OFF. Note the turn knob must be in the detent otherwise the Auto Pilot will not capture.
7. When GS becomes alive, gear down. When GS needle shows on slope flaps 25 bug + 15 knots.
8. If auto pilot does not auto capture at GS intercept, immediately place mode switch to GS MAN. Auto Pilot annunciator shows "GS CAP" with either auto or manual capture.

NOTE: If above glide slope, use VERT SPEED mode for interception. When on the glide slope and localiser, select GS MAN.

CAUTION

DO NOT SELECT GSM MORE THAN 1 DOT ABOVE. 12° PITCH DOWN WILL RESULT.

9. After capture of GS, keep one hand on the wheel near the AP disconnect button and the other on the throttles.
10. Both radio signals (LOC and G.S.) start desensitizing at LOM and the G.S. is further desensitized from the LMM on.
11. At minimums, pushing the disengage button will disengage the AP and FD, place the flight director in the SC mode. Disconnect the auto throttle with the throttle switches.
12. Single Engine ILS approaches -

    The procedures for 1 engine ILS approaches are the same with the exception of the following:

    a. Set bug to Vref 50° + 10 knots.
    b. Make final approach and landing with 25° flaps at Bug + 5 knots.

    Due to limited authority the auto pilot will have difficulty manoeuvring or holding heading with significant speed or thrust changes. Assist with manual rudder input.

CAUTION

THE CONTROL WHEEL YOKE AND AUTO PILOT DISENGAGE BUTTON MUST BE MONITORED AT ALL TIMES DURING FINAL APPROACH IN THE EVENT AUTO PILOT HARDOVER OCCURS.

7.6.9. MISSED APPROACHES:

The purpose of this manoeuvre is to teach the student how to obtain the maximum performance from the aircraft on a missed approach from the landing configuration using one or two engines. Single engine missed approaches shall be practised visually for some proficiency before performing them out of an ILS or other approaches.

BULLETIN NO. 7
(Insert to face main text page 64)

OPERATING IN LOW VISIBILITY FROM THE ILS MINIMUM THROUGH TO TOUCHDOWN

A. General

(1) Accidents that have occurred overseas in recent years have included a number of aircraft that have deviated below the normal approach slope after becoming visual at the ILS minimum.

(2) At the moment, we do not have a clearly defined Company policy on the requirements for descent below the minima in reduced but acceptable visibility conditions. It has therefore been found necessary to lay down guidelines for assessing the conditions which permit continued descent, and the factors which affect this assessment.

(3) At the same time, it has become necessary to make changes to the crew procedures so as to consistently operate in these conditions through to touchdown or to overshoot from any point, with the highest degree of safety.

B. Operation

(1) The lowest visibility which permits flight below the ILS minimum is 1200 metres. At this minimum (approximately 300 ft above the threshold height) the pilot in command will make the 'assessment whether the meteorological conditions are equal to or better than the minimum prescribed' (IAL).

(2) To assess visibility as being 1200 metres or greater at the minimum of 300 ft, the first groups of approach lights and cross–bars should be seen when the glide slope reference is at the standard 1000 ft point. The remaining approach lights and cross–bars should come into view as the approach continues, but the runway threshold lights will not be visible until reaching approximately 250 ft above threshold height.

(3) When the glideslope reference point is displaced further up the runway, the runway lights should be visible sooner but from a higher altitude.

(4) Many accidents have occurred in this environment where the aircraft has been flown accurately to the minimum but has 'ducked under' when continuing descent in the required visibility.

(5) The factors which cause 'duck under' to occur are considered to be the effect of illusions on pilot judgement of his position in relation to the 3^{o} approach slope. There are many conditions which can result in being illusory and these are expanded elsewhere in this study guide, and in Aircrew Information Bulletins.

(6) In conditions of reduced visibility, the illusion of being high on slope can further be exaggerated by the following:–

(a) An impression that it will be possible to see better further below cloud.

(b) The reduced number of lights visible giving an apparent shortness of the runway and a sense of being high on slope.

(c) Outside cues giving very little vertical guidance.

(d) Seat adjustment causing the cockpit windshield cut–off angle to reduce the field of view.

(e) Effect on approach visibility from the cockpit by changes in aircraft attitude as a result of changes of airspeed caused by wind shear.

(f) Refraction due to rain on windshield.

(g) Wind shear and its effect on body angle.

(h) Changes in body angle which alter the angular perspective of the runway; this will occur with airspeed changes as a result of wind shear.

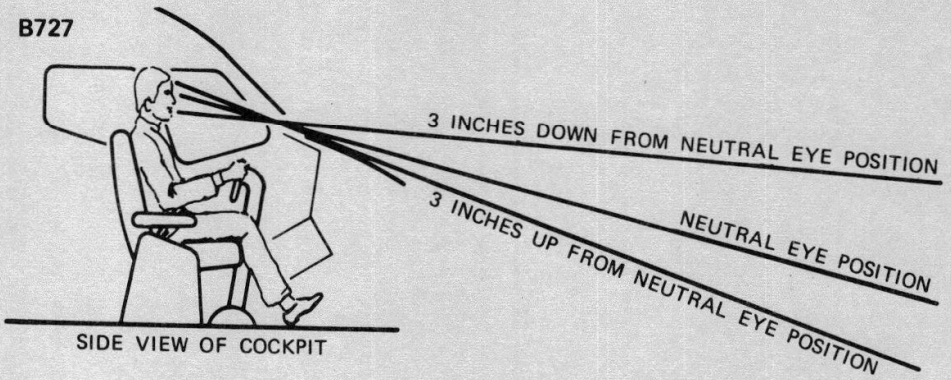
(7) It should be understood that an illusion can be very compelling and cannot be overcome by the pilot without the assistance of his flight instruments. Body angle on the HDI, speed on the ASI, vertical speed on the IVSI and with normal levels of thrust all combine to indicate the present flight path or impending departure from the desired flight path.

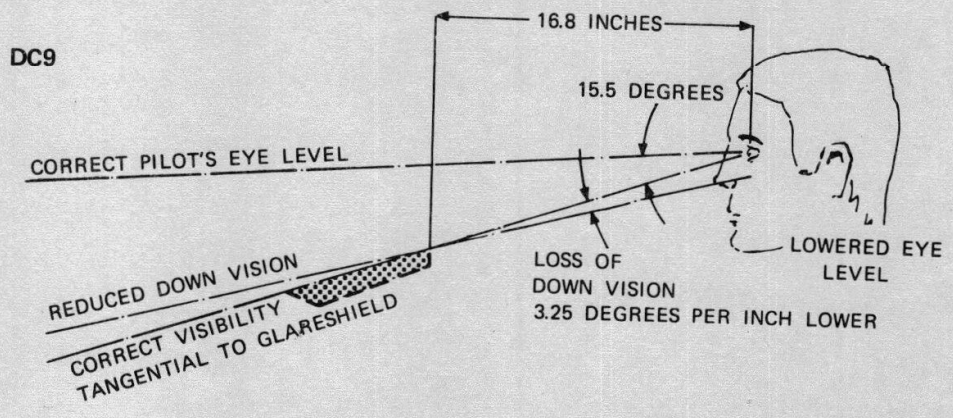
(8) Comparison at all times with the electric glide path and/or VASIS when available is essential to further ensure a stable approach slope is followed from the minimum. When available, this information should be utilised through to 100 ft above the threshold.

(9) Effective monitoring, crew co–ordination and the use of flight instrumentation as stated is necessary to remedy erroneous visual perception.

C. **Cut–off Angle**

(1) The term 'cut–off angle' pertains to the extent to which visibility, ahead and down from the cockpit, is limited by the glareshield and nose of the aircraft. The following illustrations depict the effect of the pilot's eye position on the cut–off angle as related to the B727 and the DC9. The effects related to the L188 and the F27 are similar.



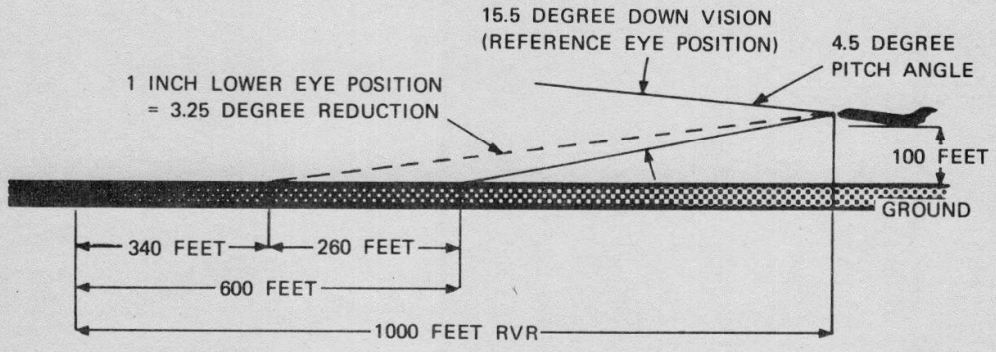


Further lowering results in steadily worsening visibility as in the following table:

SEAT HEIGHT	DOWN VISION ANGLE
CORRECT	15.5°
1 INCH LOWER	12.3°
2 INCHES LOWER	9.0°
3 INCHES LOWER	5.6°

The effect on typical Category 2 landing conditions is illustrated in Figure 2

Figure 1 – CUT–OFF ANGLE vs EYE POSITION



The diagram shows 600 feet of visible ground segment would be reduced to 340 feet due to the pilot's seat being 1 inch too low

Figure 2 – EFFECT OF INCORRECT EYE POSITION ON TYPICAL CATEGORY 2 LANDING CONDITIONS.

(2) Obviously, eye position has a significant effect on the cut–off angle. For maximum forward and downward vision, the pilot's tendency would be to lean forward with his eye against the windshield. This is impractical, since the pilot must be able to see the instrument panel as well as outside.

(3) Therefore, eye position must be a compromise which will produce absolute maximum forward and downward visibility while retaining sufficient view of the instruments to fly the aircraft. This is accomplished by sitting as high and as far forward as possible without having the flight instruments obscured by the glareshield.

(4) On the B727 [200] aircraft, a Seat Position Indicator (the use of which is described in D. following) is provided to assist the pilot to determine the proper seat adjustment to obtain the optimum eye position.

(5) On the DC9, the slope of the glare shield is used as an indication of optimum eye position.

(6) On the L188, the pilots' seats should be raised giving an eye position as high as possible without the glareshield cutting off view of the beta lights.

(7) On the F27, the optimum seat position occurs when a small portion of the radome is visible just above the glareshield when looking in line with the windshield wiper arm. Lower seat positions cause the glareshield to restrict forward/downward visibility. A higher seat position than that recommended above only marginally improves forward/downward visibility while, at the same time, rudder/brake pedal operation could be affected.

D. Seat Position Indicator – B727 [200]

(1) The Seat Position Indicator is installed to assist the pilot to adjust his seat to the optimum position ('neutral eye position' – refer to the illustration). The device consists of three small spheres arranged in a triangular configuration and mounted on the windshield centre post. When the pilot is sitting in a normal upright position, the seat is properly adjusted when the centre sphere obscures all but the outer rim of the sphere furthest from the pilot, as viewed by his outboard eye.

(2) It should also be borne in mind that when the seat is adjusted to the most forward and highest position practical, the most favourable eye position is attained; i.e., the resultant cutoff angle will provide the most downward vision possible. However, be sure that the flight instruments and other significant indicators are not obscured by the glare shield overhang.

E. Approach Visibility

When the aircraft breaks out of the overcast, and the pilot reverts to visual flight, his forward and downward view of the approach lights and runway environment is limited by the Cutoff Angle, as discussed on preceding pages, and RVR. In addition, certain other factors may limit the visibility, as follows:

(1) Aircraft Body Angle
Any increase or decrease in aircraft pitch will have a marked effect upon the pilot's visibility forward and downward. An ANU attitude greater than normal will result in the nose blocking out the nearer approach lights, thus limiting the visual cues available to the pilot.

(2) Crosswind Correction
A crab angle applied to correct for crosswind will result in the pilot seated on the side from which the wind is blowing seeing less of the approach lights, and the other pilot seeing more. For example, with the wind crossing from the left, the aircraft will be crabbed toward the left and the forward and downward visibility of the pilot in the left seat would be partially blocked out by the nose; the visibility of the pilot in the right seat would be noticeably increased. Yaw has a similar effect.

(3) Roll
If the aircraft is not in a wings–level attitude, the pilot seated on the side of the lower wing would have increased visibility, while that of the other pilot would be decreased.

(4) Centreline Displacement
If the aircraft is not lined up with the runway centreline, the degree of approach lights visibility available to the pilot seated on the side away from the centreline will be limited.

F. Orientation

(1) It is necessary for a pilot to closely monitor the instruments throughout the approach, and to be aware of the aircraft's attitude (pitch, roll, wind correction angle) at the moment of reverting to visual flight. Awareness of what the aircraft is doing prior to reverting to visual flight will aid in avoiding disorientation as the visual cues are observed.

(2) A wind correction crab (or to a lesser degree, a wings–down attitude) may cause a pilot to interpret his visual cues to indicate that he is not aligned with the runway, or is not tracking the centreline. More (or less) than normal ANU may cause him to misjudge his point of touchdown.

(4) After reverting to visual flight, the pilot should continue to include the flight instruments in his scan. If he continuously notes the glide slope deviation indicator, he will be prepared to avoid the tendency to 'duck under' when the approach lights and runway environment come into view. A 'duck under' manoeuvre at the late stages of the approach will invariably result in a hard landing, or worse.

G. Rain Refraction

When flying in rain, a refraction error in vision causes the eye to indicate a horizon below the true horizon. The error, including effect of reduced transparency of the window, may cause objects to appear lower than they are by as much as 5^{o} or 200 ft at one mile.

H. Procedure

The new ILS procedure is listed below – the manipulating and support pilot duties are changed and apply from this date.

(1) Captain

(a) The Captain will normally manipulate the aircraft when operating in these conditions. After reaching 100 ft above and approaching the minimum, he is to start looking ahead as part of his scan.

(b) If the approach lights are installed they should become visible when the minimum is reached and after the "MINIMUM" call has been given he will call "VISUAL" and continue the approach.

(c) If approach lights are not installed, the runway threshold lights should be visible to be able to continue the approach. When continuing the approach, he will continuously cross–check his visual position against the electric Glide Slope and Flight Instruments.

(d) If these lights are not visible and the First Officer calls "MINIMUM" the Captain should call "NIL SIGHTING" and commence the missed approach procedure.

(2) First Officer

(a) The First Officer will primarily monitor flight instruments through to the minima.

(b) He will call "100 FEET FROM THE MINIMUM" – Airspeed and vertical speed, and "MINIMUM".

(c) From the minimum he will continue to monitor flight instruments primarily until reaching 100 ft above the threshold, and call when any excursion from the following tolerances occurs –

Glide Slope 'High' or 'Low'	– more than 1 dot high or low.
Speed	– ±5 kt from nominated approach speed.
Sink	– exceeds 800 fpm ROD.

(d) On missed approach he will remain on instruments and select flap, gear, set thrust on command and provide normal back up calls.

(3) Reference to the Glide Slope information (or VASIS if installed) is essential throughout transition to 100 ft. Since glide slope information is not subject to distortion to any degree (unless stated as unusable below the minimum), it is the pilot's only insurance against errors of visual assessment of the approach slope.

K. Missed Approach

(1) When the supporting pilot calls "MINIMUM" the pilot should quickly recheck the visibility and, if insufficient, carry out the missed approach procedure.

(2) When continuing the approach in ' visual ' conditions, the pilot should be alert to any deterioration in the available visual cues after leaving the minimum and should execute a missed approach whenever :—

(a) There is a deterioration or loss of essential cues,

or

(b) the aircraft is not positioned for a safe landing,

or

(c) the runway threshold or threshold lights are not visible from a height of 100 ft above the threshold. If the threshold or threshold lights are not visible from 100 ft, it is probable that an obstruction to visibility, such as shallow fog or scud, may be encountered which could cause the loss of all visual cues during the most critical part of the approach.

(3) Missed approaches, when properly executed, involve little loss of altitude below the altitude at which the missed approach is started.

L. Non Precision Runway Approach

(1) The same crew procedures as approach on the ILS to the minimum applies when operating on a non precision category let down.

(2) Descent from the minimum will normally be in visual conditions of at least 2 kilometres and the approach lights or threshold lights should be in view from that point.

(3) The supporting pilot should give the same support calls as on the ILS with the exception of "Glide Slope" which should be called when 2 dots high or low on VASIS.

(4) The missed approach procedure should be carried out if sight of the approach lights or threshold lights is lost at any time during the approach.

NOTE: The VASIS may not be in sight at the minimum but should come into view as the aircraft descends with the threshold lights in sight.

Four diagrams showing limits of visibility in the idealised condition of Glide Slope transmitter at 1000 ft from the approach end of the runway, as viewed from the left seat, are attached as follows:–

Diagram 1. Depicts the lights visible in conditions of 1200 metres visibility from 350, 300, 200 and 100 ft with a cut–off angle applicable to the DC9.

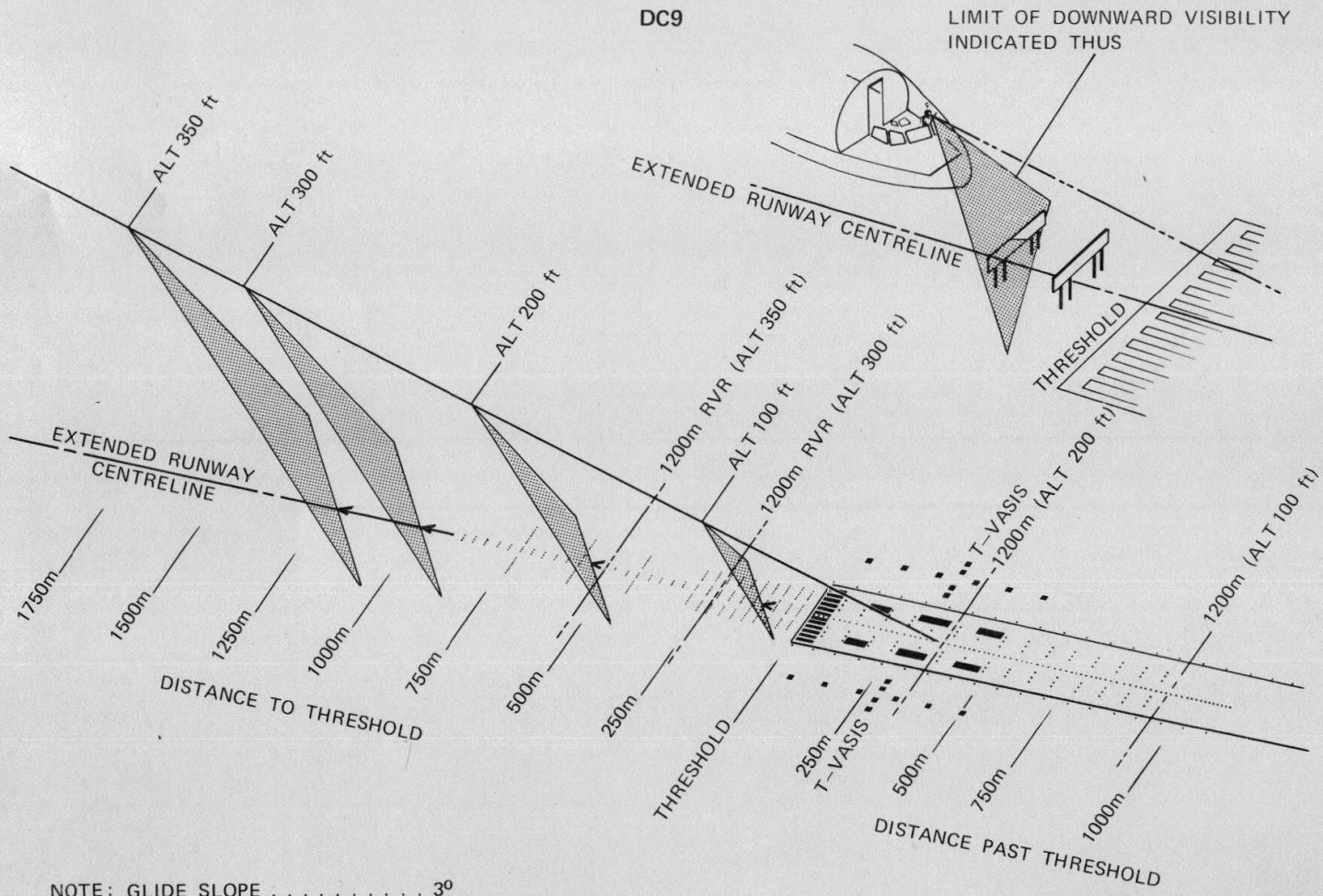
Diagram 2. A profile diagram indicating the precise area visible in the three jet aircraft and assuming that the pilot is viewing from the design eye position.

Diagram 3. An 'on slope – on localiser' presentation of the lights visible, and the position of the runway in relation to the limit of forward visibility from 350 ft and lower.

Diagram 4. Indicates the relative size and position of the runway from the B727 [200] at 200 ft – 4^{o} nose up – 15^{o} cutoff angle, and on slope or below slope but with a higher than normal body angle.

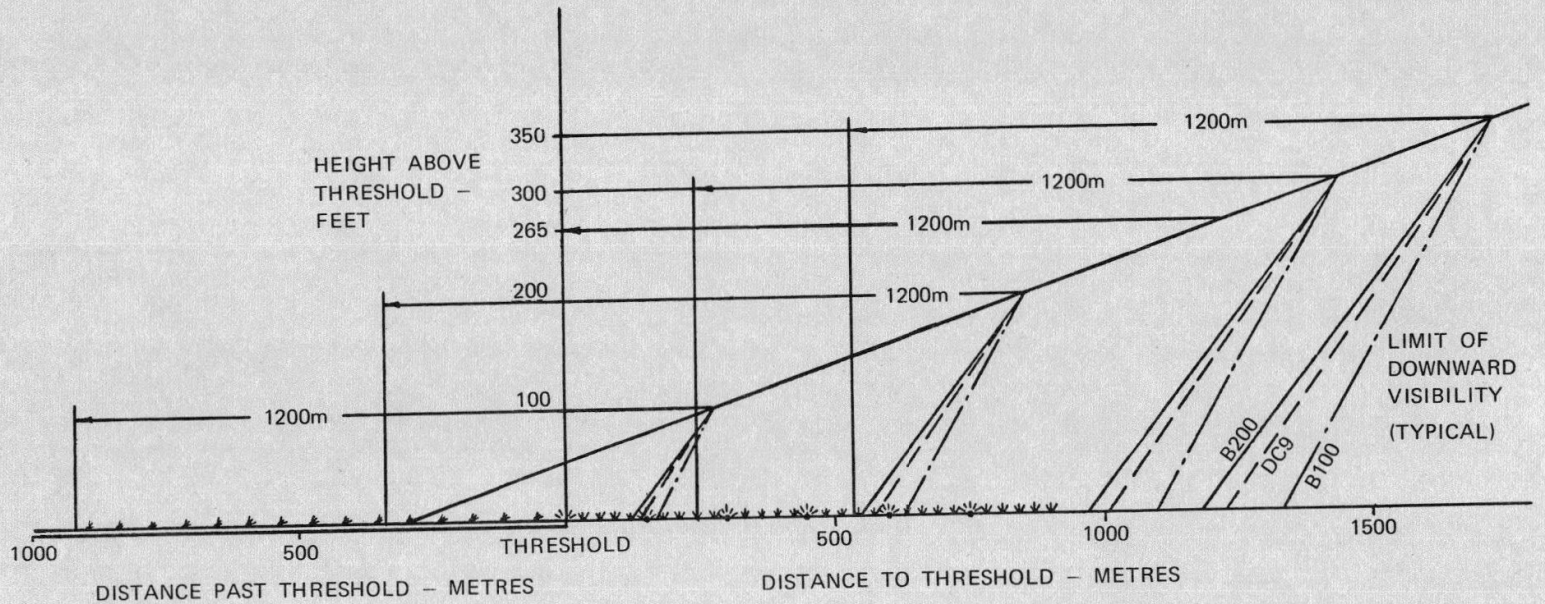
NOTE: The procedures given above are effective from this date and will be included in the Operating Manual in the next amendment to the appropriate section.

DC9



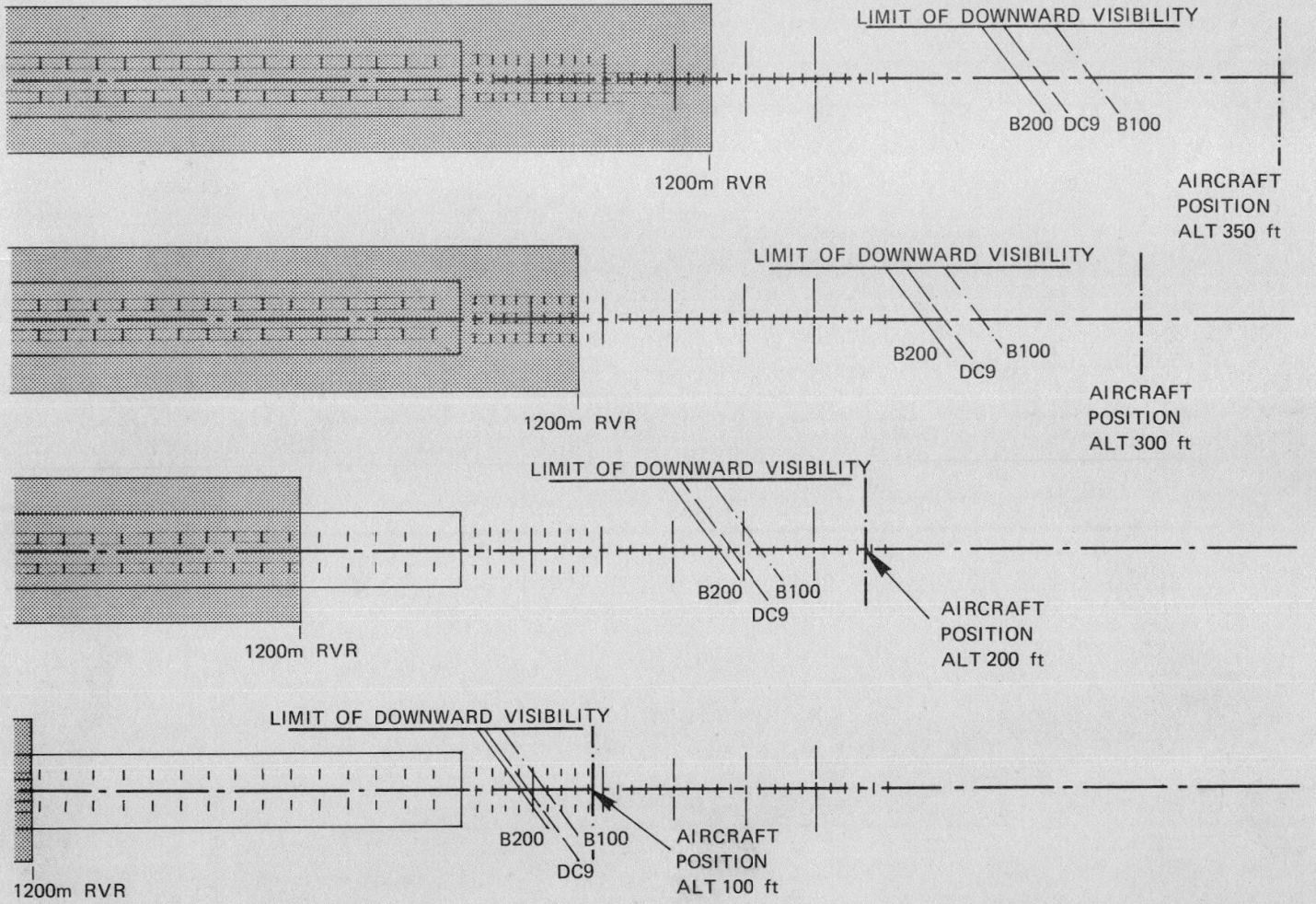
NOTE: GLIDE SLOPE . . . . . 3°
AIRCRAFT ATTITUDE . . . . . 3° NOSE UP
HEIGHT ON GLIDEPATH AT WHICH THRESHOLD BECOMES VISIBLE AT 1200m . . . . . 265 FEET
LIMIT OF DOWNWARD VISIBILITY INDICATED THUS <

Diagram 1



NOTE: HEIGHT ON GLIDE PATH AT WHICH THRESHOLD BECOMES VISIBLE WITH VISIBILITY OF 1200m – 265 FEET
GLIDE SLOPE.....3°
AIRCRAFT ATTITUDE B100.....LEVEL
DC9..... 3° NOSE UP
B200.... 4° NOSE UP

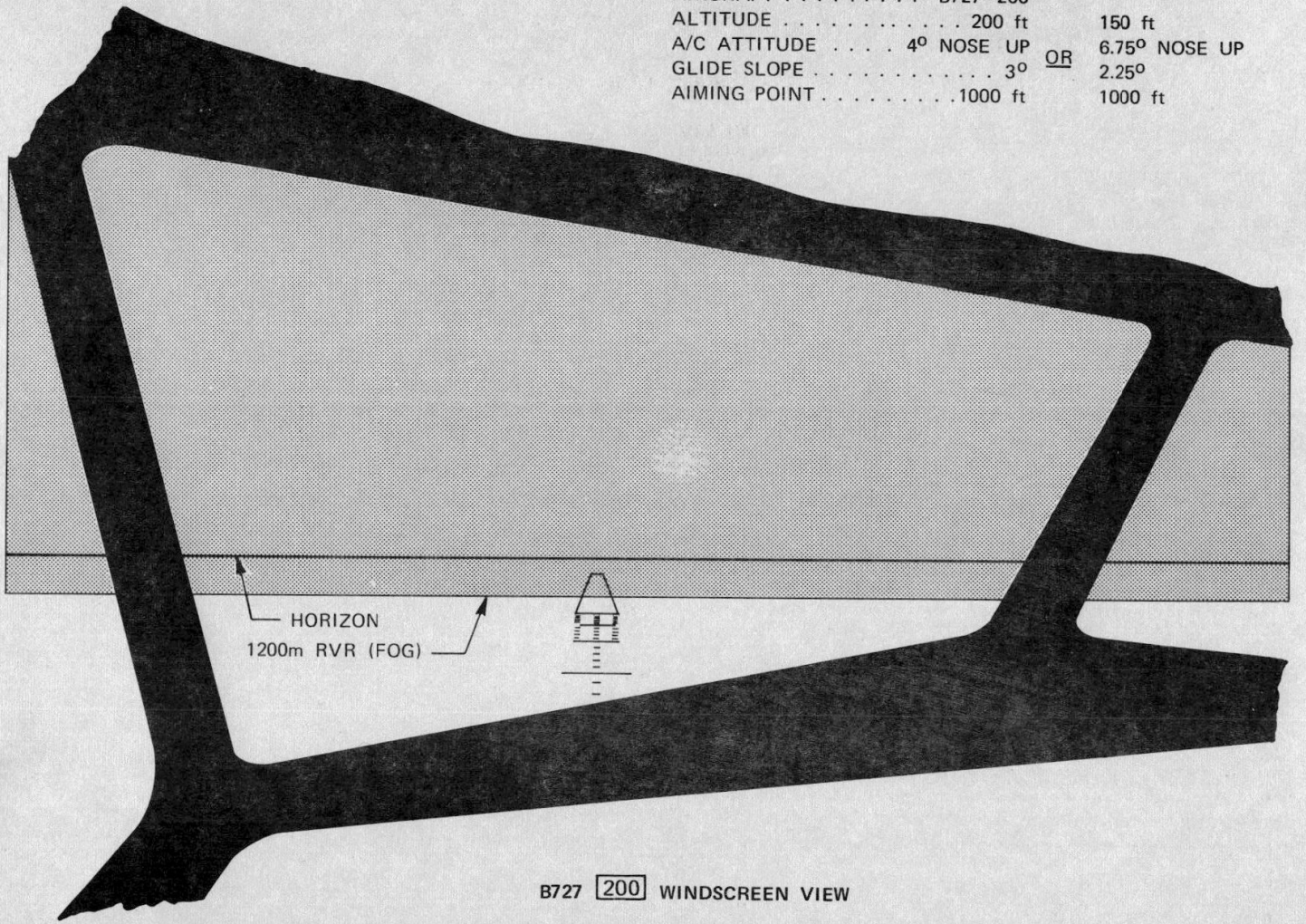
Diagram 2



APPROACH LIGHT VISIBILITY – VARIOUS ALTITUDES

Diagram 3

AIRCRAFT	B727–200		
ALTITUDE	200 ft		150 ft
A/C ATTITUDE	4° NOSE UP	OR	6.75° NOSE UP
GLIDE SLOPE	3°		2.25°
AIMING POINT	1000 ft		1000 ft



B727 [200] WINDSCREEN VIEW

Diagram 4

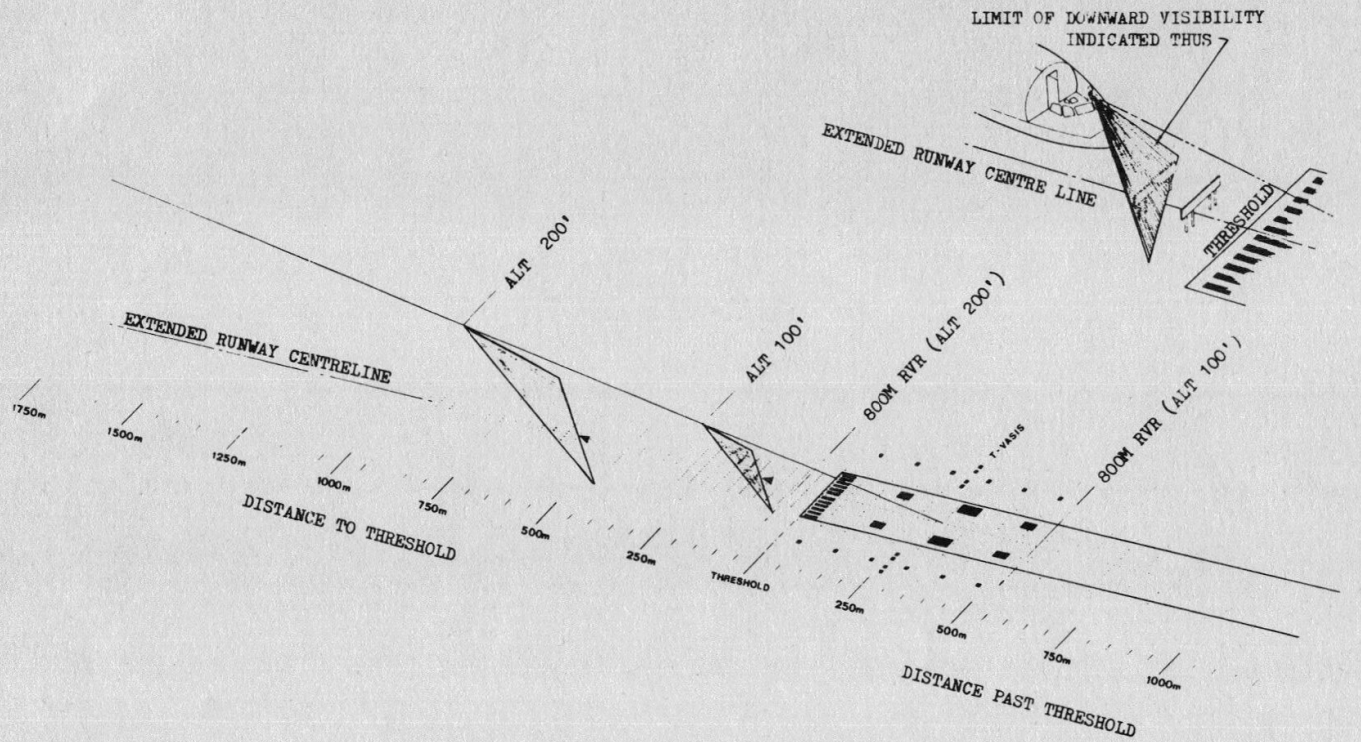
BULLETIN NO. 18

[Insert to follow Bulletin No. 8 (after page 64)]

CATEGORY 1 DIAGRAMS – FIELD OF VIEW

Attached are five diagrams showing limits of visibility in 800 metres visibility at 200 and 100 ft, additional to those for 1200 m (Bulletin No. 7) in the same idealised condition of glide slope position and body angle.

Note that the approach lights will not be in view if visibility is restricted to 800 m RVR when the aircraft is at 200 ft. Slightly higher RVR is required for the letdown to continue from that point through to the landing, unless the glide slope reference point is displayed further down the runway.



NOTES: GLIDE SLOPE .....3°

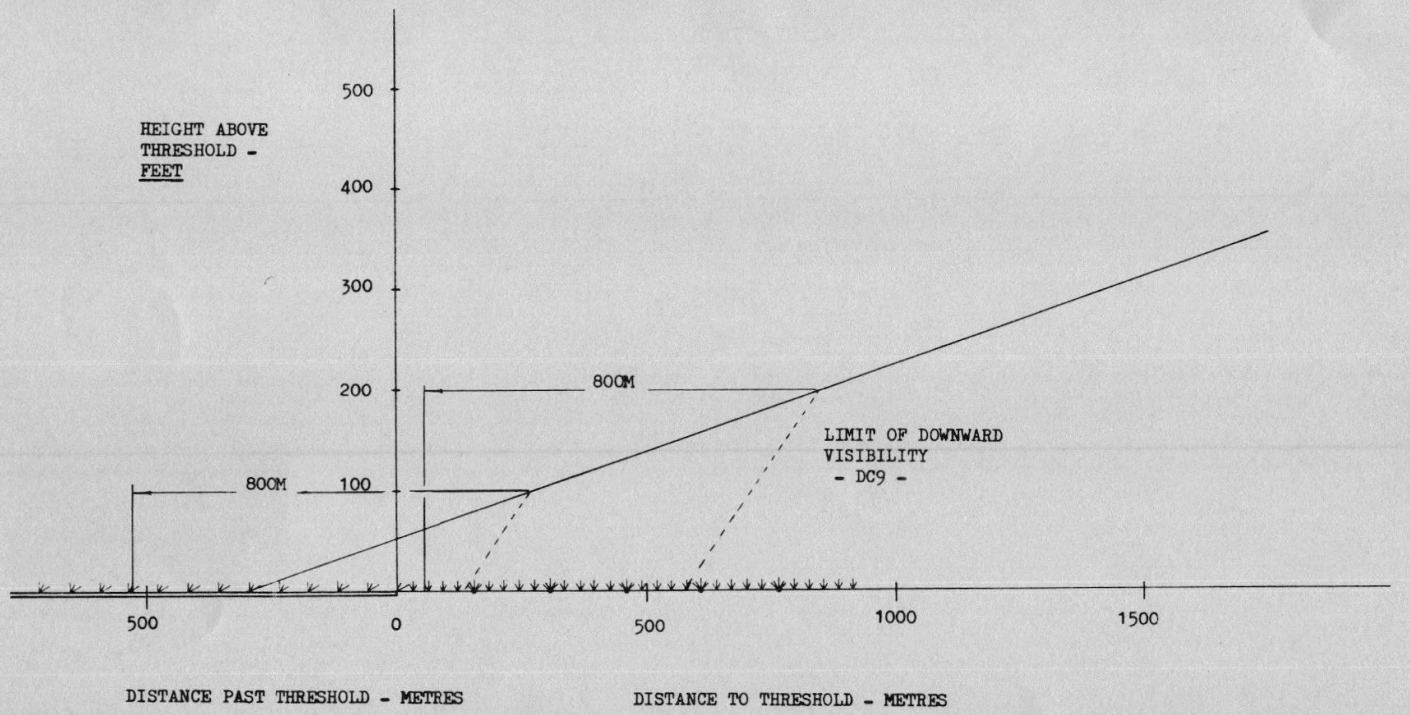
AIRCRAFT ATTITUDE .....3° NOSE UP

AIRCRAFT CONFIGURATION ..... 50°/EXT

AIRCRAFT TYPE DC9

LIMIT OF DOWNWARD VISIBILITY INDICATED THUS ◄

DC 9

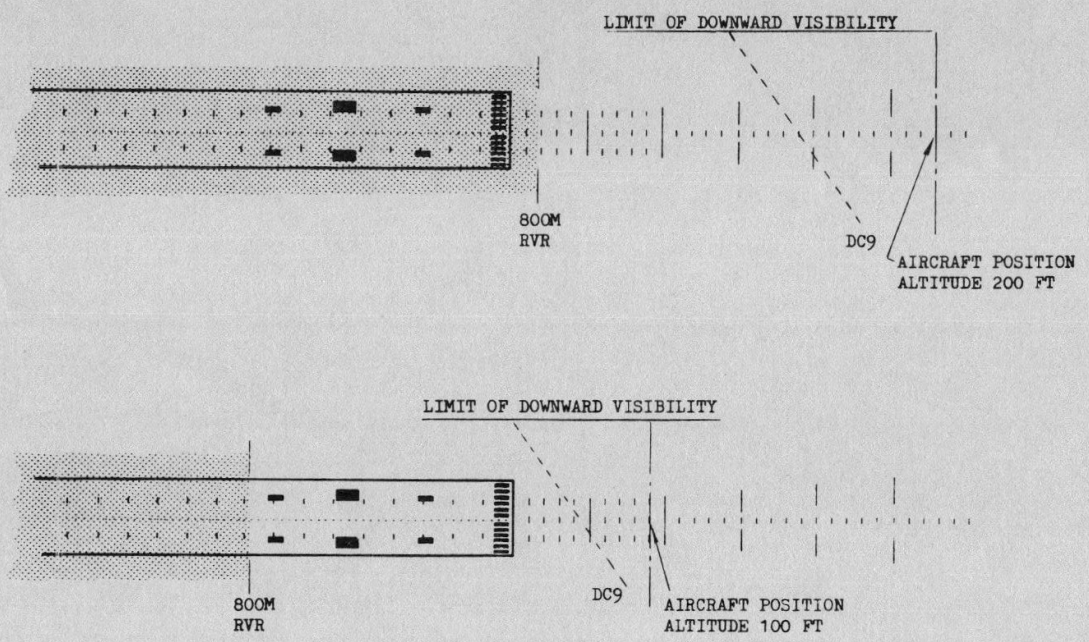


NOTE: GLIDE SLOPE .....3°

AIRCRAFT ATTITUDE .....3° NOSE UP

AIRCRAFT CONFIGURATION .....50°/EXT

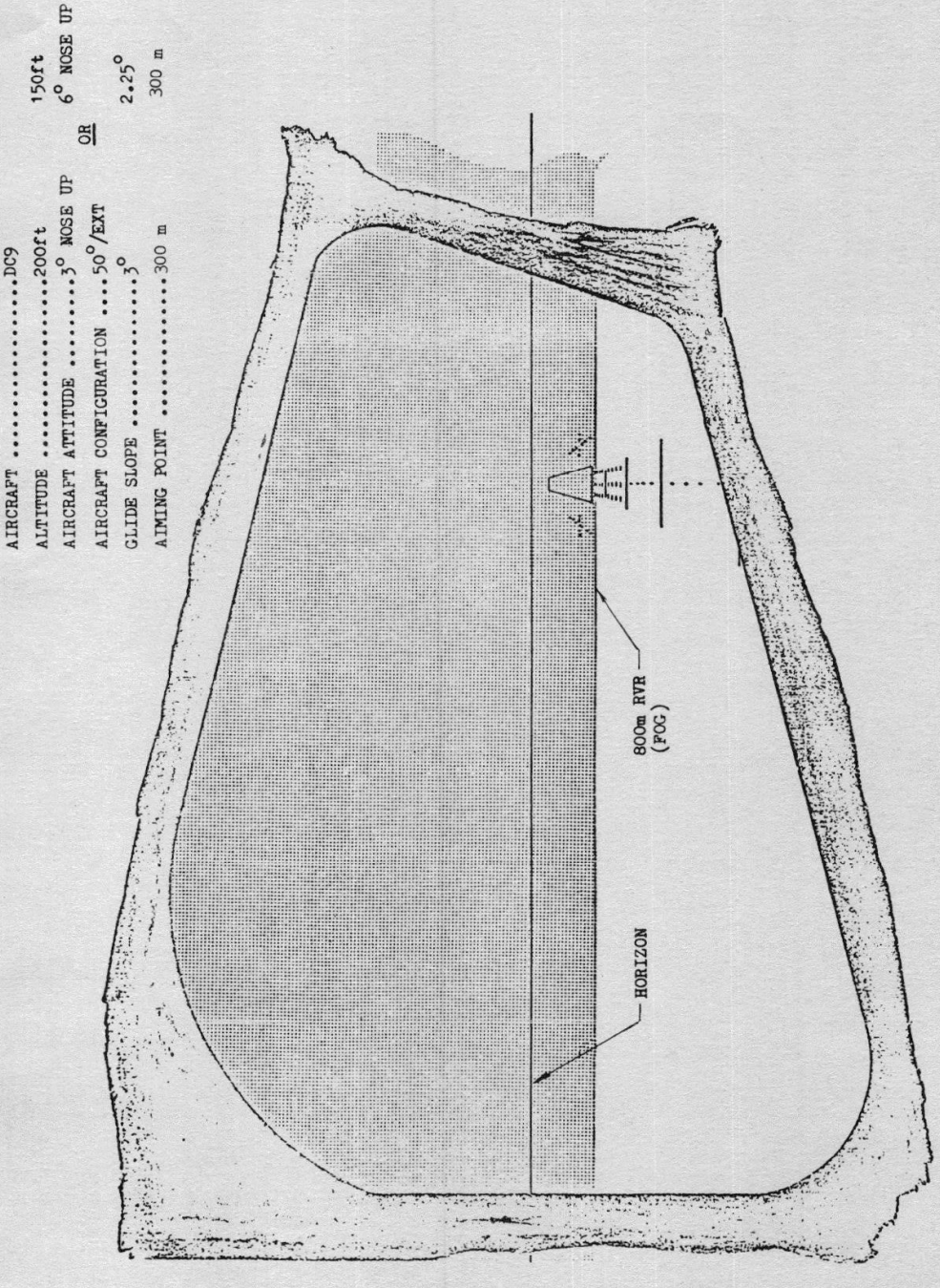
AIRCRAFT TYPE DC9

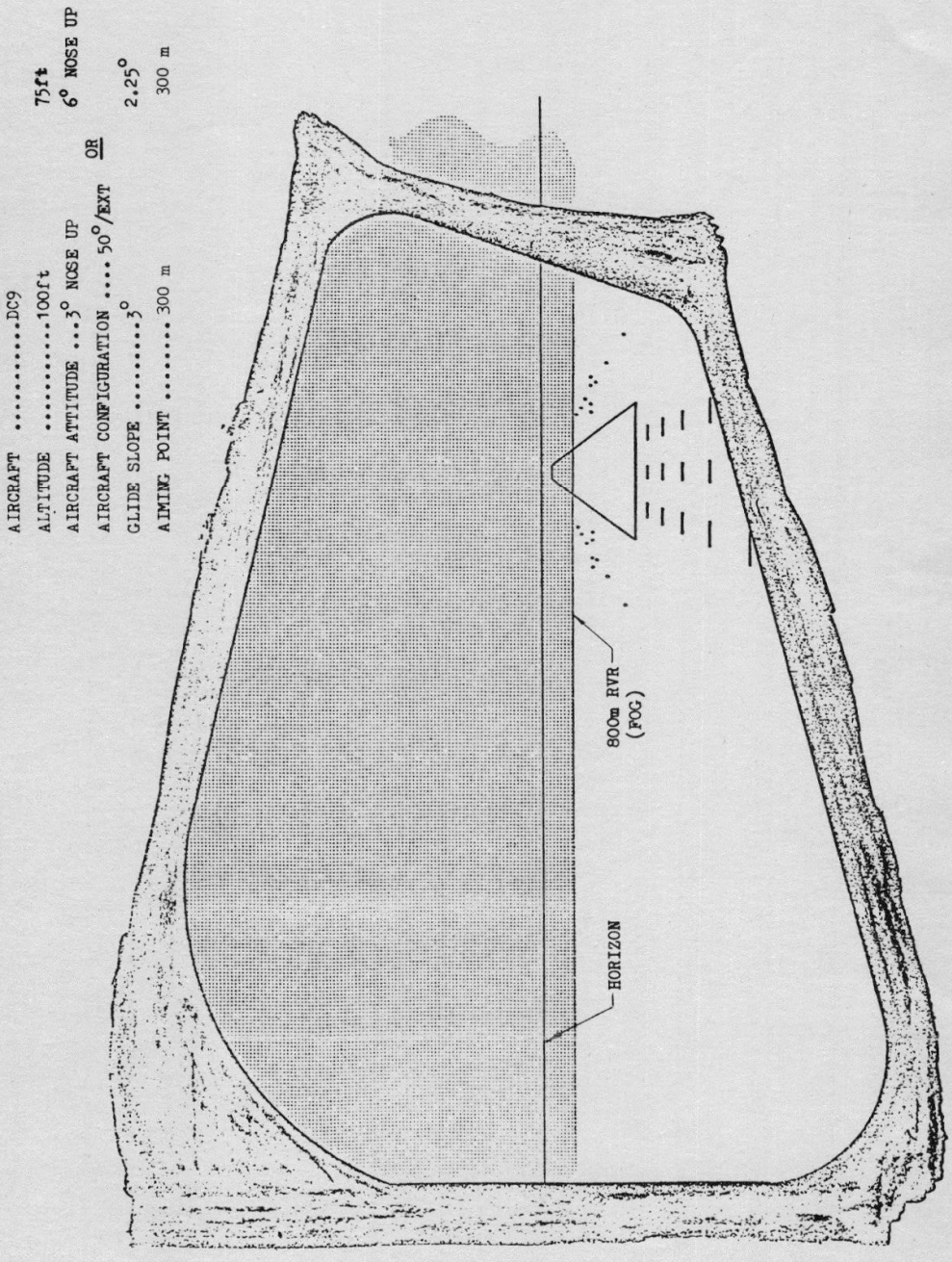


APPROACH LIGHT VISIBILITY - DC9

GLIDE SLOPE 3° , AIRCRAFT ATTITUDE 3° NOSE UP

AIRCRAFT CONFIGURATION - 50°/EXT


AIRCRAFT DC9
ALTITUDE 200ft
AIRCRAFT ATTITUDE .....3° NOSE UP
OR
AIRCRAFT CONFIGURATION ....50°/EXT
GLIDE SLOPE .....3°
AIMING POINT .....300 m
150ft
6° NOSE UP
2.25°
300 m
800m RVR
(FOG)
HORIZON


AIRCRAFT DC9
ALTITUDE 100ft 75ft
AIRCRAFT ATTITUDE ...3° NOSE UP 6° NOSE UP
AIRCRAFT CONFIGURATION .... 50°/EXT OR
GLIDE SLOPE .....3° 2.25°
AIMING POINT ..... 300 m 300 m
800m RVR
(FOG)
HORIZON

7.6.9. MISSED APPROACHES: (Cont'd)

One and Two engine missed approach:

Max. allowable thrust)
Rotate to Target Attitude) Simultaneously
Flap 15°)
Positive rate of climb, gear up.
Speed:
One engine - Bug speed
Two engine - Bug + 10 - 16° maximum body angle.
At 800' (500' - one engine) retract flaps and slats to schedule.
Observe minimum manoeuvring speeds.

This manoeuvre is done from 100' on a simulated ILS. The flight director in the SCAT mode will provide a command attitude reference to establish the proper speed to a maximum body angle of 16°. Cross check airspeed and attitude (HDI) on a missed approach.

7.7. AUTO THROTTLE APPROACH - VISUAL AND I.L.S.:

During visual or ILS approach to land the auto throttles may be engaged when slats are extended and approaching Vref 50° + 45K. The ATS system will automatically maintain the SCAT scheduled speed which will vary in relation to the flap/slat position, the increase in G force experienced in a turn and also compensates for increased sink or wind gusts encountered during final approach to land.

Except when manipulating other aircraft equipment the ATS must be physically monitored at all times during the approach and must be disengaged at a minimum of 100 ft. It may be overpowered easily whilst engaged if a speed, other than that scheduled by SCAT, is desired.

8. LANDINGS:

8.1. NORMAL APPROACH AND LANDING:

The normal glide path for the DC-9 is based on an instrument type approach of approximately 2.75°. Once the final approach is established the aircraft configuration remains fixed and only small adjustments need be made to the glide path, approach speed and trim. This results in the same type approach under IFR and VFR conditions and permits the quickest transition training.

Landing pattern work is excellent for building good habits. Stay ahead of the aircraft; complete the checklist early; and strive to fly the patterns with precision.

Instructor Information:

Aim all approaches at the 1,000 foot point on the runway (normal ILS touch-down). Perform a go-around if it is obvious that the touchdown will be significantly beyond the 1500 foot point. If the apparent point of touchdown appears to be within the first 500 feet of runway, readjust the glide path to touch down between 500 and 1500 feet or go-around. Shorter landings cannot be tolerated and the acceptance of touchdowns beyond the 1500 foot point should be discouraged.

The instructor should demonstrate the first approach and landing. This will give an example of the proper handling technique, attitude control, speed control, glide path, touchdown technique and after touchdown procedures.

Approach & Landing - Student:

Perform practice landings using the patterns and procedures outlined on the following pages. Fly smoothly with precision. Anticipate trim changes. Give yourself enough straightaway on final to be in the landing configuration, established on centerline and holding a constant glide path with the proper sink rate. These, plus good airspeed control, will set you up for a good touch down at the 1000 foot point on the runway centerline. Do not crowd yourself for space or time. Allow enough of both for 25° bank turns and unhurried cockpit procedures.

8.1.1. GO-AROUND - STUDENT:

In the event of a go-around, apply max allowable thrust and rotate raising the flaps to 15°, accelerate smoothly to Bug + 10K (V_2) and retract the landing gear after a positive rate of climb is established. After clear of obstacles (800 ft), accelerate to Bug + 20 and retract the flaps, accelerate a further 25K (Bug + 45K) and retract slats, start a turn onto downwind leg, level out at 1500 feet above the field elevation and prepare for another landing approach.

NOTE: V_2 speed = Vref 50° + 10K.

8.1.2. REFERENCE AIRSPEED AND AIRSPEED REFERENCE POINTER:

The minimum approach speed is Vref (1.3 V stall for either 25° or 50° flaps). At normal landing weights Vref will provide an airspeed margin of approximately 25 knots above V stall. Optimum IAS is Vref on final approach without wind, gusts or excessive rate of descent considerations. VREF 25 or VREF 50 are normal manoeuvring speeds and up to 40° bank is available in a level turn before reaching stall warning. There should be no concern about flying at VREF on final approach.

For normal landings set the reference pointer at VREF for the intended landing flap configuration and landing gross weight prior to entering the landing pattern; preferably at the start of descent.

8.1.3. WIND GRADIENT AND GUST FACTORS:

Keep the reference pointer set at VREF but if strong winds are present, maintain an airspeed above this to compensate for wind gradient and gust effects For the wind gradient effect, add 1/2 the wind value and for the gust factor, add 1/2 of the gust value.

Example: Wind = 18 knots, Gust to 25 knots.
Add 9 knots for wind gradient and 4 for gust effect or VREF + 13 knots.

If the total exceeds 15 knots, add only 15 knots to VREF. 5 knots are normally carried above VREF on final approach so do not add any additional speed above VREF + 5 knots for a 10 knot headwind. When adding the wind gradient effect, anticipate that the airspeed will decrease by this amount as the aircraft nears the ground. If only the wind gradient is added, the airspeed should be allowed to decrease to VREF just prior to touchdown. Raise the nose as the gradient factor bleeds off to prevent the aircraft from descending below the glide path. Do not add thrust or drop the nose in attempting to hold the additional airspeed until touchdown. If both the wind gradient factor and gust factor have been added to VREF, only the gust factor should be retained to touchdown. When determining the additive for wind shear be alert to the situation where the wind is near calm on the ground with strong winds aloft. There is a possibility of very strong wind shear on late final approach.

In normal operation the airspeed reference pointer (bug) will be set to the VREF value during the descent from cruise altitude. When the tower advises the ground wind the pilot should calculate the additives and advise the co-pilot so that he will be aware of the speed at which the Captain intends to fly the final approach. In training, the student should nominate the additives on each approach so that the habit of considering the additives becomes automatic.

8.1.4. CIRCUIT PATTERN AND SPEED CONTROL:

It is essential that the student be fully familiar with the circuit pattern and speeds. The instructor must insist that the student fly to the precise pattern. Tight control of speed particularly on base leg will enable the student to correctly assess the effect of any drift resulting in consistent turns onto final.

8.1.4. CIRCUIT PATTERN AND SPEED CONTROL: (Cont'd)

It will also result in the aircraft rolling out on final at a consistent height which is the basis of early establishment of the aircraft in the final approach slot of $2\frac{3}{4}^{\circ}$. Assessment of and correction for drift is important if a precise pattern is to be flown. Remember downwind to allow for double the drift if it is toward the runway, drift only if it is away from the runway. The establishment of good normal circuits will enable the student to fly the more difficult circling and SE approaches without trouble.

8.1.4.1. SPEED COMMAND AND FLIGHT DIRECTOR USE:

Prior to take-off the Flight Director should be selected to Speed Command mode and the pitch knob to 16° nose up. During and after rotation the V Bars will give computed body angle to maintain not less than the desired speed so long as speed command is selected.

Once the aircraft body angle has reached 16° nose up, or V Bar command, and speed is at or above the required figure the "Slow-Fast" pointer will be centered as the Speed Command computor is "Satisfied" with the speed and attitude.

As an example, the stall speed in the take-off configuration, slats extended and 15° flap at 100,000 lbs, is 112 kt - SCAT is scheduled to 1.27 Vs, 142 kt in this case, and providing the IAS is at or above this figure and body angle is not in excess of 16°, the "Slow-Fast" pointer will be centered.

Once the flap is retracted the stall speed increases to 122 kt and as SCAT is scheduled to 1.31 Vs in this configuration, the "Slow-Fast" indicator will be centered at 160 kt or above.

As turn is commenced the stall speed again increases ($7\frac{1}{2}\%$ for 30° bank) and as the Speed Command computor schedules a higher speed the "Slow-Fast" indicator may momentarily indicate to "Slow" if the speed was not increasing during a normal turn using 16° body angle.

With 30° bank the stall speed at 100,000 lbs, slats extended, is 123 kt and SCAT schedule would be for 173 kt. The manoeuvre speed of 160 kt minimum quoted in the Operating Manual allows for a 30° bank angle with a safety buffer to 45° bank before encountering the stick shaker, therefore the "Slow-Fast" pointer will indicate "Slow".

Once flap and slat are retracted the "Slow-Fast" indicator will indicate full scale fast as speed increases above 230 kt.

Computed body angle is only presented on the V Bars while the Flight Director is selected to Speed Command mode.

When the power levers have been reduced below the throttle switch (as indicated by the white line on the throttle quadrant), and Flight Director selected to HDG **or** VOR/LOC, the speed command computor will change to "Approach" mode and present this speed reference on the "Slow-Fast" pointer.

8.1.4.1. SPEED COMMAND AND FLIGHT DIRECTOR USE: (Cont'd)

On entering a visual circuit or when radar vectoring is discontinued the Flight Director should be selected "OFF". In this mode the Speed Command will be in the "Approach" mode and allow reference to the "Slow-Fast" indicator to be made to gain a cross check and back up for correct flap/slat configuration and speeds.

Any indication to the "Slow" side should alert both pilots to cross check flap/slat indication and confirm correct speed additive or manoeuvre speed.

If the "Slow-Fast" indicator varies more than 5 knots from the manoeuvre speed the manoeuvre speed should be used.

Once 25^{o} or more of flap has been selected a gust integration is introduced through the Speed Command computor which can call for up to a 10 knot increase in speed over normal reference speed should a downwards gust be experienced. This would be reflected by the "Slow-Fast" indicator calling for a speed increase. Gust integration is only available whilst Speed Command is in the "Approach" mode.

When 25^{o} flap is selected and manoeuvre speed established the "Slow-Fast" indicator will read "Fast" as 1.32 Vs landing reference with 25^{o} flap is being scheduled, whereas the manoeuvre speed is based on 1.4 Vs.

After switching the Flight Director to "OFF" the HDG marker may be selected to the runway heading if the runway has no ILS or front beam localiser. It can then be used as a reference when turning through base leg particularly during low circuits.

If an ILS or front beam localiser is available it should be set and tuned. The HDG marker should then be left at its last setting.

After final flap is selected (700' - 1000' on normal approach or before descending below 400' on low circuit) and the aircraft is stable in thrust and trim etc., the Flight Director should be selected to Speed Command (SC) for the "Go-around" mode.

Computed information is then presented on the V Bars in the event of an overshoot being necessary.

Refer to Appendix 2 page 4 for SCAT Speed Schedule.

8.1.5. DOWNWIND AND BASE LEG:

On downwind complete the pre-land checklist. Be at 1500 feet above the runway elevation with flaps 15, the gear up and holding Bug + 25K.

Extend the landing gear after passing opposite the downwind end of the runway and continue downwind for approximately 45 seconds in zero wind conditions.

After gear extension and prior to turning onto base, extend the flaps to 25° and allow speed to decrease to Bug + 15K. Turn onto base and commence descent at 300 to 500 FPM. Continue to descend and turn on to final approach. Very little thrust change will be necessary because the drag of the gear and flaps will cause the speed to decrease and a descent of 300 to 500 feet per minute will hold Bug + 15 knots.

8.1.6. FLAPS:

The speeds recommended with each flap setting allow a margin of 1.4 Vs above the stall for normal manoeuvring and places the aircraft in an attitude of 8° to 9° nose up. Flap extension pitches the aircraft nose down and causes a slight ballooning effect which should be anticipated with use of the elevator and trim to pitch the nose down approximately 2° to 3° as the flap extends. Then as the speed decays with the drag from the flap slowly increase pitch to maintain level flight at the slower speed. Refer Appendix 2 for pitch attitude versus speed and flap. When extending landing flap maintain the pitch attitude and thrust keeping the aircraft in trim during the transition and until the speed is stabilizing. Do not allow the nose to drop which could result in descent below the glide path and early touchdown.

8.1.7. FINAL APPROACH:

The aircraft should complete the turn onto the final between 800 - 1000 ft. intercepting the approach slot of $2\frac{3}{4}°$. As the $2\frac{3}{4}°$ slope is intercepted, extend the landing flap and adjust to the desired speed by approximately 700 ft. and fly a straight line approach to the 1000 ft. aiming point. The landing flap is normally extended after roll out on final but the position of the aircraft relative to the desired glide slope should be constantly assessed during the base leg and landing flap extended should the aircraft intercept $2\frac{3}{4}°$ prior to turning onto final. The aircraft should be maintained in the approach slot with the elevator and longitudinal trim controlling speed with the throttle.

8.1.7. FINAL APPROACH (Contd)

The elevator must be used to control flight path. On prop aircraft application of power will also affect lift due to the increased airflow over the wing and little or no pitch change may be required to vary the flight path. On jet aircraft this change in lift does not occur and variation of thrust will result only in speed change. Naturally if speed varies considerably so will flight path and, in practice, both pitch and thrust are varied. Initially the student may have difficulty in recognising the $2\frac{3}{4}^{\circ}$ slot and flying a glide slope for several approaches will be beneficial. However, competance without assistance is essential if the student is to handle approaches where the glide slope is not available.

There are several methods and cues which may be used :-

(a) Endeavour to come out on final at a consistent height and distance which places the aircraft on $2\frac{3}{4}^{\circ}$.

(b) Establish the aircraft in the slot on speed, frequently look ahead to the 1000 ft aiming point and assess the instantaneous flight path of the aircraft. If this path would not carry the aircraft to the aiming point a correction should be made. The use of a theoretical sighting mark on the windshield or structure should be avoided as this will vary with the change in pitch which occurs when differing speeds or flap configuration are used. e.g. No flap approach.

(c) Cross check the speed and sink rate. With the VREF speed and in normal 10K headwind conditions the sink will be 500 to 700 FPM. If the ground speed is higher (higher airspeed or less headwind or possibly a tail wind component) the sink rate will be higher and conversly lower in strong headwind conditions.

(d) Pitch Attitude..

At the VREF 50° speed the pitch attitude will be 3 to4° nose up. If the pitch attitude is higher with a lower sink rate the approach may be flat. However, this would be normal for an approach in strong headwinds. If pitch attitude is lower than usual at VREF speed and sink rate is high the descent path is steep or the aircraft is in a tailwind component.

It is essential that a straight line approach be flown. If the approach is commenced at the correct height this will prevent high sink rates from developing. While it is essential that high sink rates be avoided it is also important that the aircraft not be permitted to go above the slot particularly after passing 200'. In strong, gusty wind conditions an increase in airspeed will cause the aircraft to go above the slot due to the increase in lift. This must be controlled with forward elevator. As the aircraft is maintained in the slot under these conditions speed will normally increase further but thrust should not be reduced significantly as a reduction in the wind speed could leave the speed dangerously low. If the aircraft is permitted to go above the slot late in the approach take a new aiming point further along the runway rather than push the nose down to make the original 1000 ft. mark or, if this is unacceptable, overshoot. If the nose is pushed down a high sink rate will develop and a larger rotation for flare will be necessary.

8.1.7. FINAL APPROACH: (Cont'd)

possibly with insufficient speed. This can result in a hard and possibly short landing.

During the latter part of the approach (below 150 ft.) the student should concentrate most attention on the aiming point and runway checking the airspeed and VSI less frequently. Due to ground effect the VSI indication will be less reliable below 150 ft. and changes in sink rate are best assessed visually. Likewise speed can be assessed by observation of the flight path. If it is necessary to increase the pitch attitude to continue on straight line at constant thrust the aircraft has lost lift due to loss of speed. Add thrust if necessary. If the opposite occurs speed has increased. Reduce thrust with caution.

While it is necessary to keep in trim throughout the approach small variations encountered in gusty conditions should be controlled with elevator only to minimise trim activity. DO NOT TRIM during the flare.

8.1.8. THRUST:

The throttles must be thought of as a primary flight control in co-ordination with elevator to control airspeed, rate of descent and glide path. Keeping one hand on the throttles will result in automatic reaction to small thrust requirements and no large changes should be necessary, except when performing a go-around.

In normal flight, acceleration and deceleration of the aircraft is effected with either MCT or idle thrust each requiring physically large throttle movements. There is a tendency to carry over this method into the approach and landing resulting in speed hunting. Once "on speed" particularly on final approach the engines are spun up to about 70% N_1 which is on the steep part of the thrust curve and consequently small throttle movements produce relatively large thrust changes. It will be necessary, normally, to make many small thrust changes during a normal approach but throttle movement should be small and, in general, proportional to the rate of speed change. However, if the aircraft encounters a rapid and significant speed loss in gusty conditions add sufficient thrust immediately to accelerate quickly to the desired speed. Use max. power if necessary.

In the landing pattern, keep one hand on the thrust levers. Initially, many pilots tend to over control laterally. Have the student neutral the lateral input. The oscillations will usually dampen out.

8.1.9. FLARE AND TOUCHDOWN:

The addition of speed if carried for wind shear should be allowed to bleed off as the aircraft passes the 50 to 75 ft. height. Ground effect is marked below 100' and it may be necessary to lower the nose 1 to 2° to counter the tendency for the aircraft to go above the glide path. The flare which should be commenced at the same height as any other comparable aircraft (approximately 20 ft. wheel height) and should be a very gentle rotation of 2° to 3° to slow the sink rate.

8.1.9. FLARE AND TOUCHDOWN:

The elevators are sensitive and any rapid or harsh input will result in ballooning. Use gentle backward stick to arrest the rate of sink then relax the stick forward to counter ground effect and to ensure a positive touch down. Thrust should be reduced to idle just as the flare is commenced. Touchdown will occur about 5K below Vref speed. If speed is Vref plus 10K reduce to idle just before the flare is commenced. If it is Vref - 5K flare, then reduce to idle thrust after the flare. The ground effect is marked and equals a sink rate of 300 FPM.

If the stick is not eased forward positively the aircraft will, on occasions, ride on the ground effect particularly if speed is in excess of that required. Continue to ease the stick forward to positively put the aircraft on the runway. Using a flare with the concept of bleeding off the flying speed to near initial buffet speed (near maximum lift coefficient) at touchdown will only result in floating and use of excessive runway. The aircraft must touchdown with a positive roll on.

Abrupt rotation usually follows late rotation which will in most cases result in a hard landing particularly if speed is on the low side. To appreciate this one must visualise the main landing gear aft of the CG around which the aircraft rotates when airborne. As the nose of the aircraft is pulled up at touchdown the landing gear is pushed down and literally driven on to the runway.

If the student persists in driving the wheels on to the runway or levels off too high he should be instructed to change his ground reference, e.g. late flare - ground reference too close to the nose of the aircraft; level off high - ground reference too far from aircraft. Fixation on a single point on the runway is not advisable. During the latter part of approach the aiming point and the entire runway should be referenced to maintain runway perspective consistent with $2\frac{1}{4}°$ and for early detection of increase in rate of sink in the latter part of the approach. Fixation on the aiming point will cause the nose to drop. Just prior to flare look ahead and forget the aiming point.

8.1.10. AFTER TOUCHDOWN AND LANDING ROLL:

At touchdown the spoilers will automatically extend to the 60° position. Immediately, but gently, lower the nose wheel on to the runway and hold it there. Apply moderate braking and reverse thrust (1.5 to 1.7 EPR). Check that spoilers have extended and be prepared to extend manually.

As noted earlier raising spoilers reduces wing lift and increases drag both of which help to slow the aircraft. Bringing the nose wheel down to the runway also reduces wing lift and increases the effectiveness of the brakes. Throughout the landing roll keep enough forward pressure on the control column and hold the nose wheels firmly on the runway to improve directional control particularly in cross winds. At high speeds reverse thrust is most effective and should be established as soon as possible, normally 1.6 EPR to 80K. Passing 80K reduce EPR to just below 1.2 by 60K and maintain until a fast taxy speed is reached.

8.1.10. AFTER TOUCHDOWN AND LANDING ROLL: (Cont'd)

If manual extension of the spoilers is necessary extend them as the nose wheel is lowered. Extension of the spoilers will cause a slight, easily controllable nose down pitch. The manual extension sequence is : UP, AFT AND UP.

Rudder and rudder pedal steering is effective down to 40-50 kt and is sufficient to maintain directional control during landing roll out. Do not use nose wheel steering during landing roll out.

8.1.11 MANUAL SPOILER EXTENSION:

Manual extension of the spoilers will be necessary in the event they fail to extend automatically or where an aborted take off is necessary. Manual dexterity can be obtained by practising this sequence repeatedly while taxiing. Start with the student holding the throttles and control wheel as for landing. The instructor announces "touchdown". The student then performs the after touchdown (or abort) sequence as quickly as possible. Do not forget the wheel brakes.

The Captain must always operate the manual spoiler extension.

8.1.12 REVERSE THRUST:

Brakes only stopping distances are affected by varying runway, tyre and brake conditions. Reverse thrust stopping distance is affected only by field elevation and temperature (engine limitations). A combination of wheel braking and reverse thrust always results in shorter stopping distance than with wheel brakes alone, and saves wear on brakes & tyres.

Proper use of thrust reversers after touchdown will always reduce the "brakes only" stopping distance. At high speeds, reverse thrust is most efficient. Use the maximum allowable reverse thrust immediately after touchdown.

After the main wheels are on the runway check the throttles at idle and, at the same time, quickly raise the reverse thrust levers to the interlock (10 o'clock) position. Maintain gentle pressure against the interlock then place the RT levers to approx. the 12 o'clock position as it releases. Depending on the temperature of the day etc. the 12 o'clock position will result in 1.5 to 1.7 EPR. Maximum EPR may be used when operating on wet runways or in adverse conditions. Normally set 1.5 to 1.7 EPR. Passing 80 kt reduce reverse thrust to reach 1.2 EPR by 60 kt to prevent exhaust gas re-ingestion, engine surging and FOD damage and maintain until approx. 35 kt is reached. Slowly move RT levers to reverse idle position (approx. 1.1 EPR) and maintain until normal taxy speed. Select forward idle before turning off the runway centreline.

Do not move the reverse thrust levers rapidly from high reverse thrust (high RPM) into forward idle as sudden opening of the reversers will allow greater than idle thrust to accelerate the aircraft. This nullifies a portion of the wheel braking and reverse thrust just applied. Reduce reverse thrust (and RPM) gradually to idle reverse before going to normal idle.

As the RT levers are moved out of the forward idle position and the reversers move out of the forward stowed position the amber intransit light will illuminate. Then as the reversers reach the full reverse position the blue reverser light will illuminate.

8.1.12. REVERSE THRUST: (Cont'd)

CAUTION

DO NOT DELIBERATELY SELECT ASYMMETRIC REVERSE THRUST. IT MAY INTRODUCE RATHER THAN CONTROL DIRECTIONAL CONTROL PROBLEMS.

8.1.13. BRAKES AND ANTI-SKID:

The braking force available from the tyres is proportional to the area in contact with the runway, the force on the tyres perpendicular to the runway and co-efficien of friction between the tyres and runway. The contact area normally changes little during the braking cycle. The co-efficient of friction depends on the tyre condition and runway surface (concrete, asphalt dry, wet or icy). The perpendicular force comes from aircraft weight and any downward, aerodynamic force. Raising the spoilers dumps the lift of the wing at this high speed and places approx. 70% of the aircraft weight on the wheels. This makes the wheel brakes very effective at the high speed end of the landing roll. Immediately the nose wheel contacts the runway establish sufficient braking to ensure the brakes are operating and then brake as required depending upon runway length available. Avoid heavy braking unless it is necessary. In normal operations make use of more runway with lighter braking and take taxiways towards end of runway rather than earlier turn-offs.

When using moderate to heavy braking on wet runways rapid cycling of the anti-skid system can be anticipated and is indicated by "jerking" of the aircraft as the brakes release and then again become effective. A slight swing may be experienced when brakes release asymmetrically as wheels encounter varying degrees of water.

If braking with accumulator pressure only, the anti-skid is switched off to preclude rapid pressure loss which could occur with anti-skid cycling. When braking with anti-skid off, apply brakes lightly to prevent wheel lock up and tyre damage. Hold them on constantly to prevent loss of pressure. The initial application results in an 800 p.s.i. loss.

For normal rudder usage the pilot's heels will be on the floor. But to properly operate the wheel brakes, he must shift his feet up and place the heels on the instep rest. Only in this position can most pilots obtain enough pedal displacement and pedal pressure to achieve maximum braking. Practice applying the brakes when sitting at the ramp with chocks under the wheels. Notice the difficulty when attempting to apply brakes with full rudder displaced. Always adjust the pedals to obtain full rudder and maximum brakes. Normal hydraulic pressure should be available for this practice.

8.1.14. LANDING DISTANCES - STOPPING:

Aircraft handling by the student during the final approach can effect the total stopping distance, but pilots should be warned against trying to touchdown near the end of the runway. Aiming at a touchdown point 1000 ft. from the end of the runway will still provide sufficient distance to bring the aircraft to a stop. Landing short of the runway can have even more serious consequence than overrunning the end at low

8.1.14. LANDING DISTANCES - STOPPING:

speed. Floating just off the runway surface for several thousand feet before touchdown must be avoided, as this procedure uses up a large portion of the available runway. If the aircraft should be over the recommended speed at the point of intended touchdown, deceleration on the runway is about three times greater than in the air. Therefore, in such a case, the aircraft should be set onto the runway as near the 1000 foot point as possible rather than allow the aircraft to float in the air to bleed off speed.

Height of the aircraft over the end of the runway also has a very significant effect on total landing distance. For example, flying over the end of the runway at 100 feet altitude rather than 50 feet could possibly increase the total landing distance by approximately 900 feet on a 2.75° glide path.

This change in total landing distance results primarily because of the length of runway used up before the aircraft actually touches down. Glide path angle also effects total landing distance. Even while maintaining the 50 foot height over the end of the runway, total landing distance is increased as the approach path becomes flatter. A combination of excess height over the end of the runway and a flat approach uses up runway at an extremely high rate. Glide path angle is a function of pilot technique and best results will be obtained at a normal ILS glide slope angle of 2.75°.

Whatever may contribute to a poor approach, the instructor or pilot should be prepared to make an early decision to go-around rather than touchdown far beyond the 1000 foot aim point and assume the chance of overrunning the end of the runway.

Common Errors:

1. Maintains too high an airspeed throughout approach and landing.
2. Makes too flat an approach and flies up to runway.
3. Drops the nose due fixation on aiming point then over-rotates when attempting to stop high rate of descent for level off and lands hard and short.
4. Maintains too shallow bank angle or excess speed on base leg, overshoots runway centreline and "S" turns on final.
5. Attempts to angle onto centreline and never lines up properly. This results in manoeuvring below 100 ft.
6. Allows aircraft to balloon with flap extension, especially from 0 to 15°. Depress the nose attitude 2° to 3° with elevator and trim to zero stick force.
7. Over-rotates during flare or flares too early and floats excessively while trying to make touchdown.
8. Flares late and over-rotates. With insufficient speed this could lead to hard nose high touchdown. With struts fully compressed and 50% tyre deflection the tail skid contacts at 10.5° body angle.
9. Too slow in actuating reverse thrust and brakes.
10. Uses partial reverse thrust for only a very short time.

8.1.14. LANDING DISTANCES - STOPPING: (Cont'd)

11. Holds nose in air after touchdown. The aircraft must be rolled on.
12. Releases control column and grabs nosewheel steering immediately after touchdown.
13. Returns thrust levers to idle forward thrust quickly from high reverse thrust.
14. Aims short of the 1000 foot point.
15. Does not trim stabiliser to zero stick force on final after flap extension.
16. Flies final approach with both hands on the control column.
17. Uses insufficient thrust to accelerate aircraft with speed loss in gusty conditions.
18. Does not counter the ground effect when passing below 100 ft. Ground effect is equal to approx. 300 FPM.
19. Does not reduce thrust at the flare to account for speed.

8.1.15. 2 ENGINE GO-AROUND:

The aircraft has the capability to go-around from the start of the flare even though the thrust has been reduced to idle and the engines have spun down. On a two engine landing approach, after the start of flare, the instructor should call a missed approach.

The student should advance the throttles to the max. power position while rotating to stop the sink rate, and command 15° flaps. Continue rotation to a climb out attitude as thrust increases and call "Gear up" after positive rate of climb indicated. Call "MAX. POWER". From this point on, the manoeuvre shall be conducted using the normal missed approach procedure. It should be pointed out that the gear may touch the runway during the pull-out.

Common Errors:

1. Max. power throttle position falls far short of, or is in excess of max. EPR.
2. Allows aircraft to continue descent due to inadequate rotation.
3. Flap is not retracted to 15° immediately.
4. 16° body angle not reached or maintained.
5. Gear retracted before positive rate of climb.
6. Gear forgotten or not selected up on initial positive rate of climb.
7. Normal clean up after 800 ft delayed.

8.2. CROSSWIND LANDINGS:

Crosswind landings will not normally be practiced in training until the student has demonstrated reasonable proficiency in normal landing approaches.

For maximum training value, a crosswind of at least 15 kt is recommended. In training, crosswind components of this magnitude are not always available, but crosswind techniques as applied to the DC9 can be practiced with a lesser wind component. The highest crosswind component encountered in training shall be noted on the pilot's training record.

8.2. CROSSWIND LANDINGS: (Cont'd)

The certified crosswind capability was determined by the crosswinds available during certification and are not necessarily physically limiting.

When executing a crosswind circuit and landing it is important to anticipate the drift and make the appropriate correction on the downwind so that the aircraft will come out on final centreline and with the aircraft established on a heading which will maintain the centreline. If the aircraft is lined up with the heading the same as the runway heading it will drift off and further correction to regain the centreline will be necessary.

8.2.1. CROSSWIND TECHNIQUE: (Include Manual Rudder)

The objective of the crosswind technique is to maintain wings level throughout the approach and landing roll lowering the into wind wing slightly during the flare and touchdown.

On final approach, a crab angle is established with wings level to hold the aircraft on the desired course. Over the last 100 ft (in Max crosswind conditions) lower the up wind wing and apply downwind rudder to eliminate the crab and align the centreline of the aircraft with the runway centreline. With lesser crosswind lower the wing prior to flare. As the rudder is applied, the upwind wing will sweep forward, developing roll. Hold the wing slightly down by simultaneous **application** of lateral control into the wind.

Touchdown may be made with the upwind wheels touching down first. If so, lower the downwind and nose wheels to touch shortly thereafter. Then either hold the wings level or hold the upwind wing down a very small amount.

The lateral control is effective down to 40 kt. Hold the wings level during landing roll as outboard flap clearance is limited to 8° of bank and maximum braking is achieved with aircraft weight equally distributed on the wheels.

When performing a crosswind landing, over-control or under-control laterally can cause difficulties. Any downwind lateral control inputs or control oscillations can allow the wind to get under and raise the upwind wing. Any bank angle on the ground obviously will reduce flap clearance.

8.2.2. WIND CORRECTIONS:

The aircraft will react to wind gradients and gusts for the headwind component of the wind vector. These further complicate the crosswind problem and unless compensated for, the aircraft may land short.

Experience has proved that it is difficult to predict the exact headwind vector or gust factor. If the wind is steady, use the criteria discussed in Normal Approach and Landing. Hold an air speed above the Bug Setting equal to one-half the wind value. Allow this to bleed off so as to touch down at or below BUG SETTING. If gusts exist, add both the wind gradient factor and ½ of the gust, retaining only the gust value above Bug Setting to the flare. Exercise care if the wind is gusting at 70° to 90° off the centreline.

BULLETIN NO. 5

(Insert to face page 77)

GLIDE SLOPE REFERENCE DISTANCE

The aiming point, with reference to the Glide Slope, can be calculated from the GP REF DATUM height stated on the IAL chart. Multiplying this figure by 20 will give the distance of the aiming point down the runway from the threshold.

8.2.2. WIND CORRECTIONS: (Cont'd)

Common Errors:

1. Does not lead with wing down before the flare.
2. Oscillates rudder and lateral control during roll out. Remove cross control input gradually.
3. Applies too much rudder when correcting "crab" for touchdown and too little upwind aileron allowing yaw to raise upwind wing.
4. Does not align aircraft on the runway centreline during the approach.
5. Touchdown or landing roll occurs downwind of centreline.
6. Allows speed to remain above BUG + additives on approach.
7. Leaves power on during flare and touches down above the BUG.

8.3. SINGLE ENGINE LANDING AND GO-AROUND:

8.3.1. SINGLE ENGINE APPROACH AND LANDING:

These landings are performed to familiarise the student with the approach and landing techniques with one engine inoperative.

The basic techniques and procedures for a single engine landing are the same as for a two engine landing except the final approach and touchdown are made with flaps 25.

Procedure - Instructor:

Any time before entering base leg or before approaching the outer marker, retard one thrust lever to idle then set 40% N1.

Procedure - Student:

Correct for any thrust asymmetry with rudder application; increase thrust on the other engine as required to maintain airspeed and flight path. Complete the necessary emergency procedures considering the different decisions required if the failure occurs during take-off, departure, cruise or approach.

Perform a normal landing pattern using flaps 25 for landing. Set the airspeed reference BUG at VREF 50 + 10 kt (VREF 25).

Set rudder trim to 5^{o} to 6^{o} and use rudder as required to counter thrust and speed variations but zero the rudder trim prior to landing and maintain rudder displacement with foot pressure.

Use reverse thrust on the operating engine, as desired. Select both levers to the reverse range.

8.3.1. SINGLE ENGINE APPROACH AND LANDING: (Cont'd)

Discussion:

During engine out manoeuvring it will be found that the DC-9 is quite susceptible in the yaw axis to variation in speed and thrust. Although the aircraft is sensitive to speed and thrust changes it is relatively easy to control providing the student realises that rudder input must be closely co-ordinated with thrust and speed changes.

It is recommended that rather than trim each time speed is changed the rudder trim be set to a constant value of 5° to 6° which is approximately the mean used during manoeuvring. The many small trim changes which occur are best controlled with rudder and not trim, finally trimming to neutral when established on speed on final approach. The student should think of varying thrust or speed and rudder input at the same time. If anything, rudder input should slightly lead speed or thrust change to prevent yaw. If yaw develops so will wing oscillation, making aircraft handling, particularly heading control, difficult. Remember that the yardstick of correct rudder input is zero lateral input.

During this manoeuvre follow the scat command speeds which are scheduled to 1.4 Vs during manoeuvre, 1.32 Vs with landing flap, 1.27 (V2) during overshoot. During approach the speeds are scheduled in relation to flap position and, on overshoot, to throttle and flap position. At anytime the operative engine is spun down, commence spin up approximately 20 kt above the required manoeuvre speed to allow for the smaller amount of total thrust available.

At least once during training in this manoeuvre the student should establish the final phase with 50° flap on one engine to demonstrate the critical performance capabilities in this configuration.

With 25 flaps on final approach, thrust required is approximately the same as with 50 flaps. Thrust must be adjusted to maintain an IAS of BUG + 5 kt on final.

With flaps set to 25° the speed of bug + 5 kt places the aircraft slightly on the backside of the drag curve and speed control is therefore more difficult than with the 50° flap approach. Reference to Diagram 11 in Appendix 2 shows that speed can vary up to 15 kt with little or no variation in thrust. It is most important to enter the final approach as near to the desired speed and height as possible. If too high or fast difficulty will be experienced in reducing speed to the correct value and the aircraft may enter the critical area below 200 ft with the engine spun down, the area in which the engine must be spun up in order to safely accomplish an overshoot should this be necessary. Conversely if the aircraft is low on speed or height the available thrust may be inadequate to enable the aircraft to reach the runway with safe margins of thrust in hand.

As in previous aircraft, attempt to touchdown with little or no thrust asymmetry. If a proper approach is made, little or no thrust change is required until thrust is reduced to idle just prior to touchdown.

8.3.1. SINGLE ENGINE APPROACH AND LANDING: (Cont'd)

Use the rudder to maintain directional control, near zero yaw and wings level. The correct rudder input will keep the wings level with the control wheel centered. Full lateral control will be available in either direction.

When reducing thrust for the touchdown the thrust level should be retarded gradually while smoothly removing any rudder that had been applied to offset the asymmetric thrust. Rudder forces should be applied and removed smoothly so that no rudder yaw conditions exist during initial flare and touchdown. After touchdown check that the spoilers have extended, apply the brakes and reverse thrust as on a normal two engine landing. When manoeuvring with the engine shutdown the throttle of the inoperative engine should be used symmetrically with the other. Apply thrust in reverse (1.5 to 1.7 EPR) as directional control will permit after landing. A high level of reverse thrust can be maintained during single engine roll out without fear of engine stall and surge. High levels of reverse thrust may be used (Max. Reverse EPR if necessary where runway lengths are restricted) but normal limits should be observed where possible.

8.3.2. GO-AROUND:

The aircraft is committed to land as the thrust is reduced for landing. A go-around cannot be performed if the engine is spun down.

1. Apply maximum allowable thrust, rotate to target attitude (16^{o}) and retract flaps to 15^{o} simultaneously.
2. Retract the landing gear after positive rate of climb.
3. Command max.power.
4. Hold the airspeed to the Bug Speed. V_2 = Bug Speed.
5. Climb to 500 feet above the airport elevation.
6. Accelerate to Bug + 10K and retract the flaps/slats to the normal schedule.
7. Climb to missed approach altitude.(SE climb speed = GW + 100K)

Discussion:

The aircraft has the capability of going around from any height providing the engine is spun up to the normal approach thrust setting - 65% - 75% N_1. It is committed to land whenever the thrust is reduced below bleed valve closure during flare and landing. When initiating overshoot it is important to advance to Max. Allowable thrust, rotate to target attitude (16^{o}) and retract to 15^{o} flap simultaneously. Maintain Bug speed. Bug speed is equivalent to the V_2 speed for 15^{o} flap whereas on a 2 engine overshoot the required speed is Bug(Vref 50) plus 10K which is the equivalent of the V_2 speed.

INSTRUCTOR:

It should be pointed out that if the gear touches the runway the spoilers will extend unless the left throttle is moved to the max.power position. In actual engine out manoeuvres, both throttles should be used once the shut down is completed. This would prevent spoiler extension.

8.3.2. GO-AROUND: (Cont'd)

Common Errors:

1. Forgets to increase thrust on other engine to hold speed and flight path.

2. Rushes into approach, does not stabilise before entering final approach phase.

3. Allows sink rate to vary. Control of the prespective abort lies in the control of sink and airspeed.

4. Forgets to utilise "attitude flying" targets, to control altitude, sink rate on final, and speed on pull-out.

5. Forgets the engine out Vref additive of plus 10K.

6. Does not co-ordinate rudder input with speed and thrust changes, particularly during overshoot.

7. Does not establish "slot" soon enough. Enter the final approach on height and speed.

8. Does not trim out rudder to "unloaded" position on approach then forgets to zero trim prior to touchdown.

9. On pull-out, does not advance throttle to max power. Does not call max. power. Slow with rotation and flap retraction.

10. Under or over-rotates on pull-out. Teach the Target attitude of 16°.

11. Does not co-ordinate thrust, rotation and flap retraction on overshoot.

NOTE: On pull-out, at light weights, the 16° maximum body angle may not control the airspeed at bug value.

8.4. NO FLAP LANDING:

The manoeuvre is performed to familiarise the student with the procedure for landing in the highly remote situation that the flaps or slats cannot be lowered. Two procedures are included - one, slats extended, flaps up. The other both slats and flaps retracted. With flaps and slats retracted the bug is set to Vref 50^{o} plus 50 kt which equals 1.25 Vs. With flaps retracted slats extended the bug is set to Vref 50^{o} plus 30 kt which equals 1.35 Vs. Both result in a body angle of 8^{o} to 9^{o} on an approach slope of approx. 2.5^{o}. As the tail skid will contact at a body angle of approx. 12^{o} on a normal touchdown (10.5^{o} on a hard landing with full strut compression and 50% tyre deflection) sink rate should not exceed 600 FPM (the maximum certificated for touchdown) and the flare should be held to a minimum.

Procedure - Instructor:

Perform this manoeuvre with the gross weight as light as possible in view of required reserves. Inform the student that all hydraulics have failed and combine with manual gear extension. Switch off hydraulic pumps and reduce hydraulic pressure to zero if necessary by actuating the lateral control system (spoilers). Extend the gear with the emergency gear selector. When the gear down position has been verified (depress the switch below the gear selector) place the gear selector down and return the emergency gear selector to the normal position. Restore hydraulic system pressure in order to retract the gear doors normally. DO NOT retract by the emergency method.

Start the go-around when landing is assured. (Min. 30 ft.)

Procedure - Student:

a. Burn off to a gross weight commensurate with circumstances.

b. Set the airspeed bug to (i) flaps and slats retracted - Vref 50^{o} + 50 kt
(ii) flaps up, slats extended - Vref 50^{o} + 30 kt.

c. Slow the aircraft to Bug + 15 kt in the circuit = approx. 1.4 Vs.

d. Manually lower the landing gear in the circuit.

e. On final approach, establish airspeed at bug + additives and maintain this speed until crossing the threshold.

f. From 100 ft. allow speed to bleed to bug + gust factor.

g. In training make simulated low approach and then apply MCT and perform a missed approach. Accelerate to a minimum of Bug + 15 kt.

Discussion:

No flap approaches are performed to give the student practice and feel for speed and lateral control during this situation. It should be understood that this manoeuvre, to be totally feasible, could require loss of left and right hydraulic systems or mechanical malfunction of the flap system. The remoteness of the above failures occurring and the high touchdown speeds limit this manoeuvre to a one-time only air demonstration.

8.4. NO FLAP LANDING: (Cont'd)

The student should be thoroughly briefed on conditions which may lead to a no flap approach and landing. It should also be stressed that runway, weather, and general airport conditions must be closely studied in the event the pilot is faced with the possibility of a no flap landing.

The aircraft is approached slightly flatter than on a normal approach to preclude high sink rates at the flare and to hold engine RPM above bleed valve opening. The pitch attitude is approximately 8° nose up and the pilot may find it helpful to raise his seat a notch to retain the normal perspective from the cockpit. Bug speed should be closely adhered to during the last portion of the approach. Bug + 15K should be used while manoeuvring. The gear should be extended early for speed stabilisation. A long straight in approach from 1000' is recommended in order to obtain speed stability and runway alignment. The desired speed should be established as soon as possible after entering the final approach. Speed deceleration will be slow, and any change of attitude such as lowering the nose, will normally give an increase in speed, sometimes with throttle reduction. Speed can be increased rapidly with thrust application due to the low drag factor. As the aircraft enters ground effect, a slight increase in control effectiveness is noted, especially in the longitudinal axis, for which the student should be cautioned so as to prevent the possibility of over-rotation at the flare.

Speed control during approach is most important particularly approaching touchdown. If speed is high approaching the flare thrust will be reduced early resulting in engine spin down and a longer time to spin up for effective reverse which is a most valuable braking device at the higher speeds associated with the flapless landing. It is extremely important that the aircraft not be held off the ground in an attempt to make a smooth landing as the speeds for this type of manoeuvre will increase the air distances approx. 25% above that which occur for normal landings.

Use optimum braking technique (braking with accumulation press. only) if the flapless landing is associated with loss of all hydraulic pressure. Remember that anti-skid is switched off with loss of left and right hydraulic pressure. The student should be thoroughly briefed on the various factors which must be considered prior to attempting an actual zero flap approach and landing. Such factors should include:

1. Runway available and surface conditions.
2. Runway required. (Refer to Diagram 26 Appendix 2)
3. Plan the landing for the lightest weight commensurate with fuel remaining. (Reserve)
4. Missed approach capabilities. (It may not be possible to raise the gear)

8.5. MINIMUM DISTANCE LANDING:

The purpose of this manoeuvre is to teach the student the correct technique to stop the aircraft in the shortest distance and to show the short stopping capabilities of the aircraft.

The same approach configurations and speeds shall be used for a minimum distance landing as are used for normal landings. The difference in technique is in the use of maximum braking.

Auto spoilers (if armed) operate at touchdown. Immediately after the nose wheel touches on, apply maximum braking and maximum allowable reverse thrust. Maximum braking is obtained when the wheels are just short of the skid point. This is accomplished by the anti-skid system which relieves brake pressure automatically when a skid develops.

If an actual minimum distance landing is required, maintain directional control using rudder steering during maximum braking and reversing.

On practice minimum-distance landings, discontinue the maximum stopping effort as soon as the maximum deceleration characteristics of the aircraft (above 80 kts) have been demonstrated and experienced by the student.

NOTE: Practice minimum distance landings shall normally be the last landing of the period. This will give the brakes time to cool while the aircraft is being serviced.

Discussion:

As a general rule flight training is often conducted on a runway offering no appreciable stopping distance problem. This may be misleading to the student who suddenly is confronted with a minimum runway distance long after he has completed his training. Therefore, the Instructor should apply all possible effort in his briefing and flight training sessions to insure that the student gains an adequate knowledge or preferably experience, associated with the techniques required for maximum deceleration of the aircraft under all known conditions.

Thrust reversers can be used to shorten the stopping distance once the aircraft is on the ground and, thereby shorten the total landing distance. By operating the thrust reversers at published limits during normal operation from touchdown to 60 knots indicated airspeed, significant reductions in landing distance can be achieved.

Normally ingestion of exhaust gases may cause engine surging is excessive reverse thrust is used below 60 knots. The reverse thrust should not exceed 1.2 EPR below 60 knots, above 60 knots max. reverse is authorised, however operationally 1.6 EPR from touchdown to 80 K is recommended. Passing 80 knots reduce to just below 1.2 EPR and maintain until approx. 25 knots when Reverse Idle (1.1 EPR) is set.

Due to the 2-3 second delay before the build-up of full effective reverse thrust, brakes will normally be operating before reverse thrust becomes totally effective.

8.5. MINIMUM DISTANCE LANDING: (Cont'd)

The importance of timing during the use of all means for stopping the aircraft cannot be over-emphasised. As soon as it is definitely known that the main wheels are rolling on the runway, move the RT levers to the interlock, use elevators to bring the nosewheels onto the runway smoothly and hold them there. Apply wheel brakes, and actuate thrust reversers. The spoilers should be checked for proper extension.

The DC-9 anti-skid system offers individual wheel control which affords the maximum degree of braking on wet or icy runways. This configuration is considered optimum as each wheel is regulated to its needs alone and is not influenced by different runway surface conditions which often affect the paired wheel installations. When using this type of anti-skid system the pilot's function is to select and hold a steady brake pedal pressure desired for the particular operation.

Should the pilot not want full or near full system brake pressure, the DC-9 anti-skid system will adapt to whatever metered pressure he chooses. The system provides the most efficient utilisation of the amount of pressure desired by the pilot.

Instructors must emphasise the need for well co-ordinated and early application of brakes and reverse on every landing. It is important to develop the technique as soon as possible and to stress optimum use of brakes and reverse particularly on wet surfaces.

8.6. STOP - REVERSE ONLY (AIRCRAFT ONLY):

The purpose of this manoeuvre is to show the student the deceleration capabilities of the aircraft using only reverse thrust and the limitations of maintaining the directional control by the use of differential reverse thrust.

In order that the student will be familiar with the stopping capabilities of the aircraft on slick runways, at least one landing and roll-out shall be completed using reverse thrust only.

The approach and landing shall be made in the normal manner. The auto spoilers are activated by main wheel spin-up and cause the nose to pitch down. Hold positive pressure on the yoke to give maximum rudder steering capability and use maximum reverse. As soon as the main wheels are on the runway bring reverse levers to the 1 o'clock position and maintain max. reverse thrust reducing as necessary to avoid compressor stall. Then gradually reduce thrust so as to reach idle reverse at taxi speed.

CAUTION

EXTREME OR SUDDEN DIFFERENTIAL THRUST IS TO BE AVOIDED. IT IS EASY TO GET OUT OF PHASE WITH REVERSE THRUST APPLICATION AND NEARLY IMPOSSIBLE TO RESTORE DIRECTIONAL CONTROL USING ONLY REVERSE THRUST.

The reverse only stopping distance (2 eng) is approx. 150% of the 50° flap landing distance requirement.

8.7. TOUCH AND GO LANDING:

These landings are performed in training to help reduce training time and save wear on the brakes and tyres. Touch and go landings should not be performed until the student is comfortable with full stop landings.

Procedure - Instructor:

Advise the student whether reverse thrust is to be used. After touch down place the flap lever in the 15° detent. Check the spoiler handle full forward. Check the stabiliser and the rudder trim to the take-off position and command "go around". Trim desired max. power.

Procedure - Student:

After touchdown use reverse as instructed. Maintain aircraft on center line with rudder and rudder pedal steering. On command advance throttles to desired EPR for take-off and call for "max. power". As thrust increases monitor airspeed and proceed as in normal take-off.

For 2 Eng. V_R = Bug, V_2 = Bug + 10K
For 1 Eng. V_R = Bug - 10K, V_2 = Bug

8.7. TOUCH AND GO LANDING:

Discussion:

Flaps -

The flaps are raised to the 15° to conform with a normal go-around. This is performed first so that the flaps will have more time to be retracting prior to reaching max allowable thrust, thereby reducing the time the take-off warning horn sounds.

It takes approximately 15 secs. for the flaps to retract from 50 to 15.

Thrust -

The throttles are advanced to the vertical position after the flap lever has been positioned to 15°. This allows the engines to accelerate evenly while the flaps are retracting. Then the throttles are advanced to take-off thrust.

It takes approximately 8 seconds for the engines to accelerate from idle to max. allowable thrust.

Spoilers -

The Spoiler Handle will automatically go to the forward (down) position if armed for auto extension. If they do not automatically lower, ensure they are manually lowered.

Stabiliser -

Usually the in-trim position for approach will be good for go-around.

Reverse Thrust -

The student should use reverse thrust as directed. Reverse thrust should not normally be used on runways of less than 6500' to prevent the possibility of any malfunction in the system compromising the ensuing take-off.

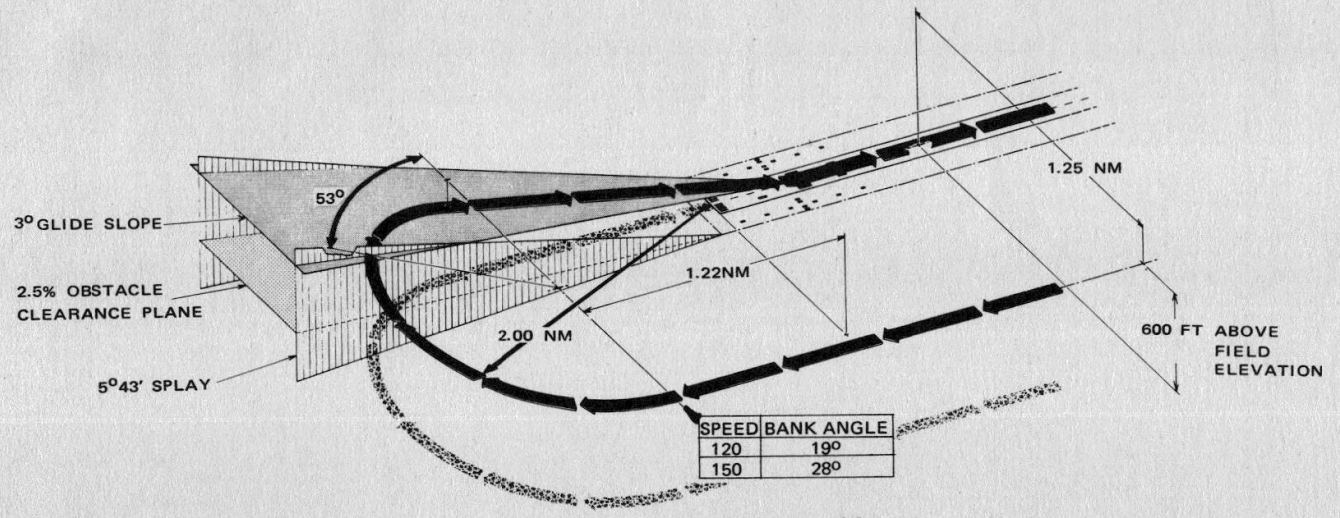
8.8. STOP AND GO LANDINGS:

During training after performing a normal full stop landing a straight ahead takeoff may be performed if 6000' or more of runway is available.

CAUTION

AT HIGH ALTITUDE AIRPORTS OR ON EXTREMELY HOT DAYS, STOP AND GO LANDINGS ARE NOT RECOMMENDED.

Do not raise landing gear after take-off. Allow sufficient time to cool the brakes before gear retraction. Leave extended for a minimum of one circuit.



SPEED	BANK ANGLE
120	19°
150	28°

Diagram 1A

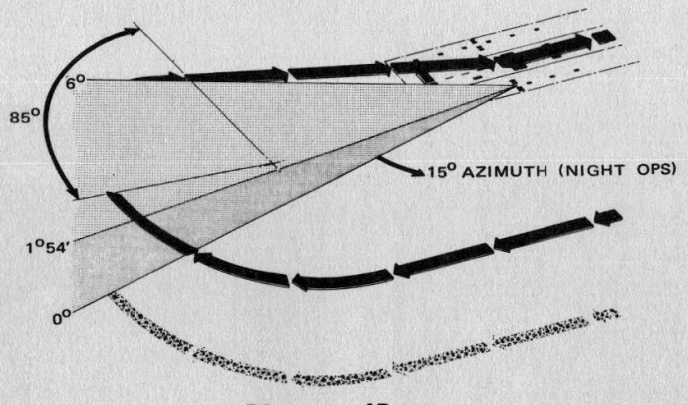


Diagram 1B

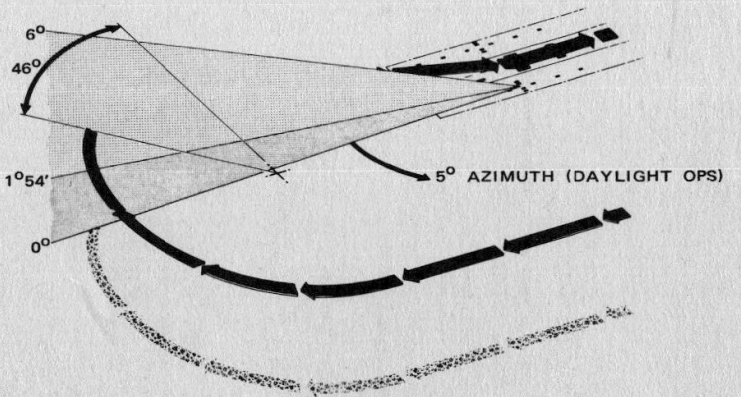


Diagram 1C

B727 – BULLETIN NO. 28 (Section 11 – insert to face page 37)
DC9 – BULLETIN NO. 17 (Insert to face page 87)
L188 BULLETIN NO. 8 (Chapter 7 – insert to face page 23)
F27 – BULLETIN NO. 12 (Insert to face page 35)

MINIMUM WEATHER CIRCUIT

The IAL requirement, when manoeuvring in reduced visibility and cloud base, lays down a minimum obstacle clearance height of 400 ft ~ Day and 600 ft ~ Night. This height must be maintained until aligned with the runway on final approach.

So that the pilot can be assured that the aircraft is within the approach splay, which is aligned with the runway, a diagram has been developed to indicate a typical flight path at 600 ft.

The attached Diagram 1A indicates a circuit at 600 ft, 1.25 NM from the runway, downwind.

After maintaining the downwind heading for approximately 25 seconds at 150 kt or 30 seconds at 120 kt in zero wind conditions, the aircraft will be in a position where a turn through base leg can be commenced.

Normally, a 30° bank turn is utilised (the diagram indicates a bank angle for a rate 1 turn in conditions of zero wind) so that the effects of wind can be minimised and therefore enable a minimum of centreline overshoot to occur if a tail wind exists during the turn.

As the centreline is approached, it can be seen that the aircraft should be safely within the splay around the centreline when the turn heading is within – for DAY operation 30°: for NIGHT operation 45° – of the runway heading.

It is at that point that the pilot may permit the aircraft to follow the 3° slope required for the approach. The angle indicated on the diagram is the precise angle where the edge of the splay is penetrated, assuming that the above conditions exist and therefore a more practical figure of 30° DAY/45° NIGHT is applied.

The two associated diagrams depict the VASIS vertical scale at night (1B ~ 15° usable azimuth) and day (1C ~ 5° usable azimuth) at the point where the lights are first seen. The lower area indicates the three red light 'fly up' indication. The upper area indicates from the three white light 'fly up' to the three white 'fly down' indication.

The 15° night diagram (1B) shows the aircraft at 600 ft first observing white 'fly up' lights and well outside the approach splay. It would be necessary to maintain 600 ft in this particular example until aircraft heading is within 45° of runway heading before commencing descent.

The 5° day diagram (1C) indicates that the VASIS would not be usable until after entering the splay but would be close to 'on slope' indications when first observed. It is, however, recommended that the descent not be initiated from 400 ft until the aircraft heading is within 30° of the runway centreline.

These diagrams are applicable to circling areas based on a two mile arc from the runway ends. Circling areas based on the aerodrome reference points (runways less than 1800m) will require closer manoeuvring as presently laid down.

8.9. MINIMUM WEATHER CIRCUIT:

The circling approach manoeuvre assumes a base of 500 ft. and a visibility of 2 miles. It will be conducted at a height of 400 ft. & $1\frac{1}{2}$ miles from the runway. The aircraft should normally approach the field in the same manner as it would following any instrument approach. Should the initial approach be conducted on the ILS/LOC flap should be set to 25° and retracted to 15° to manoeuvre in the circuit.

Manoeuvring under conditions of low cloud and poor visibility requires close control of speed and height, and smoothness and precision in flying the aircraft. The effect of wind and related drift must be properly assessed to ensure a safe reasonably banked turn onto final approach within the 2 mile limit. Good co-ordination between crew members is essential , particularly in a right hand circuit.

Procedure.

Establish the aircraft in the circuit with 15° flap, gear extended, & checklist completed (except for landing flap) before passing abeam the runway threshold. As the threshold is passed extend 25° flap (2 engines only. Allow for drift downwind and commence the turn on to base 20 seconds (still air) after passing the threshold. Bank initially to the maximum of 30° and concentrate primarily on instruments crosschecking periodically for the position of the runway until the runway can be seen and maintained in view without difficulty. Maintenance of the correct speed on base is essential to prevent overshoot of the center line. As the extension of the $2\frac{3}{4}$° glide path is intercepted (this normally occurs on base leg) extend the landing flap, stabilise the speed to the desired value and continue the turn onto final.

At times higher minimums require descent on down wind leg at 600/800 FPM to arrive at commencement of base leg (20 secs. still air) at 900' approximately. Descent should be continued (if necessary) during the turn to maintain the correct flight path and to ensure normal descent rates during the subsequent final approach through to touchdown.

Landing flap should be selected as the $2\frac{3}{4}$° slope is intercepted during base leg. When the slope is intercepted earlier (e.g. down wind) a maximum of 25° flap is to be used <u>until</u> turning through base.

During the turn from down wind to base leg the pilot should concentrate on maintaining accurate bank airspeed height or vertical speed and should restrict outside scanning to a minimum.

If overflying the runway to join the circuit the timing for turning downwind from a 45°, 60° or 90° intercept of downwind leg can be determined from the associated chart in Appendix 2. Also included is a chart laying out the minimum visibility circuit pattern.

It is essential to keep in trim throughout the procedure particularly when extending landing flap during the turn onto final approach in conditions of poor visibility. If a right hand circuit is being carried out the F/O is required to call passage of the runway and give the Captain advice regarding the progress of the turn and position of the runway until such time as the Captain can see and maintain the runway in view.

8.9. MINIMUM WEATHER CIRCUIT: (Cont'd)

Crosschecking of height and speed is essential in this manoeuvre. As the Captain (with the exception of the right hand circuit) will be concentrating primarily on visual contact the F/O must concentrate on height and speed.

As this type of approach may be conducted under conditions of poor visibility and without glide path information the importance of establishing the aircraft in the normal slot of 2.75° together with the required back up calls from the F/O cannot be overemphasised. Read the DC-9 Operating Manual for specific details of the procedure.

8.10. HIGH SINK RATE LANDING:

Poor landings usually follow poor approaches.

A smooth touchdown can occasionally be made from a poor approach; however, good landings are made consistently from proper approaches. (ILS Glide Slope Angle)

Causes:

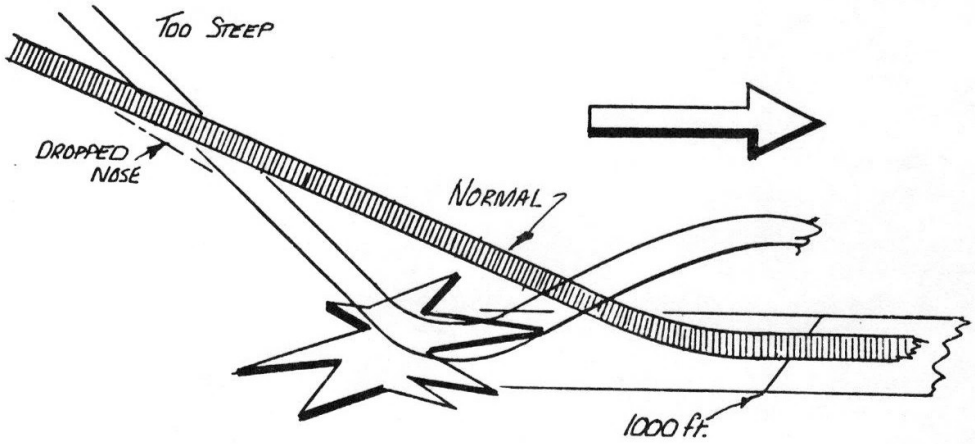
Hard landings are generally made from high approaches at higher than normal sink rates with excessive and/or late rotation. Plan ahead and monitor the approach angle so that steepening the glide path is not necessary. Rapid-rotation under the above conditions increases the "G" loading. At maximum landing weight, the stall speed increases approximately 4 kts for each 1/10 "G". Thus, rapid-rotation will increase the sink rate instead of decreasing it.

Thrust must be added to decrease a high sink rate when holding the proper approach speed (Vref) and using a normal rotation. At rates of sink approaching 2000 feet per minute, nearly take-off thrust may be required during rotation to stop the sink rate while holding the approach speed.

When approaching on a steep glide slope, extra airspeed above Vref must be maintained. This combined with an early and smooth rotation can result in a smooth landing. But this sequence requires very good judgement of both the amount of excess speed and the altitude to start rotation. Any error results in a poor landing. Steep approaches are not permitted.

A normal approach aimed at the 1000 foot mark can result in a hard landing when the pilot unintentionally moves his eyes to the approach end of the runway as he nears the runway or "breaks out" on an instrument approach. Thus the nose is dropped and the rate of sink increases - unnoticed - until too late.

8.10. HIGH SINK RATE LANDING.



Hard landings, but rarely bounced landings, can result from a normal approach and over-rotation with excessive floating (holding the aircraft off).

8.11. HIGH SINK RATE DEMONSTRATION (SIMULATOR AND CAPTAINS ONLY).

This manoeuvre is used to demonstrate the altitude loss which results rounding out from a simulated approach to land with engines set at idle thrust.

SEE BUL No. 14.

8.11 HIGH SINK RATE DEMONSTRATION: (Cont'd)

Procedure: (Student and Instructor)

Altitude	-	6,000' above terrain
Configuration	-	Gear down, 50° flap
Airspeed	-	Vref 50°
Thrust	-	IDLE

The instructor will establish the aircraft in the above configuration and, at an altitude not less than 4000 ft. above terrain, initiate the recovery by applying max. allowable thrust and rotating the aircraft so as to maintain the Vref 50° speed. The student should note the altitude loss during recovery, normally 150 feet. During the descent the rate of sink will stabilise at approximately 1800-2000 FPM and the pitch attitude will be 1½° nose up, both of which should be discussed with the student. Engine acceleration characteristics will have been discussed in the section dealing with take-off but the student must be fully aware that the time required to accelerate the engine from idle to maximum allowable thrust is 8-12 seconds depending on temperature, altitude, length of idle stabilisation, RPM and condition of the fuel control. Very little thrust is developed until the bleed valves have closed and the N1 RPM approaches 65%. Irrespective of the speed with which the throttle is opened thrust response will not exceed the rate scheduled by the fuel controller.

To preclude operation of the aircraft in a high sink rate condition during final descent and approach the following rules must be observed.

a. Below 1500 ft. above the terrain maximum descent rate at any time is 1000 fpm.

b. Below 1500 ft. above the terrain any time flap is at 25° the engines must be spun up to at least bleed valve closure.

c. At any time landing flap (25° or 50°) is extended in normal operations, regardless of altitudes, engines must be spun up to bleed valve closure.

d. Specific speed and sink calls are listed in the DC-9 Operating Manual. These must be called by the monitoring pilot.

BULLETIN NO. 14
(Insert to face page 88b)

NOTE: THIS BULLETIN SUPERSEDES BULLETIN NO. 13 WHICH SHOULD BE REMOVED AND DESTROYED. The Record of Bulletins sheet is to be updated accordingly.

After discussions with D.O.T. it has been agreed that the High Sink Rate exercise is to be demonstrated to each pilot (Captain and First Officer) by the Check Captain during simulator conversion.
Only the exercise with the engines at idle is to be demonstrated and only one demonstation is required for each two students.
Following this each student Captain is to carry out the two exercises listed. It is not necessary for a First Officer to fly the exercises.
The High Sink Rate exercise is no longer a requirement in the aircraft.
The following replaces the entire text of paragraph 8.11 on pages 88a and 88b.

8.11 HIGH SINK RATE (SIMULATOR)

(1) This exercise highlights the dangerous sink rate that would develop if an approach to land were made at idle thrust.

(2) The factors to be stressed are:
- (a) The high sink rate at idle, compared with a normal approach.
- (b) The time lag in recovering full power from idle thrust.
- (c) The loss of altitude during recovery.

(3) Procedure.
- (a) Commence the exercise at 6000 ft. With the aircraft in the landing configuration, establish level flight at V_{REF}. Select idle thrust and maintain V_{REF} speed. (Note the body angle required to maintain V_{REF} and sink rate stabilises at approximately 2000 fpm). At 4000 ft apply maximum permissible thrust and recover to level flight. As soon as height loss ceases, operate the "Problem Freeze" switch. With the applicable parameters frozen, point out to the student the height lost (approx. 150 ft), the time for engine spin up to full power and the body angle attained to maintain V_{REF}.
- (b) Emphasise that if an approach were made at idle power, flare would have to be commenced at 150 ft and maximum power would need to be applied to recover. This is obviously an impossible situation, and an approach of this type would NEVER be made.
- (c) Repeat the exercise but with the engines at minimum spin up (approx. 55% N_1). Point out the considerably reduced sink rate, how much quicker full power is achieved, and the relatively small loss of height before recovering level flight compared with the previous case.
- (d) In the DC9, it is very easy for a sink rate to develop unnoticed. Together with the slow spin up of the engines, this can create a hazardous condition if a pilot is not fully aware of the potential problem. To safeguard against a high sink rate developing near the ground, the following conditions apply at all times:
  - (i) Below 1500 ft above terrain, maximum descent rate at any time is 1000 fpm.
  - (ii) Below 1500 ft above terrain, any time flap is at 25^{o} the engines must be spun up at least to bleed valve closure.
  - (iii) At any time landing flap (25^{o} or 50^{o}) is extended in normal operations, regardless of altitude, engines must be spun up at least to bleed valve closure.

BULLETIN NO. 4

(Insert to follow page 88a)

LOW LEVEL WIND SHEAR

The low level wind shear which causes difficulties for aircraft taking off or landing is due to vertical or horizontal variations of wind and to turbulence. Its potential as an accident cause is greater today because of the weight of the aircraft being flown.

Wind shear is expressed in Knots per Hundred Feet altitude. If a 20 kt headwind at 100 ft dropped to 10 kt at the surface, it would be termed as a 10 kt shear. Also, if a 10 kt cross-wind at 100 ft swings to 10 kt headwind or 10 kt tail-wind at the surface, it would also be a 10 kt shear.

Vertical shear is the change between levels of the average wind direction and wind speed and will exist as low as ground level. Shear up to 5 kt each 100 kt can be expected frequently.

Most cases of vertical wind shear exceeding 5 kt each 100 ft of altitude occur in stable atmospheric conditions associated with a night time inversion.

This mostly occurs during summer evenings when the ground wind has dropped through cooling but the overriding stream winds remain unaffected. Shear in excess of 10 kt per 100 ft can be expected in these conditions but normally occurs at heights above 200 ft. The surface wind given to pilots is usually light in these circumstances and there are no external visual clues to detect the condition.

Wind shear associated with strong gusty winds can be significantly greater than that associated with an inversion.

The gust front of approaching fronts and thunderstorms can cause extreme changes in wind speed and direction at different levels and is of significance on both take-off and approach.

Horizontal shear is caused by wind deflection from terrain or obstructions such as hangers. This can be experienced as low as the flare height. An example is the approach to Runway 25 at Sydney ariport in a moderate wind from the NW.

The momentum of a large aircraft will cause it to gain or lose airspeed and lift, whenever wind changes occur, in less time than it takes for the speed of the aircraft to be adjusted to the new wind condition.

There are two basic shear conditions to consider. In one the effective airflow over the wing is increased during the transition period between changing wind conditions. It is decreased in the other.

Effective airflow is increased in any shear condition of increasing head wind or decreasing tail wind. If you are on glide path with a stabilized approach, this increased effective airflow over the wing will cause at least two things to happen:

(1) The airspeed will increase
(2) The aircraft will go above the glide path.

If this happens, suspect low-level wind shear. If it happens under any of the meteorological conditions mentioned above, you can be virtually certain of it. While the causes are quite different, the aircraft acts very much as it would in an ordinary updraft.

The reverse is true if you encounter a condition of decreasing head wind or increasing tail wind. During the transition period, the effective airflow over the wing decreases. Again, at least two things will happen, but this time:

(1) Airspeed will decrease.
(2) The aircraft will go below the glide slope.

In this case, the aircraft reacts very much like it would in a downdraft.

The N.T.S.B. in its report on the DC10 accident at Boston on Dec. 17/73, described the effect of wind shear as follows:

"The Wind Shear Phenomenon

When encountering a wind shear on final approach, the pilot or auto-pilot must make co-ordinated pitch attitude, thrust, and heading changes to minimize deviations from the optimum flight path and airspeed. The direction and extent of the deviations will depend on the characteristics of the shear and the response of the flight control system.

During a precision instrument approach through a wind shear characterised by a diminishing tailwind, the higher-than-normal ground speed produced by the initially stable tailwind necessitates a higher-than-normal rate of descent for the aircraft to remain on the glide slope. Under these conditions a lower pitch attitude and less thrust are required than would be required during the more common no wind or headwind approach. As the descent continues, the effect of the shear induced by a rapid decrease in the tailwind component is a rapid increase in the velocity of the aircraft relative to the air mass in which it is moving. The increased velocity causes the indicated airspeed to rise, and the resultant increase in lift causes the aircraft to rise above the glide slope. Both pitch attitude and thrust must be decreased further to limit deviations from the glide slope and the target airspeed. As the tailwind continues to diminish, or becomes an increasing headwind, re-adjustments of pitch attitude and thrust must be made continuously. Ideally, the attitude and thrust, at any instant, should be that required to decelerate the aircraft at a rate equal to the rate of change of the longitudinal wind component, while

establishing a rate of descent compatible with the instantaneous ground speed and the glide slope angle. After passing through the wind shear and into a wind with a constant longitudinal component, the aircraft will descend below the glide slope, because of the continuous deceleration and resultant loss of lift. Prompt pitch control changes and throttle corrections are required to prevent an increase in the rate of descent. In addition to attitude and thrust changes, heading corrections are required to minimize deviations from the localizer course that are caused by the diminishing speed of the crosswind component.

The hazard presented by a diminishing tailwind type shear on final approach is the continuous need for pitch attitude changes and reductions to thrust. If the shear persists to a low altitude, the aircraft can be placed in a high rate of descent, thrust-deficient condition close to the ground."

To correct this decreasing tail wind shear condition of low speed, low thrust and low body angle it may be necessary to make coarse body angle increases and rapid thrust application to prevent an excessive undershoot.

A decreasing headwind or increasing tailwind encountered during the approach will call for an increased thrust level and decreased rate of descent. If the headwind shears out at low altitude, the thrust will initially have to be increased but will very quickly have to be decreased to maintain speed. If there is insufficient time to decrease thrust an excessive speed increase will occur.

It is of importance, therefore, to have a good understanding of the conditions that create instability on final approach. It is also necessary to anticipate the aircraft response, thrust requirements and aircraft attitudes needed to maintain the normal approach slope in the varying shear conditions.

Shear Recognition

During the approach, the thrust required and vertical speed are the most important and easily recognised parameters associated with the wind shear phenomenon.

Pilots should initially be prepared by noting the ground wind and relating it to the wind estimated to exist below 2000 ft on final approach.

If a more precise wind component is desired it can be assessed by noting the stabilised vertical speed when maintaining the approach speed required to hold a 3° slope and use of the following table to obtain actual ground speed:-

Vertical Speed (fpm)	Ground Speed (kt)
400	75
500	95
600	115
700	130
800	150
900	170
1000	190

Comparison with the IAS and ground speed will indicate the degree of H/W or T/W existing.

For example, if a normal thrust for the AUW is applied, IAS is 130 kt, ROD is 700 fpm and body angle normal, indications are that a zero wind exists.

Where ROD is 800 fpm and thrust is reduced to maintain the same speed, and body angle is low to maintain the slope, a tail wind condition is indicated and shear can be assessed in relation to the ground wind.

Approaches to many runways are known to have shear conditions frequently because of the local terrain etc. Pilots should become familiar with the airports concerned and continually assess the wind during the final approach so that the affect of shear is not unexpected.

Some examples of runway approaches particularly affected are:-

(1) Perth Runway 20 and 24 - when airflow from an easterly direction overlays a calm or sea breeze condition at the airport.

(2) Adelaide Runway 30 and 23 - light easterly winds from the hills on approach when calm or sea breeze conditions exist on the runway.

(3) Sydney Runway 07 - a westerly wind to 150-100 ft translating to a northerly/NE sea breeze or to a south easterly.

(4) Alice Springs Runway 30 - calm on the ground with an overriding SE stream.

Approach Speed

Approach speed additives should be re-assessed when a shear condition causing an increase in speed and decrease in thrust requirements is recognised and is anticipated below 500 ft. Speed should be allowed to increase to a maximum of 15 kt depending on the shear assessment.

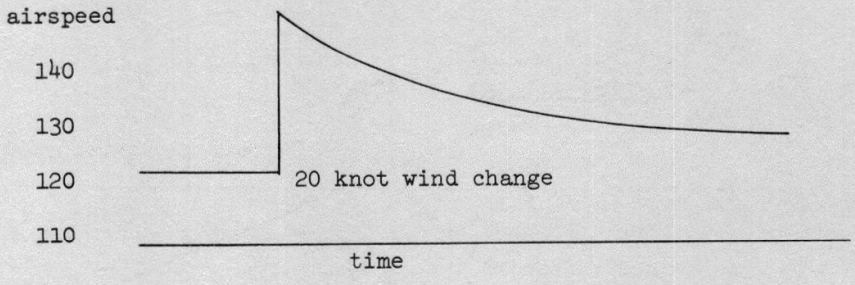
For example, if vertical speed is 800 fpm when holding a 3° slope at 130 kt IAS a tail wind of approx. 20 kt is indicated. An additive of 10 kt is therefore recommended above the bug speed to offset the speed loss that will occur when through the wind shear.

Once through the shear the speed should be allowed to bleed off to the original approach speed. Prompt thrust handling is necessary when this type of shear extends to the runway to avoid use of excessive landing runs.

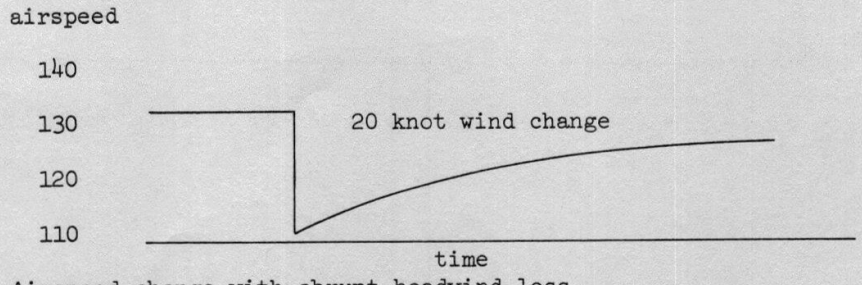
An additive is not required for shear where speed decreases and higher than normal thrust is required to maintain a low vertical speed. The normal additive for the ground wind is sufficient because of the low vertical speed and the possibility of penetrating the shear, gaining excessive airspeed and over-flying the slide slope during late final approach.

For proper co-ordination in the cockpit it is necessary for the Captain to advise anytime speed is to be varied from that initially stated. This will then permit normal back-up calls to be given by the supporting pilot. Once through the shear and the speed is being reduced to permit flare and touch down in the normal area the original approach speed should again be advised.

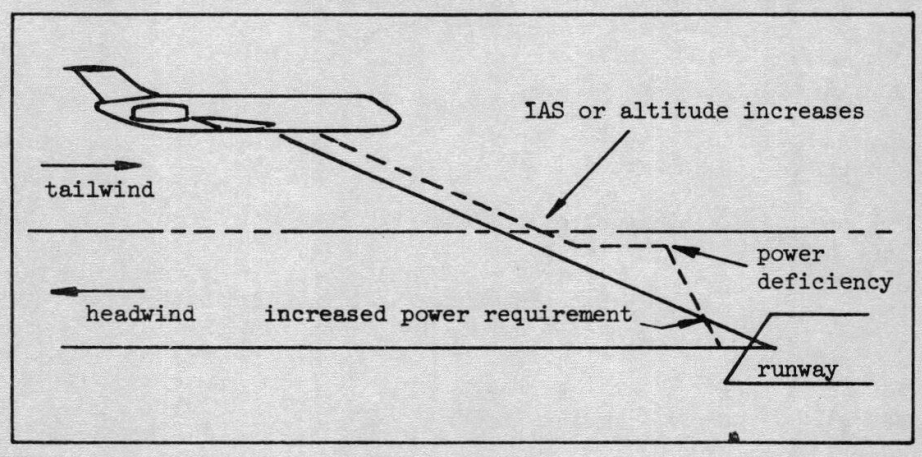
The following illustrations, show the effect on airspeed of abrupt low-level wind shears and of their effect on approach profiles.



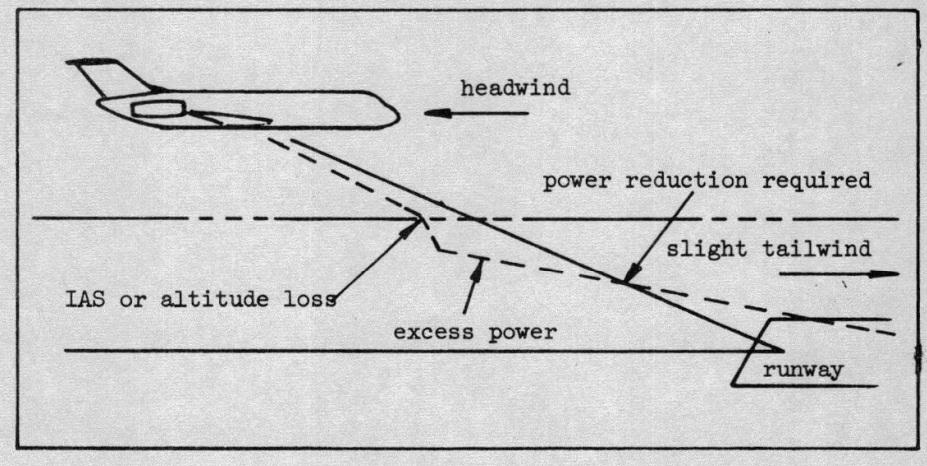
Airspeed change with abrupt headwind increase.



Airspeed change with abrupt headwind loss.



Approach profile with tailwinds shearing out to a headwind condition.



Approach profile with headwind shearing out to a slight tailwind.

AUTO THROTTLE OPERATION IN CONDITIONS OF LOW LEVEL WIND SHEAR

A continuing review of flight recorder data obtained from aircraft that have experienced a hard or short landing as a result of encountering a low level wind shear indicates a need to further evaluate operational procedures for the use of autothrottle systems.

Actual inflight data, as well as data accumulated during flight simulator experimentation on the factors associated with low level wind shear, appear to substantiate the possibility that the autothrottle system when used during a manual approach can mask a prominent clue that the flight is encountering a tail-to-headwind-type shear, i.e., lower thrust than normally required during approach in the appropriate configuration. As the tail-to-headwind shear condition is encountered, it generally produces a ballooning effect to an above glideslope position, necessitating a thrust reduction as the aircraft is pitched down to regain the glideslope. If the autothrottles are engaged, the system may reduce engine thrust to near idle values depending on the severity of the shear. Although the pilot may position his hands on the throttles during the approach, a slow automatic reduction of thrust may go undetected; particularly when the pilot is concentrating on recapturing the glideslope or is attempting to restabilize the approach.

Use of autothrottles in this manner under these conditions partially removes the pilot "from the loop". If he does not manually monitor the throttles during the approach, he becomes completely removed "from the Loop". However, in either case the end result can, in many shear conditions, predictably be cause for the aircraft to assume a higher than normal descent rate. This is generally followed with an associated decrease in airspeed as the pilot increases the pitch attitude to correct for an excessive sink rate. The inherent lag in acquiring sufficient thrust from a near idle setting to arrest the sink rate and accelerate the aircraft at low altitude is characteristic of the causal factors associated with a hard or short landing.

Taking the foregoing date and examples under consideration, Douglas Flight Operations recommends that operators review their respective training and operational procedures to ensure that the flight crews do not allow the autothrottles to program an excessive thrust reduction during the landing approach manouever whenever low level wind shear is forecast, anticipated or encountered.

BULLETIN NO. 10

(Insert to follow page 88b, adjacent to Bulletin No. 4)

WINDSHEAR AT DARWIN

The following B747 report is published as an alert to this condition at Darwin:–

A classic case of windshear was experienced during the approach and landing on R/W 11 at Darwin and I am reporting it in the hope it may be of interest to those collating information on this subject.

ATIS "A" 160/05–10 Cavok $16^{o}C$ 1014
Tower reported wind when we were at 2000 ft as 110/10 kt

On final at 2000 ft, the head wind component by INS was exactly 30 kt. The landing weight was 215000 kg with a V_{REF} of 129 kt. The IAS was reduced from 180 kt to 155 kt as the aircraft was configured for the landing. Coincident with the flaps 30 selection at 1000 ft, thrust was applied to obtain the target speed of 149 kt as it was observed that the headwind was still 110/10 kt. Maximum increment of 20 kt was applied and maintained during the approach. At 200 ft, the headwind component reduced to 25 kt and remained at that figure until the threshold when there was a rapid reduction to 10 kt on touchdown. The speed bled precisely according to theory and on touchdown, was V_{REF} + 3 i.e., 2 kt below the Command Airspeed Bug setting. Control response during the flare was normal, and the touchdown smooth.

The aircraft was fitted with 3 M IX INS's, which assisted greatly in the approach.

Comment:

After landing, tower advised that there is an Air Force Notam advising of the possibility of a strong shear in just such met. conditions on that runway, i.e., a south–easterly wind backing to easterly, but D.O.T. do not provide this NOTAM. It is my opinion that a permanent Notam should be raised by D.O.T. to provide warning of the possibility of shear, as not all aircraft have our sophisticated navigation systems with the redundancy of information implicit.

In consequence, the item below is added to the list of examples of runway approaches particularly affected (Page 4 of Bulletin No. 4):

(5) Darwin Runway 11 – Strong south–easterly wind backing to a light easterly from 200 ft through to touchdown.

8.12. ILLUSIONS IN THE APPROACH TO LAND

The approach phase of flight is particularly susceptible to sensory illusion, yet the pilot may not even realise that he is experiencing it. Illusory effects should be anticipated and guarded against as discussed in the subsequent paragraphs.

Visibility Restrictions

You will appear to be higher than you actually are in conditions of darkness, haze, smoke and glare. It must be remembered that shadows aid depth perception; when they are missing, due to visibility restriction, altitude is interpreted by the senses as being higher because shadows are not discerned. The effect is most pronounced during dark-night landings or when haze or smoke layers lay low across the threshold. Under these conditions, straight-in VFR approaches may cause the pilot greater illusory effects than from approaches conducted from a downwind-base leg entry.

To counteract these effects, a precision glidepath rate of descent should be maintained to touchdown. A proper use of altitude callout procedures and altimeter cross-checking will assist the pilot in offsetting the illusory effect.

Runway Characteristics-Lighting, Slope, Dimensions, Contrast

If runway lights are dim, the pilot can expect to appear higher and farther from the runway than actual. On straight-in clear-night approaches, one may appear to be closer than actual. The illusion is that bright lights or bold colours advance, and that dim or dull ones recede. The effect is most pronounced in cold-clear air or approaching over an unlighted (desert or water) surface. Absence of approach-zone lighting increases the exposure to illusion.

To counteract these characteristics, the pilot should familiarise himself with the type of lighting and follow the published instrument or visual approach procedures. The precision glidepath should be used when available. Increased attention to cockpit instrumentation and regular callouts of deviations from the proper glidepath greatly negate any illusory effects.

The aircraft will seem to be higher than it actually is if the approach zone terrain slopes upward toward the threshold. Conversely, if the approach zone terrain slopes downward, the normal glidepath will seem too flat, or the aircraft will appear to be lower than actual. The exposure to hazard from this sloping threshold terrain illusion may be amplified by the far runway end terrain or a desire to touch down near the approach end. Correcting for the illusion of the upward sloping terrain can result in an undershoot. Moreover, runway slope tends to create an illusory effect since we inherently assess our approach path in relation to the normal ILS or VASIS path. With an upslope condition, the glidepath appears steeper, causing a tendency to fly a low approach. On the other hand, with a downslope condition, the glidepath appears to be lower, causing a tendency to fly a steep approach.

To counteract such conditions, you should familiarise yourself with runway-slope characteristics during flight planning. A precision glidepath should

be followed to touchdown even though you are familiar with the runway.

Relative runway dimensions may affect the senses during approach because we relate to a normal or expected scene. On a shorter runway, with identical proportions (length-to-width), the tendency is to judge the aircraft to be farther out and, therefore, higher than normal. It is preferable to determine the runway proportion by viewing it down the centreline and obtaining a proper perspective, rather than from an oblique angle which would possibly cause distortion.

Lack of runway contrast with surrounding terrain presents an illusion which affects depth perception. Extreme examples are a snow-covered runway, a night landing on a dimly lit runway, or any lack of colour contrast. As previously discussed, visibility restrictions also reduce the runway/terrain contrast, all of which can add up to an undershoot or overshoot.

Under the above runway/terrain contrast conditions, you should exercise caution and be prepared to go around. A precision approach, if available, should be utilised to minimise the effect.

Everyone has expectations (or motivations) which influence the correlation of what he sees. This human characteristic can result in an expectant attitude so pronounced as to cause a person to see something wrong, but to take it at face value for what he wanted or expected to see. Such an attitude must be kept out of the cockpit. Yet, we have read of illusory cases of time and marker beacon passage which did not agree with actual position, and of actual landings at wrong airports.

Fatigue can also affect proper responses to stimuli. A tired individual is prone to overlook or disregard indications that require a response. This can be a subtle incapacitation. It is also known that the eyes experience a sort of fatigue where a constant (steady) stimulus can reduce an individual's perceptive ability to virtually zero. In other words, the eyes have recorded a phenomenon so long that the individual can be almost blind to a need for action.

In addition to poor visibility, there is a refraction error in vision while flying in rain which causes the eye to indicate a horizon below the true horizon. The error, including effect of reduced transparency of the windshield, may cause objects to appear lower than they are by as much as 5^{o} or 200 ft at 1 mile.

The flight crew should use altimeter cross checks and altitude callout procedures because this phenomenon presents the greatest hazard on final approach after breaking out at the base of a ceiling.

<u>False Horizon</u>

An insidious illusion can be expected on dark nights when surface lights are not visible, and a steady light comes into view suddenly. The light can dominate a pilot's vision and appear to be a star or planet, particularly if he has just broken into the clear. If the light is forward of the aircraft, a pilot may have an overwhelming visual sensation that the light is above the horizon, and that the nose of the aircraft should be pointed below the light.

An uncomfortable illusion of climbing has been experienced by pilots under this situation even though they continued to fly a straight and level course.

Fully automated approaches and landings will, some day, be routine, but until that time the foregoing conditions must be expected and guarded against, even in the flight planning stage.

Flight crews should exercise extra vigilance with the compounded illusory potential of the 'black hole' approach, such as over water or unlighted terrain toward well-lighted airports. It is emphasised that illusions and their effects can be minimised by procedural use of cockpit instrumentation and by awareness of the special problems associated with such approaches. Precision ILS or VASIS approach should be used whenever possible. When conducting approaches to non-instrumented runways (non ILS or VASIS), a 3^{o} flight path can be fairly accurately flown by use of DME when it is at a usable location on the airport, and correction is made for its position in relation to the threshold. Altitude for the approximately 3^{o} flight path angle can then be monitored by a 'rule of thumb' method of figuring - 3 times the distance times 100, i.e., Altitude (ft) = Distance (NM) x (3) (100). Here are some examples: 300 ft = 1 NM; 600 ft = 2 NM; 900 ft = 3 NM; 1200 ft = 4 NM; and 1500 ft = 5 NM.

Conclusions

The common defences against the perceptual threats are equally effective for approach-landing or altitude-related accident prevention. They are:

(a) Increased use of cockpit instrumentation and of altitude warning or alert systems

(b) Establishment of a precision approach flight path to touchdown from airborne and ground aids which are available

(c) Emphasis on crew co-ordination and discipline.

Since the eyes, however, remain the predominant sense which provides the link between the aircraft and its environment, illusions must always be expected as a part of flying. Unless counteracted, the sensory illusion may initiate a sequence which could result in an accident.

9. EMERGENCY AND ABNORMAL PROCEDURES:

9.1. CARGO COMPARTMENT FIRE:

Discuss cargo compartment fire with student. He should be aware that the compartments are class "D" which required no fire extinguishing/ detection system because of the restricted circulation allowed within the compartment.

9.2. SMOKE REMOVAL (SIMULATOR OR STATIC AIRCRAFT ONLY):

The smoke removal procedure should be thoroughly discussed using the emergency check list amplification as a guide. The student should be required to put on the supplemental mask and goggles and be familiar with their use.

9.3. COMPASS FAILURE:

Compass failure will be simulated by pulling a circuit breaker. The student should be able to recognise the failure, take the proper corrective action and have an understanding of the system.

9.4. HORIZON FAILURE - #1:

Horizon failures will be given by pulling a circuit breaker. The student will be judged on his ability to quickly recognise the failure. Refer initially to the standby horizon then switch the Captain's horizon to the First Officer's instrument.

9.5. VOR/ADF FAILURE:

The student shall have an understanding of the VOR and glide slope systems and instrumentation. Frequently during transition, the instructor will fail the VOR or Glide Slope receiver while the student is executing a holding procedure or an instrument final approach. He should be proficient in recognising the failure and in taking proper corrective action.

9.6. ENGINE FIRE:

The student shall be given several simulated engine fires. He will be required to know the phase 1 items and comply with the procedures outlined in theemergency check list and emergency check list amplification.

9.7. ELECTRICAL FIRE OR SMOKE (SIMULATOR OR AIRCRAFT):

The electrical fire or smoke procedure should be conducted when possible in the simulator. In the aircraft it should be conducted on the tarmac at the termination of flying and with the APU generator operative.

9.7. ELECTRICAL FIRE: (Cont'd)

Phase 1 and sufficient Phase 2 of the drill should be completed to ensure a proper understanding of the drill. Thorough discussion of the drill should precede actual conduct in the simulator or aircraft.

9.8. HYDRAULIC SYSTEM INOPERATIVE:

A complete discussion of the hydraulic system and its possible malfunctions shall take place between instructor and student. The emergency check list and its amplification shall be reviewed and understood. Hydraulic system failures should be used as a lead into manual gear extension and no flap approach.

9.9. ANTI-ICE AND BLEED AIR EMERGENCY:

The anti-ice and bleed air system shall be thoroughly reviewed. The student shall know the corrective action to be taken in the event of a malfunction of any part of these systems.

9.10. EMERGENCY AND ALTERNATE GEAR EXTENSION PROCEDURES:

Completely discuss how the alternate hydraulic system is tied into the landing gear operation. Point out how this system is affected electrically. This will be accomplished in the air. A gear extension will be made using the emergency gear release. Do not retract the doors electrically on the aircraft.

NOTE: In the event of a malfunction of the normal landing gear extension system, the function of the emergency landing gear extension lever is to mechanically release the main gear door latches, nose gear overcentre lock and place the gear hydraulic system in a bypass condition, thus allowing the gear to free-fall and lock into the safe landing position.
Analysis of system tolerances and operation in service has shown that the emergency landing gear extension lever operating forces may be unexpectedly high (approximately 45 kg). The handle and associated components, however, have been designed to withstand operating forces required to actuate a system that is rigged within tolerances. In the event that it becomes necessary to extend the landing gear with emergency landing gear extension lever, the force required may be more than expected.

9.11. APU AIRSTART:

The student shall be required to demonstrate his ability to accomplish an in-flight APU start with at least one normal AC bus powered.
Discuss windmill start requirements and technique.

ANSETT
AIRLINES OF AUSTRALIA

DOUGLAS DC9 FLIGHT STUDY GUIDE

SECTION 10 – FLIGHT PLANNING AND CRUISE CONTROL

1. GENERAL

This section is intended to provide the necessary information for the training of pilots in the use of the flight planning information contained in the Company DC9 Operating Manual, the McDonnell Douglas (DACO) Performance Manual and Flight Planning Folders at ATC centres.

Specimen pages have been extracted from the Company Manual, the DACO Performance Manual and Flight Planning Folders so that all aspects of the subject may be readily available for study.

Explanatory notes have been added to highlight certain areas and to provide background information and, in some cases, working examples are included.

All performance figures quoted in these notes are to the nearest minute, knot, nautical mile, degree etc. Fuel figures are quoted to the nearest 10 lb and NM/1000 lb to the nearest 0.1.

2. FUEL POLICY

A. The policy includes the methods of calculating the required fuel for any flight including alternate and holding fuel, fixed and variable reserves.

B. On all flights when there is no payload limitation, except those into Sydney airport, it is Company Policy to carry a variable reserve plus a fixed reserve of 60 min. at the approved rate. On flights into Sydney, the fixed reserve is increased to 75 min. at the approved rate.

C. The increased fixed reserve at Sydney caters for delayed approaches due to traffic congestion etc.

D. As the mandatory reserve of 10% plus 45 min at the approved rate will cover both asymmetric and F/L 130 depressurised Critical Point fuel requirements, carriage of the above reserves will provide a margin for unforeseen circumstances, such as missed approach etc.

E. Contingency fuel should be carried also for some airports as specified in the operating manual.

F. In order to minimise fuel costs, additional fuel should be carried on occasions in accordance with the Operating Manual, General Operating Procedures, 'Fuel Transporting.'

G. Flight planning and payload considerations require that crew members, and Captains in particular, have a good knowledge of the various methods of planning and cruise control. A good knowledge is necessary so that:

(1) Decisions as to the method of cruise control, selection of alternates, holding or other options can be made quickly.

(2) The flight plan can be completed accurately and in the minimum of time.

H. It is expected that the available methods of planning and cruise control will be exploited in order to satisfactorily complete a flight including use of Long Range Cruise (LRC), cruise altitude diversion to alternate and "in flight" replanning, including update of the Point of No Return (PNR).

Flight planning and cruise control (continued)

J. Whilst it is expected that Captains will plan and operate with minimum fuel loads to accommodate payload or adopt max. range techniques if fuel is marginal, it is the Captain's prerogative, having regard to the various factors involved, to carry such fuel as is considered necessary for the safe and efficient conduct of the flight.

K. Definitions

(1) Start-up and Initial Taxi: An allowance to cover fuel required for engine start and the initial taxi to the brake release point.

(2) Take-off and Set Heading: An allowance to cover fuel required for take-off, clean-up, and two engine climb to set-heading over the departure point at 1500 feet above the aerodrome level.

(3) Flight Fuel: The fuel for flight from over departure point to over the destination.

(4) Final Manoeuvre: An allowance to cover fuel required for manoeuvring from 1500 ft. over the destination to completion of the landing roll.

(5) Final Taxi: An allowance to cover fuel required for taxi from the end of the landing roll to engines stopped at the parking position.

(6) Block Fuel: The total fuel burn-off during the flight. It includes flight fuel and taxi and manoeuvre allowances.

(7) Alternate Fuel: The fuel required for flight from over the destination to over the top of the alternate.

(8) Holding Fuel: The fuel provided for planned holding at the destination.

(9) Variable Reserve: A percentage added to block fuel to cover unplanned contingencies encountered during the flight.

(10) Fixed Reserve: A fixed amount of fuel to provide for delays between arrival over, and landing at the destination.

(11) Margin Fuel: All fuel in excess of planned burn-off plus reserves. Margin fuel is calculated at normal cruise consumption rate.

(12) Pre-Flight Requirements:

(a) An aircraft shall not depart unless the following fuel is carried, i.e. the combined total of:

(i) Start-up and Initial Taxi

(ii) Take-off and Set Heading

(iii) Flight Fuel

(iv) Final Manoeuvre Allowance

(v) Alternate Fuel (if required)

(vi) Variable Reserve

(vii) Fixed Reserve

(viii) Holding Fuel (if required)

(ix) Contingency Fuel (if required)

(b) If, for any reason, the above requirements cannot be met, the aircraft may depart providing sufficient fuel is uplifted to permit the flight to proceed to a selected point en-route or a Point of No Return (PNR). Fuel requirements can then be re-assessed to determine if:

(i) the flight may be continued to destination

(ii) the flight may proceed to another suitable airfield

(iii) the flight may return to departure airfield

with mandatory reserves of fuel.

(c) The PNR may be based on the departure point or a suitable en-route alternate if one is available, e.g. on a flight from BN to TL, the PNR could be based on return to RK if it were suitable.

(d) The PNR should be updated during flight having regard to the actual fuel remaining and changes in wind components and weather conditions. Calculations should be based on observed rates of fuel consumption in conjunction with wind components derived from a comparison of the forecast components and those actually encountered.

3. FLIGHT PLANNING METHODS

A. Flight Planning Tabulations

(1) Tabulations currently in use for DC9 operations are based on DACO performance data processed by the Company IBM computer. These tabulations appear in two forms [see (2) and (3) following].

(2) Specific Planning Tables

(a) Standard Flight Planning Tables prepared by the Company (in agreement with T.A.A. and D.O.T.) and published by D.O.T. at major ATC centres. These tables cover M.76 operations on all regular DC9 routes.

(Continued on next page)

(b) Pre–computed Flight Planning Tables prepared and published by the Company to cover additional routes not included in the Standard Flight Planning Tables. These tables cover operations on route sectors such as:

LT – CG – LT	ML – AS – ML	CS – AS – CS
HB – CG – HB	SY – AS – SY	

(3) General Planning Tables

In addition to the specific pre–computed tabulations, General planning Tables for M.76 and LRC covering stage lengths to 1600 nm at increments of 50 nm and wind components from –120 kt to +120 kt are provided for those flights for which specific pre–computed planning is not available.

B. Standard Flight Planning Tables

(1) These tables are grouped under two temperature conditions:

(a) All routes south of BN are calculated at ISA +10°C conditions.

(b) All routes north of BN are calculated at ISA +15°C conditions.

(2) Wind component brackets for increments of 40 kt are listed from maximum headwind of 180 kt to maximum tailwind of 180 kt.

(3) Flight time and fuel burn–off figures are calculated for the mid–component in each bracket, e.g.,

bracket –180/–141 is based on headwind 160 kt
bracket –140/–101 is based on headwind 120 kt
bracket –100/–61 is based on headwind 80 kt

(4) Each bracket of components is identified by a route designator (e.g. D2SM meaning the second bracket of components on the SY – ML route for DC9 aircraft).

(5) Calculations for each route are based on a normal flight level for the stage distance and aircraft brake release weight is derived from selected zero fuel weight plus total fuel required (i.e. block burn–off plus 10% plus 60 min).

(6) Time intervals listed are from set heading at departure to over–top at destination and do not include air or ground manoeuvre time.

(7) Fuel figures include burn–off on climb, cruise and descent plus initial taxi allowance (200 lb), initial manoeuvre allowance (500 lb) and final manoeuvre allowance (400 lb), but do not include final taxi allowance (200 lb). When fuel is uplifted for more than one flight stage, provision of fuel for final taxi at intransit ports should be considered.

Flight planning and cruise control (continued)

(8) ATC nominates the route designator applicable for each forecast period and this helps to produce flight plans common to all DC9 operations over a particular route.

Example:

Route: SY – BN, Temp. ISA + 10, Wind Comp. T/W 40 kt.
Flight Plan Designator D4SB. Total Fuel 12500 lb.
Fuel required:

Destination	56 min	6600 lb
Variable Reserve (10%)	6 min	700 lb
Fixed Reserve (at 5200 lb/hr)	45 min	3900 lb
Margin (at 6000 lb/hr)	13 min	1300 lb
Total Fuel available	120 min	12500 lb

ROUTE: SYDNEY – BRISBANE (DC9)

DESIGNATOR	D1SB	D2SB	D3SB	D4SB	D5SB
WIND COMPS	–100/–61	–60/–21	–20/+19	+20/+59	+60/+100
SY – WMD	14	13	12	12	11
– PLO	23	21	19	18	17
– CAS	16	15	14	13	12
– BNT	8	8	8	7	7
– BN	8	7	7	6	6
TIME	69	64	60	56	53
FUEL	7900	7400	7000	6600	6300

Typical Standard Flight Planning Table

(9) With the introduction of new coloured multi–stage flight plans in January 1979, standard Flight Planning Data is now provided directly on the flight plan form.
The figures printed on the plans agree with those published by ATC but the time intervals shown are between mandatory check points only and therefore are reduced in number.
The usual correction factor for variation in BRW on long stage operations is not printed on the flight plan but is still available on the relevant Standard Flight Planning pages held by ATC.

Flight planning and cruise control (continued)

C. **Company Pre–computed Flight Planning Tables**

(1) The presentation of these tables conforms to the same pattern as already discussed for Standard Flight Planning Tables, with some minor differences as follows:

(a) Additional notes are printed on each sheet to explain some of the factors included in the published figures.

(b) The reference figures published at the bottom of each page show the stage distance (nm) – mean F/L – zero fuel weight (1000's kg) used in the calculations.

(c) The BRW applicable to each wind component bracket is published on the page immediately below the calculated burn–off for each bracket.

(d) To permit compensations to be made to fuel burn–off figures for variation in brake release weight a correction factor is published on each page.
e.g. To plan for CS to AS – M.76 – H/W 40 kt – F/L 310 – BRW 43.7

Published M.76 planning figures based on F/L 310 – BRW 45.7 show
121 min – 12800 lb.
Correction – Minus 100 lb/1000 kg decrease in BRW.
i.e. Minus 200 lb for 2000 kg less BRW.
Use 121 min – 12600 lb.

(2) Using the Company tables, it is possible to plan each zone for varying wind components.

Example:
Route AS – CS, Temp. ISA + 15, Wind Comps. AS – MA T/W 40 kt, MA – CS Zero.
Holding at CS 30 min. Fuel available 20000 lb
Fuel required:

AS – MA	48 min	6600 lb		
MA – CS	60 min	5000 lb		
		Total	108 min	11600 lb
Variable Reserve (10%)			11 min	1200 lb
Fixed Reserve (at 5200 lb/hr)			45 min	3900 lb
Holding (at 4800 lb/hr)			30 min	2400 lb
Margin (at 6000 lb/hr)			9 min	900 lb
Total (fuel available			203 min	20000 lb

Continued on next page

FLIGHT PLANNING DATA – DC9

ROUTE: CAIRNS – ALICE SPRINGS

TEMPS: ISA +10 to ISA +20 | WIND COMPONENTS – kt | CRUISE: M.76

ROUTE SECTOR	−100/−61		−60/−21		−20/+19		+20/+59		+60/+100	
	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
CS – BIB	5		5		4		4		3	
– RIK	31		29		27		25		24	
– MA	34	8800	31	8200	29	7700	27	7300	25	7000
– HOG	26		23		21		19		18	
– AS	35	5100	33	4600	31	4200	29	3900	27	3600
TOTALS	131	13900	121	12800	112	11900	104	11200	97	10600
BRW (kg)		46300		45700		45300		44900		44600

ROUTE: ALICE SPRINGS – CAIRNS

AS – HOG	34		32		30		28		27	
– MA	26	7800	24	7300	22	6900	20	6600	18	6300
– RIK	34		31		28		26		24	
– BIB	33		30		28		26		24	
– CS	4	6100	4	5500	4	5000	4	4600	4	4300
TOTALS	131	13900	121	12800	112	11900	104	11200	97	10600
BRW (kg)		46300		45700		45300		44900		44600

CORRECTION: PLUS / MINUS 100 lb/1000 kg INC / DEC IN BRW.

REF: 790/310/37.0

Effective: 1–11–79

TYPICAL COMPANY PRE–COMPUTED FLIGHT PLANNING TABLE

Flight planning and cruise control (continued)

D. General Flight Planning Tables

(1) General Flight Planning Tables are published for stage distances up to 1600 nm at increments of 50 nm, and each page shows the flight time and fuel burn-off for wind components in 40 kt increments from −120 kt to +120 kt.

(2) The cruise conditions covered by the tables are:

(a) M.76 − ISA +10°C − Cruise F/L's 350, 310, 270 and 250.

(b) L.R.C. − ISA +10°C − Cruise F/L's 350, 310 and 270.

(3) The time intervals listed are from S/Hdg at departure to over-top at destination.

(4) The fuel burn-off figures include taxi and manoeuvre allowances (1100 lb).

(5) These tables should be used when planning for any flight or condition which is not covered by normal pre-computed data.

(a) Example:
Route BN − AS, Dist 1040 nm, M.76, F/L 310, H/W 40 kt.
From General Planning Tables (M.76 − F/L 310).

H/W 40 kt − 1000 nm	151 min −	15620 lb.
H/W 40 kt − 1050 nm	159 min −	16280 lb.
Interpolating − 1010 nm	157 min −	16200 lb.
Variable Reserve (10%)		1600 lb.
Fixed Reserve (45 min @ 5200 lb/hr)		3900 lb.
Total fuel required		21700 lb.

NOTE: A fixed reserve of 3900 lb is shown. If available, 5200 lb should be carried and the additional 1300 lb listed at the margin rate of 6000 lb/hr.

(6) The table covering M.76 operations at F/L 250 should be used when planning a flight which is limited to F/L 250. This could be due to an abnormally high wind gradient or one air-conditioning pack inoperative.

4. NORMAL OPERATIONS

A. Climb

(1) Climb speed is 300 kt IAS to 26000 feet then M.73 to cruise altitude. When separation from another aircraft is required by ATC the climb speed may be reduced to 270 kt IAS up to 27500 feet then M.68 to cruise altitude.

(2) Normal climb tables showing time, air distance, fuel burn-off and rate of climb for various weights, temperatures and altitudes are contained in the Operating Manual, Cockpit Cruise Control Book and Flight Planning Folder at ATC, and are reproduced here. These tables are a simplified form of data contained in the DACO Performance Manual.

GENERAL PLANNING DATA

ISA +10 ZFW 37000 kg F/L 350 M.76 MEAN CRUISE TAS 446 kt.

	WIND COMPONENT ~ kt													
	−120		−80		−40		ZERO		+40		+80		+120	
DIST (nm)	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
100	24	3440	22	3270	21	3120	19	2980	18	2860	17	2760	16	2660
150	32	4280	30	4070	28	3890	27	3730	25	3590	24	3460	23	3340
200	40	4940	38	4740	35	4560	34	4390	32	4240	30	4100	29	3960
250	48	5660	45	5370	43	5160	40	4980	38	4800	36	4640	35	4500
300	57	6370	53	6020	50	5730	47	5500	45	5340	42	5160	41	5000
350	66	7170	61	6730	57	6380	54	6100	51	5850	49	5640	47	5470
400	75	7980	69	7440	64	7040	61	6680	57	6390	54	6140	52	5930
450	84	8810	77	8190	72	7680	67	7270	63	6930	60	6640	57	6400
500	93	9640	86	8940	79	8350	74	7880	70	7490	66	7150	63	6870
550	103	10510	94	9670	87	9030	81	8490	76	8040	72	7670	68	7340
600	112	11360	102	10450	94	9710	87	9110	82	8610	77	8190	73	7820
650	121	12230	110	11210	101	10400	94	9730	88	9180	83	8710	79	8310
700	130	13100	118	11980	109	11090	101	10360	94	9750	89	9240	84	8780
750	139	13990	127	12770	116	11790	108	10990	100	10300	94	9740	89	9270
800	148	14830	135	13560	124	12500	114	11630	107	10880	100	10270	95	9750
850	157	15630	143	14350	131	13210	121	12270	113	11460	106	10800	100	10240
900	167	16390	151	15060	138	13910	128	12910	119	12080	111	11340	105	10730
950	176	17150	159	15750	145	14610	135	13550	125	12670	117	11910	110	11240
1000	185	17920	167	16430	153	15230	141	14200	132	13260	123	12460	116	11770
1050	–	–	175	17110	160	15850	148	14800	138	13850	129	13000	121	12270
1100	–	–	183	17790	167	16470	154	15370	144	14440	135	13550	127	12780
1150	–	–	192	18460	175	17070	161	15940	150	14970	140	14100	132	13290
1200	–	–	–	–	182	17680	168	16490	156	15490	146	14620	137	13800
1250	–	–	–	–	190	18290	174	17140	162	16010	151	15110	143	14310
1300	–	–	–	–	–	–	181	17600	168	16520	157	15590	147	14780
1350	–	–	–	–	–	–	188	18160	174	17030	163	16060	153	15230
1400	–	–	–	–	–	–	–	–	180	17530	168	16540	158	15670

NOTE: Figures below the line are for F/L 350, above the line for optimum altitude.

BRW equals burn-off plus 10% plus 60 min plus ZFW.

Increase (decrease) burn-off by 5% for each 4500 kg increase (decrease) in BRW.

GENERAL PLANNING DATA

ISA +10 ZFW 37000 kg F/L 310 M.76 MEAN CRUISE TAS 454 kt.

	WIND COMPONENT~ kt													
	−120		−80		−40		ZERO		+40		+80		+120	
DIST (nm)	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
100	24	3440	22	3270	21	3120	19	2980	18	2860	17	2760	16	2660
150	32	4280	30	4070	28	3890	27	3730	25	3590	24	3460	23	3340
200	40	4940	38	4740	35	4560	34	4390	32	4240	30	4100	29	3960
250	49	5780	45	5460	43	5190	40	4980	38	4800	36	4640	35	4500
300	58	6620	53	6210	50	5870	47	5590	44	5370	42	5180	40	5000
350	67	7470	61	6960	57	6550	53	6220	50	5940	48	5700	46	5490
400	76	8320	69	7720	64	7240	60	6840	57	6510	54	6230	51	5980
450	85	9180	77	8480	72	7940	67	7470	63	7080	59	6760	56	6480
500	94	10040	85	9250	79	8620	73	8100	69	7660	65	7290	61	6970
550	103	10900	93	10020	86	9320	80	8730	75	8240	70	7830	67	7470
600	112	11770	102	10810	93	10020	87	9370	81	8830	76	8370	72	7970
650	121	12640	110	11590	101	10720	93	10010	87	9420	82	8910	77	8480
700	129	13520	118	12360	108	11420	100	10650	93	10010	87	9460	83	8980
750	138	14400	126	13150	115	12130	107	11300	99	10600	93	10000	88	9490
800	147	15240	134	13940	122	12840	113	11940	105	11190	99	10550	93	10000
850	156	16070	142	14730	130	13550	120	12590	112	11780	104	11100	98	10510
900	165	16880	150	15460	137	14260	126	13240	118	12370	110	11640	104	11020
950	174	17690	158	16180	144	14960	133	13890	124	12970	116	12190	109	11520
1000	183	18490	166	16910	151	15620	140	14550	130	13570	121	12740	114	12040
1050	–	–	174	17630	159	16280	146	15160	136	14170	127	13300	119	12550
1100	–	–	182	18350	166	16930	153	15760	142	14770	133	13850	125	13060
1150	–	–	–	–	173	17580	160	16350	148	15320	138	14400	130	13580
1200	–	–	–	–	180	18230	166	16950	154	15870	144	14940	135	14090
1250	–	–	–	–	–	–	173	17550	160	16420	150	15460	140	14620
1300	–	–	–	–	–	–	179	18140	166	16970	155	15970	146	15100
1350	–	–	–	–	–	–	–	–	172	17510	161	16470	151	15570
1400	–	–	–	–	–	–	–	–	178	18060	166	16980	156	16050

NOTE: Figures below the line are for F/L 310, above the line for optimum altitude.

BRW equals burn-off plus 10% plus 60 min plus ZFW.

Increase (decrease) burn-off by 5% for each 4500 kg increase (decrease) in BRW.

GENERAL PLANNING DATA

ISA +10 ZFW 37000 kg F/L 270 M.76 MEAN CRUISE TAS 462 kt.

	WIND COMPONENT~kt													
	−120		−80		−40		ZERO		+40		+80		+120	
DIST (nm)	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
100	24	3440	22	3270	21	3120	19	2980	18	2860	17	2760	16	2660
150	32	4280	30	4070	28	3890	27	3730	25	3590	24	3460	23	3340
200	41	5160	38	4860	35	4610	33	4410	32	4240	30	4100	29	3960
250	50	6080	46	5680	43	5350	40	5090	38	4860	36	4660	34	4500
300	58	7000	54	6500	50	6100	47	5770	44	5490	42	5250	40	5040
350	67	7930	61	7330	57	6850	53	6450	50	6120	47	5830	45	5580
400	76	8860	69	8160	64	7600	60	7140	56	6750	53	6410	50	6130
450	85	9790	77	9000	71	8350	66	7820	62	7380	58	7000	55	6670
500	94	10730	85	9840	78	9110	73	8520	68	8010	64	7590	60	7220
550	102	11680	93	10680	85	9880	79	9210	74	8650	69	8180	66	7770
600	111	12630	101	11530	93	10650	86	9910	80	9290	75	8770	71	8320
650	120	13580	109	12380	100	11410	92	10610	86	9930	81	9360	76	8870
700	129	14540	117	13240	107	12180	99	11310	92	10580	86	9960	81	9420
750	138	15460	125	14090	114	12950	105	12010	98	11230	92	10560	86	9980
800	146	16330	132	14930	121	13730	112	12720	104	11880	97	11160	92	10540
850	155	17240	140	15740	128	14530	118	13430	110	12530	103	11760	97	11090
900	164	18120	148	16540	135	15250	125	14140	116	13180	109	12360	102	11650
950	–	–	156	17340	143	15980	132	14840	122	13830	114	12960	107	12210
1000	–	–	164	18130	150	16700	138	15510	128	14500	120	13560	112	12770
1050	–	–	–	–	157	17420	144	16170	134	15110	126	14170	118	13330
1100	–	–	–	–	164	18130	151	16830	140	15720	131	14770	123	13900
1150	–	–	–	–	–	–	157	17480	146	16330	136	15340	128	14480
1200	–	–	–	–	–	–	164	18140	152	16930	142	15900	133	15010
1250	–	–	–	–	–	–	–	–	158	17540	147	16460	138	15540
1300	–	–	–	–	–	–	–	–	164	18140	153	17020	143	16060
1350	–	–	–	–	–	–	–	–	–	–	158	17580	149	16580
1400	–	–	–	–	–	–	–	–	–	–	164	18140	154	17100

NOTE: Figures below the line are for F/L 270, above the line for optimum altitude.

BRW equals burn–off plus 10% plus 60 min plus ZFW.

Increase (decrease) burn–off by 5% for each 4500 kg increase (decrease) in BRW.

GENERAL PLANNING DATA

ISA +10 ZFW 37000 kg F/L 250 M.76

	WIND COMPONENT ~ kt													
	−120		−80		−40		ZERO		+40		+80		+120	
DIST (nm)	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
50	15	2670	13	2470	12	2310	11	2180	10	2070	9	1990	8	1940
100	26	3860	24	3650	22	3450	20	3270	19	3110	18	2980	17	2860
150	32	4520	30	4360	28	4150	27	4020	26	3860	25	3750	24	3630
200	40	5420	37	5120	35	4860	33	4660	31	4480	30	4340	29	4210
250	49	6390	45	5980	42	5650	39	5380	37	5140	35	4940	34	4770
300	57	7360	53	6850	49	6430	46	6090	43	5800	41	5560	39	5340
350	66	8330	61	7720	56	7220	52	6810	49	6460	46	6170	44	5920
400	75	9310	68	8600	63	8020	59	7540	55	7130	52	6780	49	6490
450	84	10290	76	9480	70	8810	65	8260	61	7800	58	7400	55	7060
500	92	11280	84	10360	77	9610	72	8990	67	8470	63	8020	60	7640
550	101	12270	92	11240	85	10410	78	9720	73	9140	69	8640	65	8210
600	110	13270	100	12130	92	11210	85	10450	79	9810	74	9260	70	8790
650	119	14270	108	13030	99	12020	92	11180	85	10480	80	9890	75	9370
700	127	15220	116	13920	106	12830	98	11920	91	11160	86	10510	81	9950
750	136	16160	123	14800	113	13640	105	12660	97	11840	91	11140	86	10540
800	145	17100	131	15640	120	14450	111	13400	103	12520	97	11770	91	11120
850	153	18040	139	16480	127	15220	118	14160	109	13210	102	12400	96	11710
900			147	17320	134	15980	124	14860	115	13890	108	13040	101	12300
950			155	18160	141	16740	130	15560	121	14560	113	13670	107	12890
1000					148	17500	137	16260	127	15210	119	14310	112	13480
1050					155	18260	143	16960	133	15850	124	14910	117	14090
1100							150	17650	139	16500	130	15510	122	14650
1150							156	18350	145	17140	135	16100	127	15210
1200									151	17780	141	16700	132	15760
1250									157	18420	146	17290	137	16320
1300											152	17880	143	16870
1350											157	18470	148	17420
1400													153	17980
1450													158	18530

NOTE: Figures below the line are for F/L 250, above the line for optimum altitude.

BRW equals burn-off plus 10% plus 60 min plus ZFW.

Increase (decrease) burn-off by 5% for each 4500 kg increase (decrease) in BRW.

DOUGLAS DC9 FLIGHT STUDY GUIDE

Flight planning and cruise control (continued)

GENERAL PLANNING DATA

ISA +10 | ZFW 37000 kg | F/L 350 | LRC

	WIND COMPONENT~kt													
	−120		−80		−40		ZERO		+40		+80		+120	
DIST (nm)	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
50	14	2590	12	2440	11	2310	10	2210	9	2130	8	2050	7	1990
100	23	3490	22	3330	20	3170	18	3040	17	2930	16	2830	15	2740
150	33	4370	30	4150	28	3960	26	3790	24	3640	23	3520	22	3400
200	41	5100	39	4880	36	4650	34	4490	32	4330	30	4170	29	4020
250	50	5790	47	5550	44	5280	41	5090	39	4900	37	4740	35	4590
300	58	6410	54	6170	51	5900	48	5680	46	5460	43	5280	41	5100
350	67	7270	62	6930	58	6490	55	6250	52	6020	50	5800	47	5600
400	76	8140	70	7650	66	7220	62	6870	59	6540	56	6300	53	6110
450	85	8960	79	8380	73	7900	69	7520	65	7170	62	6840	59	6640
500	94	9820	87	9140	81	8570	76	8120	72	7740	68	7400	65	7190
550	104	10650	95	9860	88	9260	83	8720	78	8300	74	7940	70	7630
600	113	11490	104	10610	96	9900	89	9350	84	8850	79	8450	76	8100
650	122	12350	112	11360	103	10580	96	9930	90	9440	85	8990	81	8580
700	132	13220	120	12130	111	11260	103	10550	96	9960	91	9510	86	9090
750	141	14100	128	12900	118	11940	110	11170	103	10530	97	9980	92	9570
800	150	14920	136	13690	125	12640	116	11790	109	11090	102	10510	97	10000
850	159	15670	145	14470	133	13360	123	12430	115	11670	108	11030	102	10490
900	168	16440	153	15170	140	14060	130	13080	121	12250	114	11560	108	10980
950	177	17170	161	15830	148	14730	137	13720	128	12840	120	12100	113	11470
1000	186	17930	169	16520	155	15360	144	14380	134	13440	125	12650	118	11970
1050			177	17160	162	15950	150	14950	140	14030	131	13200	124	12480
1100			185	17840	170	16570	157	15490	146	14610	137	13750	129	12980
1150			194	18510	177	17150	164	16060	152	15130	143	14310	134	13500
1200					184	17770	170	16620	159	15620	149	14800	140	14010
1250					192	18370	177	17150	165	16140	154	15290	145	14520
1300							184	17710	171	16660	160	15740	150	14970
1350							190	18260	177	17140	166	16220	156	15390
1400									183	17650	171	16690	161	15830
1450									189	18160	177	17140	166	16280
1500											183	17610	172	16720
1550											188	18080	177	17130
1600											194	18550	182	17570

NOTE: Figures below the line are for F/L 350, above the line for optimum altitude.

BRW equals burn-off plus 10% plus 60 min plus ZFW.

Increase (decrease) burn-off by 5% for each 4500 kg increase (decrease) in BRW.

GENERAL PLANNING DATA

ISA +10 ZFW 37000 kg F/L 310 LRC

	WIND COMPONENT~ kt													
	−120		−80		−40		ZERO		+40		+80		+120	
DIST (nm)	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
50	14	2590	12	2440	11	2310	10	2210	9	2130	8	2050	7	1990
100	23	3490	22	3330	20	3170	19	3040	17	2930	16	2830	15	2740
150	33	4370	30	4150	28	3960	26	3790	24	3640	23	3520	22	3400
200	41	5100	39	4880	36	4650	34	4490	32	4330	30	4170	29	4020
250	50	5800	47	5550	44	5280	41	5100	39	4900	37	4740	35	4590
300	59	6640	55	6250	51	5930	48	5680	46	5460	43	5280	41	5100
350	69	7490	63	7000	59	6610	55	6280	52	6030	50	5800	47	5600
400	79	8350	72	7760	67	7280	62	6900	59	6580	56	6320	53	6080
450	88	9200	80	8520	74	7970	69	7520	65	7140	61	6830	58	6570
500	98	10070	89	9280	82	8650	76	8140	71	7710	67	7350	64	7040
550	107	10930	97	10050	90	9340	83	8760	78	8280	73	7880	69	7530
600	117	11800	106	10820	97	10030	90	9390	84	8850	79	8400	75	8020
650	126	12680	114	11600	105	10730	97	10020	91	9430	85	8930	80	8510
700	135	13560	123	12380	113	11420	104	10650	97	10000	91	9460	86	9000
750	145	14450	131	13170	120	12130	111	11280	103	10580	97	9990	91	9490
800	154	15260	139	13950	128	12840	118	11920	110	11170	103	10530	97	9980
850	164	16080	148	14710	135	13550	125	12570	116	11750	109	11070	102	10480
900	174	16890	156	15430	143	14260	132	13210	122	12340	114	11610	108	10980
950	184	17700	165	16150	150	14910	138	13860	129	12940	120	12150	113	11480
1000	194	18500	174	16870	158	15560	145	14490	135	13530	126	12700	119	11990
1050			182	17580	166	16210	152	15080	141	14140	132	13250	124	12500
1100			191	18290	173	16850	159	15670	147	14680	138	13800	129	13010
1150					181	17490	166	16250	154	15220	143	14350	135	13520
1200					189	18130	173	16840	160	15760	149	14840	140	14030
1250							180	17410	167	16290	155	15340	146	14520
1300							188	17990	173	16820	161	15830	151	14980
1350									180	17350	167	16320	156	15440
1400									186	17880	173	16810	162	15900
1450									193	18400	179	17300	167	16350
1500											185	17790	173	16810
1550											191	18270	178	17260
1600													184	17710

NOTE: Figures below the line are for F/L 310, above the line for optimum altitude.

BRW equals burn-off plus 10% plus 60 min plus ZFW.

Increase (decrease) burn-off by 5% for each 4500 kg increase (decrease) in BRW.

GENERAL PLANNING DATA

ISA +10 ZFW 37000 kg F/L 270 LRC

	WIND COMPONENT ~ kg													
	−120		−80		−40		ZERO		+40		+80		+120	
DIST (nm)	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF	FLT TIME	BURN OFF
50	14	2590	12	2440	11	2310	10	2210	9	2130	8	2050	7	1990
100	23	3490	22	3330	20	3170	19	3040	17	2930	16	2830	15	2740
150	33	4370	30	4150	28	3960	26	3790	24	3640	23	3520	22	3400
200	42	5160	39	4880	36	4650	34	4490	32	4330	30	4170	29	4020
250	52	6060	48	5670	44	5360	41	5120	39	4900	37	4740	35	4590
300	63	6970	57	6470	52	6070	49	5750	46	5500	43	5270	41	5090
350	73	7880	66	7270	60	6780	56	6390	52	6070	49	5810	47	5580
400	83	8790	75	8070	69	7500	63	7040	59	6660	55	6340	52	6090
450	93	9710	84	8880	77	8220	71	7690	66	7250	62	6890	58	6580
500	104	10630	93	9690	85	8940	78	8340	72	7840	68	7430	64	7080
550	114	11560	102	10500	93	9670	85	8990	79	8440	74	7970	69	7580
600	124	12500	111	11320	101	10390	93	9650	86	9030	80	8520	75	8080
650	134	13450	120	12150	109	11130	100	10310	92	9630	86	9070	81	8590
700	144	14400	129	12990	117	11870	107	10970	99	10230	92	9620	87	9100
750	155	15280	138	13820	125	12610	115	11630	106	10840	98	10170	92	9610
800	165	16150	147	14630	133	13360	122	12310	112	11440	105	10730	98	10120
850	176	17020	156	15400	141	14120	129	12980	119	12050	111	11280	104	10630
900	186	17890	165	16170	149	14810	136	13660	126	12670	117	11840	109	11150
950			174	16930	157	15500	144	14340	132	13290	123	12410	115	11660
1000			184	17690	165	16180	151	14960	139	13900	129	12980	121	12190
1050			193	18450	174	16860	158	15570	146	14510	135	13550	126	12710
1100					182	17540	166	16190	152	15070	141	14130	132	13240
1150					190	18210	173	16800	159	15640	147	14650	138	13760
1200							180	17410	166	16200	153	15170	143	14300
1250							188	18020	172	16760	160	15690	149	14780
1300									179	17310	166	16200	154	15260
1350									186	17870	172	16720	160	15730
1400									192	18420	178	17230	166	16210
1450											184	17740	171	16680
1500											190	18250	177	17160
1550													183	17630
1600													189	18100

NOTE: Figures below the line are for F/L 270, above the line for optimum altitude.

BRW equals burn-off plus 10% plus 60 min plus ZFW.

Increase (decrease) burn-off by 5% for each 4500 kg increase (decrease) in BRW.

Flight planning and cruise control (continued)

(3) The time listed is the total time taken to climb to the cruise altitude, the fuel is the total fuel used during the climb and the distance is that which would be covered during the climb in zero wind conditions. TAS can be derived from the air miles flown in the published time interval.

(4) Generally, the wind component on climb has been found to be equal to 60% of the wind component at the cruise altitude. Use of the climb wind component and TAS will provide G/S and, from this, the GNM's covered on the climb may be calculated.

(5) Example:
From the normal two-engine climb tables — start climb weight 45000 kg, temperature ISA+10, cruise altitude 31000 ft, wind component at 31000 ft = T/W 60 kt.

Time for climb	=	23 min
Distance on climb	=	151 nm (zero wind)
Fuel burned during climb to cruise altitude	=	3500 lb.
Average Climb TAS	=	394 kt.
Effective wind component (60% of 60 kt)	=	+36 kt.
Average Climb G/S	=	430 kt.
Ground Distance	=	165 nm

B. Cruise

(1) The optimum cruise altitudes with regard to cost and time are shown in the Optimum Cruise Altitude table in the performance section of the Company Manual and the Flight Planning Folder at ATC, and reproduced here.

(2) The normal cruise altitude is independent of wind gradient.

(3) Normal cruise speed is 320 kt IAS below 25000 feet and M.76 at higher altitudes.

(4) The DACO Performance Manual includes cruise tables (reproduced here) from which true airspeed and fuel flow (per engine) may be obtained for a range of altitudes, air temperatures and aircraft weights. Tables are also available for reference when anti-icing systems are in use. Extracts of these tables are included in the Cockpit Cruise Control Book. It should be noted that to derive the consumption rate it is necessary to double the fuel flow figure listed in the tables.

Flight planning and cruise control (continued)

C. **Descent**

(1) Standard M.76/300 kt Descent

(a) Descent Initiation Point

Determine the descent initiation point as follows:

(i) Enter the 'M.76/300 kt DESCENT INITIATION POINT' table with cruise altitude and cruise wind component, and read the descent initiation point (nm).

(ii) For non sea–level airports, reduce initiation point by 2 nm/1000 ft field elevation.

(iii) Adjust the obtained initiation point for the following factors:

1. Top of Descent Weight
Adjust as per the correction given below the tabulations.

2. Miles to Run
Make an adjustment if the DME is not at the field, or if a straight–in approach is not being made. As a general rule, subtract 5 nm if entering the circuit on a base leg, and subtract 10 nm if entering for a full downwind leg.

3. Descent at Non Standard Speeds
For separation purposes, ATC may request descent at speeds between 320 kt and 230 kt. Under these circumstances, use the normal 300 kt descent initiation point and monitor the profile as per paragraph (1) (c) below.

ATC have been made aware of the substantially increased cost of descending at speeds above 300 kt. However, in some instances they may consider that the overall optimum solution to providing the required separation will be achieved by speeding up the 'number one' aircraft (DC9 – max. 320 kt), hence eliminating the necessity for subsequent aircraft to hold. Under these circumstances, the descent speed requested by ATC should be used. Descent speeds higher than 300 kt should not be requested by crews.

(b) Descent Procedure

(i) Cruise above 28000 ft:
At the descent initiation point, commence descent at 1000 fpm, and immediately reduce power to approximately 78% N_1. Maintain M.76 and 1000 fpm until 300 kt is intercepted at 28000 ft. Select idle thrust at this point and descend at 300 kt.

Cruise at, or below 28000 ft:
At the descent initiation point, reduce thrust to idle and deceleration at cruise altitude until 300 kt is attained.

(ii) Descend to 5000 ft above the field at 300 kt and idle thrust.

(iii) At 5000 ft above the field, reduce the rate of descent to less than 1000 fpm, to arrive at 3000 ft above the field at 210 kt and 10 nm to run.

Flight planning and cruise control (continued)

(iv) Descent from 3000 ft to touchdown:
VMC – Descend and reduce speed to arrive at 800 – 1000 ft above the field elevation in the landing configuration, and at final approach speed.
IMC – Descend and reduce speed, to extend landing flap at 1500 ft above the field elevation.

(c) Monitoring Descent Profile

Monitor the descent and check that the actual profile stays between the MAX and MIN limits as specified on the table 'DESCENT LIMIT PROFILES'. If the profile deviates above the MAX or below the MIN limit, take the appropriate corrective action to stay within the limits i.e., use speed–brake when above MAX, or thrust when below MIN.

(d) Pressurisation

Approaching the descent point, set the cabin to field elevation plus 200 ft, and rate to 400 fpm. Operate at 400 ± 50 fpm during the descent.

The descent distance can be reduced so far as the capability of the aircraft to descend to circuit height at the field is concerned, but sufficient time must be allowed to ensure that the cabin descent is at a comfortable rate – desirable, between 350 and 450 fpm.

At the '15000 ft' checklist call, check cabin altitude and, if below 3000 ft, the rate of cabin descent may be reduced to approximately 300 fpm.

(2) It is most important to realise that a poorly controlled descent can be wasteful of fuel and will reduce fuel endurance.

(3) A 'NORMAL DESCENT DATA' Table showing time, ground distance and fuel burned for various altitudes and wind components is contained in the Operation Manual, Flight Planning Folders and Cockpit Cruise Control Book; it is also reproduced on page 30.

(4) The table is entered for cruise altitude and time, burn–off and R.O.D. are read directly. The ground distance is read in the relevant cruise wind component column.

(5) The wind component on descent has been found to be equal to 50% of the wind component at the cruise altitude. The ground distances tabulated are based on this wind factor.

(6) These descent figures are calculated for top of descent weight 40000 kg at ISA +10°C and are usable for all weights and temperatures.

Example:
Cruise F/L 290 Cruise Wind Comp. T/W 40 kt.
Normal Descent Table reads:
13 min. – 350 lb. – 85 GNM – R.O.D. 1000 fpm to 28000 ft, then 2200 fpm. reducing with further descent.

ISA

ISA

NORMAL CLIMB DATA (300 kt – M.73) ISA

ALTITUDE ~1000 ft	START CLIMB WEIGHT~1000 kg				
	37	39	41	43	45
	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC
9	3–13–600–3100	3–14–600–2900	3–14–700–2700	3–15–750–2600	3–16–800–2400
11	3–16–700–2900	4–18–750–2700	4–19–850–2500	4–20–900–2400	4–21–950–2200
13	4–20–850–2700	4–22–900–2500	5–24–1000–2300	5–25–1050–2200	5–27–1100–2100
15	5–25–1000–2500	5–27–1050–2300	6–29–1150–2200	6–31–1200–2000	6–33–1300–1900
17	6–31–1150–2300	6–33–1200–2200	7–35–1300–2000	7–38–1400–1900	7–40–1500–1700
19	7–37–1300–2100	7–39–1350–2000	8–42–1450–1800	8–45–1600–1700	8–48–1700–1600
21	8–44–1450–1900	8–46–1500–1800	9–50–1600–1600	9–53–1800–1500	9–57–1900–1400
23	9–52–1600–1700	9–54–1650–1600	10–59–1800–1400	10–62–2000–1300	11–67–2100–1200
25	10–60–1750–1500	10–63–1800–1400	11–69–2000–1200	11–73–2200–1100	13–79–2350–1000
27	11–68–1900–1800	11–73–2000–1700	12–79–2200–1500	13–85–2400–1300	15–92–2600–1200
29	12–77–2050–1700	13–83–2200–1500	14–90–2400–1300	15–97–2600–1200	17–105–2800–1100
31	14–86–2200–1500	15–93–2400–1300	16–101–2600–1200	17–110–2800–1000	19–119–3000–900
33	16–96–2350–1300	17–104–2600–1100	18–114–2800–1000	19–125–3000–900	21–137–3300–700
35	18–107–2550–1100	19–118–2800–900	20–129–3000–800	22–143–3300–700	—

CLIMB TIME~min CLIMB DIST~ANM CLIMB FUEL~lb RATE OF CLIMB~ft/min

ISA +10

ISA +10

ALTITUDE	START CLIMB WEIGHT~1000 kg				
	37	39	41	43	45
~ 1000 ft	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC
9	3–14–650–2800	3–15–700–2600	3–17–750–2400	4–18–800–2300	4–19–850–2100
11	4–19–800–2600	4–20–850–2400	4–22–900–2200	5–23–950–2100	5–25–1000–1900
13	5–24–950–2400	5–25–1000–2200	5–28–1050–2000	6–29–1150–1900	6–32–1200–1800
15	6–29–1100–2200	6–31–1150–2000	6–34–1200–1900	7–36–1350–1700	7–39–1400–1600
17	7–35–1250–2000	7–38–1300–1800	7–41–1400–1700	8–44–1550–1600	8–47–1650–1400
19	8–42–1400–1800	8–46–1500–1600	8–49–1600–1500	9–53–1750–1400	10–57–1900–1300
21	9–50–1550–1600	9–55–1700–1400	9–59–1800–1300	10–64–1950–1200	12–69–2150–1100
23	10–60–1700–1400	11–65–1900–1300	11–70–2000–1200	12–76–2200–1000	14–83–2400–900
25	11–70–1900–1200	12–76–2100–1100	13–82–2250–1000	14–89–2450–900	16–98–2650–800
27	12–81–2100–1500	13–88–2300–1300	15–95–2500–1200	16–104–2700–1000	18–114–2900–900
29	14–92–2300–1300	14–100–2500–1200	17–109–2750–1000	18–120–2950–900	20–131–3200–800
31	16–104–2500–1200	17–113–2700–1000	19–125–3000–900	21–137–3200–800	23–151–3500–700
33	18–117–2700–1100	19–128–2900–900	21–142–3250–800	24–157–3500–600	26–176–3850–500
35	20–132–2900–900	22–146–3150–700	24–163–3500–600	27–183–3800–500	–

CLIMB TIME~min CLIMB DIST~ANM CLIMB FUEL~lb RATE OF CLIMB~ft/min

NORMAL CLIMB DATA (300 kt – M.73) ISA +10

ISA +20

ISA +20

ALTITUDE	START CLIMB WEIGHT~1000 kg				
	37	39	41	43	45
~1000 ft	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC	TIME–DIST–FUEL–ROC
9	3–17–700–2500	4–18–750–2300	4–19–800–2100	4–19–850–2000	4–19–900–1900
11	4–22–850–2300	5–24–900–2100	5–25–950–2000	5–25–1000–1900	5–26–1100–1700
13	5–28–1000–2100	6–30–1050–1900	6–32–1150–1800	6–32–1200–1700	6–35–1300–1500
15	6–35–1150–1900	7–37–1250–1700	7–40–1350–1600	7–40–1400–1500	8–46–1500–1400
17	7–42–1350–1700	8–45–1450–1500	8–49–1550–1400	9–50–1600–1300	10–58–1750–1200
19	8–50–1550–1500	9–55–1650–1300	10–59–1800–1200	11–63–1900–1100	12–71–2000–1000
21	10–60–1750–1300	11–66–1900–1200	12–71–2050–1100	13–78–2200–1000	14–85–2350–900
23	12–73–1950–1100	13–79–2150–1000	14–86–2300–900	15–94–2500–800	16–101–2700–700
25	14–87–2150–900	15–94–2400–800	16–103–2600–700	17–112–2800–600	19–122–3050–500
27	16–101–2400–1100	17–110–2650–900	18–121–2900–800	20–133–3150–700	22–147–3450–600
29	18–116–2650–1000	19–127–2900–800	21–141–3200–700	23–156–3500–600	26–176–3850–500
31	20–131–2900–900	22–146–3150–700	24–163–3500–600	27–183–3850–500	–
33	22-149–3150–800	25–167–3450–600	28–188–3850–500	–	–
35	25–170–3400–600	28–193–3800–500	–	–	–

CLIMB TIME~min CLIMB DIST~ANM CLIMB FUEL~lb RATE OF CLIMB~ft/min

NORMAL CLIMB DATA (300 kt – M.73) ISA +20

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 13000 FEET										CRUISE 13000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	-25.8	-20.8	-15.8	-10.8	-5.8	-0.8	4.2	9.2	14.2
110000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.50/1.89	1.50/1.85	1.50/1.80	1.50/1.76	1.50/1.72	1.50/1.67	1.50/1.64	1.50/1.60	1.50/1.57
	N2 /N1	83.7/78.1	84.5/78.9	85.4/79.7	86.2/80.4	87.0/81.2	87.8/81.9	88.6/82.7	89.4/83.4	90.2/84.1
	F/F (AV)	3440	3462	3524	3566	3608	3649	3693	3732	3771
	EGT	342	355	367	380	392	404	417	429	441
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	54.22	54.10	53.99	53.87	53.75	53.63	53.48	53.40	53.30
108000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.50/1.89	1.50/1.85	1.50/1.80	1.50/1.76	1.50/1.72	1.50/1.67	1.50/1.64	1.50/1.60	1.50/1.57
	N2 /N1	83.6/78.0	84.5/78.8	85.3/79.5	86.1/80.3	86.9/81.1	87.7/81.8	88.5/82.6	89.3/83.3	90.1/84.0
	F/F (AV)	3421	3462	3504	3545	3587	3628	3671	3709	3752
	EGT	341	354	366	379	391	403	416	428	440
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	54.53	54.42	54.30	54.19	54.06	53.94	53.80	53.73	53.59
106000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.49/1.89	1.49/1.85	1.49/1.80	1.49/1.76	1.49/1.72	1.49/1.67	1.49/1.64	1.49/1.60	1.49/1.57
	N2 /N1	83.6/77.9	84.4/78.7	85.2/79.4	86.0/80.2	86.9/80.9	87.7/81.7	88.5/82.4	89.2/83.2	90.0/83.9
	F/F (AV)	3401	3442	3483	3525	3566	3610	3648	3689	3729
	EGT	341	353	365	378	390	402	415	427	439
	RAT/TAS	-6.9/373	-1.6/377	3.7/384	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	54.85	54.73	54.62	54.50	54.38	54.22	54.14	54.02	53.91
104000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.49/1.89	1.49/1.85	1.49/1.80	1.49/1.76	1.49/1.72	1.49/1.67	1.49/1.64	1.49/1.60	1.49/1.57
	N2 /N1	83.5/77.8	84.3/78.5	85.2/79.3	86.0/80.1	86.8/80.8	87.6/81.6	88.4/82.3	89.2/83.0	90.0/83.7
	F/F (AV)	3381	3422	3463	3504	3545	3588	3626	3667	3707
	EGT	340	352	364	377	389	401	414	426	438
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	55.17	55.05	54.94	54.82	54.70	54.55	54.47	54.34	54.22
102000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.49/1.89	1.49/1.85	1.48/1.80	1.48/1.76	1.48/1.72	1.48/1.67	1.48/1.64	1.48/1.60	1.48/1.57
	N2 /N1	83.4/77.6	84.3/78.4	85.1/79.2	85.9/79.9	86.7/80.7	87.5/81.4	88.3/82.2	89.1/82.9	89.9/83.6
	F/F (AV)	3361	3402	3443	3484	3525	3565	3608	3646	3686
	EGT	339	351	363	376	388	400	413	425	437
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	55.49	55.38	55.26	55.14	55.02	54.89	54.74	54.66	54.54
100000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.48/1.89	1.48/1.85	1.48/1.80	1.48/1.76	1.48/1.72	1.48/1.67	1.48/1.64	1.48/1.60	1.48/1.57
	N2 /N1	83.4/77.5	84.2/78.3	85.0/79.0	85.8/79.8	86.6/80.6	87.4/81.3	88.2/82.1	89.0/82.8	89.8/83.5
	F/F (AV)	3342	3383	3423	3464	3504	3545	3588	3625	3665
	EGT	338	350	362	375	387	399	412	424	436
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	55.81	55.70	55.58	55.46	55.34	55.21	55.05	54.98	54.85
98000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.48/1.89	1.48/1.85	1.48/1.80	1.48/1.76	1.48/1.72	1.48/1.67	1.48/1.64	1.48/1.60	1.48/1.57
	N2 /N1	83.3/77.4	84.1/78.2	84.9/78.9	85.8/79.7	86.6/80.4	87.4/81.2	88.2/81.9	89.0/82.6	89.7/83.4
	F/F (AV)	3323	3363	3403	3444	3484	3524	3564	3604	3644
	EGT	337	349	361	374	386	398	410	423	435
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	56.13	56.02	55.90	55.78	55.66	55.53	55.41	55.29	55.16
96000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.47/1.89	1.47/1.85	1.47/1.80	1.47/1.76	1.47/1.72	1.47/1.67	1.47/1.64	1.47/1.60	1.47/1.57
	N2 /N1	83.2/77.3	84.1/78.0	84.9/78.8	85.7/79.6	86.5/80.8	87.3/81.0	88.1/81.8	88.9/82.5	89.7/83.2
	F/F (AV)	3304	3344	3384	3424	3464	3504	3544	3584	3624
	EGT	336	348	360	373	385	397	409	422	434
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	56.45	56.34	56.22	56.10	55.98	55.85	55.73	55.60	55.48
94000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.47/1.89	1.47/1.85	1.47/1.80	1.47/1.76	1.47/1.72	1.47/1.67	1.47/1.64	1.47/1.60	1.47/1.57
	N2 /N1	83.2/77.1	84.0/77.9	84.8/78.7	85.6/79.4	86.4/80.2	87.2/80.9	88.0/81.7	88.8/82.4	89.6/83.1
	F/F (AV)	3285	3325	3365	3405	3445	3485	3524	3564	3604
	EGT	335	347	359	372	384	396	408	421	433
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	56.77	56.66	56.54	56.42	56.29	56.17	56.05	55.91	55.79

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 13000 FEET										CRUISE 13000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	-25.8	-20.8	-15.8	-10.8	-5.8	-0.8	4.2	9.2	14.2
92000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.46/1.89	1.46/1.85	1.46/1.80	1.46/1.76	1.46/1.72	1.46/1.67	1.46/1.64	1.46/1.60	1.46/1.57
	N2 /N1	83.1/77.0	83.9/77.8	84.7/78.6	85.6/79.3	86.4/80.1	87.2/80.0	88.0/81.5	88.7/82.3	89.5/83.0
	F/F (AV)	3267	3306	3346	3386	3425	3465	3504	3544	3584
	EGT	334	346	359	371	383	395	407	420	432
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	57.09	56.98	56.86	56.74	56.61	56.48	56.36	56.22	56.10
90000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.46/1.89	1.46/1.85	1.46/1.80	1.46/1.76	1.46/1.72	1.46/1.67	1.46/1.64	1.46/1.60	1.46/1.57
	N2 /N1	83.0/76.9	83.9/77.7	84.7/78.4	85.5/79.2	86.3/79.9	87.1/80.7	87.9/81.4	88.7/82.1	89.3/82.9
	F/F (AV)	3250	3289	3329	3368	3407	3447	3486	3526	3565
	EGT	333	345	358	370	382	394	406	419	431
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	57.39	57.28	57.16	57.03	56.91	56.78	56.66	56.52	56.39
88000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.46/1.89	1.46/1.85	1.46/1.80	1.46/1.76	1.46/1.72	1.46/1.67	1.46/1.64	1.46/1.60	1.46/1.57
	N2 /N1	83.0/76.8	83.8/77.6	84.6/78.3	85.4/79.1	86.2/79.8	87.0/80.6	87.8/81.3	88.6/82.0	89.4/82.7
	F/F (AV)	3233	3273	3312	3351	3390	3429	3468	3509	3547
	EGT	332	345	357	369	381	393	406	418	430
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	57.69	57.57	57.45	57.32	57.20	57.07	56.95	56.80	56.67
86000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.45/1.89	1.45/1.85	1.45/1.80	1.45/1.76	1.45/1.72	1.45/1.67	1.45/1.64	1.45/1.60	1.45/1.57
	N2 /N1	82.9/76.7	83.7/77.5	84.6/78.2	85.4/79.0	86.2/79.7	87.0/80.5	87.8/81.2	88.6/81.9	89.3/82.6
	F/F (AV)	3218	3257	3296	3335	3374	3413	3451	3492	3530
	EGT	332	344	356	368	380	393	405	417	429
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	57.97	57.85	57.73	57.61	57.48	57.35	57.23	57.08	56.95
84000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.45/1.89	1.45/1.85	1.45/1.80	1.45/1.76	1.45/1.72	1.45/1.67	1.45/1.64	1.45/1.60	1.45/1.57
	N2 /N1	82.9/76.6	83.7/77.4	84.5/78.1	85.3/78.9	86.1/79.6	86.9/80.4	87.7/81.1	88.5/81.8	89.3/82.5
	F/F (AV)	3202	3241	3280	3319	3358	3396	3435	3475	3513
	EGT	331	343	355	367	380	392	404	416	428
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/394	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	58.25	58.13	58.01	57.88	57.76	57.63	57.50	57.35	57.22
82000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.45/1.89	1.45/1.85	1.45/1.80	1.45/1.76	1.45/1.72	1.45/1.67	1.45/1.64	1.45/1.60	1.45/1.57
	N2 /N1	82.8/76.5	83.6/77.3	84.4/78.0	85.3/78.8	86.1/79.5	86.9/80.2	87.6/81.0	88.4/81.7	89.2/82.4
	F/F (AV)	3187	3226	3265	3303	3342	3380	3419	3459	3497
	EGT	330	342	354	367	379	391	403	415	427
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	58.52	58.40	58.28	58.15	58.02	57.90	57.77	57.61	57.49
80000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.44/1.89	1.44/1.85	1.44/1.80	1.45/1.76	1.44/1.72	1.44/1.67	1.44/1.64	1.44/1.60	1.44/1.57
	N2 /N1	82.7/76.4	83.6/77.2	84.4/77.9	85.2/78.7	86.0/79.4	86.8/80.1	87.6/80.9	88.4/81.6	89.2/82.3
	F/F (AV)	3173	3211	3250	3288	3327	3365	3403	3444	3482
	EGT	329	342	354	366	378	390	402	414	427
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	58.79	58.67	58.54	58.42	58.29	58.16	58.03	57.87	57.74
78000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.44/1.89	1.44/1.85	1.44/1.80	1.44/1.76	1.44/1.72	1.44/1.67	1.44/1.64	1.44/1.60	1.44/1.57
	N2 /N1	82.7/76.3	83.5/77.1	84.3/77.8	85.2/78.6	86.0/79.3	86.8/80.0	87.5/80.0	88.3/81.5	89.1/82.2
	F/F (AV)	3159	3197	3236	3274	3312	3350	3388	3429	3466
	EGT	329	341	353	365	377	389	401	414	426
	RAT/TAS	-6.9/373	-1.6/377	3.7/381	9.1/384	14.4/488	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	59.04	58.92	58.80	58.67	58.54	58.42	58.29	58.12	58.00

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 13000 FEET										CRUISE 13000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–25.8	–20.8	–15.8	–10.8	–5.8	–0.8	4.2	9.2	14.2
76000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.44/1.89	1.44/1.85	1.44/1.80	1.44/1.76	1.44/1.72	1.44/1.67	1.44/1.64	1.44/1.60	1.44/1.57
	N2 /N1	82.6/76.2	83.5/77.0	84.3/77.7	85.1/78.5	85.9/79.2	86.7/80.0	87.5/80.7	88.3/81.4	89.0/82.1
	F/F (AV)	3146	3184	3222	3260	3298	3336	3374	3412	3452
	EGT	328	340	352	364	376	389	401	413	425
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	59.30	59.18	59.05	58.92	58.79	58.67	58.54	58.41	58.24
74000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.44/1.89	1.44/1.85	1.44/1.80	1.44/1.76	1.44/1.72	1.44/1.67	1.44/1.64	1.44/1.60	1.44/1.57
	N2 /N1	82.6/76.1	83.4/76.9	84.2/77.6	85.0/78.4	85.9/79.1	86.6/79.9	87.4/80.6	88.2/81.3	89.0/82.0
	F/F (AV)	3132	3170	3208	3246	3284	3322	3360	3397	3437
	EGT	327	339	352	364	376	388	400	412	424
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	59.55	59.43	59.30	59.17	50.04	58.92	58.79	58.66	58.49
72000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.43/1.89	1.43/1.85	1.43/1.80	1.43/1.76	1.43/1.72	1.43/1.67	1.43/1.64	1.43/1.60	1.43/1.57
	N2 /N1	82.5/76.0	83.4/76.8	84.2/77.6	85.0/78.3	85.8/79.0	86.6/79.8	87.4/80.5	88.2/81.2	88.9/81.9
	F/F (AV)	3119	3157	3195	3233	3271	3308	3346	3383	3423
	EGT	327	339	351	363	375	387	399	411	423
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	59.70	59.67	59.53	59.42	59.29	59.16	59.03	58.90	58.73
70000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.43/1.89	1.43/1.85	1.43/1.80	1.43/1.76	1.43/1.72	1.43/1.67	1.43/1.64	1.43/1.60	1.43/1.57
	N2 /N1	82.5/76.0	83.3/76.7	84.1/77.5	85.0/78.2	85.8/78.9	86.5/79.7	87.3/80.4	88.1/81.1	88.9/81.8
	F/F (AV)	3107	3145	3182	3220	3258	3295	3332	3370	3409
	EGT	326	338	350	362	374	386	398	410	423
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	60.04	59.91	59.79	59.66	59.53	59.40	59.27	59.14	58.96
68000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.43/1.89	1.43/1.85	1.43/1.80	1.43/1.76	1.43/1.72	1.43/1.67	1.43/1.64	1.43/1.60	1.43/1.57
	N2 /N1	82.5/75.9	83.3/76.6	84.1/77.4	84.9/78.1	85.7/78.9	86.5/79.6	87.3/80.3	88.1/81.0	88.8/81.7
	F/F (AV)	3095	3132	3170	3207	3245	3282	3319	3356	3396
	EGT	325	338	350	362	374	386	398	410	422
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	60.27	60.15	60.02	59.89	59.76	59.63	59.50	59.37	59.19
66000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.42/1.90	1.42/1.85	1.42/1.80	1.42/1.76	1.42/1.72	1.42/1.67	1.42/1.64	1.42/1.60	1.42/1.57
	N2 /N1	82.4/75.6	83.2/76.6	84.0/77.3	84.9/78.0	85.7/78.8	86.5/79.5	87.2/80.2	88.0/80.9	88.8/81.6
	F/F (AV)	3083	3120	3158	3195	3233	3270	3307	3344	3381
	EGT	325	337	349	361	373	385	397	409	421
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	60.50	60.38	60.25	60.12	59.99	59.86	59.73	50.60	50.47
64000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.42/1.89	1.42/1.85	1.42/1.80	1.42/1.76	1.42/1.72	1.42/1.67	1.42/1.64	1.42/1.60	1.42/1.57
	N2 /N1	82.4/75.7	83.2/76.5	84.0/77.2	84.8/78.0	85.6/78.7	86.4/79.4	87.2/80.1	88.0/80.8	88.7/81.6
	F/F (AV)	3072	3109	3146	3183	3221	3258	3295	3331	3368
	EGT	324	336	348	360	372	384	396	408	420
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	60.72	60.60	60.47	60.34	60.21	60.08	59.95	59.82	59.69
62000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.42/1.89	1.42/1.85	1.42/1.80	1.42/1.76	1.42/1.72	1.42/1.67	1.42/1.64	1.42/1.60	1.42/1.57
	N2 /N1	82.3/75.6	83.1/76.4	84.0/77.1	84.8/77.9	85.6/78.6	86.4/79.3	87.1/80.1	87.9/80.8	88.7/81.5
	F/F (AV)	3061	3098	3135	3172	3209	3246	3283	3319	3356
	EGT	324	336	348	360	372	384	396	408	420
	RAT/TAS	–6.9/373	–1.6/377	3.7/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	60.94	60.82	60.69	60.56	60.42	60.29	60.16	60.03	59.90
60000 LB	MACH/IAS	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320	0.608/320
	EPR A/L	1.42/1.89	1.42/1.85	1.42/1.80	1.42/1.76	1.42/1.72	1.42/1.67	1.42/1.64	1.42/1.60	1.42/1.57
	N2 /N1	82.3/75.6	83.1/76.3	83.9/77.1	84.7/77.8	85.5/78.5	86.3/79.3	87.1/80.0	87.9/80.7	88.6/81.4
	F/F (AV)	3050	3087	3124	3161	3198	3235	3271	3308	3344
	EGT	323	335	347	359	371	383	395	407	419
	RAT/TAS	–6.9/373	–1.6/377	3.6/381	9.1/384	14.4/388	19.7/391	25.0/395	30.3/399	35.6/402
	NAM/1000	61.15	61.03	60.90	60.77	60.64	60.51	60.38	60.24	60.11

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 29000 FEET										CRUISE 29000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–57.5	–52.5	–47.5	–42.5	–37.5	–32.5	–27.5	–22.5	–17.5
110000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.754/291			
	EPR A/L	1.88/2.05	1.87/2.01	1.87/1.98	1.87/1.95	1.87/1.91	1.87/1.87			
	N2 /N1	85.1/83.6	86.1/84.6	87.1/85.5	88.0/86.4	89.0/87.3	89.8/88.1			
	F/F (AV)	3003	3042	3081	3121	3160	3177			
	EGT	363	377	392	406	421	434			
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.6/456			
	NAM/1000	72.26	72.15	72.03	71.91	71.79	71.81			
108000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.729/281		
	EPR A/L	1.86/2.05	1.86/2.01	1.86/1.98	1.86/1.95	1.86/1.91	1.86/1.87	1.84/1.84		
	N2 /N1	85.0/83.3	86.0/84.2	86.9/85.2	87.9/86.1	88.8/87.0	89.8/87.9	90.1/87.9		
	F/F (AV)	2968	3007	3046	3085	3123	3164	3039		
	EGT	360	375	389	404	418	433	437		
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	–1.7/446		
	NAM/1000	73.11	72.99	72.87	72.75	72.62	72.44	73.34		
106000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.738/285		
	EPR A/L	1.85/2.05	1.85/2.01	1.85/1.98	1.85/1.95	1.85/1.91	1.85/1.87	1.84/1.84		
	N2 /N1	84.9/83.0	85.8/84.0	86.8/84.9	87.7/85.8	88.7/86.7	89.6/87.6	90.1/87.9		
	F/F (AV)	2938	2977	3015	3053	3092	3130	3052		
	EGT	358	373	387	402	416	431	438		
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	–1.2/451		
	NAM/1000	73.85	73.73	73.62	73.49	73.36	73.23	73.89		
104000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.745/288	0.710/273	
	EPR A/L	1.85/2.05	1.84/2.01	1.84/1.98	1.84/1.95	1.84/1.91	1.84/1.87	1.83/1.85	1.81/1.81	
	N2 /N1	84.7/82.8	85.7/83.7	86.7/84.7	87.6/85.6	88.6/86.5	89.5/87.4	90.1/87.8	90.3/87.7	
	F/F (AV)	2911	2949	2987	3025	3063	3101	3062	2913	
	EGT	356	371	385	400	414	428	438	440	
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	–0.7/455	2.5/438	
	NAM/1000	74.55	74.43	74.31	74.18	74.05	73.91	74.35	75.18	
102000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.751/290	0.718/277	
	EPR A/L	1.84/2.05	1.84/2.01	1.84/1.98	1.84/1.95	1.83/1.91	1.83/1.87	1.83/1.83	1.80/1.80	
	N2 /N1	84.6/82.6	85.6/83.5	86.6/84.5	87.5/85.4	88.4/86.3	89.4/87.2	90.1/87.8	90.3/87.7	
	F/F (AV)	2886	2924	2962	2999	3037	3075	3072	2924	
	EGT	354	369	383	398	412	427	438	441	
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	–0.3/459	3.0/443	
	NAM/1000	75.19	75.07	74.95	74.82	74.69	74.55	74.73	75.78	
100000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.757/293	0.725/280	
	EPR A/L	1.83/2.05	1.83/2.01	1.83/1.98	1.83/1.95	1.83/1.91	1.83/1.87	1.82/1.82	1.80/1.80	
	N2 /N1	84.5/82.4	85.5/83.3	86.5/84.2	87.4/85.1	88.3/86.0	89.3/86.9	90.2/87.8	90.4/87.6	
	F/F (AV)	2861	2899	2936	2973	3011	3048	3080	2934	
	EGT	353	367	382	396	410	425	439	441	
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	3.5/448	
	NAM/1000	75.85	75.72	75.60	75.47	75.34	75.20	75.10	76.31	
98000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.732/282	0.698/268
	EPR A/L	1.82/2.05	1.82/2.01	1.82/1.98	1.82/1.95	1.82/1.91	1.82/1.87	1.82/1.82	1.79/1.79	1.77/1.77
	N2 /N1	84.4/82.1	85.4/83.1	86.3/84.0	87.3/84.9	88.2/85.8	89.1/86.7	90.1/87.6	90.4/87.6	90.5/87.4
	F/F (AV)	2834	2872	2909	2946	2983	3020	3060	2942	2793
	EGT	351	365	380	394	408	423	437	441	443
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	4.0/452	7.2/435
	NAM/1000	76.55	76.43	76.30	76.17	76.04	75.89	75.69	76.83	77.95
96000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.739/285	0.706/272
	EPR A/L	1.81/2.05	1.81/2.01	1.81/1.98	1.81/1.95	1.81/1.91	1.81/1.87	1.81/1.82	1.79/1.79	1.76/1.76
	N2 /N1	84.3/81.9	85.3/82.9	86.2/83.8	87.2/84.7	88.1/85.6	89.0/86.5	89.9/87.3	90.4/87.6	90.5/87.4
	F/F (AV)	2809	2846	2882	2919	2956	2993	3029	2950	2801
	EGT	349	363	378	392	406	421	435	442	444
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	4.4/456	7.7/440
	NAM/1000	77.26	77.13	77.01	76.88	76.74	76.59	76.45	77.31	78.59
94000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.745/288	0.714/275
	EPR A/L	1.80/2.05	1.80/2.01	1.80/1.98	1.80/1.95	1.80/1.91	1.80/1.87	1.80/1.82	1.79/1.79	1.76/1.76
	N2 /N1	84.2/81.7	85.2/82.6	86.1/83.5	87.1/84.5	88.0/85.3	88.9/86.2	89.8/87.1	90.4/87.5	90.5/87.3
	F/F (AV)	2783	2820	2856	2893	2929	2965	3001	2938	2809
	EGT	347	362	376	390	404	419	433	442	444
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	4.8/460	8.2/445
	NAM/1000	77.97	77.84	77.71	77.58	77.44	77.30	77.16	77.77	79.18

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 29000 FEET										CRUISE 29000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–57.5	–52.5	–47.5	–42.5	–37.5	–32.5	–27.5	–22.5	–17.5
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.751/290	0.721/278
	EPR A/L	1.79/2.05	1.79/2.01	1.79/1.98	1.79/1.95	1.79/1.91	1.79/1.87	1.79/1.82	1.78/1.78	1.76/1.76
92000	N2 /N1	84.1/81.5	85.0/82.4	86.0/83.3	86.9/84.2	87.9/85.1	88.8/86.0	89.7/86.9	90.4/87.5	90.6/87.3
LB	F/F (AV)	2756	2792	2828	2864	2900	2936	2972	2965	2829
	EGT	345	360	374	388	402	417	431	442	444
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.2/464	8.7/449
	NAM/1000	78.73	78.61	78.48	78.35	78.21	78.07	77.92	78.21	79.42
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.757/293	0.728/281
	EPR A/L	1.78/2.05	1.78/2.01	1.78/1.98	1.78/1.95	1.78/1.91	1.78/1.87	1.78/1.82	1.78/1.78	1.75/1.75
90000	N2 /N1	84.0/81.3	84.9/82.2	85.9/83.1	86.8/84.0	87.7/84.9	88.7/85.8	89.6/86.6	90.4/87.5	90.6/87.2
LB	F/F (AV)	2729	2765	2800	2836	2871	2907	2942	2972	2823
	EGT	344	358	372	386	400	414	429	442	444
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/467	9.1/454
	NAM/1000	79.51	79.39	79.26	79.13	79.00	78.85	78.71	78.62	80.35
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.734/283
	EPR A/L	1.78/2.05	1.77/2.01	1.77/1.98	1.77/1.95	1.77/1.91	1.77/1.87	1.77/1.82	1.77/1.78	1.75/1.75
88000	N2 /N1	83.8/81.0	84.8/82.0	85.7/82.9	86.7/83.8	87.6/84.6	88.5/85.5	89.4/86.4	90.3/87.3	90.6/87.2
LB	F/F (AV)	2702	2737	2773	2808	2843	2878	2913	2951	2832
	EGT	342	356	370	384	398	412	426	441	444
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	9.5/458
	NAM/1000	80.31	80.18	80.06	79.93	79.79	79.64	79.50	79.27	80.83
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.741/286
	EPR A/L	1.77/2.05	1.77/2.01	1.77/1.98	1.76/1.95	1.76/1.91	1.76/1.87	1.76/1.82	1.76/1.78	1.74/1.74
86000	N2 /N1	83.7/80.8	84.7/81.7	85.6/82.6	86.6/83.5	87.5/84.4	88.4/85.3	89.3/86.2	90.2/87.0	90.6/87.2
LB	F/F (AV)	2675	2710	2745	2780	2815	2849	2884	2919	2838
	EGT	340	354	368	382	396	410	424	438	445
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	10.0/462
	NAM/1000	81.12	80.99	80.86	80.73	80.59	80.44	80.30	80.14	81.32
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.746/288
	EPR A/L	1.76/2.05	1.76/2.01	1.76/1.98	1.76/1.95	1.76/1.91	1.76/1.87	1.75/1.82	1.75/1.78	1.74/1.74
84000	N2 /N1	83.6/80.6	84.6/81.5	85.5/82.4	86.4/83.3	87.4/84.2	88.3/85.1	89.2/85.9	90.1/86.8	90.6/87.2
LB	F/F (AV)	2656	2691	2726	2761	2795	2830	2865	2900	2844
	EGT	338	352	366	380	394	408	422	436	445
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	10.3/465
	NAM/1000	81.70	81.56	81.43	81.29	81.15	80.99	80.84	80.68	81.74
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.751/290
	EPR A/L	1.75/2.05	1.75/2.01	1.75/1.98	1.75/1.95	1.75/1.91	1.75/1.87	1.75/1.82	1.75/1.78	1.74/1.74
82000	N2 /N1	83.5/80.4	84.4/81.3	85.4/82.2	86.3/83.1	87.2/84.0	88.2/84.9	89.1/85.7	90.0/86.6	90.6/87.1
LB	F/F (AV)	2625	2660	2694	2729	2763	2797	2831	2866	2849
	EGT	336	350	364	378	392	406	420	434	445
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	10.6/468
	NAM/1000	82.65	82.52	82.39	82.24	82.10	81.95	81.79	81.63	82.12
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.755/292
	EPR A/L	1.74/2.05	1.74/2.01	1.74/1.98	1.74/1.95	1.74/1.91	1.74/1.87	1.74/1.82	1.74/1.78	1.73/1.73
80000	N2 /N1	83.4/80.2	84.3/81.1	85.3/82.0	86.2/82.9	87.1/83.8	88.0/84.7	88.9/85.5	89.8/86.4	90.6/87.1
LB	F/F (AV)	2602	2636	2670	2704	2738	2772	2806	2840	2854
	EGT	335	349	363	377	391	405	419	433	445
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	10.9/471
	NAM/1000	83.39	83.26	83.12	82.99	82.85	82.70	82.54	82.38	82.48
	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.73/2.05	1.73/2.01	1.73/1.98	1.73/1.95	1.73/1.91	1.73/1.87	1.73/1.82	1.73/1.78	1.73/1.73
78000	N2 /N1	83.3/80.0	84.2/80.9	85.2/81.8	86.1/82.7	87.0/83.6	87.9/84.5	88.8/85.3	89.7/86.2	90.6/87.0
LB	F/F (AV)	2579	2613	2647	2680	2714	2747	2781	2815	2849
	EGT	333	347	361	375	389	403	417	431	445
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/463	11.1/473
	NAM/1000	84.13	84.00	83.87	83.73	83.59	83.43	83.28	83.12	82.92

Flight planning and cruise control (continued)

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 29000 FEET										CRUISE 29000 FEET
GROSS WT	OPERATING PARAMETER	OAT–C AMBIENT								
		–57.5	–52.5	–47.5	–42.5	–37.5	–32.5	–27.5	–22.5	–17.5
76000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.73/2.05	1.73/2.01	1.73/1.98	1.73/1.95	1.73/1.91	1.72/1.87	1.72/1.82	1.72/1.78	1.72/1.73
	N2 /N1	83.2/79.9	84.1/80.8	85.1/81.7	86.0/82.6	86.9/83.4	87.8/84.3	88.7/85.2	89.6/86.0	90.5/86.8
	F/F (AV)	2558	2591	2624	2658	2691	2724	2758	2791	2824
	EGT	332	346	360	373	387	401	415	429	443
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	84.84	84.71	84.57	84.44	84.29	84.14	83.98	83.82	83.65
74000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.72/2.05	1.72/2.01	1.72/1.98	1.72/1.95	1.72/1.91	1.72/1.87	1.72/1.82	1.72/1.78	1.72/1.73
	N2 /N1	83.1/79.7	84.0/80.6	85.0/81.5	85.9/82.4	86.8/83.3	87.7/84.1	88.6/65.0	89.5/85.8	90.4/86.7
	F/F (AV)	2537	2571	2604	2637	2670	2703	2736	2769	2802
	EGT	330	344	358	372	386	400	413	427	441
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	85.52	85.39	85.25	85.11	84.97	84.81	84.65	84.49	84.32
72000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.71/2.05	1.71/2.01	1.71/1.98	1.71/1.95	1.71/1.91	1.71/1.87	1.71/1.82	1.71/1.78	1.71/1.73
	N2 /N1	83.0/79.6	83.9/80.5	84.9/81.3	85.8/82.2	86.7/83.1	87.6/84.0	88.5/84.8	89.4/85.7	90.3/86.5
	F/F (AV)	2518	2551	2584	2616	2649	2682	2715	2748	2781
	EGT	329	343	357	370	384	398	412	426	440
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	86.18	86.04	85.91	85.77	85.62	85.46	85.30	85.13	84.96
70000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.71/2.05	1.71/2.01	1.71/1.98	1.71/1.95	1.71/1.91	1.71/1.87	1.71/1.82	1.70/1.78	1.70/1.73
	N2 /N1	82.9/79.4	83.9/80.3	84.8/81.2	85.7/82.1	86.6/83.0	87.5/83.8	88.4/84.7	89.3/85.5	90.2/86.4
	F/F (AV)	2500	2532	2565	2597	2630	2663	2695	2729	2761
	EGT	328	342	355	369	383	397	411	424	438
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	86.81	86.67	86.54	86.40	86.25	86.09	85.93	85.76	85.58
68000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.70/2.05	1.70/2.01	1.70/1.98	1.70/1.95	1.70/1.91	1.70/1.87	1.70/1.82	1.70/1.78	1.70/1.73
	N2 /N1	82.8/79.3	83.8/80.2	84.7/81.0	85.6/81.9	86.5/82.8	87.4/83.7	88.3/84.5	89.2/85.4	90.1/86.2
	F/F (AV)	2480	2513	2545	2577	2610	2642	2674	2707	2739
	EGT	326	340	354	368	382	395	409	423	437
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	87.49	87.35	87.21	87.07	86.92	86.76	86.59	86.42	86.25
66000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.70/2.05	1.70/2.01	1.69/1.98	1.69/1.95	1.69/1.91	1.69/1.87	1.69/1.82	1.69/1.78	1.69/1.73
	N2 /N1	82.7/79.1	83.7/80.0	84.6/80.9	85.5/81.8	86.4/82.6	87.3/83.5	88.2/84.4	89.1/85.2	90.0/86.0
	F/F (AV)	2461	2493	2526	2558	2590	2622	2654	2686	2718
	EGT	325	339	353	366	380	394	408	421	435
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	88.16	88.02	87.88	87.74	87.59	87.43	87.26	87.09	86.91
64000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.69/2.05	1.69/2.01	1.69/1.98	1.69/1.95	1.69/1.91	1.69/1.87	1.69/1.82	1.69/1.78	1.69/1.73
	N2 /N1	82.6/79.0	83.6/79.9	84.5/80.7	85.4/81.6	86.4/82.5	87.3/83.4	88.1/84.2	89.0/85.0	89.9/85.9
	F/F (AV)	2442	2474	2506	2538	2570	2602	2634	2666	2698
	EGT	324	338	351	365	379	392	406	420	434
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	88.84	88.70	88.56	88.42	88.26	88.10	87.93	87.76	87.58
62000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.68/2.05	1.68/2.01	1.68/1.98	1.68/1.95	1.68/1.91	1.68/1.87	1.68/1.82	1.68/1.76	1.68/1.73
	N2 /N1	82.5/78.8	83.5/79.7	84.4/80.6	85.3/81.5	86.3/82.3	87.2/83.2	86.1/84.1	88.9/84.9	89.8/85.7
	F/F (AV)	2424	2456	2488	2519	2551	2582	2614	2646	2677
	EGT	323	336	350	364	377	391	405	418	432
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	89.51	89.37	89.23	89.08	88.93	88.76	88.60	88.42	88.24
60000 LB	MACH/IAS	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293	0.758/293
	EPR A/L	1.68/2.05	1.68/2.01	1.68/1.98	1.68/1.95	1.68/1.91	1.68/1.87	1.68/1.82	1.68/1.78	1.67/1.73
	N2 /N1	82.5/78.7	83.4/79.6	84.4/80.5	85.3/81.4	86.2/82.2	87.1/83.1	88.0/83.9	88.9/84.8	89.8/85.6
	F/F (AV)	2410	2442	2473	2505	2536	2568	2599	2631	2662
	EGT	322	335	349	363	376	390	404	417	431
	RAT/TAS	–32.8/434	–27.3/439	–21.8/444	–16.3/449	–10.9/454	–5.4/458	0.1/463	5.6/468	11.1/473
	NAM/1000	90.02	89.88	89.74	89.59	89.44	89.27	89.10	88.92	88.74

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 35000 FEET										CRUISE 35000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–69.3	–64.3	–59.3	–54.3	–49.3	–44.3	–39.3	–34.3	–29.3
90000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256			
	EPR A/L	1.93/2.12	1.93/2.09	1.93/2.06	1.93/2.03	1.93/1.99	1.93/1.96			
	N2 /N1	83.5/82.8	84.6/83.8	85.6/84.7	86.5/85.7	87.5/86.7	88.5/87.6			
	F/F (AV)	2381	2413	2446	2479	2511	2544			
	EGT	342	357	372	387	402	417			
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447			
	NAM/1000	88.60	88.46	88.32	88.17	88.02	87.86			
88000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256		
	EPR A/L	1.91/2.12	1.91/2.09	1.91/2.06	1.91/2.03	1.91/1.99	1.91/1.96	1.91/1.92		
	N2 /N1	83.3/82.3	84.3/83.3	85.3/84.3	86.3/85.2	87.2/86.2	88.2/87.1	89.3/88.1		
	F/F (AV)	2341	2372	2406	2438	2469	2501	2521		
	EGT	338	353	368	383	398	412	426		
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452		
	NAM/1000	90.11	89.99	89.80	89.66	89.51	89.36	89.61		
86000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.751/233	
	EPR A/L	1.90/2.12	1.90/2.09	1.90/2.06	1.89/2.03	1.89/1.99	1.89/1.96	1.89/1.92	1.89/1.89	
	N2 /N1	83.0/81.8	84.0/82.8	85.0/83.8	86.0/84.8	87.0/85.7	87.9/86.6	88.9/87.6	89.8/88.3	
	F/F (AV)	2304	2335	2366	2398	2429	2460	2491	2474	
	EGT	335	349	364	379	394	409	423	434	
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.9/452	
	NAM/1000	91.56	91.43	92.29	91.15	91.00	90.85	90.69	91.42	
84000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	
	EPR A/L	1.88/2.12	1.88/2.09	1.88/2.06	1.88/2.03	1.88/1.99	1.88/1.96	1.88/1.92	1.88/1.88	
	N2 /N1	82.8/81.4	83.8/82.4	84.8/83.4	85.8/84.3	86.8/85.3	87.7/86.2	88.7/87.1	89.8/88.1	
	F/F (AV)	2267	2298	2329	2360	2390	2421	2452	2468	
	EGT	331	346	361	376	390	405	420	433	
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	
	NAM/1000	93.04	92.90	92.76	92.62	92.47	92.31	92.15	92.50	
82000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.742/250
	EPR A/L	1.86/2.12	1.86/2.09	1.86/2.06	1.86/2.03	1.86/1.99	1.86/1.96	1.86/1.92	1.86/1.88	1.85/1.85
	N2 /N1	82.6/81.0	83.6/82.0	84.6/82.9	85.5/83.9	86.5/84.8	87.5/85.7	88.6/86.7	89.5/87.6	90.1/88.0
	F/F (AV)	2234	2264	2295	2325	2356	2386	2398	2428	2387
	EGT	329	343	358	373	387	402	415	429	438
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–2.9/452
	NAM/1000	94.43	94.29	94.14	93.98	93.83	93.67	94.20	94.03	94.65
80000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.752/253
	EPR A/L	1.85/2.12	1.85/2.09	1.85/2.06	1.85/2.03	1.85/1.99	1.85/1.96	1.85/1.92	1.85/1.88	1.84/1.84
	N2 /N1	82.4/80.7	83.4/81.6	84.4/82.6	85.3/83.5	86.3/84.5	87.3/85.4	88.2/86.3	89.4/87.3	90.2/88.0
	F/F (AV)	2206	2236	2266	2296	2326	2356	2366	2396	2400
	EGT	326	341	355	370	385	399	414	426	438
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–2.3/456
	NAM/1000	95.61	95.48	95.33	95.17	95.01	94.85	94.68	95.29	95.44
78000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.84/2.12	1.84/2.09	1.84/2.06	1.84/2.03	1.84/1.99	1.84/1.96	1.84/1.92	1.84/1.88	1.84/1.84
	N2 /N1	82.2/80.4	83.2/81.3	84.2/82.3	85.2/83.2	86.1/84.1	87.1/85.1	88.0/86.0	89.2/87.0	90.1/87.9
	F/F (AV)	2181	2211	2241	2271	2300	2330	2359	2367	2398
	EGT	324	339	353	368	382	397	411	423	438
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	96.70	96.56	96.41	96.25	96.09	95.93	95.75	96.44	96.21
76000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.83/2.12	1.83/2.09	1.83/2.06	1.83/2.03	1.83/1.99	1.83/1.96	1.83/1.92	1.83/1.88	1.83/1.84
	N2 /N1	82.1/80.1	83.1/81.0	84.0/82.0	85.0/82.9	86.0/83.9	86.9/84.8	87.8/85.7	89.1/86.7	90.0/87.6
	F/F (AV)	2158	2188	2217	2247	2276	2305	2335	2341	2370
	EGT	322	337	351	366	380	395	409	421	435
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	97.73	97.59	97.43	97.27	97.11	96.94	96.77	97.52	97.33

CRUISE CONTROL TABLES
TWO ENGINE CRUISE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30
CRUISE AT 320 KT IAS TO 25000 FT THEN AT M=.76

CRUISE 35000 FEET										CRUISE 35000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–69.3	–64.3	–59.3	–54.3	–49.3	–44.3	–39.3	–34.3	–29.3
74000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.82/2.12	1.82/2.09	1.82/2.06	1.82/2.03	1.82/1.99	1.81/1.96	1.81/1.92	1.81/1.88	1.81/1.84
	N2 /N1	81.9/79.8	82.9/80.7	83.9/81.7	84.9/82.6	85.8/83.5	86.8/84.5	87.7/85.4	88.9/86.4	89.8/87.2
	F/F (AV)	2133	2162	2191	2220	2249	2278	2307	2313	2342
	EGT	320	334	349	363	378	392	407	418	433
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	98.90	98.76	98.60	98.44	98.27	98.10	97.92	98.71	98.52
72000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.81/2.12	1.80/2.09	1.80/2.06	1.80/2.03	1.80/1.99	1.80/1.96	1.80/1.92	1.80/1.88	1.80/1.84
	N2 /N1	81.7/79.5	82.7/80.4	83.7/81.4	84.7/82.3	85.6/83.2	86.6/84.1	87.5/85.0	88.8/86.0	89.7/86.9
	F/F (AV)	2109	2138	2166	2195	2224	2253	2281	2285	2314
	EGT	318	332	347	361	376	390	404	416	430
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	100.03	99.87	99.72	99.55	99.38	99.21	99.03	99.90	99.71
70000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.79/2.12	1.79/2.09	1.79/2.06	1.79/2.03	1.79/1.99	1.79/1.96	1.79/1.92	1.79/1.88	1.79/1.84
	N2 /N1	81.6/79.2	82.6/80.1	83.5/81.1	84.5/82.0	85.4/82.9	86.4/83.8	87.3/84.7	88.6/85.7	89.5/86.6
	F/F (AV)	2084	2112	2141	2169	2198	2226	2254	2256	2284
	EGT	316	330	345	359	373	388	402	413	427
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	101.21	101.07	100.91	100.75	100.58	100.41	100.23	101.19	101.00
68000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.78/2.12	1.78/2.09	1.78/2.06	1.78/2.03	1.78/1.99	1.78/1.96	1.78/1.92	1.78/1.88	1.78/1.84
	N2 /N1	81.4/78.9	82.4/79.8	83.3/80.8	84.3/81.7	85.2/82.6	86.2/83.5	87.1/84.4	88.4/85.4	89.3/86.3
	F/F (AV)	2059	2087	2115	2143	2171	2199	2227	2227	2254
	EGT	314	328	342	357	371	385	400	410	424
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	102.46	102.31	102.15	101.99	101.81	101.64	101.46	102.52	102.33
66000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.77/2.12	1.77/2.09	1.77/2.06	1.77/2.03	1.77/1.99	1.77/1.96	1.77/1.92	1.77/1.88	1.77/1.84
	N2 /N1	81.2/78.6	82.2/79.5	83.1/80.5	84.1/81.4	85.0/82.3	86.0/83.2	86.9/84.1	87.7/84.9	89.2/86.0
	F/F (AV)	2034	2061	2089	2117	2144	2172	2199	2217	2225
	EGT	312	326	340	355	369	383	397	411	421
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	103.72	103.58	103.42	103.25	103.08	102.90	102.72	102.98	103.69
64000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.76/2.12	1.76/2.09	1.76/2.06	1.76/2.03	1.76/1.99	1.76/1.96	1.76/1.92	1.76/1.88	1.76/1.84
	N2 /N1	81.0/78.3	82.0/79.2	82.9/80.2	83.9/81.1	84.8/82.0	85.8/82.9	86.7/83.0	87.6/84.7	89.0/85.7
	F/F (AV)	2009	2037	2064	2091	2119	2146	2173	2201	2196
	EGT	310	324	338	353	367	381	395	409	419
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	104.98	104.83	104.67	104.50	104.33	104.15	103.96	103.75	105.04
62000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.75/2.12	1.75/2.09	1.75/2.06	1.75/2.03	1.75/1.99	1.75/1.96	1.75/1.92	1.74/1.88	1.73/1.84
	N2 /N1	80.9/78.1	81.8/79.0	82.8/79.9	83.8/80.8	84.7/81.8	85.6/82.6	86.6/83.5	87.5/84.4	88.8/85.4
	F/F (AV)	1985	2012	2039	2066	2098	2125	2152	2179	2171
	EGT	308	322	336	350	364	379	393	407	416
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	106.27	106.12	105.96	105.78	105.34	105.15	104.96	104.76	106.26
60000 LB	MACH/IAS	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256	0.758/256
	EPR A/L	1.74/2.12	1.74/2.09	1.74/2.06	1.74/2.03	1.74/1.99	1.73/1.96	1.73/1.92	1.73/1.88	1.74/1.84
	N2 /N1	80.7/77.8	81.7/78.7	82.6/79.7	83.6/80.6	84.5/81.5	85.5/82.4	86.4/83.3	87.3/84.1	88.7/85.2
	F/F (AV)	1965	1991	2018	2045	2070	2096	2123	2149	2145
	EGT	306	320	334	348	362	377	391	405	414
	RAT/TAS	–45.9/422	–40.4/427	–34.9/432	–29.4/437	–23.9/442	–18.4/447	–12.9/452	–7.4/457	–1.9/461
	NAM/1000	107.35	107.21	107.05	106.88	106.76	106.61	106.42	106.22	107.54

NORMAL DESCENT DATA

PRESS ALT. (1000 ft)	TIME (min)	FUEL (lb)	INITIATION DISTANCES – GNM CRUISE LEVEL WIND COMPONENT (kt)							A/C R.O.D.
			H/120	H/80	H/40	ZERO	T/40	T/80	T/120	
35	19	710	109	115	121	127	133	139	145	1000
34	18	660	103	109	115	120	126	131	137	↑
33	17	600	98	103	108	113	118	123	128	↑
32	16	540	91	96	101	105	110	114	118	↑
31	15	480	85	89	93	98	102	106	110	fpm
30	14	420	78	82	86	90	94	98	102	↓
29	13	350	70	74	78	82	85	89	93	↓
28	12	290	62	66	70	73	77	81	85	1000
27	12	280	61	65	68	72	75	78	81	2200
26	11	270	60	63	66	69	73	76	79	↑
25	11	260	58	61	64	67	71	74	77	↑
24	10	250	56	59	62	65	68	71	74	fpm
22	10	240	51	54	57	60	62	65	68	↓
20	9	230	46	49	52	55	57	60	63	↓
18	8	220	42	45	48	50	52	55	58	2000
16	8	210	39	41	43	45	48	50	52	1800
14	7	190	35	37	39	41	43	45	47	↕
12	6	170	31	33	35	36	38	40	42	1800

CONDITIONS:

(a) Temp. ISA +5 – Use for all temps.

(b) Top of descent weight – 40000 kg – Use for all weights.

(c) Descent wind component equal to 50% of cruise wind component has been used in above calculations.

NORMAL DESCENT TECHNIQUE:

(a) M.76 at 1000 fpm to 28000 ft at 300 kt – Idle thrust at 300 kt to 5000 ft – Reduce to 210 kt at 10 nm/3000'– Decelerate to approach speed.

NOTE:
The above tabulations show computed distances and are published for information only. Actual descent procedures will still be governed by requirements laid down in the Company Operating Manual, Section 3.

Flight planning and cruise control (continued)

D. Altitude Selection Data

(1) Normal Cruise

(a) The following tables provide a method of selecting the optimum altitude for a flight based on a minimum cost concept, i.e., both fuel and time costs have been evaluated and the altitude derived reflects a balancing of these costs.

(b) The tables require basic input information on stage length, general wind gradient, brake release weight and ambient temperature and the method used to select the optimum altitude is as follows:

(i) Establish wind gradient from the forecast wind data for the altitude bracket given in the RH column of the table 'OPTIMUM CRUISE ALTITUDE'.

NOTE: For stage lengths less than 100 nm, wind gradient is not required.

(ii) For appropriate wind gradient and stage length read optimum altitude from 'OPTIMUM CRUISE ALTITUDE' table. The wind gradients shown imply an increase in the wind conditions, i.e., an increasing headwind or increasing tailwind with altitude. For reverse gradients use the appropriate zero gradient column.

Under high weight/temperature conditions, the optimum altitude may not be achievable initially. Reference to the 'INITIAL CRUISE ALTITUDE CAPABILITY' table will provide the initial cruise altitude for BRW and also information on gross weight at which it is possible to step up toward the optimum altitude. Under certain high temperature/weight conditions the initial altitude has not been given. In these cases it is recommended that the initial altitude be 29000 ft and the aircraft allowed to cruise at Max. Cruise EPR. The 'INITIAL CRUISE ALTITUDE CAPABILITY' table indicates the initial mach number under these conditions. As weight decreases allow aircraft to accelerate to M.76, set thrust for this mach number, and then as weight further reduces step up to appropriate optimum altitude.

Continued on next page

Flight planning and cruise control (continued)

OPTIMUM CRUISE ALTITUDE (M.76) ~ 1000 ft

STAGE LENGTH NM	HEADWINDS WIND GRADIENT: kt/1000 ft				NIL WIND	TAILWINDS WIND GRADIENT: kt/1000 ft				FLIGHT LEVEL BRACKET FOR WIND GRADIENT
	6	4	2	0		0	2	4	6	
50	9	9	9	9	9	9	9	9	9	WIND GRADIENT NOT REQUIRED
75	13	13	13	13	13	11	11	11	11	
100	17	17	17	17	17	15	15	15	15	
125	17	19	19	19	19	17	17	17	17	BETWEEN F/L 185 & F/L 235
150	19	21	21	21	21	21	21	21	21	
175	21	25	25	25	23	23	23	23	23	
200	25	29	29	29	27	27	27	27	27	BETWEEN F/L 235 & F/L 300
225	25	31	31	31	29	29	29	29	29	
250	25	31	33	33	31	29	29	29	29	BETWEEN F/L 300 & F/L 340 (See NOTE below)
275	25	33	35	35	33	31	31	31	31	
300	25	33	35	35	35	33	33	33	33	
350	27	33	35	35	35	33	33	33	33	
400	29	33	35	35	35	35	35	35	35	
500 & GREATER	31	33	35	35	35	35	35	35	35	

NOTE: If headwind gradient greater than 4 kt/1000 ft, also check headwind gradient between F/L 235 and F/L 300. If this gradient is less than 5 kt/1000 ft, use 29000 ft as optimum altitude, otherwise use altitude given in table for 6 kt/1000 ft.

OPTIMUM CRUISE ALTITUDE TABLE

INITIAL CRUISE ALTITUDE CAPABILITY ~ 1000 ft
M.76 UNLESS OTHERWISE SPECIFIED

BRW ~1000 kg	GROSS WEIGHT ~1000 kg	ISA +			
		0	10	15	20
40	38.4	35	35	35	35
41	39.3	35	35	35	34
42	40.3	35	35	34	31
43	41.2	34	34	34	(M.754)
44	42.2	34	34	33	(M.748)
45	43.1	34	33	32	(M.742)
46	44.1	33	33	31	(M.735)
46.7	44.7	33	32	30	(M.730)

NOTE: Mach numbers in ISA +20 column are for 29000 ft.

INITIAL CRUISE ALTITUDE CAPABILITY TABLE

Flight planning and cruise control (continued)

CRUISE CONTROL TABLES
TWO ENGINE LONG RANGE OPERATION
JT8D-7 ENGINE NORMAL BLEED
DC-9 SERIES 30

LONG RANGE 13000 FEET										LONG RANGE 13000 FEET
GROSS WT	OPERATING PARAMETER	OAT-C AMBIENT								
		-25.8	-20.8	-15.8	-10.8	-5.8	-0.8	4.2	9.2	14.2
110000 LB	MACH/IAS	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309
	EPR A/L	1.48/1.90	1.48/1.86	1.48/1.81	1.48/1.77	1.48/1.73	1.48/1.68	1.48/1.65	1.48/1.61	1.48/1.57
	N2 /N1	83.2/77.3	84.0/78.1	84.9/78.8	85.7/79.6	86.5/80.4	87.3/81.1	88.1/81.8	88.9/82.6	89.7/83.3
	F/F (AV)	3286	3325	3365	3405	3445	3484	3524	3565	3603
	EGT	335	347	359	372	384	396	408	421	433
	RAT/TAS	-8.0/360	-2.7/364	2.6/367	7.9/371	13.2/375	18.5/378	23.8/381	29.1/385	34.4/388
	NAM/1000	54,82	54,71	54,59	54,48	54,36	54,24	54,12	53,98	53,88
108000 LB	MACH/IAS	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309	0.587/309
	EPR A/L	1.48/1.90	1.48/1.86	1.48/1.81	1.48/1.77	1.48/1.73	1.48/1.68	1.48/1.65	1.48/1.61	1.47/1.57
	N2 /N1	83.1/77.2	84.0/77.9	84.8/78.7	85.6/79.5	86.4/80.2	87.2/80.9	88.0/81.7	88.8/82.4	89.6/83.1
	F/F (AV)	3264	3304	3343	3383	3422	3462	3501	3542	3580
	EGT	334	346	358	371	383	395	407	420	432
	RAT/TAS	-8.0/360	-2.7/364	2.6/367	7.9/371	13.2/375	18.5/378	23.8/381	29.1/385	34.4/388
	NAM/1000	55,18	55.07	54.95	54.83	54.71	54.60	54.48	54.33	54.22
106000 LB	MACH/IAS	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302
	EPR A/L	1.46/1.90	1.46/1.86	1.46/1.82	1.46/1.78	1.46/1.73	1.46/1.69	1.46/1.65	1.46/1.62	1.46/1.58
	N2 /N1	82.7/76.5	83.6/77.3	84.4/78.0	85.2/78.8	86.0/79.5	86.8/80.2	87.6/81.0	88.4/81.7	89.2/82.4
	F/F (AV)	3153	3191	3229	3267	3305	3343	3381	3421	3457
	EGT	329	341	353	365	377	389	401	414	426
	RAT/TAS	-8.6/352	-3.4/356	1.9/359	72./363	12.5/366	17.8/370	23.0/373	28.3/376	33.6/380
	NAM/1000	55.87	55.76	55.64	55,52	55.40	55,29	55,17	55,01	54,91
104000 LB	MACH/IAS	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302
	EPR A/L	1.46/1.90	1.46/1.86	1.46/1.82	1.46/1.78	1.46/1.73	1.45/1.69	1.45/1.65	1.45/1.62	1.45/1.58
	N2 /N1	82.7/76.4	83.5/77.1	84.3/77.9	85.1/78.6	85.9/79.4	86.7/80.1	87.5/80.8	88.3/81.6	89.1/82.3
	F/F (AV)	3131	3169	3207	3245	3283	3320	3358	3398	3434
	EGT	328	340	352	364	376	388	400	412	424
	RAT/TAS	-8.6/352	-3.4/356	1.9/359	7.2/363	12.5/366	17.8/370	23.0/373	28.3/376	33.6/380
	NAM/1000	56.25	56.13	56.02	55.90	55.78	55.66	55,54	55,38	55,28
102000 LB	MACH/IAS	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302	0.574/302
	EPR A/L	1.45/1.90	1.45/1.86	1.45/1.82	1.45/1.78	1.45/1.73	1.45/1.69	1.45/1.65	1.45/1.62	1.45/1.58
	N2 /N1	82.6/76.2	83.4/77.0	84.2/77.7	85.0/78.5	85.8/79.2	86.6/79.9	87.4/80.7	88.2/81.4	89.0/82.1
	F/F (AV)	3111	3148	3186	3223	3261	3298	3335	3373	3411
	EGT	327	339	351	363	375	387	399	411	423
	RAT/TAS	-8.6/352	-3.4/356	1.9/359	7.2/363	12.5/366	17.8/370	23.0/373	28.3/376	33.6/380
	NAM/1000	56,62	56,51	56,39	56,27	56,15	56,03	55,91	55.79	55.65
100000 LB	MACH/IAS	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294
	EPR A/L	1.43/1.91	1.43/1.87	1.43/1.83	1.43/1.78	1.43/1.74	1.43/1.70	1.43/1.66	1.43/1.62	1.43/1.59
	N2 /N1	82.1/75.5	83.0/76.2	83.8/77.0	84.6/77.7	85.4/78.4	86.2/79.2	87.0/79.9	87.7/80.6	88.5/81.3
	F/F (AV)	2992	3028	3065	3101	3137	3172	3208	3244	3281
	EGT	321	333	345	357	369	381	393	405	417
	RAT/TAS	-9.4/343	-4.1/347	1.2/350	6.4/354	11.7/357	17.0&360	22.2/364	27.5/367	32.8/370
	NAM/1000	57.38	57.26	57.14	57,02	56.91	56,79	56,67	56,55	56,39
98000 LB	MACH/IAS	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294
	EPR A/L	1.43/1.91	1.43/1.87	1.43/1.83	1.43/1.78	1.43/1.74	1.43/1.70	1.43/1.66	1.43/1.62	1.43/1.59
	N2 /N1	82.1/75.3	82.9/76.1	83.7/76.8	84.5/77.5	85.3/78.3	86.1/79.0	86.9/79.7	87.6/80.4	88.4/81.1
	F/F (AV)	2972	3007	3043	3079	3115	3150	3186	3221	3259
	EGT	320	332	344	356	368	380	391	403	415
	RAT/TAS	-9.4/343	-4.1/347	1.2/350	6.4/354	11.7/357	17.0/360	22.2/364	27.5/367	32.8/370
	NAM/1000	57.78	57.66	57.54	57.42	57.30	57,18	57,06	56,94	56.79
96000 LB	MACH/IAS	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294	0.560/294
	EPR A/L	1.42/1.91	1.42/1.87	1.42/1.83	1.42/1.78	1.42/1.74	1.42/1.70	1.42/1.66	1.42/1.62	1.42/1.59
	N2 /N1	82.0/75.2	82.8/75.9	83.6/76.7	84.4/77.4	85.2/78.1	86.0/78.8	86.8/79.6	87.6/80.3	88.3/81.0
	F/F (AV)	2951	2987	3023	3058	3094	3129	3164	3199	3236
	EGT	319	331	343	355	366	378	390	402	414
	RAT/TAS	-9.4/343	-4.1/347	1.2/350	6.4/354	11.7/357	17.0/360	22.2/364	27.5/367	32.8/370
	NAM/1000	58.17	58.06	57.94	57,82	57,70	57,58	57,46	57,33	57,18
94000 LB	MACH/IAS	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285
	EPR A/L	1.41/1.91	1.41/1.87	1.41/1.83	1.41/1.79	1.41/1.75	1.41/1.70	1.41/1.66	1.41/1.63	1.40/1.59
	N2 /N1	81.5/74.3	82.3/75.1	83.1/75.8	83.9/76.5	84.7/77.3	85.5/78.0	86.3/78.7	87.0/79.4	87.8/80.1
	F/F (AV)	2830	2864	2898	2932	2966	2999	3033	3067	3100
	EGT	313	324	336	348	360	372	383	395	407
	RAT/TAS	-10.1/334	-4.9/337	0.4/341	5.7/344	10.9/347	16.2/350	21.4/354	26.7/357	31.9/360
	NAM/1000	58.99	58.87	58.75	58.63	58,52	58,40	58.28	58,16	58.03
92000 LB	MACH/IAS	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285
	EPR A/L	1.40/1.91	1.40/1.87	1.40/1.83	1.40/1.79	1.40/1.75	1.40/1.70	1.40/1.66	1.40/1.63	1.40/1.59
	N2 /N1	81.4/74.2	82.2/74.9	83.0/75.7	83.8/76.4	84.6/77.1	85.4/77.8	86.2/78.5	86.9/79.2	87.7/79.9
	F/F (AV)	2809	2843	2877	2911	2944	2978	3011	3045	3078
	EGT	312	323	335	347	359	370	382	394	406
	RAT/TAS	-10.1/334	-4.9/337	0.4/341	5.7/344	10.9/347	16.2/350	21.4/354	26.7/357	31.9/360
	NAM/1000	59.43	59.31	59.19	59.06	58.95	58.83	58.70	58.58	58.45

CRUISE CONTROL TABLES
TWO ENGINE LONG RANGE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30

LONG RANGE 13000 FEET										LONG RANGE 13000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–25.8	–20.8	–15.8	–10.8	–5.8	–0.8	4.2	9.2	14.2
90000 LB	MACH/IAS	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285	0.544/285
	EPR A/L	1.40/1.91	1.40/1.87	1.40/1.83	1.40/1.79	1.40/1.75	1.40/1.70	1.40/1.66	1.40/1.63	1.40/1:59
	N2 /N1	81.4/74.1	82.2/74.9	83.0/75.6	83.8/76.3	84.6/77.0	85.4/77.7	86.2/78.4	86.9/79.1	87.7/79.8
	F/F (AV)	2793	2827	2863	2899	2928	2963	2997	3030	3063
	EGT	311	322	334	346	358	370	381	393	405
	RAT/TAS	–10.1/334	–4.9/337	0.4/341	5.7/344	10.9/347	16.2/350	21.4/354	26.7/357	31.9/360
	NAM/1000	59.77	59.65	59.48	59.31	59.28	59.11	58.99	58.87	58.73
88000 LB	MACH/IAS	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277
	EPR A/L	1.38/1.92	1.38/1.88	1.38/1.84	1.38/1.80	1.38/1.76	1.38/1.71	1.38/1.67	1.38/1.63	1.38/1.60
	N2 /N1	80.9/73.3	81.7/74.0	82.5/74.7	83.3/75.5	84.1/76.2	84.8/76.8	85.6/77.5	86.4/78.2	87.1/78.9
	F/F (AV)	2682	2714	2746	2778	2809	2840	2873	2905	2936
	EGT	305	317	328	340	351	363	375	386	398
	RAT/TAS	–10.8/324	–5.6/328	–0.4/331	4.9/334	10.1/337	15.4/340	20.6/343	25.8/347	31.1/350
	NAM/1000	60.46	60.35	60.23	60.13	60.02	59.93	59.78	59.65	59.53
86000 LB	MACH/IAS	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277
	EPR A/L	1.38/1.92	1.38/1.88	1.38/1.84	1.38/1.80	1.38/1.76	1.38/1.71	1.38/1.67	1.38/1.63	1.38/1.60
	N2 /N1	80.8/73.1	81.6/73.9	82.4/74.6	83.2/75.3	84.0/76.0	84.8/76.7	85.5/77.4	86.3/78.1	87.0/78.7
	F/F (AV)	2662	2694	2725	2757	2787	2820	2852	2883	2915
	EGT	304	315	327	339	350	362	373	385	397
	RAT/TAS	–10.8/324	–5.6/328	–0.4/331	4.9/334	10.1/337	15.4/340	20.6/343	25.8/347	31.1/350
	NAM/1000	60.93	60.81	60.70	60.59	60.49	60.34	60.22	60.09	59.97
84000 LB	MACH/IAS	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277	0.529/277
	EPR A/L	1.37/1.92	1.37/1.88	1.37/1.84	1.37/1.80	1.37/1.76	1.37/1.71	1.37/1.67	1.37/1.63	1.37/1.60
	N2 /N1	80.7/73.0	81.5/73.7	82.3/74.4	83.1/75.1	83.9/75.8	84.7/76.5	85.4/77.2	86.2/77.9	86.9/78.6
	F/F (AV)	2650	2682	2713	2744	2777	2808	2840	2871	2903
	EGT	303	314	326	337	349	361	372	384	395
	RAT/TAS	–10.8/324	–5.6/328	–0.4/331	4.9/334	10.1/337	15.4/340	20.6/343	25.8/347	31.1/350
	NAM/1000	61.20	61.09	60.97	60.86	60.72	60.59	60.47	60.34	60.22
82000 LB	MACH/IAS	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268
	EPR A/L	1.36/1.93	1.36/1.89	1.36/1.85	1.36/1.81	1.36/1.76	1.36/1.72	1.36/1.68	1.36/1.64	1.36/1.61
	N2 /N1	80.2/72.1	81.0/72.8	81.8/73.5	82.6/74.2	83.3/74.9	84.1/75.6	84.9/76.2	85.6/76.9	86.4/77.6
	F/F (AV)	2533	2564	2595	2625	2655	2685	2714	2743	2774
	EGT	297	309	320	331	343	354	366	377	389
	RAT/TAS	–11.6/315	–6.3/318	–1.1/321	4.1/324	9.3/327	14.6/330	19.8/333	25.0/336	30.2/339
	NAM/1000	62.08	61.95	61.82	61.70	61.59	61.47	61.36	61.26	61.11
80000 LB	MACH/IAS	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268
	EPR A/L	1.35/1.93	1.35/1.89	1.35/1.85	1.35/1.81	1.35/1.76	1.35/1.72	1.35/1.68	1.35/1.64	1.35/1.61
	N2 /N1	80.1/71.9	80.9/72.6	81.7/73.3	82.5/74.0	83.2/74.7	84.0/75.4	84.8/76.1	85.5/76.7	86.3/77.4
	F/F (AV)	2514	2545	2575	2605	2635	2664	2693	2722	2753
	EGT	296	307	319	330	342	353	365	376	387
	RAT/TAS	–11.6/315	–6.3/318	–1.1/321	4.1/324	9.3/327	14.6/330	19.8/333	25.0/336	30.2/339
	NAM/1000	62.55	62.42	62.29	62.17	62.06	61.94	61.83	61.73	61.58
78000 LB	MACH/IAS	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268	0.513/268
	EPR A/L	1.35/1.93	1.35/1.89	1.35/1.85	1.35/1.81	1.35/1.76	1.35/1.72	1.35/1.68	1.35/1.64	1.35/1.61
	N2 /N1	80.0/71.7	80.8/72.4	81.6/73.1	82.3/73.8	83.1/74.5	83.9/75.2	84.6/75.9	85.4/76.5	86.1/77.2
	F/F (AV)	2496	2526	2554	2584	2615	2644	2673	2702	2732
	EGT	295	306	318	329	341	352	363	375	386
	RAT/TAS	–11.6/315	–6.3/318	–1.1/321	4.1/324	9.3/327	14.6/330	19.8/333	25.0/336	30.2/339
	NAM/1000	63.02	62.89	62.80	62.68	62.52	62.41	62.29	62.19	62.04
76000 LB	MACH/IAS	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260
	EPR A/L	1.33/1.93	1.33/1.80	1.33/1.85	1.33/1.81	1.33/1.77	1.33/1.73	1.33/1.68	1.33/1.65	1.33/1.61
	N2 /N1	79.4/70.7	80.2/71.4	81.0/72.1	81.7/72.8	82.5/73.5	83.3/74.2	84.0/74.8	84.8/75.5	85.5/76.1
	F/F (AV)	2385	2414	2443	2471	2500	2528	2555	2583	2610
	EGT	289	300	312	323	334	346	357	368	379
	RAT/TAS	–12.2/305	–7.0/308	–1.8/311	3.4/314	8.6/317	13.8/320	19.0/323	24.2/326	29.4/329
	NAM/1000	63.94	63.81	63.68	63.56	63.44	63.32	63.20	63.09	62.99
74000 LB	MACH/IAS	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260
	EPR A/L	1.33/1.93	1.33/1.89	1.33/1.85	1.33/1.81	.133/1.77	1.33/1.73	1.33/1.68	1.33/1.65	1.33/1.61
	N2 /N1	79.3/70.5	80.1/71.2	80.9/71.9	81.6/72.6	82.4/73.3	83.2/74.0	83.9/74.6	84.7/75.3	85.4/75.9
	F/F (AV)	2367	2395	2424	2452	2480	2508	2535	2562	2589
	EGT	288	299	311	322	333	344	356	367	378
	RAT/TAS	–12.2/305	–7.0/308	–1.8/311	3.4/314	8.6/317	13.8/320	19.0/323	24.2/326	29.4/329
	NAM/1000	64.45	64.31	64.19	64.06	63.94	63.82	63.71	63.59	63.49
72000 LB	MACH/IAS	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260	0.497/260
	EPR A/L	1.32/1.93	1.32/1.89	1.32/1.85	1.32/1.81	1.32/1.77	1.32/1.73	1.32/1.68	1.32/1.65	1.32/1.61
	N2 /N1	79.2/70.4	80.0/71.1	80.8/71.7	81.5/72.4	82.3/73.1	83.1/73.8	83.8/74.4	84.5/75.1	85.3/75.7
	F/F (AV)	2348	2377	2405	2433	2461	2488	2516	2543	2569
	EGT	287	298	309	321	332	343	354	366	377
	RAT/TAS	–12.2/305	–7.0/308	–1.8/311	3.4/314	8.6/317	13.8/320	19.0/323	24.2/326	29.4/329
	NAM/1000	64.95	64.82	64.69	64.56	64.44	64.32	64.20	64.09	63.96

CRUISE CONTROL TABLES
TWO ENGINE LONG RANGE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30

LONG RANGE 29000 FEET										LONG RANGE 29000 FEET
GROSS WT	OPERATING PARAMETER	OAT–C AMBIENT −57.5	−52.5	−47.5	−42.5	−37.5	−32.5	−27.5	−22.5	−17.5
110000 LB	MACH/IAS	0.748/289	0.748/289	0.748/289	0.748/289	0.748/289	0.748/289			
	EPR A/L	1.87/2.05	1.87/2.02	1.87/1.99	1.87/1.95	1.86/1.91	1.87/1.87			
	N2 /N1	84.9/83.3	85.9/84.2	86.9/85.2	87.8/86.1	88.7/87.0	89.7/87.9			
	F/F (AV)	2946	2985	3023	3062	3100	3141			
	EGT	359	374	388	403	417	432			
	RAT/TAS	−33.4/428	−27.9/433	−22.4/438	−17.0/443	−11.5/448	−6.0/452			
	NAM/1000	72.69	72.57	72.45	72.33	72.20	72.01			
108000 LB	MACH/IAS	0.748/289	0.748/289	0.748/289	0.748/289	0.748/289	0.748/289	0.729/281		
	EPR A/L	1.86/2.05	1.86/2.02	1.85/1.99	1.85/1.95	1.85/1.91	1.85/1.87	1.84/1.84		
	N2 /N1	84.8/83.0	85.8/83.9	86.7/84.9	87.7/85.8	88.6/86.7	89.5/87.6	90.1/87.9		
	F/F (AV)	2912	2950	2988	3026	3064	3102	3038		
	EGT	357	371	386	400	415	429	437		
	RAT/TAS	−33.4/428	−27.9/433	−22.4/438	−17.0/443	−11.5/448	−6.0/452	−1.7/446		
	NAM/1000	73.54	73.42	73.30	73.18	73.05	72.92	73.35		
106000 LB	MACH/IAS	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282		
	EPR A/L	1.83/2.06	1.83/2.02	1.83/1.99	1.83/1.96	1.83/1.92	1.83/1.88	1.83/1.84		
	N2 /N1	84.3/82.2	85.3/83.2	86.2/84.1	87.2/85.0	88.1/85.9	89.0/86.8	89.9/87.7		
	F/F (AV)	2795	2832	2868	2905	2941	2978	3014		
	EGT	350	364	378	392	407	421	435		
	RAT/TAS	−34.4/419	−28.9/423	−23.4/428	−18.0/433	−12.5/437	−7.1/442	−1.6/447		
	NAM/1000	74.87	74.75	74.63	74.51	74.37	74.24	74.10		
104000 LB	MACH/IAS	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.709/273	
	EPR A/L	1.82/2.06	1.82/2.02	1.82/1.99	1.82/1.96	1.82/1.92	1.82/1.88	1.82/1.84	1.81/1.81	
	N2 /N1	84.2/82.0	85.2/82.9	86.1/83.8	87.0/84.7	88.0/85.6	88.9/86.5	89.8/87.4	90.3/87.7	
	F/F (AV)	2767	2803	2839	2876	2912	2948	2984	2911	
	EGT	348	362	376	390	405	419	433	440	
	RAT/TAS	−34.4/419	−28.9/423	−23.4/428	−18.0/433	−12.5/437	−7.1/442	−1.6/447	2.5/438	
	NAM/1000	75.63	75.51	75.39	75.26	75.12	74.99	74.85	75.19	
102000 LB	MACH/IAS	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.731/282	0.718/276	
	EPR A/L	1.82/2.06	1.81/2.02	1.81/1.99	1.81/1.96	1.81/1.92	1.81/1.88	1.81/1.84	1.80/1.80	
	N2 /N1	84.1/81.8	85.0/82.7	86.0/83.6	86.9/84.5	87.9/85.4	88.8/86.3	89.7/87.2	90.3/87.6	
	F/F (AV)	2741	2777	2813	2849	2885	2920	2956	2923	
	EGT	346	360	376	388	403	417	431	441	
	RAT/TAS	−34.4/419	−28.9/423	−23.4/428	−18.0/433	−12.5/437	−7.1/442	−1.6/447	3.0/443	
	NAM/1000	76.34	76.22	76.09	75.97	75.83	75.69	75.55	75.79	
100000 LB	MACH/IAS	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	
	EPR A/L	1.78/2.07	1.78/2.04	1.78/2.01	1.78/1.97	1.78/1.94	1.78/1.90	1.78/1.86	1.78/1.82	
	N2 /N1	83.3/80.6	84.2/81.5	85.2/82.4	86.1/83.3	87.0/84.2	87.9/85.0	88,8/85.9	89.7/85.8	
	F/F (AV)	2549	2582	2616	2649	2682	2715	2748	2781	
	EGT	334	347	361	375	389	403	417	431	
	RAT/TAS	−36.2/398	−30.8/403	−25.4/408	−20.0/412	−14.6/417	−9.2/421	−3.8/425	1.7/430	
	NAM/1000	78.16	78.04	77.91	77.79	77.66	77.52	77.38	77.23	
98000 LB	MACH/IAS	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267
	EPR A/L	1.77/2.07	1.77/2.04	1.77/2.01	1.77/1.97	1.77/1.94	1.77/1.90	1.77/1.86	1.77/1.82	1.77/1.77
	N2 /N1	83.1/80.3	84.1/81.2	85.0/82.1	86.0/83.0	86.9/83.9	87.8/84.9	88.7/85.6	89.6/86.5	90.5/87.3
	F/F (AV)	2519	2551	2584	2617	2650	2682	2715	2748	2782
	EGT	331	345	359	373	387	401	415	429	443
	RAT/TAS	−36.2/398	−30.8/403	−25.4/408	−20.0/412	−14.6/417	−9.2/421	−3.8/425	1.7/430	7.1/434
	NAM/1000	79.11	78.99	78.86	78.73	78.60	78.46	78.32	78.17	77.99
96000 LB	MACH/IAS	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267	0.696/267
	EPR A/L	1.76/2.07	1.76/2.04	1.76/2.01	1.76/1.97	1.76/1.94	1.76/1.90	1.76/1.86	1.76/1.82	1.76/1.77
	N2 /N1	83.0/80.0	83.9/81.0	84.9/81.9	85.8/82.7	86.7/83.6	87.6/84.5	88.5/85.4	89.4/86.2	90.3/87.1
	F/F (AV)	2489	2522	2554	2587	2619	2651	2684	2716	2748
	EGT	329	343	357	371	385	398	412	426	440
	RAT/TAS	−36.2/398	−30.8/403	−25.4/408	−20.0/412	−14.6/417	−9.2/421	−3.8/425	1.7/430	7.1/434
	NAM/1000	80.04	79.92	79.79	79.66	79.53	79.38	79.24	79.09	79.93
94000 LB	MACH/IAS	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262
	EPR A/L	1.74/2.07	1.74/2.04	1.74/2.01	1.74/1.98	1.74/1.94	1.74/1.91	1.74/1.86	1.74/1.82	1.74/1.78
	N2 /N1	82.6/79.5	83.6/80.4	84.5/81.3	85.4/82.2	86.3/83.0	87.2/83.9	88.1/84.8	89.0/85.6	89.9/86.4
	F/F (AV)	2409	2440	2472	2503	2534	2565	2597	2628	2659
	EGT	324	337	351	365	379	392	406	420	433
	RAT/TAS	−36.9/392	−31.5/396	−26.1/401	−20.7/405	−15.3/409	−9.9/414	−4.5/418	0.9/422	6.3/426
	NAM/1000	81.29	81.16	81.03	80.90	80.77	80.63	80.48	80.32	80.17

CRUISE CONTROL TABLES
TWO ENGINE LONG RANGE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30

LONG RANGE 29000 FEET										LONG RANGE 29000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–57.5	–52.5	–47.5	–42.5	–37.5	–32.5	–27.5	–22.5	–17.5
	MACH/IAS	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262
	EPR A/L	1.73/2.07	1.73/2.04	1.73/2.01	1.73/1.98	1.73/1.94	1.73/1.91	1.73/1.86	1.73/1.82	1.73/1.78
92000	N2 /N1	82.5/79.2	83.4/80.1	84.4/81.0	85.3/81.9	86.2/82.8	87.1/83.6	88.0/84.5	88.9/85.3	89.7/86.2
LB	F/F (AV)	2379	2410	2441	2472	2503	2534	2565	2595	2626
	EGT	321	335	349	363	376	390	404	417	431
	RAT/TAS	–36.9/392	–31.5/396	–26.1/401	–20.7/405	–15.3/409	–9.9/414	–4.5/418	0.9/422	6.3/426
	NAM/1000	82.31	82.18	82.05	81.92	81.78	81.64	81.49	81.33	81.17
	MACH/IAS	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262	0.684/262
	EPR A/L	1.72/2.07	1.72/2.04	1.72/2.01	1.72/1.98	1.72/1.94	1.72/1.91	1.72/1.86	1.72/1.82	1.72/1.78
90000	N2 /N1	82.3/79.0	83.3/79.9	84.2/80.8	85.1/81.6	86.0/82.5	86.9/83.4	87.8/84.2	88.7/85.0	89.6/85.9
LB	F/F (AV)	2347	2378	2409	2439	2469	2500	2530	2561	2592
	EGT	319	333	346	360	374	387	401	415	428
	RAT/TAS	–36.9/392	–31.5/396	–26.1/401	–20.7/405	–15.3/409	–9.9/414	–4.5/418	0.9/422	6.3/426
	NAM/1000	83.42	83.29	83.16	83.02	82.89	82.74	82.58	82.43	82.26
	MACH/IAS	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261
	EPR A/L	1.71/2.07	1.71/2.04	1.71/2.01	1.71/1.98	1.70/1.94	1.70/1.91	1.70/1.87	1.70/1.82	1.70/1.78
88000	N2 /N1	82.1/78.6	83.0/79.5	83.9/80.3	84.8/81.2	85.8/82.1	86.7/82.9	87.5/83.8	88.4/84.6	89.3/85.5
LB	F/F (AV)	2296	2326	2356	2386	2415	2445	2475	2505	2535
	EGT	316	329	343	356	370	383	397	410	424
	RAT/TAS	–37.1/389	–31.7/394	–26.3/398	–20.9/402	–15.5/407	–10.1/411	–4.7/415	0.7/419	6.1/424
	NAM/1000	84.74	84.61	84.47	84.32	84.18	84.03	83.87	83.72	83.56
	MACH/IAS	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261
	EPR A/L	1.69/2.07	1.69/2.04	1.69/2.01	1.69/1.98	1.69/1.94	1.69/1.91	1.69/1.87	1.69/1.82	1.69/1.78
86000	N2 /N1	81.9/78.3	82.8/79.2	83.7/80.1	84.7/80.9	85.6/81.8	86.5/82.6	87.4/83.5	88.3/84.3	89.1/85.2
LB	F/F (AV)	2264	2294	2324	2353	2383	2412	2442	2470	2500
	EGT	313	327	340	354	367	381	394	408	421
	RAT/TAS	–37.1/389	–31.7/394	–26.3/398	–20.9/402	–15.5/407	–10.1/411	–4.7/415	0.7/419	6.1/424
	NAM/1000	85.90	85.77	85.63	85.49	85.34	85.18	85.01	84.90	84.73
	MACH/IAS	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261	0.679/261
	EPR A/L	1.68/2.07	1.68/2.04	1.68/2.01	1.68/1.98	1.68/1.94	1.68/1.91	1.68/1.87	1.68/1.82	1.68/1.78
84000	N2 /N1	81.7/78.0	82.7/78.9	83.6/79.8	84.5/80.7	85.4/81.5	86.3/82.4	87.2/83.2	88.1/84.1	89.0/84.9
LB	F/F (AV)	2236	2266	2295	2324	2353	2383	2412	2439	2468
	EGT	311	325	338	352	365	379	392	405	419
	RAT/TAS	–37.1/389	–31.7/394	–26.3/398	–20.9/402	–15.5/407	–10.1/411	–4.7/415	0.7/419	6.1/424
	NAM/1000	86.98	86.84	86.70	86.55	86.40	86.24	86.07	85.99	85.82
	MACH/IAS	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259
	EPR A/L	1.67/2.08	1.67/2.04	1.67/2.01	1.67/1.98	1.67/1.95	1.67/1.91	1.67/1.87	1.67/1.83	1.67/1.78
82000	N2 /N1	81.5/77.7	82.4/78.6	83.3/79.5	84.2/80.3	85.1/81.2	86.0/82.0	86.9/82.9	87.8/83.7	88.7/84.6
LB	F/F (AV)	2193	2222	2250	2279	2308	2336	2365	2395	2418
	EGT	308	322	335	349	362	375	389	402	415
	RAT/TAS	–37.3/386	–31.9/391	–26.6/395	–21.2/400	–15.8/404	–10.4/408	–5.0/412	0.4/417	5.8/421
	NAM/1000	88.12	87.98	87.83	87.68	87.53	87.37	87.19	86.98	87.02
	MACH/IAS	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259
	EPR A/L	1.66/2.08	1.66/2.04	1.66/2.01	1.66/1.98	1.66/1.95	1.66/1.91	1.66/1.87	1.66/1.83	1.66/1.78
80000	N2 /N1	81.3/77.5	82.3/78.4	83.2/79.2	84.1/80.1	85.0/81.0	85.9/81.8	86.8/82.6	87.6/83.5	88.6/84.3
LB	F/F (AV)	2171	2197	2226	2254	2282	2311	2339	2369	2390
	EGT	307	320	334	347	360	374	387	400	413
	RAT/TAS	–37.3/386	–31.9/391	–26.6/395	–21.2/400	–15.8/404	–10.4/408	–5.0/412	0.4/417	5.8/421
	NAM/1000	89.02	88.96	88.81	88.66	88.50	88.34	88.16	87.94	88.01
	MACH/IAS	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259	0.675/259
	EPR A/L	1.65/2.08	1.65/2.04	1.65/2.01	1.65/1.98	1.65/1.95	1.65/1.91	1.65/1.87	1.65/1.83	1.65/1.78
78000	N2 /N1	81.2/77.3	82.1/78.2	83.1/79.1	84.0/79.9	84.9/80.8	85.8/81.6	86.6/82.4	87.5/83.3	88.5/84.1
LB	F/F (AV)	2148	2176	2204	2233	2261	2289	2315	2343	2365
	EGT	305	319	332	345	359	372	385	399	411
	RAT/TAS	–37.3/386	–31.9/391	–26.6/395	–21.2/400	–15.8/404	–10.4/408	–5.0/412	0.4/417	5.8/421
	NAM/1000	89.95	89.81	89.66	89.51	89.35	89.19	89.08	88.90	88.97
	MACH/IAS	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255
	EPR A/L	1.64/2.08	1.64/2.05	1.64/2.02	1.64/1.98	1.64/1.95	1.64/1.91	1.64/1.87	1.64/1.83	1.64/1.79
76000	N2 /N1	80.9/76.9	81.8/77.7	82.7/78.6	83.6/79.5	84.5/80.3	85.4/81.2	86.3/82.0	87.1/82.8	68.1/83.7
LB	F/F (AV)	2090	2117	2144	2172	2199	2226	2253	2279	2296
	EGT	301	315	328	341	354	368	381	394	405
	RAT/TAS	–37.8/381	–32.4/366	–27.0/390	–21.7/394	–16.3/399	–10.9/403	–5.5/407	–0.1/411	5.2/415
	NAM/1000	91.24	91.10	90.95	90.79	90.63	90.47	90.30	90.19	90.39

CRUISE CONTROL TABLES
TWO ENGINE LONG RANGE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30

LONG RANGE 29000 FEET										LONG RANGE 29000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–57.5	–52.5	–47.5	–42.5	–37.5	–32.5	–27.5	–22.5	–17.5
74000 LB	MACH/IAS	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255
	EPR A/L	1.63/2.08	1.63/2.05	1.63/2.02	1.63/1.98	1.63/1.95	1.63/1.91	1.63/1.87	1.63/1.83	1.63/1.79
	N2 /N1	80.7/76.7	81.7/77.6	82.6/78.4	83.5/79.3	84.4/80.1	85.3/81.0	86.1/81.8	87.0/82.6	88.0/83.5
	F/F (AV)	2067	2094	2121	2148	2176	2203	2229	2256	2271
	EGT	300	313	326	340	353	366	379	392	403
	RAT/TAS	–37.8/381	–32.4/386	–27.0/390	–21.7/394	–16.3/399	–10.9/403	–5.5/407	–0.1/411	5.2/415
	NAM/1000	92.22	92.08	91.93	91.77	91.61	91.44	91.27	91.09	91.42
72000 LB	MACH/IAS	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255	0.666/255
	EPR A/L	1.62/2.08	1.62/2.05	1.62/2.02	1.62/1.98	1.62/1.95	1.62/1.91	1.62/1.87	1.62/1.83	1.62/1.79
	N2 /N1	80.6/76.5	81.5/77.4	82.4/78.2	83.4/79.1	84.2/79.9	85.1/80.8	86.0/81.6	86.9/82.4	87.9/83.3
	F/F (AV)	2046	2072	2099	2126	2153	2179	2206	2233	2246
	EGT	298	312	325	338	351	364	377	391	401
	RAT/TAS	–37.8/381	–32.4/386	–27.0/390	–21.7/394	–16.3/399	–10.9/403	–5.5/407	–0.1/411	5.2/415
	NAM/1000	93.20	93.06	92.90	92.74	92.58	92.41	92.24	92.06	92.42
70000 LB	MACH/IAS	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249
	EPR A/L	1.60/2.08	1.60/2.05	1.60/2.02	1.60/1.99	1.60/1.96	1.60/1.92	1.60/1.88	1.60/1.84	1.60/1.80
	N2 /N1	80.1/75.9	81.0/76.8	81.9/77.7	82.8/78.5	83.7/79.3	84.6/80.2	85.4/81.0	86.3/81.8	87.2/82.6
	F/F (AV)	1966	1992	2019	2044	2070	2096	2120	2146	2172
	EGT	293	306	319	332	345	358	371	384	398
	RAT/TAS	–38.6/372	–33.2/377	–27.8/381	–22.5/385	–17.1/389	–11.8/393	–6.4/397	–1.0/402	4.3/405
	NAM/1000	94.72	94.58	94.36	94.21	94.04	93.87	93.77	93.56	93.34
68000 LB	MACH/IAS	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249
	EPR A/L	1.59/2.08	1.59/2.05	1.59/2.02	1.59/1.99	1.59/1.96	1.59/1.92	1.59/1.88	1.59/1.84	1.59/1.80
	N2 /N1	80.0/75.7	80.9/76.6	81.8/77.4	82.7/78.3	83.6/79.1	84.4/79.9	85.3/80.8	86.2/81.6	87.0/82.4
	F/F (AV)	1946	1970	1996	2021	2047	2073	2099	2125	2149
	EGT	292	305	318	331	344	357	370	383	396
	RAT/TAS	–38.6/372	–33.2/377	–27.8/381	–22.5/385	–17.1/389	–11.8/393	–6.4/397	–1.0/402	4.3/405
	NAM/1000	95.68	95.61	95.44	95.27	95.09	94.88	94.70	94.48	94.35
66000 LB	MACH/IAS	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249	0.650/249
	EPR A/L	1.58/2.08	1.58/2.05	1.58/2.02	1.58/1.99	1.58/1.96	1.58/1.92	1.58/1.88	1.58/1.84	1.58/1.80
	N2 /N1	79.8/75.5	80.7/76.4	81.7/77.2	82.6/78.1	83.4/78.9	84.3/79.7	85.2/80.5	86.0/81.3	86.9/82.1
	F/F (AV)	1926	1951	1976	2002	2027	2051	2076	2102	2127
	EGT	290	303	316	329	342	355	368	381	394
	RAT/TAS	–38.6/372	–33.2/377	–27.8/381	–22.5/385	–17.1/389	–11.8/393	–6.4/397	–1.0/402	4.3/405
	NAM/1000	96.69	96.53	96.38	96.20	96.02	95.92	95.74	95.50	95.32
64000 LB	MACH/IAS	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240
	EPR A/L	1.55/2.09	1.55/2.06	1.55/2.03	1.55/2.00	1.55/1.96	1.55/1.93	1.55/1.89	1.55/1.85	1.55/1.81
	N2 /N1	79.1/74.5	80.0/75.4	80.9/76.2	81.7/77.1	82.7/77.9	83.5/78.7	84.4/79.5	85.2/80.3	86.1/81.1
	F/F (AV)	1829	1853	1877	1901	1924	1947	1970	1997	2021
	EGT	284	297	310	323	335	348	361	374	387
	RAT/TAS	–39.6/360	–34.3/364	–28.9/368	–23.6/372	–18.3/376	–12.9/380	–7.6/384	–2.3/388	3.1/392
	NAM/1000	98.44	98.30	98.14	97.98	97.84	97.71	97.53	97.20	97.01
62000 LB	MACH/IAS	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240
	EPR A/L	1.55/2.09	1.55/2.06	1.55/2.03	1.55/2.00	1.54/1.96	1.54/1.93	1.54/1.89	1.54/1.85	1.54/1.81
	N2 /N1	79.0/74.3	79.9/75.2	80.8/76.0	81.6/76.8	82.5/77.7	83.4/78.5	84.2/79.3	85.1/80.1	85.9/80.9
	F/F (AV)	1810	1833	1857	1880	1903	1927	1951	1975	1998
	EGT	282	295	308	321	334	347	359	372	385
	RAT/TAS	–39.6/360	–34.3/364	–28.9/368	–23.6/372	–18.3/376	–12.9/380	–7.6/384	–2.3/388	3.1/392
	NAM/1000	99.50	99.36	99.21	99.05	98.89	98.71	98.49	98.31	98.13
60000 LB	MACH/IAS	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240	0.629/240
	EPR A/L	1.54/2.09	1.54/2.06	1.54/2.03	1.54/2.00	1.54/1.96	1.54/1.93	1.53/1.89	1.53/1.85	1.53/1.81
	N2 /N1	78.8/74.1	79.7/74.9	80.6/75.8	81.5/76.6	82.4/77.4	83.2/78.2	84.0/79.0	84.9/79.8	85.7/80.6
	F/F (AV)	1789	1812	1836	1859	1882	1906	1929	1953	1976
	EGT	281	294	307	319	332	345	358	371	384
	RAT/TAS	–39.6/360	–34.3/364	–28.9/368	–23.6/372	–18.3/376	–12.9/380	–7.6/384	–2.3/388	3.1/392
	NAM/1000	100.64	100.50	100.34	100.18	100.01	99.79	99.61	99.42	99.23

CRUISE CONTROL
TWO ENGINE LONG RANGE OPERATION
JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30

LONG RANGE 31000 FEET										LONG RANGE 31000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–61.4	–56.4	–51.4	–46.4	–41.4	–36.4	–31.4	–26.4	–21.4
108000 LB	MACH/IAS	0.758/280	0.758/280	0.758/280	0.758/280	0.758/280				
	EPR A/L	1.93/2.07	1.93/2.04	1.93/2.01	1.93/1.97	1.92/1.94				
	N2 /N1	85.1/84,3	86.1/85.3	87.1/86.2	88.1/87.2	89.0/88.1				
	F/F (AV)	2879	2918	2956	2995	3030				
	EGT	363	378	393	408	423				
	RAT/TAS	–37.2/430	–31.7/435	–26.2/440	–20.7/445	–15.2/450				
	NAM/1000	74.72	74.60	74.47	74.34	74.27				
106000 LB	MACH/IAS	0.751/278	0.751/278	0.751/278	0.751/278	0.751/278	0.751/278			
	EPR A/L	1.91/2.07	1.91/2.04	1.91/2.01	1.91/1.98	1.90/1.94	1.90/1.90			
	N2 /N1	84.8/83.6	85.8/84.6	86.7/85.6	87.7/86.5	88.6/87.4	89.6/88.4			
	F/F (AV)	2798	2835	2872	2909	2946	2982			
	EGT	357	372	387	402	416	431			
	RAT/TAS	–37.6/426	–32.1/431	–26.6/436	–21.1/441	–15.6/446	–10,2/450			
	NAM/1000	76.12	76.00	75.88	75.76	75.63	75.52			
104000 LB	MACH/IAS	0.751/278	0.751/278	0.751/278	0.751/278	0.751/278	0.751/278			
	EPR A/L	1.89/2.07	1.89/2.04	1.89/2.01	1.89/1.98	1.89/1.94	1.89/1.90			
	N2 /N1	84.6/83.3	85.6/84.2	86.5/85.2	87.5/86.1	88.4/87.0	89.4/88.0			
	F/F (AV)	2758	2795	2832	2868	2905	2941			
	EGT	354	369	384	398	413	428			
	RAT/TAS	–37.6/426	–32.1/431	–26.6/436	–21.1/441	–15.6/446	–10.2/450			
	NAM/1000	77.22	77.10	76.98	76.85	76.72	76.59			
102000 LB	MACH/IAS	0.751/278	0.751/278	0.751/278	0.751/278	0.751/278	0.751/278	0.739/273		
	EPR A/L	1.88/2.07	1.88/2.04	1.88/2.01	1.88/1.98	1.88/1.94	1.88/1.90	1.87/1.87		
	N2 /N1	84.4/82.9	85.4/83.9	86.3/84.8	87.3/85.7	88.3/86.7	89.2/87.6	89.9/88.1		
	F/F (AV)	2720	2756	2792	2828	2864	2900	2875		
	EGT	351	366	381	395	410	424	435		
	RAT/TAS	–37.6/426	–32.1/431	–26.6/436	–21.1/441	–15.6/446	–10.2/450	–5.4/448		
	NAM/1000	78.31	78.19	78.06	77.93	77.80	77.67	77.94		
100000 LB	MACH/IAS	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273		
	EPR A/L	1.86/2.08	1.86/2.05	1.86/2.01	1.86/1.98	1.86/1.95	1.86/1.91	1.86/1.87		
	N2 /N1	84.0/82.2	85.0/83.2	85.9/84.1	86.9/85.0	87.8/86.0	88.8/86.9	89.7/87.8		
	F/F (AV)	2630	2665	2700	2735	2769	2804	2839		
	EGT	345	360	374	388	403	417	432		
	RAT/TAS	–38.2/420	–32.7/425	–27.2/430	–21.8/434	–16.3/439	–10.8/444	–5.4/449		
	NAM/1000	79.80	79.68	79.55	79.42	79.29	79,15	79.00		
98000 LB	MACH/IAS	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.725/267	
	EPR A/L	1.85/2.08	1.85/2.05	1.85/2.01	1.85/1.98	1.84/1.95	1.84/1.91	1.84/1.87	1.83/1.83	
	N2 /N1	83.8/81.9	84.8/82.9	85.8/83.8	86,7/84.7	87.7/85.6	88.6/86.5	89.5/87.4	90.2/87.9	
	F/F (AV)	2598	2632	2667	2701	2735	2769	2804	2766	
	EGT	343	357	371	386	400	415	429	438	
	RAT/TAS	–38.2/420	–32.7/425	–27.2/430	–21.8/434	–16.3/439	–10.8/444	–5.4/449	–0.8/444	
	NAM/1000	80.80	80.67	80.54	80.41	80.28	80.14	79.99	80.28	
96000 LB	MACH/IAS	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.740/273	0.735/271	
	EPR A/L	1.84/2.08	1.84/2.05	1.84/2.01	1.83/1.98	1.83/1.95	1.83/1.91	1.83/1.87	1.83/1.83	
	N2 /N1	83.7/81.6	84.7/82.6	85.6/83.5	86.6/84.4	87.5/85.3	88.5/86.2	89.4/87.1	90.2/87.8	
	F/F (AV)	2569	2603	2637	2671	2705	2739	2773	2779	
	EGT	340	355	369	383	398	412	427	439	
	RAT/TAS	–38.2/420	–32.7/425	–27.2/430	–21.8/434	–16.3/439	–10.8/444	–5.4/449	–0.2/450	
	NAM/1000	81,71	81.58	81.45	81.32	81.18	81.04	80.88	80.96	
94000 LB	MACH/IAS	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.706/260
	EPR A/L	1.81/2.09	1.81/2.05	1.81/2.02	1.81/1.99	1.81/1.96	1.81/1.92	1.81/1.88	1.81/1.84	1.80/1.80
	N2 /N1	83.2/80.8	84.1/81.7	85.1/82.6	86.0/83.6	87.0/84.5	87.9/85.3	88.8/86.2	89.7/87.1	90.4/87.6
	F/F (AV)	2447	2480	2512	2545	2577	2609	2641	2674	2651
	EGT	332	346	360	375	389	403	417	431	442
	RAT/TAS	–39.3/408	–33.9/412	–28.5/417	–23.0/422	–17.6/426	–12.1/431	–6.7/435	–1.2/440	3.4/437
	NAM/1000	83.27	83.15	83.01	82.87	82.73	82.59	82.44	82.27	82.38
92000 LB	MACH/IAS	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.715/263
	EPR/ A/L	1.80/2.09	1.80/2.05	1.80/2.02	1.80/1.99	1.80/1.96	1.80/1.92	1.80/1.88	1.80/1.84	1.79/1.79
	N2 /N1	83.0/80.5	84.0/81.5	85.0/82.4	85.9/83.3	86.9/84.2	87.8/85.1	88.7/86.0	89.6/86.8	90.4/87.6
	F/F (AV)	2421	2453	2485	2517	2549	2581	2613	2645	2661
	EGT	330	344	358	372	387	401	415	429	442
	RAT/TAS	–39.3/408	–33.9/412	–28.5/417	–23.0/422	–17.6/426	–12.1/431	–6.7/435	–1.2/440	4.0/442
	NAM/1000	84.17	84.04	83.91	83.77	83.64	83.50	83.34	83.18	83.13

CRUISE CONTROL TABLES
TWO ENGINE LONG RANGE OPERATION
JT8D-7 ENGINE NORMAL BLEED
DC-9 SERIES 30

LONG RANGE 31000 FEET										LONG RANGE 31000 FEET
GROSS	OPERATING	OAT-C AMBIENT								
WT	PARAMETER	-61.4	-56.4	-51.4	-46.4	-41.4	-36.4	-31.4	-26.4	-21.4
90000 LB	MACH/IAS	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265	0.718/265
	EPR A/L	1.79/2.09	1.79/2.05	1.79/2.02	1.79/1.99	1.79/1.96	1.79/1.92	1.79/1.88	1.79/1.84	1.79/1.79
	N2 /N1	82.9/80.2	83.9/81.2	84.8/82.1	85.8/83.0	86.7/83.9	87.6/84.8	88.5/85.7	89.4/86.5	90.3/87.4
	F/F (AV)	2392	2424	2456	2487	2519	2550	2581	2613	2646
	EGT	328	342	356	370	384	398	412	426	440
	RAT/TAS	-39.3/408	-33.9/412	-28.5/417	-23.0/422	-17.6/426	-12.1/431	-6.7/435	-1.2/440	4.2/444
	NAM/1000	85.18	85.06	84.91	84.77	84.63	84.49	84.35	84.19	83.97
88000 LB	MACH/IAS	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255
	EPR A/L	1.76/2.09	1.76/2.06	1.76/2.03	1.76/2.00	1.76/1.97	1.76/1.93	1.76/1.89	1.76/1.85	1.76/1.81
	N2 /N1	82.2/79.3	83.1/80.2	84.1/81.1	85,0/82.0	86.0/82,9	86.9/83.8	87.8/84.7	88.8/85.6	89.7/86.4
	F/F (AV)	2269	2299	2329	2359	2389	2419	2449	2471	2501
	EGT	319	333	347	361	375	389	403	416	430
	RAT/TAS	-40.6/394	-35.2/399	-29.8/403	-24.3/408	-18.9/412	-13.5/417	-8.1/421	-2.7/426	2.7/430
	NAM/1000	86.87	86.74	86.60	86.46	86.32	86.17	86.00	86.11	85.95
86000 LB	MACH/IAS	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255
	EPR A/L	1.75/2.09	1.75/2.06	1.75/2.03	1.75/2.00	1.75/1.97	1.75/1.93	1.75/1.89	1.75/1.85	1.75/1.81
	N2 /N1	82.0/79.0	83.0/80.0	83.9/80.9	84.9/81.8	85.8/82.6	86.7/83.5	87.6/84.4	88.6/85.3	89.5/86.1
	F/F (AV)	2253	2283	2313	2342	2372	2390	2420	2441	2470
	EGT	317	331	345	359	373	387	400	413	427
	RAT/TAS	-40.6/394	-35.2/399	-29.8/403	-24.3/408	-18.9/412	-13.5/417	-8.1/421	-2.7/426	2.7/430
	NAM/1000	87.50	87.37	87.23	87.08	86.93	87.21	87.04	87.19	87.02
84000 LB	MACH/IAS	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255	0.695/255
	EPR A/L	1.74/2.09	1.74/2.06	1.74/2.03	1.74/2.00	1.74/1.97	1.74/1.93	1.74/1.89	1.74/1.85	1.74/1.81
	N2 /N1	81.9/78.8	82.8/79.7	83.8/80.6	84.7/81.5	85.6/82.4	86.5/83,2	87.4/84.1	88.4/85.0	89.3/85.8
	F/F (AV)	2215	2244	2273	2303	2332	2361	2390	2410	2439
	EGT	315	329	343	357	370	384	398	410	424
	RAT/TAS	-40.6/394	-35.2/399	-29.8/403	-24.3/408	-18.9/412	-13.5/417	-8.1/421	-2.7/426	2.7/430
	NAM/1000	89.00	88.88	88.73	88.59	88.44	88.29	88.12	88.30	88.13
82000 LB	MACH/IAS	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254
	EPR A/L	1.72/2.09	1.72/2.06	1.72/2.03	1.72/2.00	1.72/1.97	1.72/1.93	1.72/1.89	1.72/1.85	1.72/1.81
	N2 /N1	81.6/78.4	82.5/79.3	83.5/80.2	84.4/81.1	85.3/81.9	86.2/82.8	87.1/83.7	88.0/84.5	89.1/85.4
	F/F (AV)	2168	2197	2226	2254	2283	2311	2340	2370	2306
	EGT	312	326	339	353	367	381	394	408	420
	RAT/TAS	-40.8/392	-35.4/397	-30.0/401	-24.6/406	-19.2/410	-13.7/414	-8.3/419	-2.9/423	2.5/427
	NAM/1000	90.38	90.25	90.11	89.96	89.81	89.66	89.49	89.25	89.57
80000 LB	MACH/IAS	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254
	EPR A/L	1.71/2.09	1.71/2.06	1.71/2.03	1.71/2.00	1.71/1.97	1.71/1.93	1.71/1.89	1.71/1.85	1.71/1.81
	N2 /N1	81.4/78.1	82.4/79.0	83.3/79.9	84.2/80.8	85.1/81.6	86.0/82.5	86.9/83.4	87.8/84.2	88.9/85.1
	F/F (AV)	2137	2165	2194	2222	2250	2278	2307	2335	2351
	EGT	310	323	337	351	364	378	392	405	417
	RAT/TAS	-40.8/392	-35.4/397	-30.0/401	-24.6/406	-19.2/410	-13.7/414	-8.3/419	-2.9/423	2.5/427
	NAM/1000	91.70	91.57	91.42	91.27	91.12	90.96	90.79	90.60	90.91
78000 LB	MACH/IAS	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254	0.691/254
	EPR A/L	1.70/2.09	1.70/2.06	1.70/2.03	1.70/2.00	1.70/1.97	1.70/1.93	1.70/1.89	1.70/1.85	1.70/1.81
	N2 N/1	81.2/77.8	82.2/78.7	83.1/79.6	84.0/80.4	84.9/81.3	85.8/82.2	86.7/83.0	87.6/83.9	88.7/84.4
	F/F (AV)	2106	2134	2162	2190	2218	2245	2273	2301	2315
	EGT	307	321	335	348	362	375	389	403	414
	RAT/TAS	-40.8/392	-35.4/397	-30.0/401	-24.6/406	-19.2/410	-13.7/414	-8.3/419	-2.9/423	2.3/427
	NAM/1000	93.05	92.91	92.77	92.61	92.45	92.30	92.12	91.93	92.29
76000 LB	MACH/IAS	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252
	EPR A/L	1.69/2.10	1.68/2.07	1.68/2.03	1.68/2.00	1.68/1.97	1.68/1.93	1.68/1,90	1.68/1.85	1.68/1.81
	N2 /N1	80.9/77.4	81.9/78.3	82.8/79.2	83.7/80.0	84.6/80.9	85.5/81.8	86.4/82.6	87.3/83.5	88.4/84.4
	F/F (AV)	2062	2088	2115	2143	2170	2197	2224	2252	2263
	EGT	304	318	331	345	358	372	385	399	410
	RAT/TAS	-40.0/389	-35.6/394	-30.2/398	-24.8/403	-19.4/407	-14.0/411	-8.6/416	-3.2/420	2.2/424
	NAM/1000	94.34	94.27	94.12	93.96	93.80	93.64	93.46	93.26	93.74

CRUISE CONTROL TABLES
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JT8D–7 ENGINE NORMAL BLEED
DC–9 SERIES 30

LONG RANGE 31000 FEET										LONG RANGE 31000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–61.4	–56.4	–51.4	–46.4	–41.4	–36.4	–31.4	–26.4	–21.4
74000 LB	MACH/IAS	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252
	EPR A/L	1.68/2.10	1.67/2.07	1.67/2.03	1.67/2.00	1.67/1.97	1.67/1.93	1.67/1,90	1.67/1.85	1.67/1.81
	N2 /N1	80.8/77.2	81.7/78.1	82.6/78.9	83.6/79.8	84.5/80.7	85.4/81.5	86.3/82.4	87.1/83.2	88.3/84.1
	F/F (AV)	2038	2065	2090	2117	2144	2173	2198	2226	2235
	EGT	302	316	329	343	356	370	383	397	407
	RAT/TAS	–41.0/389	–35.6/394	–30.2/398	–24.8/403	–19.4/407	–14.0/411	–8.6/416	–3.2/420	2.2/424
	NAM/1000	95.45	95.32	95.25	95.08	94.92	94.67	94.57	94.37	94.91
72000 LB	MACH/IAS	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252	0.686/252
	EPR A/L	1.67/2.10	1.67/2.07	1.67/2.03	1.66/2.00	1.66/1.97	1.66/1.93	1.66/1,90	1.66/1.85	1.66/1.81
	N2 /N1	80.6/76.9	81.6/77.8	82.5/78.7	83.4/79.6	84.3/80.5	85.2/81.3	86.1/82.2	87.0/83.0	88.1/83.9
	F/F (AV)	2016	2043	2069	2096	2123	2149	2176	2201	2209
	EGT	301	314	328	341	355	368	382	395	405
	RAT/TAS	–41.0/389	–35.6/394	–30.2/398	–24.8/403	–19.4/407	–14.0/411	–8.6/416	–3.2/420	2.2/424
	NAM/1000	96.51	96.37	96.22	96.06	95.69	95.72	95.54	95.43	96.02
70000 LB	MACH/IAS	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246
	EPR A/L	1.64/2.10	1.64/2.07	1.64/2.04	1.64/2.01	1.64/1.98	1.64/1.94	1.64/1.90	1.64/1.86	1.64/1.82
	N2 /N1	80.1/75.3	81.1/77.2	82.0/78.1	82.9/78.1	83.8/79.8	84.7/80.7	85.6/81.5	86.4/82.3	87.3/83.1
	F/F (AV)	1939	1964	1990	2016	2041	2067	2093	2118	2144
	EGT	296	309	322	336	349	362	376	389	402
	RAT/TAS	–41.8/381	–36.4/385	–31.0/390	–25.6/394	–20.3/398	–14.9/402	–9.5/407	–4.1/411	1.3/415
	NAM/1000	98.16	98.01	97.86	97.69	97.52	97.35	97.17	96.98	96.80
68000 LB	MACH/IAS	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246
	EPR A/L	1.63/2.10	1.63/2.07	1.63/2.04	1.63/2.01	1.63/1,98	1.63/1.94	1.63/1.90	1.63/1.86	1.63/1.82
	N2 /N1	80.0/76,1	80.9/77.0	81.8/77.9	82.7/78.7	83.6/79.6	84.5/80.4	85.4/81.3	86.3/82.1	87.1/82.9
	F/F (AV)	1917	1942	1968	1993	2019	2044	2069	2095	2119
	EGT	294	307	321	334	347	361	374	387	401
	RAT/TAS	–41.8/381	–36.4/385	–31.0/390	–25.6/394	–20.3/398	–14.9/402	–9.5/407	–4.1/411	1.3/415
	NAM/1000	99.27	99.12	98.97	98.80	98.63	98.45	98.27	98.08	97.91
66000 LB	MACH/IAS	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246	0.671/246
	EPR A/L	1.63/2.10	1.63/2.07	1.62/2.04	1.62/2.01	1.62/1.98	1.62/1.94	1.62/1.90	1.62/1.86	1.62/1.82
	N2 /N1	79.8/75.9	80.7/76.8	81.7/77.7	82.6/78.5	83.5/79.4	84.4/80.2	85.2/81.0	86.1/81.9	87.0/82.7
	F/F (AV)	1896	1921	1947	1972	1997	2022	2047	2072	2092
	EGT	293	306	319	332	346	359	372	386	399
	RAT/TAS	–41.8/381	–36.5/385	–31.0/390	–25.6/394	–20.3/398	–14.9/402	–9.5/407	–4.1/411	1.3/415
	NAM/1000	100.36	100.21	100.05	99.88	99.71	99.53	99.34	99.15	98.96
64000 LB	MACH/IAS	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235
	EPR A/L	1.59/2.11	1.59/2.08	1.59/2.05	1.59/2.02	1.59/1.99	1.59/1.95	1.59/1.92	1.59/1.88	1.59/1.83
	N2 /N1	78.9/74.9	79.8/75.8	80.7/76.6	81.6/77.5	82.5/78.3	83.4/79.2	84.2/80.0	85.1/80.8	86.0/81.6
	F/F (AV)	1783	1806	1828	1852	1876	1899	1923	1947	1970
	EGT	285	298	311	324	338	351	364	377	390
	RAT/TAS	–43.2/364	–37.8/369	–32.5/373	–27.1/377	–21.8/381	–16.4/385	–11.1/389	–5.7/393	–0.4/397
	NAM/1000	102.23	102.09	102.00	101.82	101.63	101.44	101.25	101.02	100.88
62000 LB	MACH/IAS	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235
	EPR A/L	1.58/2.11	1.58/2.08	1.58/2.05	1.58/2.02	1.58/1.99	1.58/1.95	1.58/1.92	1.58/1.88	1.58/1.83
	N2 /N1	78.7/74.7	79.7/75.5	80.6/76.4	81.5/77.3	82.4/78.1	83.2/78.9	84.1/79.7	85.0/80.5	85.8/81.3
	F/F (AV)	1761	1784	1807	1831	1854	1876	1899	1922	1945
	EGT	283	297	310	323	336	349	362	375	388
	RAT/TAS	–43.2/364	–37.8/369	–32.5/373	–27.1/377	–21.8/381	–16.4/385	–11.1/389	–5.7/393	–0.4/397
	NAM/1000	103.51	103.35	103.18	102.99	102.80	102.70	102.52	102.33	102.15
60000 LB	MACH/IAS	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235	0.642/235
	EPR A/L	1.57/2.11	1.57/2.08	1.57/2.05	1.57/2.02	1.57/1.99	1.57/1.95	1.57/1.92	1.57/1.88	1.57/1.83
	N2 /N1	78.6/74.4	79.5/75.3	80.4/76.2	81.3/77.0	82.2/77.8	83.1/78.7	84.0/79.5	84.8/80.3	85.7/81.1
	F/F (AV)	1739	1762	1785	1808	1832	1855	1878	1901	1922
	EGT	282	295	308	321	334	347	360	373	386
	RAT/TAS	–43.2/364	–37.8/369	–32.5/373	–27.1/377	–21.8/381	–16.4/385	–11.1/389	–5.7/393	–0.4/397
	NAM/1000	104.79	104.64	104.48	104.31	104.06	103.87	103.69	103.49	103.38

CRUISE CONTROL TABLES
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LONG RANGE 35000 FEET										LONG RANGE 35000 FEET
GROSS WT	OPERATING PARAMETER	OAT–C AMBIENT								
		–69.3	–64.3	–59.3	–54.3	–49.3	–44.3	–39.3	–34.3	–29.3
90000 LB	MACH/IAS	0.760/256	0.760/256	0.760/256	0.760/256	0.760/256	0.760/256			
	EPR A/L	1.93/2.12	1.93/2.09	1.93/2.06	1.93/2.03	1.93/1.99	1.93/1.96			
	N2 /N1	83.6/82.8	84.6/83.8	85.6/84.8	86.6/85.8	87.6/86.8	88.5/87.7			
	F/F (AV)	2389	2422	2455	2487	2520	2553			
	EGT	342	357	372	387	402	417			
	RAT/TAS	–45.8/423	–40.3/428	–34.8/433	–29.3/438	–23.8/443	–18.3/448			
	NAM/1000	88.52	88.39	88.24	88.09	87.94	87.78			
88000 LB	MACH/IAS	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256		
	EPR A/L	1.91/2.12	1.91/2.09	1.91/2.06	1.91/2.03	1.91/1.99	1.91/1.96	1.91/1.92		
	N2 /N1	83.3/82.3	84.3/83.3	85.3/84.3	86.3/85.3	87.3/86.2	88.2/87.2	89.3/88.1		
	F/F (AV)	2343	2377	2410	2442	2474	2505	2525		
	EGT	338	353	368	383	398	413	427		
	RAT/TAS	–45.8/422	–40.3/428	–34.9/433	–29.4/438	–23.9/443	–18.4/448	–12.9/452		
	NAM/1000	90.14	89.94	89.76	89.61	89.46	89.32	89.57		
86000 LB	MACH/IAS	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.751/253	
	EPR A/L	1.90/2.12	1.90/2.09	1.90/2.06	1.90/2.03	1.89/1.99	1.89/1.96	1.89/1.92	1.89/1.89	
	N2 /N1	83.1/81.9	84.1/82.9	85.1/83.6	86.0/84.8	87.0/85.7	88.0/86.7	88.9/87.6	89.8/88.3	
	F/F (AV)	2308	2339	2371	2492	2433	2465	2496	2473	
	EGT	335	350	365	379	394	409	424	434	
	RAT/TAS	–45.8/422	–40.3/428	–34.9/433	–29.4/438	–23.9/443	–18.4/448	–12.9/452	–7.9/452	
	NAM/1000	91.51	91.38	91.25	91.10	90.95	90.80	90.61	91.44	
84000 LB	MACH/IAS	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	0.759/256	
	EPR A/L	1.88/2.12	1.88/2.09	1.88/2.06	1.88/2.03	1.88/1.99	1.88/1.96	1.88/1.92	1.88/1.88	
	N2 /N1	82.8/81.4	83.8/82.4	84.8/83.4	85.8/84.3	86.8/85.3	87.7/86.2	88.7/87.1	89.8/88.1	
	F/F (AV)	2271	2302	2333	2364	2395	2426	2456	2473	
	EGT	332	347	361	376	391	405	420	433	
	RAT/TAS	–45.8/422	–40.3/428	–34.9/433	–29.4/438	–23.9/443	–18.4/448	–12.9/452	–7.4/457	
	NAM/1000	92.99	92.85	92.71	92.57	92.42	92.26	92.10	92.46	
82000 LB	MACH/IAS	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.743/250
	EPR A/L	1.86/2.12	1.86/2.09	1.86/2.06	1.86/2.03	1.86/2.00	1.86/1.96	1.86/1.92	1.86/1.88	1.85/1.85
	N2 /N1	82.5/80.9	83.5/81.9	84.5/82.8	85.5/83.8	86.4/84.7	87.4/85.7	88.3/86.5	89.5/87.6	90.1/88.0
	F/F (AV)	2224	2254	2285	2315	2345	2375	2400	2416	2387
	EGT	328	343	357	372	386	401	415	428	438
	RAT/TAS	–46.0/420	–40.5/426	–35.1/431	–29.6/436	–24.1/441	–18.6/445	–13.1/450	–7.6/455	–2.9/452
	NAM/1000	94.53	94.39	94.25	94.09	93.94	93.78	93.82	94.18	94.69
80000 LB	MACH/IAS	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.752/253
	EPR A/L	1.85/2.12	1.85/2.09	1.85/2.06	1.85/2.03	1.85/2.00	1.85/1.96	1.85/1.92	1.85/1.88	1.84/1.84
	N2 /N1	82.3/80.6	83.3/81.5	84.3/82.5	85.3/83.4	86.2/84.4	87.2/85.3	88.1/86.2	89.3/87.2	90.2/88.0
	F/F (AV)	2196	2226	2256	2286	2316	2346	2375	2384	2399
	EGT	325	340	355	369	384	398	413	425	438
	RAT/TAS	–46.0/420	–40.5/426	–35.1/431	–29.6/436	–24.1/445	–18.6/445	–13.1/450	–7.6/455	–2.3/458
	NAM/1000	95.73	95.59	95.44	95.29	95.13	94.96	94.80	95.44	95.44
78000 LB	MACH/IAS	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255	0.755/255
	EPR A/L	1.84/2.12	1.84/2.09	1.84/2.06	1.84/2.03	1.84/2.00	1.84/1.96	1.83/1.92	1.83/1.88	1.84/1.84
	N2 /N1	82.1/80.3	83.1/81.2	83.1/82.2	85.1/83.1	86.1/84.1	87.0/85.0	87.9/85.9	89.2/86.9	90.1/87.8
	F/F (AV)	2171	2201	2231	2260	2290	2319	2349	2356	2387
	EGT	323	338	352	367	382	396	411	422	437
	RAT/TAS	–46.0/420	–40.5/426	–35.1/431	–29.6/436	–24.1/441	–18.6/445	–13.1/450	–7.6/455	–2.1/460
	NAM/1000	96.82	96.68	96.53	96.37	96.21	96.04	95.87	96.60	96.33
76000 LB	MACH/IAS	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241
	APR A/L	1.80/2.13	1.80/2.10	1.80/2.07	1.80/2.04	1.80/2.01	1.80/1.98	1.80/1.94	1.79/1.90	1.80/1.86
	N2 /N1	81.1/78.9	82.1/79.8	83.0/80.8	84.0/81.7	84.9/82.6	85.9/83.5	86.8/84.4	87.7/85.3	89.2/86.3
	F/F (AV)	2024	2051	2079	2107	2134	2161	2189	2216	2208
	EGT	313	327	341	355	370	384	398	412	422
	RAT/TAS	–47.9/401	–42.4/406	–37.0/411	–31.5/415	–26.1/420	–20.6/425	–15.2/429	–9.8/434	–4.3/439
	NAM/1000	99.06	98.92	98.77	98.62	98.45	98.28	98.11	97.93	99.33

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LONG RANGE 35000 FEET										LONG RANGE 35000 FEET
GROSS	OPERATING	OAT–C AMBIENT								
WT	PARAMETER	–69.3	–64.3	–59.3	–54.3	–49.3	–44.3	–39.3	–34.3	–29.3
74000 LB	MACH/IAS	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241
	EPR A/L	1.79/2.13	1.79/2.10	1.79/2.07	1.78/2.04	1.78/2.01	1.78/1.98	1.78/1.94	1.78/1.90	1.78/1.86
	N2 /N1	80.7/78.5	81.7/79.5	82.7/80.4	83.7/81.3	84.6/82.2	85.5/83.1	86.4/84.0	88.1/85.1	89.0/86.0
	F/F (AV)	2004	2033	2060	2088	2115	2141	2168	2148	2176
	EGT	311	326	340	354	368	382	397	404	419
	RAT/TAS	–47.9/401	–42.4/406	–37.0/411	–31.5/415	–26.1/420	–20.6/425	–15.2/429	–9.8/434	–4.3/439
	NAM/1000	100.04	99.81	99.66	99.51	99.35	99.20	99.04	101.02	100.78
72000 LB	MACH/IAS	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241	0.720/241
	EPR A/L	1.77/2.13	1.77/2.10	1.77/2.07	177./2.04	1.77/2.01	1.77/1.98	1.77/1.94	1.77/1.90	1.77/1.86
	N2 /N1	80.6/78.2	81.6/79.2	82.5/80.1	83.5/81.0	84.4/81.9	85.4/82.8	86.3/83.7	87.9/84.8	88.6/83.7
	F/F (AV)	1977	2004	2031	2057	2085	2111	2136	2119	2145
	EGT	309	323	337	351	366	380	394	402	416
	RAT/TAS	–47.9/401	–42.4/406	–37.0/411	–31.5/415	–26.1/420	–20.6/425	–15.2/429	–9.8/434	–4.3/439
	NAM/1000	101.40	101.26	101.12	100.97	100.79	100.62	100.55	102.44	102.23
70000 LB	MACH/IAS	0.691./231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231
	EPR A/L	1.74/2.14	1.74/2.11	1.74/2.08	1.74/2.05	1.74/2.02	1.74/1.99	1.74/1.95	1.74/1.92	1.74/1.88
	N2 /N1	79.8/77.1	80.8/78.0	81.8/79.0	82.7/79.9	83.6/80.8	84.6/81.7	85.5/82.5	86.4/83.4	88.0/84.5
	F/F (AV)	1852	1877	1903	1928	1954	1979	1997	2022	2001
	EGT	299	312	326	340	354	368	382	396	403
	RAT/TAS	–49.3/385	–43.9/390	–38.5/394	–33.1/399	–27.7/403	–22.3/408	–16.9/412	–11.5/417	–6.1/421
	NAM/1000	103.89	103.74	103.58	103.41	103.21	103.03	103.19	103.02	105.17
68000 LB	MACH/IAS	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231
	EPR A/L	1.72/2.14	1.73/2.11	1.72/2.08	1.72/2.05	1.72/2.02	1.72/1.99	1.72/1.95	1.72/1.92	1.72/1.88
	N2 /N1	79.6/76.8	80.6/77.7	81.6/78.6	82.5/79.5	83.4/80.4	84.4/81.3	85.3/82.2	86.2/83.0	87.8/84.1
	F/F (AV)	1814	1839	1863	1888	1913	1937	1961	1985	1967
	EGT	296	310	324	338	351	365	379	393	399
	RAT/TAS	–49.3/385	–43.9/390	–38.5/394	–33.1/399	–27.7/403	–22.3/408	–16.9/412	–11.5/417	–6.1/421
	NAM/1000	106.06	105.92	105.77	105.60	105.43	105.25	105.09	104.90	107.00
66000 LB	MACH/IAS	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231	0.691/231
	EPR A/L	1.71/2.14	1.71/2.11	1.71/2.08	1.71/2.05	1.71/2.02	1.71/1.99	1.71/1.95	1.71/1.92	1.71/1.88
	N2 /N1	79.4/76.4	80.4/77.3	81.4/78.2	82.3/79.2	83.2/80.0	84.1/80.9	85.1/81.8	86.0/82.7	87.5/83.7
	F/F (AV)	1782	1806	1830	1855	1879	1903	1927	1952	1932
	EGT	293	307	321	335	348	362	376	390	396
	RAT/TAS	–49.3/385	–43.9/390	–38.5/394	–33.1/399	–27.7/403	–22.3/408	–16.9/412	–11.5/417	–6.1/421
	NAM/1000	107.97	107.82	107.67	107.50	107.32	107.15	106.97	106.68	108.93
64000 LB	MACH/IAS	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226
	EPR A/L	1.66/2.15	1.68/2.12	1.68/2.09	1.68/2.06	1.68/2.02	1.68/1.99	1.68/1.96	1.68/1.92	1.68/1.88
	N2 /N1	79.0/75.8	80.0/76.7	80.9/77.6	81.9/78.5	82.8/79.4	83.7/80.2	84.6/81.1	85.5/82.0	86.4/82.8
	F/F (AV)	1711	1734	1757	1780	1804	1827	1850	1873	1892
	EGT	287	301	315	318	342	356	369	383	396
	RAT/TAS	–50.0/378	–44.6/382	–39.2/387	–33.8/391	–28.4/396	–23.0/400	–17.6/404	–12.2/409	–6.8/413
	NAM/1000	110.35	110.20	110.04	109.87	109.69	109.51	109.32	109.12	109.14
62000 LB	MACH /IAS	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226
	EPR A/L	1.67/2.15	1.67/2.12	1.67/2.09	1.67/2.06	1.67/2.02	1.67/1.99	1.67/1.96	1.67/1.92	1.67/1.88
	N2 /N1	78.8/75.5	79.8/76.4	80.7/77.3	81.7/78.2	82.6/79.1	83.5/80.0	84.4/80.8	85.3/81.7	86.2/82.5
	F/F (AV)	1685	1708	1731	1753	1776	1799	1822	1844	1866
	EGT	285	299	312	326	340	353	367	380	394
	RAT/TAS	–50.0/378	–44.6/382	–39.2/387	–33.8/391	–28.4/396	–23.0/400	–17.6/404	–12.2/409	–6.8/413
	NAM/1000	112.05	111.90	111.74	111.57	111.39	111.20	111.00	110.80	110.64
60000 LB	MACH/IAS	0.678/226	0.678/226	0.678/226	0.678/226	0.678/226	0.678/266	0.678/266	0.678/266	0.678/266
	EPR A/L	1.66/2.15	1.66/2.12	1.66/2.09	1.66/2.06	1.66/2.02	1.66/1.99	1.66/1.96	1.66/1.92	1.66/1.88
	N2 /N1	78.7/75.2	79.6/76.2	80.6/77.1	81.5/77.9	82.4/78.8	83.4/79.7	84.3/80.5	85.1/81.4	86.0/82.2
	F/F (AV)	1661	1684	1706	1728	1751	1773	1796	1818	1841
	EGT	283	298	310	324	337	351	365	378	392
	RAT/TAS	–50.0/378	–44.6/382	–39.2/387	–33.8/391	–28.4/396	–23.0/400	–17.6/404	–12.2/409	–6.8/413
	NAM/1000	113.67	113.52	113.35	113.18	112.99	112.80	112.61	112.40	112.19

5. LONG RANGE TECHNIQUE

A. Climb

Normal climb flight planning data and operating technique are applied.
Long range climb shows minimal advantage.

B. Cruise

(1) DACO published long range cruise speeds are close to Ansett M.76 cruise speeds, particularly at high gross weights.

(2) There is usually a greater difference between normal cruise and long range cruise speeds, however, Ansett Airlines elected to operate at a cruise speed of M.76 rather than the DACO recommended M.80 because of the significantly higher cost of fuel in Australia. For this reason, the range advantage usually associated with long range cruise is not present, particularly in strong headwinds at constant altitude. Advantages accrue as gross weight decreases and in tailwind conditions. While the ANM/1000 lb increases with altitude at both M.76 and LRC, the difference between the two is greater at lower operational levels – e.g. the difference is greater at F/L 250 than it is at F/L 350.

(3) Saving of fuel in adopting long range descent is now minimal when compared with the normal M.76/300 kt descent.

(4) If maximum range is to be achieved it is necessary to maintain tight control of speed and descent technique. Frequent checks of GNM/1000 lb are necessary, particularly when considering change of altitude in strong headwind conditions.

(5) The optimum cruise altitude is that altitude which gives the best GNM/1000 lb of fuel. In order to determine the optimum cruise altitude it may be necessary to compare the GNM/1000 lb for several altitudes considering both M.76 and LRC.

(6) The DACO Long Range Cruise Tables (reproduced here) also include ANM/1000 lb. To calculate GNM/1000 lb, it is necessary to factor the wind component as in the following example.

(7) Example:
From the DACO Long Range Cruise Tables: Mean Cruise Weight 92000 lb. Cruise Altitude 31000 ft. Temp. ISA +10 (–37°C).
Fuel Flow 2580 lb/eng./hr = 5160 lb/hr. TAS 431 kt and 83.5 ANM/1000 lb.
To calculate GNM/1000 lb assuming cruise wind component = 60 kt.
On computer set TAS on the inner scale against ANM/1000 lb on the outer scale, then against G/S on the inner scale, read GNM/1000 lb on the outer scale.
Thus 60 kt Tailwind (G/S 491 kt) = 95.0 GNM/1000 lb.
60 kt Headwind (G/S 371 kt) = 72.0 GNM/1000 lb.

(8) It should be noted that the blank sections in the tables indicate conditions of weight, altitude and temperature under which cruise is not possible.

Flight planning and cruise control (continued)

(9) Examples:

(a) The DACO Long Range Cruise Table for 31000 feet indicates that it is just possible to cruise the aircraft at that altitude at a weight of 96000 lb if the temperature is not above $-26^{o}C$.

(b) The Long Range Cruise Table for 35000 feet indicates that it is not possible to cruise the aircraft at that altitude if the weight is greater than 90000 lb at temperatures above $-44^{o}C$.

(10) Aircraft weight and ambient air temperature may limit the initial cruise altitude to 31000 feet (or 33000 feet) with a step climb to 35000 feet when the aircraft weight is reduced by fuel burn–off (normally at 90000 lb).

(11) Long Range Cruise airspeed varies with gross weight and altitude, and is obtained from the tables in the Cruise Control Book. Similar tables are also available for reference when anti–icing systems are in use. These tables are used in the same way as the Normal Cruise Tables.

C. Descent

(1) The Company Long Range Descent Data Table contained in the Operating Manual and Flight Planning Folder, and reproduced here, is similar in presentation to the Normal Descent Table.

(2) The table is entered for cruise altitude and time, burn–off and R.O.D. are read directly. The ground distance is read in the relevant cruise wind component column.

(3) Descent is made at a constant 250 kt IAS. This descent technique requires a rate of descent of approximately 700 fpm with power to maintain 250 kt IAS to 25500 feet at which altitude idle thrust is selected.

(4) Example:
Cruise F/L 290. Cruise Wind Comp. T/W 40 kt
Long Range Descent Table reads:
18 min–560lb –105 GNM and shows varying rates of descent.

D. Comparison of Range Charts

The following charts covering both Normal Cruise and Long Range Cruise are provided for range comparison at different altitudes. The charts can be used to decide whether it is advantageous to cruise at a lesser (or greater) altitude with its associated wind component.

On each chart, the illustrated example shows how to obtain the necessary wind component to give the same range capability at a different altitude. If the actual wind component at the new altitude is a lesser headwind (or greater tailwind) than that determined from the chart then it would be advantageous to plan at the alternative altitude.

To obtain the actual GNM/1000 lb of fuel burn–off for a given weight, altitude and wind, follow the guide lines back to the zero wind line and then proceed vertically up to the NM/1000 lb scale.

LONG RANGE DESCENT DATA

PRESS. ALT. (1000 ft.)	TIME (min)	FUEL (lb.)	INITIATION DISTANCES – GNM							A/C R.O.D.
			CRUISE LEVEL WIND COMPONENT (kt.)							
			H/120	H/80	H/40	ZERO	T/40	T/80	T/120	
35	27	1060	132	141	150	159	168	177	186	765
34	25	980	123	132	140	149	158	166	175	745
33	24	900	115	123	131	139	147	155	163	724
32	22	820	106	114	121	129	137	144	151	706
31	21	730	98	105	112	119	126	133	140	688
30	19	650	89	96	103	109	116	122	129	672
29	18	560	81	87	93	99	105	111	117	656
28	16	470	72	77	83	88	94	99	105	642
27	15	370	63	68	73	78	83	88	93	628
26	14	340	59	64	69	73	78	83	87	614
25	13	300	55	59	64	68	72	77	81	2240
23	12	290	50	54	58	62	66	70	74	2189
21	11	270	45	48	52	56	60	63	67	2153
19	10	260	41	44	48	51	54	58	61	2116
17	9	240	36	39	42	45	48	51	54	2072
15	8	220	32	35	37	40	43	45	48	2021
13	7	200	28	30	33	35	37	40	42	1974

CONDITIONS:

(a) Above figures calculated for landing weight 41000 kg and ISA +10 – Use for all weights and temperatures.

(b) Descent wind component equal to 50% of cruise wind component has been used in above calculations.

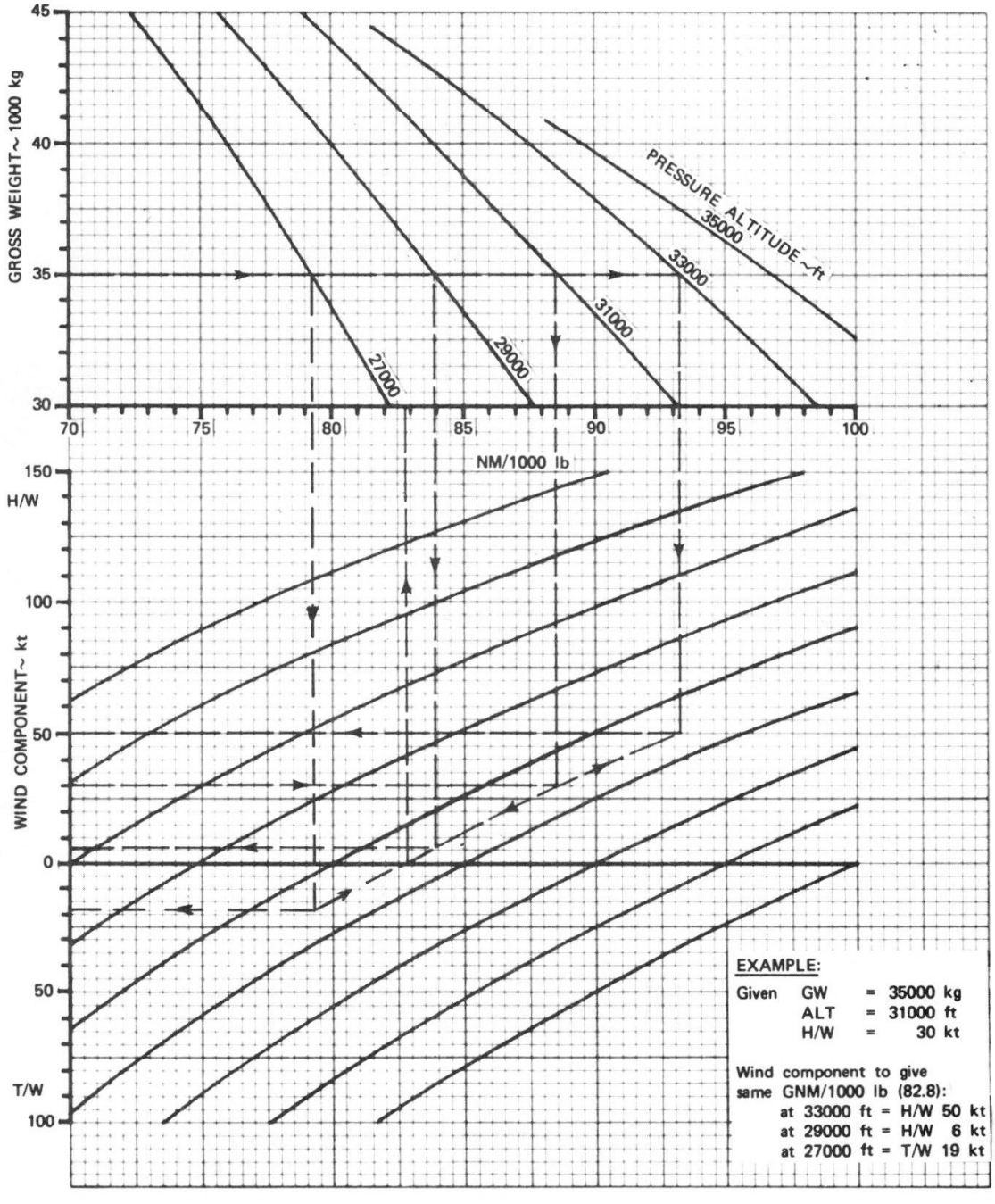
LONG RANGE DESCENT TECHNIQUE:

(a) Descend at 250 kt IAS

(b) Thrust as required to obtain 700 fpm to 25500 ft., approximately 1.5 EPR

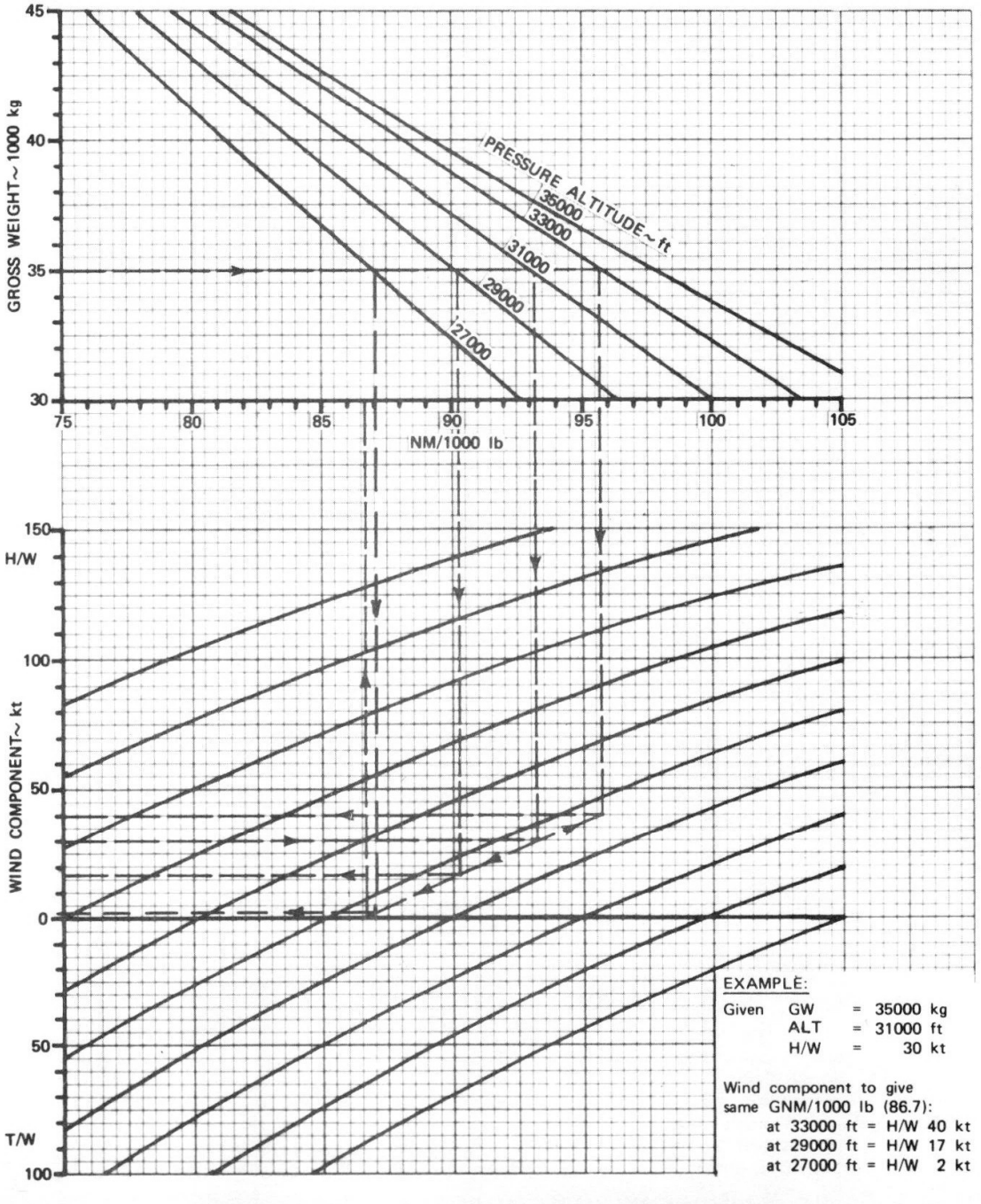
(c) Select Idle Thrust at 25500 ft and maintain 250 kt IAS.

Flight planning and cruise control (continued)



COMPARISON OF RANGE~M.76 CRUISE

Flight planning and cruise control (continued)



COMPARISON OF RANGE~LONG RANGE CRUISE

6. ALTERNATE FUEL

A. Calculation of Fuel to an Alternate

(1) Calculation of fuel to an alternate is made using the same basic performance data and methods employed in establishing fuel requirements for the flight from departure to destination.

(2) As nautical miles per 1000 pounds (NM/1000 lb) of fuel decrease with decreasing altitude and as fuel usage is greatest during the climb segment, it is most important that careful consideration be given to fuel usage involved in a planned descent to destination and en route climb to alternate as against planned diversion to alternate at cruise altitude.

(3) The Company Operating Manual and Flight Planning Folders contain lists of Standard Alternates (reproduced here). These lists give flight time and fuel burn–off for a specified route at a nominated flight level for normal operation (M.76), long range operation (LRC) and LRC diversion at cruise altitude.

(4) These figures are calculated at ISA +10°C and published as a bracket of temperatures from ISA to ISA +15°C, zero wind component and, except for diversion at cruise altitude, provide for climb to a specified altitude, cruise and descent. Diversion at cruise altitude provides for LRC and descent only. The fuel burn–off figures do not include taxi and manoeuvre allowances.

(5) A correction, to be applied to time interval and fuel burn–off for applicable wind component, is also included.

(6) As would be expected, diversion at cruise altitude requires least fuel for diversion and should be considered on occasions when fuel is critical. The reduction in burn–off to alternate could obviate any need to impose payload limitations.

(7) However, if diversion to alternate at cruise altitude is used in planning a flight, the calculated burn–off from departure to destination should be increased by 600 lb to allow for the higher consumption cruising to over the top instead of descending to circuit altitude at the destination.

(8) Example:
Route AD – BN (Alternate RK), BRW 46000 kg, ISA +10,
F/L 310, Wind Comp. zero. Fuel available 21200 lb.

Standard Planning Data –

AD – BN	125 min	13300 lb
Variable Reserve (10%)	13 min	1300 In
Fixed Reserve	30 min	2600 lb
	168 min	17200 lb
Fuel available		21200 lb
Fuel for diversion		4000 lb

From Standard Alternate Table –

	M.76		LRC		Div. at Cruise F/L	
BN – RK (282 nm)	42 min	4200 lb	45 min	4100 lb	44 min	2700 lb
Variable Reserve(10%)		400 lb		400 lb		300 lb
Diversion fuel required		4600 lb		4500 lb		3000 lb

i.e. with fuel available (3900 lb) diversion BN – RK may be planned as diversion at cruise F/L only and, as mentioned above (7), 600 lb should be added to the calculated burn–off from AD to BN.

Flight planning and cruise control (continued)

(9) Additional Considerations

When planning alternate requirements, sufficient fuel must be carried to cover diversion under the following conditions:

(a) Normal Cruise

(b) Asymmetric Cruise – loss of engine at point of overshoot at destination.

(c) Depressurised Cruise – loss of pressurisation at point of overshoot at destination.

NOTE: Refer to item 7. B. (3)

Minimum fuel required for M.76 diversion (i.e., burn–off plus 10% plus 2600 lb) covers both Asy and Depress requirements in all wind conditions up to a diversion distance of 400 nm.

In DC9 operations, the most limitating condition is Asy diversion due to single engine climb from 1500 ft to cruise altitude (approximately F/L 170) with its associated long range cruise and long range descent. Fuel to cover Asy requirement (i.e., burn–off plus 10% plus 20 min) covers Depress requirement (i.e., burn–off plus 20 min with nil variable) for all stage distances and wind components.

The following table shows diversion distances in excess of 400 nm, and the listed figures show the fuel amounts (lb) additional to minimum fuel for M.76 diversion, including reserves (10% plus 2600 lb).

The single engine fixed reserve rate at alternate can be reduced to 4500 lb/hr (aircraft weight 41000 kg at 1500 ft, under ISA conditions).

The total Asy diversion fuel required therefore includes LRC burn–off plus 10% plus 1500 lb (i.e., 20 min at 4500 lb/hr).

To limit the necessity for carriage of additional fuel to cover Asy diversion, calculations should be based on the use of the closest suitable alternate.

Continued on next page

STANDARD ALTERNATES

ISA TO ISA +15 ZERO FUEL WT. 37000 kg. WIND COMP ZERO

TYPE OF DIVERSION					M.76		LRC		DIVERSION AT CRUISE LEVEL	
SECTOR	LSA	TR (M)	DIST (nm)	FLT LVL	TIME (min)	BURN–OFF (lb)	TIME (min)	BURN–OFF (lb)	TIME (min)	BURN–OFF (lb)
AD–AS	4900	334	717	340	101	9400	104	9200	102	7500
–HB	5800	129	642	340	91	8500	94	8300	92	6600
–LT	3800	125	583	340	83	7800	86	7600	84	5900
–ML	4900	110	359	330	53	5100	56	5000	54	3400
–SY	5000	075	632	340	90	8400	93	8200	91	6500
–WH	1900	331	128	180	22	2300	24	2200	23	1400
–WR	2100	333	250	280	38	3900	41	3800	40	2400
AS–AD	4900	154	717	340	101	9400	104	9200	102	7500
–DN	4400	342	717	340	101	9400	104	9200	102	7500
–MA	5000	054	363	330	54	5200	57	5100	55	3500
–TC	4500	000	250	280	38	3900	41	3800	40	2400
–TN	4400	348	564	340	80	7600	83	7400	81	5700
–WR	4200	155	559	340	79	7500	82	7300	80	5600
BN–CB	6200	191	537	340	77	7200	80	7000	78	5400
–CG	2900	142	52	060	10	1100	11	1000	11	800
–CS	6600	319	763	340	108	10000	111	9800	108	8100
–MK	4100	320	433	340	63	6000	66	5800	64	4200
–ML	6100	203	759	340	107	9900	110	9700	107	8000
–RK	4100	319	282	300	42	4200	45	4100	44	2700
–SY	6200	182	409	340	60	5700	63	5500	60	3900
–TL	5200	314	606	340	86	8000	89	7800	87	6100
–WLM	6200	180	360	330	53	5100	56	5000	54	3400
CB–AD	5700	264	533	340	76	7200	79	7000	77	5300
–BN	6300	011	547	340	78	7400	81	7200	79	5500
–CG	6300	016	507	340	73	6900	76	6700	74	5000
–HB	6000	165	504	340	73	6900	76	6700	74	5000
–LT	6000	179	426	340	62	5900	65	5700	63	4100
–ML	8300	225	257	280	39	4000	42	3900	41	2500
–SY	4800	041	140	200	23	2600	25	2400	25	1500
–WLM	4800	030	216	260	34	3500	36	3400	35	2100
CG–BN	2900	332	52	060	10	1100	11	1000	11	800
–MK	4100	320	485	340	70	6600	73	6400	71	4800
–ML	6100	207	731	340	103	9600	106	9400	104	7600
–RK	4100	321	334	320	50	4800	53	4700	51	3200
–SY	6200	188	381	330	56	5400	59	5300	57	3700
–TL	5200	317	658	340	93	8700	96	8500	94	6800
–WLM	6200	186	332	320	50	4800	53	4700	51	3200

STANDARD ALTERNATES (Cont'd)

ISA TO ISA +15 ZERO FUEL WT. 37000 kg WIND COMP ZERO

TYPE OF DIVERSION					M.76		LRC		DIVERSION AT CRUISE LEVEL	
SECTOR	LSA	TR (M)	DIST (nm)	FLT LVL	TIME (min)	BURN–OFF (lb)	TIME (min)	BURN–OFF (lb)	TIME (min)	BURN–OFF (lb)
CS–BN	6600	141	772	340	109	10100	112	9900	109	8200
–MA	4700	231	427	340	62	5900	65	5700	63	4100
–MK	6600	136	336	320	50	4800	53	4700	51	3200
–RK	6600	139	481	340	69	6600	72	6400	70	4700
–TL	6600	150	157	210	26	2700	28	2600	27	1700
DN–AS	4800	162	720	340	102	9500	105	9300	103	7600
–GV	2700	085	350	290	53	5100	56	5000	54	3400
–MA	2800	131	710	340	100	9300	103	9100	101	7400
–TC	2500	152	481	340	69	6600	72	6400	70	4700
–TN	2100	141	153	210	25	2600	27	2500	26	1600
GV–DN	2900	265	350	290	53	5100	56	5000	54	3400
–MA	2800	158	527	310	75	7100	78	6900	76	5200
–TN	2600	238	294	290	44	4400	47	4300	46	2900
HB–AD	6400	309	642	340	91	8500	94	8300	92	6600
–CB	6000	345	511	340	73	6900	76	6700	74	5100
–LT	3700	338	85	120	15	1700	16	1600	16	1200
–ML	3700	326	349	330	52	5000	55	4900	53	3300
–SY	6000	006	611	340	87	8100	90	7900	88	6200
LT–AD	3800	305	583	340	83	7800	86	7600	84	5900
–CB	6000	359	426	340	62	5900	65	5700	63	4100
–HB	5000	158	78	100	14	1600	15	1500	15	1100
–ML	3700	322	264	290	40	4000	43	3900	42	2500
–SY	6000	010	526	340	75	7100	78	6900	76	5200
MA–AS	5000	234	363	330	54	5200	57	5100	55	3500
–CS	5300	051	427	340	62	5900	65	5700	63	4100
–DN	2800	311	710	340	100	9300	103	9100	101	7400
–MK	5200	086	548	340	78	7400	81	7200	79	5500
–RK	3700	098	641	340	91	8500	94	8300	92	6600
–TC	2800	277	308	310	46	4500	49	4400	48	2900
–TL	4700	072	422	340	61	5900	64	5700	62	4000
–TN	2800	307	557	340	79	7500	82	7300	80	5600
MK–BN	3900	140	442	340	64	6100	67	5900	65	4300
–CG	3900	140	494	340	71	6700	74	6500	72	4900
–CS	6600	316	336	320	50	4800	53	4700	51	3200
–MA	5200	266	548	340	78	7400	81	7200	79	5500
–RK	3800	143	151	210	25	2600	27	2500	26	1600
–TL	5100	302	179	230	29	3000	31	2900	30	1800

Flight planning and cruise control (continued)

STANDARD ALTERNATES (Cont'd)

ISA TO ISA +15 ZERO FUEL WT. 37000 kg WIND COMP ZERO

TYPE OF DIVERSION					M.76		LRC		DIVERSION AT CRUISE LEVEL	
SECTOR	LSA	TR (M)	DIST (nm)	FLT LVL	TIME (min)	BURN–OFF (lb)	TIME (min)	BURN–OFF (lb)	TIME (min)	BURN–OFF (lb)
ML–AD	4700	290	350	330	52	5000	55	4900	53	3300
–BN	6100	023	761	340	107	9900	110	9700	108	8000
–CB	6800	045	261	290	40	4000	43	3900	42	2500
–CG	6100	027	721	340	101	9400	104	9200	102	7500
–HB	6400	146	337	320	50	4800	53	4700	51	3200
–LT	3000	142	266	290	40	4100	43	4000	42	2600
–SY	6700	043	390	330	57	5500	60	5400	58	3800
–WLM	6700	039	466	340	67	6400	70	6200	68	4500
PD–GN	5100	204	553	340	79	7400	82	7200	80	5600
–LM	4700	225	279	290	42	4200	45	4100	44	2700
–MR	5200	180	376	310	56	5400	59	5200	57	3700
–PBO	5100	195	176	230	28	2900	30	2800	29	1700
PH–GN	2200	343	230	270	35	3600	38	3500	37	2200
–KG	2900	077	291	300	44	4400	47	4300	46	2900
–LM	2200	353	630	340	89	8200	92	8100	90	6400
–MR	3300	024	348	330	52	5000	55	4900	53	3300
PN–BN	3900	140	496	340	71	6700	74	6500	72	4800
–CG	3900	140	548	340	78	7400	81	7200	79	5500
–CS	6600	317	284	300	43	4300	46	4200	45	2800
–MA	5200	261	514	340	74	7000	77	6800	75	5100
–MK	3200	131	54	070	10	1100	11	1000	11	800
–RK	3800	150	205	250	32	3300	35	3200	34	2000
–TL	5100	299	127	180	21	2300	23	2200	23	1400
RK–BN	3900	139	291	300	44	4400	47	4300	46	2900
–CG	3900	141	343	330	51	4900	54	4800	52	3200
–CS	6600	319	481	340	61	5800	64	5600	62	4000
–MA	3700	278	641	340	91	8500	94	8300	92	6600
–MK	3800	323	151	210	25	2600	27	2500	26	1600
–TL	5200	312	324	320	48	4700	51	4600	50	3000
SY–AD	5700	255	648	340	92	8600	95	8400	93	6700
–BN	6300	002	407	340	59	5700	62	5500	60	3900
–CB	4400	221	131	180	22	2400	24	2300	24	1500
–CG	6300	008	367	330	54	5200	57	5100	55	3500
–HB	6000	186	592	340	84	7900	87	7700	85	6000
–LT	6000	190	514	340	74	7000	77	6800	75	5100
–ML	8400	223	385	330	56	5400	59	5300	57	3700
–RK	6200	346	640	340	91	8500	94	8300	92	6600
–WLM	3200	015	76	100	14	1600	15	1500	15	1100
TL–BN	5200	134	614	340	87	8100	90	8000	88	6200
–CG	5200	137	666	340	94	8800	97	8600	95	6900
–CS	6600	330	157	210	26	2700	28	2600	27	1700
–MA	4700	252	422	340	61	5900	64	5700	62	4000
–MK	5200	123	179	230	29	3000	31	2900	30	1800
–RK	5200	133	324	320	48	4700	51	4600	50	3000

STANDARD ALTERNATES (Cont'd)

NOTE: 1. The figures in the tables allow for –
(a) Diversion to alternate from 1500 feet over destination, including normal climb, cruise at M.76 and normal descent.
(b) Diversion to alternate from 1500 feet over destination, including normal climb, long range cruise and long range descent.
(c) Diversion to alternate from over–top of destination at cruise level including longe range cruise and long range descent.

2. Fuel allowances for taxi (200 lb), take–off (500 lb) and final manoeuvre (400 lb) are NOT included.

3. Corrections for wind component:
For every 100 nm of diversion distance:
(a) Headwinds – Add 1 min and 100 lb for every 40 kt of component.
(b) Tailwinds – Subtract 1 min and 100 lb for every 40 kt of component.

4. If diversion to alternate at cruise level is used in planning a flight, the calculated burn–off from departure to destination should be increased by 600 lb to allow for the higher consumption cruising to over the top instead of descending to circuit altitude at the destination.

Continued on next page

ASYMMETRIC DIVERSION TABLE

ADDITIONAL FUEL REQUIRED (lb)

DISTANCE (nm)	M.76 CRUISE LEVEL WIND COMPONENT (kt)				
	−80	−40	Zero	+40	+80
400	NIL	50	100	150	200
450	200	250	300	350	400
500	400	450	500	550	600
550	600	650	700	750	800
600	800	850	900	950	1000
650	900	1000	1050	1100	1200
700	1000	1100	1200	1300	1400
750	1100	1200	1300	1400	1500

NOTE: 1. Above figures show fuel (lb) additional to minimum fuel for M.76 diversion including reserves (10% plus 2600 lb).

2. Above additional fuel to cover Asy requirement also covers Depress requirement.

3. Requirements covered —
   (a) Asy — LRC B/off plus 10% plus 1500 lb
   (b) Depress — LRC B/off plus 1750 lb

Flight planning and cruise control (continued)

7. FUEL

A. Fixed Allowances

(1) Fixed fuel allowances which are additive to en route burn-off are:

(a)	Engine Start and Initial Taxi	200 lb.
(b)	Take-off and Normal Climb to Set Heading (1500 ft.)	500 lb.
(c)	Circuit and Landing at Destination (or Alternate)	400 lb
(d)	Final taxi at Destination (or Alternate)	200 lb

(2) A total fuel allowance of 1100 lb is added to the flight burn-off to establish block burn-off. This figure does not include final taxi allowance (200 lb), but where fuel is uplifted for more than one stage, provision of fuel for final taxi at intransit ports should be considered.

B. Reserves

(1) D.O.T. requires carriage of additional fuel, equal to 10% of the calculated block fuel, as a reserve against unplanned additional burn-off during the flight.

(2) To provide for unforeseen delays after the aircraft reaches the destination D.O.T. requires the carriage of an additional fixed reserve calculated at 1500 ft under ISA conditions.

(3) The revised D.O.T. fuel reserves for domestic jet operations are as follows –

(a) Alternate not required
Block burn-off from departure to destination plus 10% plus a fixed reserve of 45 min i.e. 45 min @ 5200 lb/hr = 3900 lb.

(b) Alternate required
Block burn–off from departure to destination plus flight fuel from destination to alternate plus 10% plus a fixed reserve of 30 min i.e. 30 min @ 5200 lb/hr = 2600 lb.

(c) Loss of engine
On departure, fuel shall be such as to enable the aircraft after engine failure at any point en-route to fly to and land at a suitable airport, plus 10% plus a fixed reserve of 20 min i.e. 20 min @ 4500 lb/hr = 1500 lb.

(d) Loss of pressurisation
On departure, fuel shall be such as to enable the aircraft, following pressurisation failure at any point en-route to fly to and land at a suitable airport plus a fixed reserve of 20 min i.e. 20 min @ 5200 lb/hr = 1750 lb.

NOTE: There is no variable reserve (10%) required in the depressurised reserve.

Flight planning and cruise control (continued)

(e) In–flight replanning

(i) An aircraft may depart with less fuel than the minimum specified above provided that, at all times until the relevant requirements can be met, a suitable airport is available on which the operation may be predicated in compliance with the relevant requirements.

(ii) A 'suitable' airport is one that has been forecast to not require an alternate during the period in which it is anticipated that it will be used.

(iii) The D.O.T. fuel policy refers also to an 'acceptable' airport, which is defined as an airport that has been forecast to remain open during the period in which it is anticipated that it will be used.

(iv) For Company operations, calculations should be based only on suitable airports as defined above.

(v) The fixed reserve of 45 min [refer to (a), above] may be reduced to 30 min for in–flight planning.

(4) The Company approved fuel reserves are as follows:–

(a) Variable reserve:
The variable reserve for jet operations is 10% of the calculated block burn–off.

(b) Fixed reserve:

(i) Alternate not required:
The mandatory fixed reserve is 3900 lb (45 min @ 5200 lb/hr). On routes where payload permits, fuel in addition to 3900 lb may be carried at Captain's discretion, to avoid refuelling on multi–stage flights or at airports where fuel is expensive. Apart from flights requiring contingency fuel or mandatory holding, it is Company policy to depart with a fixed reserve of 60 min (5200 lb) except on flights into Sydney airport where the fixed reserve is increased to 75 min (6500 lb); however, this reserve may be reduced to the D.O.T. mandatory minimum (45 min) whenever fuel is critical.

(ii) Alternate required:
When a flight includes the carriage of an alternate the fixed reserve may be reduced to 30 min (2600 lb).

(iii) In–flight re–planning:
If it is necessary to re–plan at any time during flight, the fixed reserve may be reduced to 30 min (2600 lb).

(iv) To cover asymmetric or depressurised operations the Company fixed reserve is as per the D.O.T. minimum quoted above, i.e., 20 min (Asy 1500 lb – Depress 1750 lb).

(5) In certain circumstances it may be necessary to flight plan to a PNR, and at that point, recalculate fuel reserves before proceeding to destination. This may be the case on long haul flights such as AD–PH. Remember that, for in–flight replanning, the fixed reserve may be reduced to 30 min.

(6) Additional fuel for forecast delays, such as weather or traffic congestion, may be required and this is calculated at the holding rate of 4800 lb/hr. When holding fuel is required the fixed reserve should be reduced to 45 min when calculating the minimum fuel requirements.

(7) Fuel ex CB should be the minimum flight planned requirement to accommodate loading. Fuel ex SY or ML for CB should equal the minimum for the onwards flight from CB plus block fuel to CB.

(8) Any fuel above the minimum requirement for the flight is recorded on the flight plan as margin fuel and is calculated at cruise consumption rate (6000 lb/hr) but may be regarded operationally as holding fuel for use at destination.

(9) Irrespective of the reserve carried, the flight plan should be prepared listing the minimum requirements with any surplus shown at the margin rate [see examples 3.B. (8) (a) and 3.C. (2) (a)].

C. Contingency Fuel

(1) To provide for the increased fuel required for single–engine manoeuvring and climb out, the following minimums must be observed when taking off from an airport which is open for take–off but closed to landing:

(a) For departure from all airports except CB and CS:
Block fuel + 10% + 45 min reserve + 1500 lb.

(b) For departure from CB and CS:
Block fuel + 10% + 45 min reserve + 2000 lb.

(2) The additional fuel required at CS and CB provides for single engine manoeuvring and climb out to altitude prior to setting heading.

(3) The above requirements may be waived if an alternate airfield is available which is closer than the destination, e.g., Sydney as an alternate for a flight departing CB for ML.

(4) When the above additive fuel factors are carried there should never be an occasion when mandatory minimum fuel (i.e. block burn–off plus 10% plus fixed reserve of 45 min) will not cover loss of an engine immediately after take–off with the departure airport open for take–off but closed for landing.

HOLDING FUEL FLOW

ISA +10

PRESSURE ALTITUDE 1000 ft.	AIRSPEED IAS – kt	HOLDING FUEL FLOW – lb/hr TOTAL A/C GROSS WEIGHT – 1000 kg						
		43.1	40.8	38.6	36.3	34.0	31.8	29.5
5	200	5080	4890	4710	4550	4420	4290	4160
6	200	5080	4890	4710	4550	4420	4290	4160
7	210	5040	4870	4700	4550	4420	4300	4200
8	210	4990	4810	4650	4500	4370	4250	4140
9	210	4930	4760	4600	4450	4320	4190	4080
10	210	4890	4710	4550	4400	4270	4150	4030
11	210	4850	4670	4500	4360	4230	4100	3990
12	210	4810	4630	4460	4320	4180	4050	3940
13	210	4760	4590	4420	4280	4140	4010	3900
14	210	4720	4550	4380	4240	4100	3970	3860
15	230	4890	4740	4590	4450	4330	4220	4110
16	230	4850	4700	4550	4420	4300	4190	4080
17	230	4810	4660	4520	4390	4270	4160	4050
18	230	4780	4620	4480	4350	4230	4120	4010
19	230	4740	4590	4440	4310	4190	4090	3980
20	230	4710	4560	4420	4280	4160	4050	3940
21	230	4690	4530	4390	4260	4130	4020	3910
22	230	4670	4510	4360	4230	4100	3990	3880
23	230	4650	4480	4330	4190	4070	3950	3840
24	230	4630	4470	4310	4170	4040	3930	3810
25	230	4620	4460	4300	4160	4020	3900	3780
27	230	4600	4440	4290	4150	4010	3890	3770
29	230	4590	4430	4270	4130	3990	3870	3740
31	230	4680	4460	4280	4130	3990	3870	3740

For temperatures above ISA +10^{o}C, Add 10 lb/hr/^{o}C
For temperatures below ISA +10^{o}C, Subtract 10 lb/hr/^{o}C

Flight planning and cruise control (continued)

(5) Example:
Route CS – TL, BRW 45000 kg, ISA +15, Zero wind.
Normal fuel required to over top TL (assuming 2 engine operation – Cruise F/L 190)

	Time	Dist.	Fuel
Taxi and manoeuvre allowance			700 lb
Climb to 19000 ft	11 min	64 nm	1950 lb
Cruise (TAS 433 kt @ 6900 lb/hr)	6 min	41 nm	700 lb
Descent	9 min	52 nm	200 lb
	26 min	157 nm	3550 lb
Variable Reserve (10%)			350 lb
Total			3900 lb

With CS closed for landings:
Engine–out fuel required to over top TL (assuming single engine operation – Cruise F/L 110)

	Time	Dist.	Fuel
Taxi, take–off and clean up at 500 ft			900 lb
Climb to 6500 ft prior to set heading	12 min		1300 lb
Climb to 11000 ft	17 min	78 nm	1750 lb
Cruise (TAS 325 kt @ 5600 lb/hr)	9 min	49 nm	850 lb
Descent	7 min	30 nm	150 lb
Sub–total	45 min	157 nm	4950 lb
Variable Reserve (10%)			500 lb
Total			5450 lb

i.e., Additional fuel required: 5450 lb – 3900 lb = 1550 lb

D. **Holding**

(1) Prolonged holding is conducted in the clean configuration.

(2) The Company technique requires a holding speed of 210 kt at an aircraft gross weight of 40000 kg, with a correction factor of plus (or minus) 2 kt for each 1000 kg above (or below) that weight. In a race track pattern, the holding speed at that weight is 230 kt, with the same correction factor.

(3) The Company Holding Fuel Flow Table gives the rates for various altitudes and aircraft weights at a temperature of ISA +10°C for specified indicated speeds. Corrections for variations from the reference temperature are also given.

(4) A comparison of values in the holding table indicates that 29,000 ft is generally the best altitude for holding, when only fuel endurance is considered.

Flight planning and cruise control (continued)

(5) The holding rate of fuel flow used for flight planning purposes (4800 lb/hr) is the approximate rate of flow for an aircraft at max. landing weight holding at an altitude of 20000 ft in ISA + 10°C conditions.

(6) During flight, holding should be calculated having regard to:

(a) Fuel burn–off to destination, after consideration of found wind and observed fuel flow rate.

(b) Weather conditions at destination and alternate.

(c) Descent procedures.

(7) Example: If a weather forecast indicates:

(a) INTER conditions, the fuel reserve will be 10% of block fuel, plus 45 min fixed reserve, plus 30 min holding fuel (2400 lb).

(b) TEMPO conditions, the fuel reserve will be 10% of block fuel, plus 45 min fixed reserve, plus 60 min holding fuel (4800 lb),

NOTE: When thunderstorms are forecast and INTER conditions stated, 60 minutes holding fuel should be carried when loading permits.

(8) It should be noted that carriage of an alternate instead of mandatory holding fuel may require less fuel in certain circumstances when TEMPO conditions are forecast. On other occasions, reserve fuel additional to minimum requirements may be desirable and should be carried when loading permits. However, it must be remembered that indiscriminate carriage of fuel is costly and, because of the increased weight, causes a reduction in aircraft performance.

E. Cost of Carrying Additional Fuel

(1) The fuel cost differential minus the cost of transport shows that it does pay to carry additional fuel on some sectors. The following table lists those routes on which it does pay to carry additional fuel.

BNE–OOL
MEL–CBR
MKY–PPP
MKY–ROK
SYD–CBR
TSV–PPP

(2) Other considerations, such as weather, refuelling or supply problems may change the outcome on other sectors. Pilot discretion is necessary in these circumstances.

8. PLANNING FOR LONG RANGE

When flight planning at M.76 restricts range or payload (e.g. BN–TL with MA as alternate), the Long Range Cruise Data listed in tabular form in the Operating Manual, Flight Planning Folders and the Cockpit Cruise Control Book should be used. Use normal climb data (300 kt/M.73).

Cruise level should be that which gives the best GNM/1000 lb. At high gross weights, initial cruise flight level may be restricted to F/L 310 (or F/L 330) because of weight or temperature. A further climb to F/L 350 (if required) should be planned at that point where the aircraft weight reduces to 41000 kg (90000 lb).

Diversion to alternate (when applicable) or en–route change of cruise technique (when necessary) may also require the use of the same Long Range Cruise Data.

Actual cruise thrust settings and cruising mach numbers can be extracted from the Cruise Control Book.

9. OPERATION WITH ONE ENGINE OPERATIVE

(1) In the event of an engine failure in climb or cruise, immediately set maximum continuous thrust on the operating engine. It is permissible to use maximum continuous thrust for the duration of the flight in the event of an engine failure.

(2) Reduce airspeed to 260 kt IAS or to the enroute climb speed (V_{CL}) if necessary for terrain clearance. Refer to the Altitude Capability at Single Engine Long Range Cruise Airspeed Table (see following pages) and determine the stabilised maximum cruise altitude at the single engine long range cruise airspeed for the existing gross weight and deviation from ISA.

(3) If below the stabilised cruise altitude continue climb at 200 kt IAS or at the enroute climb speed if necessary for terrain clearance. Increase airspeed if turbulence is encountered.

(4) If above the stabilised cruise altitude drift down at 260 kt IAS.

(5) When approaching the stabilised cruise altitude, change airspeed to the Single Engine Long Range Cruise Airspeed (see following pages). If the quoted stabilised altitude cannot be held at this airspeed, descend to the next available altitude.

(6) Maximum range is obtained by flying at the single engine long range cruise airspeed at the highest possible altitude using maximum continuous thrust. As fuel burns off, increase altitude and maintain the correct airspeed using maximum continuous thrust. If unable to increase altitude for ATC or other reasons, reduce thrust progressively to maintain the correct airspeed at each weight. Data on fuel flows, etc. are given in the Cruise Control Book.

Example:

(a) On a flight from Sydney to Adelaide it was necessary to shut down an engine at 28000 ft because of a leaking fuel heat valve which caused engine oil temperature to exceed 120°C.

(b) It was noted during the taxi out at Sydney that the blue fuel heat advisory light flashed on momentarily. Later, during the cruise phase, both fuel heat and oil temperatures increased until it was necessary to shut down the engine. The flight was continued to Adelaide rather than diverted to Melbourne because the engine was considered to be available if a further emergency occurred.

Flight planning and cruise control (continued)

(c) The descent procedure of 260 kt IAS and Meto power with the auto pilot engaged was followed. Initial R.O.D. was 1000 fpm but after passing 20000 ft where Meto power is increased, R.O.D. averaged approximately 200 fpm until 15500 ft was reached. Single engine cruise altitude tabulation indicated that 15000 ft would be the cruise altitude.

(d) Fuel burn—off for the whole flight was 12100 lb compared with flight plan burn—off of 11300 lb. Minimum fuel required for the flight was 18000 lb. Total fuel carried was 20000 lb.

Continued on next page

EN–ROUTE NET CEILINGS ~ ONE ENGINE OPERATING

BASED ON:
ONE ENGINE AT MAX. CONTINUOUS THRUST
ONE A/C PACK ON
NO ICE PROTECTION

ISA CONDITION	ALTITUDE IN 1000's ft GROSS WEIGHT (1000 kg)							
	30	35	40	42	44	46	48	50
ISA –10	25	20.3	17.7	16.4	14.8	13.4	12	10.6
ISA	23.8	20	16.1	15	13.4	11.9	10.4	9
ISA +10	22	19.1	14.8	13.2	11.5	10	8.4	7
ISA +20	20	17.6	13	11.2	9.3	7.5	5.7	3.3
ISA +30	20	15.5	10.1	8	5.5	3.2	0.9	–
V_{CL} IAS (kt) CLIMB SPEED	162	176	188	192	197	202	206	210

CORRECTIONS:
ENGINE ICE PROTECTION ONLY – SUBTRACT 2300 ft.
ENGINE AND AIRFRAME ICE PROTECTION – SUBTRACT 4100 ft.

Flight planning and cruise control (continued)

ALTITUDE CAPABILITY
AT SINGLE ENGINE LRC AIRSPEED
MAXIMUM CONTINUOUS THRUST – JT8D–7 ENGINE
PRESSURE ALTITUDES (1000 ft) WITH
ANTI–ICE OFF/ENGINE ANTI–ICE ONLY/ENGINE AND AIRFRAME ANTI–ICE

GROSS WEIGHT	DEVIATION FROM ISA					
1000 kg	–5	0	+5	+10	+15	+20
45.4	15/12/10	14/11/ 9	13/10/ 8	12/ 9/ 7	10/–/–	8/–/–
44.5	16/13/11	15/12/10	14/11/ 9	12/10/ 8	11/–/–	9/–/–
43.5	17/14/12	16/13/11	15/12/10	13/10/ 9	12/–/–	10/–/–
42.6	18/15/12	17/14/11	15/12/10	14/11/ 9	13/10/–	11/–/–
41.7	18/16/13	17/14/12	16/13/11	15/12/10	14/11/–	12/–/–
40.8	19/16/14	18/15/13	17/14/12	16/13/11	15/12/10	13/–/–
39.9	20/17/15	19/16/14	18/15/13	17/14/12	15/12/10	14/–/–
39.0	20/18/15	20/17/15	19/16/13	17/15/12	16/13/11	15/–/–
38.1	20/19/16	20/18/15	19/17/14	18/15/13	17/14/12	16/–/–
37.2	20/20/17	20/19/16	20/17/15	19/16/14	18/15/13	17/14/12
36.3	20/20/18	20/19/17	20/18/16	20/17/15	19/16/14	18/15/13
35.4	21/20/19	20/20/18	20/19/17	20/18/16	20/17/15	19/16/14
34.5	22/20/19	21/20/19	20/20/18	20/19/17	20/18/16	20/17/15
33.6	23/20/20	22/20/20	20/20/19	20/20/18	20/19/17	20/18/15
32.7	24/21/20	23/20/20	21/20/20	20/20/19	20/20/18	20/19/17
31.8	25/22/20	24/21/20	23/20/20	21/20/20	20/20/19	20/20/18
30.8	25/23/20	25/22/20	24/20/20	22/20/20	21/20/20	20/20/20
29.9	25/24/21	25/23/20	25/21/20	23/20/20	22/20/20	20/20/20
29.0	25/25/22	25/24/21	25/22/20	24/21/20	23/20/20	21/20/20
28.1	25/25/23	25/25/22	25/23/20	25/22/20	24/20/20	22/20/20
27.2	25/25/25	25/25/23	25/25/21	25/23/20	25/22/20	23/20/20

ALTITUDES ARE NOT SHOWN FOR ANTI–ICE ON AND TOTAL AIR TEMPERATURE GREATER THAN ISA +20.

SINGLE ENGINE LRC AIRSPEEDS (kt IAS)

GROSS WEIGHT	PRESSURE ALTITUDE – 1000 ft										
1000 kg	7	9	11	13	15	17	19	20	21	23	25
45.4	274	275	275	274	272	–	–	–	–	–	–
44.5	272	273	273	272	270	264	–	–	–	–	–
43.5	270	271	270	270	267	262	–	–	–	–	–
42.6	268	268	268	267	265	261	256	–	–	–	–
41.7	266	266	265	264	263	260	255	–	–	–	–
40.8	263	263	262	262	260	258	254	250	–	–	–
39.9	261	260	259	259	258	256	252	249	–	–	–
39.0	258	257	256	256	255	254	250	248	–	–	–
38.1	256	255	254	253	252	251	248	247	–	–	–
37.2	254	252	251	250	249	248	246	245	–	–	–
36.3	251	250	248	247	246	245	244	243	–	–	–
35.4	249	247	245	245	244	243	242	241	240	–	–
34.5	246	245	243	242	241	240	239	238	237	235	–
33.6	244	243	240	239	238	237	237	236	236	234	–
32.7	242	240	237	237	235	234	233	233	233	232	229
31.8	239	238	235	234	232	231	231	231	231	230	227
30.8	237	235	233	231	229	228	228	228	229	229	225
29.9	235	233	231	228	227	225	225	226	228	226	223
29.0	232	231	228	226	224	223	223	223	224	223	220
28.1	230	228	226	223	221	220	220	220	222	221	217
27.2	228	226	223	220	218	217	217	217	219	218	214

Flight planning and cruise control (continued)

10. CRITICAL POINT (CP)

(1) In DC9 operations over shorter stages, i.e. less than 400 nm (approx.), the mid point of the flight may be considered to be the CP e.g. NHL on the ML – AD route. However, abnormal winds or en-route weather would change this concept.

(2) When an alternate is required, a more precise point should be computed to ensure that the flight takes the shortest path in the event of engine failure.

(3) On longer flights, consideration of a pressurisation failure should be taken into account using a TAS and fuel consumption rate based on F/L 130. At this low level, range is less on two engines than on one and therefore long range cruise operation will be necessary to allow for mandatory reserves of fuel.

(4) In-flight calculation (or revision) of the CP (or PNR) should be carried out making use of observed actual performance data.

(5) Critical Point (CP) is defined as that point in a flight from which it will take an equal time to return to departure point or proceed to destination. This is also known as Equi-Time Point (ETP).

(6) CP may be applied with any number of engines operative but, for Company operations, it is usually considered for flight with one engine inoperative, and, calculations are normally based on the relevant engine-out TAS and fuel consumption rate. In turbine aircraft, a CP based on depressurised operation may become the paramount consideration.(See CP Fuel Requirements Table).

(7) CP may be calculated in a number of ways – Formula, Computer, Howgosit Graph etc.

(a) Formula Method:

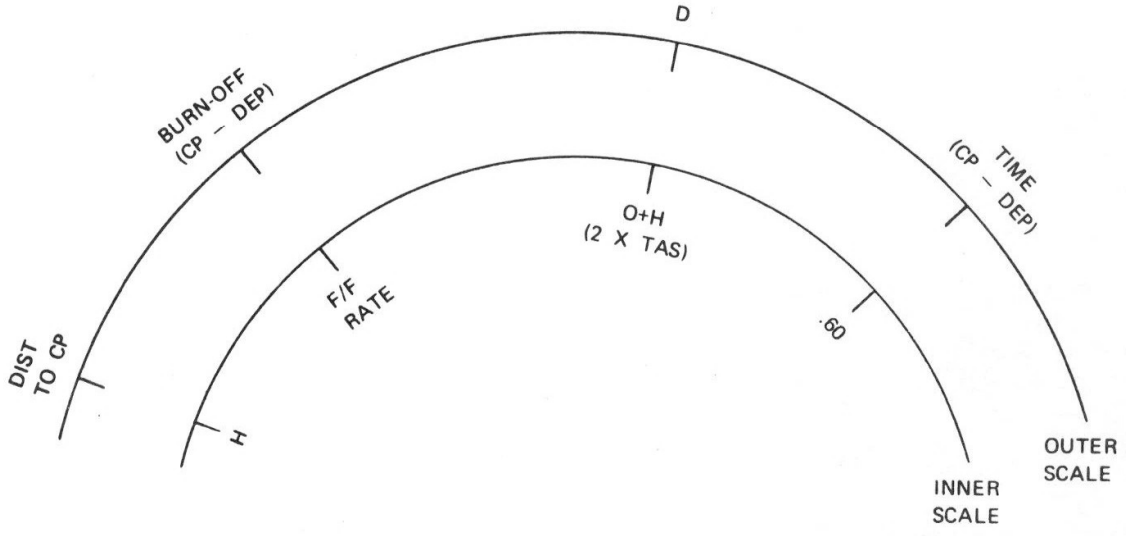
$$\text{Distance to CP} = \frac{D\ H}{O+H}$$

Where D = Total stage distance (nm)
O = G/S (ON) – Onward from CP
H = G/S (HOME) – Homeward from CP

However, this is just another way of solving $\frac{H}{O+H}$ of D and the distance to the CP is, therefore, a proportion of these factors under any operating conditions. Also, except in the case of strong crosswind, practically speaking O + H = 2 x TAS.

Flight planning and cruise control (continued)

(b) Computer Method:



(i) Set the total stage distance (D) on the outer scale against the sum of the G/S (O + H) on the inner scale and read off the distance to the CP on the outer scale against G/S (H) on the inner scale. The figure on the outer scale against 60 is the time, in minutes, from CP to Departure (or Destination), and the burn-off from CP to Departure (or Destination) can be read on the outer scale opposite the relevant fuel-flow rate.

(ii) Analysis of DC9 LRC performance data shows the following values for stage distances from 700 nm to 1100 nm in ISA +10°C conditions.

Asymmetric – F/L 170 – Mean aircraft weight (Asy.) between 39000 kg and 43000 kg – TAS 340 kt @ 5100 lb/hr.

Depressurised – F/L 130 – Mean aircraft weight (Depress.) between 39000 kg and 43000 kg – TAS 350 kt @ 5900 lb/hr.

These average values have been employed in the following examples and should be used in any CP calculations, unless particular conditions require a more detailed consideration of aircraft weight, temperature, flight level, etc. On such occasions, the relevant TAS and fuel flow rate can be extracted from the LRC tables in the DACO manual.

(iii) Examples of CP

(a) Stage Dist. 900 nm

CP based on Normal Cruise Conditions – M.76 – F/L 290 – H/W 40 kt – TAS 450 kt – F/F 5700 lb/hr.

Set 900 on outer scale against 900 on inner, then the distance to CP must be 490 nm, the time CP to Departure must be 60 min and fuel burn-off CP to Departure equals 5700 lb.

Ans: 490 nm – 60 min – 5700 lb.

Flight planning and cruise control (continued)

(b) CP based on Asym. Cruise Conditions – LRC – F/L 170 – H/W 25 kt – TAS 340 kt – F/F 5100 lb./hr.

Set 900 on outer against 680 on inner and read off distance to CP opposite 365 (483 nm) – Time CP to Departure opposite 60 (79 min) – Fuel burn-off CP to Departure opposite 5100 (6750 lb).

Ans: 483 nm – 79 min – 6750 lb.

(c) CP based on 2 Eng. Depress. Cruise Conditions – LRC – F/L 130 – H/W 20 kt – TAS 350 kt – F/F 5900 lb/hr.

Set 900 against 700 – Read off opposite 370 (476 nm) – opposite 60 (77 min) – opposite 5900 (7600 lb).

Ans: 476 nm – 77 min – 7600 lb.

(d) CP based on 1 Eng. Depress. Cruise Conditions – LRC – F/L 130 – H/W 20 kt – TAS 320 kt – F/F 5200 lb/hr.

Set 900 against 640 – Read off opposite 340 (478 nm) – opposite 60 (84 min) – opposite 5200 (7300 lb).

Ans: 478 nm – 84 min – 7300 lb.

(iv) Comparison of the above examples shows that, practically speaking, the distance to all forms of CP is almost the same, but the fuel burned, CP to departure, is greatest in 2 Eng. Depress. Cruise Conditions. The fuel burned in normal operation in reaching the CP is common to all cases.

(c) Howgosit Method – This method of solving either CP or PNR calculations is applicable only on long range operations when a Fuel Howgosit Graph (Flight Progress Chart) is carried.

11. POINT OF NO RETURN (PNR)

(1) The Point of No Return is defined as the furthest point in a flight to which an aircraft can proceed under normal operation and still have sufficient fuel to return to departure point with statutory reserves of fuel intact.

(2) The return sector may be calculated for normal operation, with one engine inoperative, or depressurised operation. PNR's for company services are usually calculated for normal operation both out and home.

(3) PNR calculations usually are not required over the shorter stage distances within the mainland network, but may be necessary on longer flights to Port Hedland, Perth and Darwin and, in some cases, may be dependent upon en-route alternate airfields being available.

(4) **Calculation of PNR**

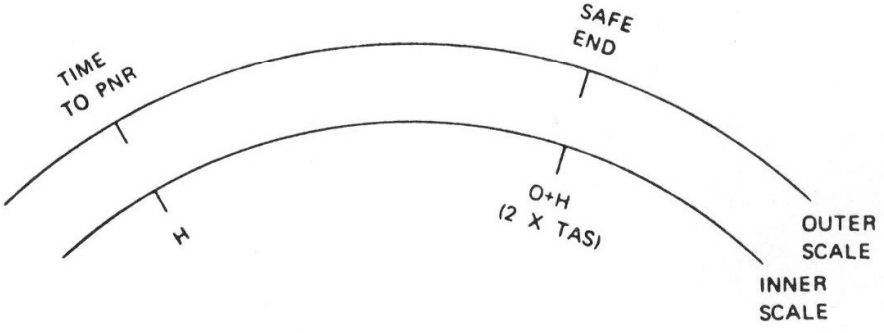
(a) Formula Method:

$$\text{Time to PNR (min)} = \frac{E\ H}{O+H}$$

Where E = Safe endurance in min (excl. statutory reserves).
O = G/S (Out) – Outward from Departure Point.
H = G/S (Home) – Homeward from PNR.

Flight planning and cruise control (continued)

(b) Computer Method:



(i) Set safe endurance (E) in min on the outer scale against the sum of G/S (O + H) on inner scale and read off time to PNR (in min) on outer scale opposite G/S (H) on inner scale.

(ii) Examples of PNR

(a) Normal Cruise Conditions – F/L 290 – T/W 20 kt.

Flight plan reads	164 min	–	17400 lb
Variable Reserve (10%)	16 min	–	1700 lb
Fixed Reserve (45 min)	45 min	–	3900 lb
Totals	225 min	–	23000 lb

Safe endurance 164 min.
Normal TAS 450 kt @ 5700 lb/hr.

Set 164 min against 900 (O+H) and read off time to PNR (min) opposite 430 (H).
Time to PNR_2 = 78 min

Dist. to PNR_2 =	Climb	–	22 min @	397 kt	–	146 nm
	Cruise	–	56 min @	470 kt	–	438 nm
	Totals	–	78 min			584 nm

(b) Asymmetric conditions

If a PNR for return on 1 Engine is required, solution by GNM/1000 lb. method is recommended, e.g., using data in previous example and allowing for 1 Eng. TAS 340 kt @ 5100 lb./hr. on the return sector proceed as follows:

Wind Comp. for return (F/L 170) = H/W 10 kt

$$\text{GNM/1000 lb (O)} = \frac{\text{2 Eng. G/S (O)}}{\text{F/F}} = \frac{470}{5700} = 82.5 \text{ GNM/1000 lb}$$

$$\text{GNM/1000 lb (H)} = \frac{\text{1 Eng. G/S (H)}}{\text{F/F}} = \frac{330}{5100} = 64.8 \text{ GNM/1000 lb}$$

$$\text{GNM/1000 lb (O + H)} = 147.3$$

Emergency Reserve (10% plus 1500 lb) = 3500 lb

Fuel available (exc. Res) = 23000 – 3500 = 19500 lb.

Less manoeuvre allowances (1100 lb) = 18400 lb.

Adjustment for climb 1600 lb (See Note below)
Fuel avail. for PNR_1 = 18400 – 1600 = 16800 lb

$$\text{Fuel to } PNR_1 = \frac{\text{Fuel available X GNM/1000 lb (H)}}{\text{GNM/1000 lb (O+H)}}$$

$$= \frac{16800 \times 64.8}{147.3} = 7400 \text{ lb}$$

Dist. to PNR_1 = 7400 lb @ 82.5 GNM/1000 lb (O)
= 611 nm

Check: Fuel to return from PNR_1

= 611 nm @ 64.8 GNM/1000 lb (H)
= 9400 lb

∴ Fuel (O) 7400 lb + fuel (H) 9400 lb = fuel avail. 16800 lb

Time to PNR_1 = 7400 lb @ 5700 lb/hr = 78 min or
Time to PNR_1 = 611 nm @ 470 kt = 78 min.

NOTE: The adjustment for climb is necessary because the above calculation includes only Cruise (O) and Cruise (H) and no allowance is made for the increased climb consumption rate. The 1600 lb is the approximate difference between the climb burn-off and the cruise burn-off for the climb distance. The above adjustment is not necessary for in-flight calculation or revision of PNR.

Flight planning and cruise control (continued)

(c) Depressurised Conditions

If a PNR based on return depressurised at F/L 130 is required, proceed as above allowing for TAS 350 kt @ 5900 lb/hr on the return sector.

W/Comp. for return (2 Eng. @ F/L 130) = H/W 10 kt

GNM/1000 lb (O) (as above) = 82.5

GNM/1000 lb (H) = $\frac{340}{5900}$ = 57.6 GNM/1000 lb (O+H) = 140.1

Emergency Reserve (20 min @ 5200 lb/hr) = 1750 lb

Fuel available (exc. Res) = 23000 – 1750 = 21250 lb.

Less manoeuvre allowances (1100 lb) = 20150 lb.

Adjustment for climb 1600 lb (See Note at *(b)* above)

Fuel avail. for PNR_{DP} = 20150 – 1600 = 18550 lb

Fuel to PNR_{DP} = $\frac{18550 \times 57.6}{140.1}$ = 7630 lb

Dist. to PNR_{DP} = 7630 lb @ 82.5 GNM/1000 lb (O) = 629 nm

Check: Fuel to return from PNR_{DP}

= 629 nm @ 57.6 GNM/1000 lb (H)
= 10920 lb

Fuel (O) 7630 lb + fuel (H) 10920 lb = fuel avail. 18550 lb

Time to PNR_{DP} = 7630 lb @ 5700 lb/hr = 80 min or
Time to PNR_{DP} = 629 nm @ 470 kt = 80 min

(d) Summary:

Time to PNR_2 (Normal Reserve) = 78 min
Time to PNR_1 (Emerg. Reserve) = 78 min
Time to PNR_{DP} (Emerg. Reserve) = 80 min

NOTE: For company operations a PNR_2 based on normal operations both out and home may be used also as asymmetric or depressurised PNR (See 'Summary' above).

(3) In flight calculation (or re–calculation) of Critical Point or Point of No Return should be carried out making use of all known performance data.

(a) Example:

Assume aircraft enroute TL – BN, Temperature ISA +15, Cruise F/L 290, Wind Comp. T/W 40 kt, BRW 45000 kg. Total fuel on board 16000 lb.

Flight planning and cruise control (continued)

At SNR aircraft is advised that BN requires alternate (RK is suitable).
Captain adopts Long Range Cruise

Calculation of PNR –

Burn-off (TL–SNR)	=	4150 lb
Fuel remaining (SNR)	=	11850 lb
Fixed reserve (30 min)	=	2600 lb
110% Flt fuel	=	9250 lb
100% Flt fuel	=	8400 lb
Final manoeuvre allowance	=	400 lb
		8000 lb

From Company L.R. Descent Data Table:
Descent on return to RK from PNR = 18 min – 93 GNM – 560 lb.

From DACO LRC Tables:

LRC (Mean wt. 93000 lb)	= TAS 418 kt @ 5160 lb/hr
LRC SNR to 93'/RK	= 240 nm @ 458 kt
	= 31 min @ 5160 lb/hr
	= 2670 lb
Fuel remain. for PNR beyond 93/RK	= 8000 – (2670 + 560) = 4770 lb
4770 lb @ 5160 lb/hr	= 55 min
Time to PNR = $\frac{55 \times 378}{836}$	= 25 min @ 458 kt = 191 nm

PNR is 191 + 93 = 284 nm/RK (i.e. 7 nm/BN).

Continued on next page

Flight planning and cruise control (continued)

12. GENERAL USE OF GNM/1000 lb.

$$\text{ANM/1000 lb} = \frac{\text{TAS}}{\text{F/F}} = \frac{450}{5500} = 81.8 \text{ ANM/1000 lb}$$

$$\text{GNM/1000 lb} = \frac{\text{G/S}}{\text{F/F}} \text{ or } \frac{\text{Distance gone}}{\text{Fuel burned}}$$

There is always an inter-relationship between these factors —

e.g. with H/W 30 kt

$$\frac{\text{TAS}}{\text{G/S}} = \frac{\text{ANM/1000 lb}}{\text{GNM/1000 lb}} \quad \text{i.e.} \quad \frac{450}{420} = \frac{81.8}{76.4}$$

$$\frac{\text{ANM/1000 lb}}{\text{TAS}} = \frac{\text{GNM/1000 lb}}{\text{G/S}} \quad \text{i.e.} \quad \frac{81.8}{450} = \frac{76.4}{420}$$

Use of GNM/1000 lb is recommended in assessing range capability of an aircraft and can be readily applied when considering diversion to alternate.

e.g. Total fuel on board at destination 6500 lb less fixed reserve (2600 lb) = 6500 — 2600 = 3900 lb.

Flt. fuel available for diversion

$$= \frac{100}{110} \text{ of } 3900 \text{ lb} = 3550 \text{ lb less final manoeuvre (400 lb)} = 3150 \text{ lb.}$$

Diversion distance 220 nm — Wind Comp. on diversion track H/W 20 kt.

TAS 450 kt — H/W 20 kt = G/S 430 kt @ 5500 lb/hr.

$$\text{GNM/1000 lb} = \frac{430}{5500} = 78.2$$

Diversion capability = 3150 lb @ 78.2 GNM/1000 lb

= 246 nm

Therefore diversion (220 nm) is acceptable.

13. CRITICAL POINT FUEL REQUIREMENTS TABLE

(1) When planning a flight with a reduced fixed reserve (i.e. 30 min) there will be occasions when the minimum fuel will not cover the Asym., and/or Depress. C.P. fuel requirement, unless there is a suitable en–route airfield available to which the aircraft could divert in the event of loss of an engine or loss of pressurisation.

(2) This is especially so:
- (a) over longer stage distances,
- (b) in strong tail–wind conditions,
- (c) and particularly when carrying minimum diversion fuel, i.e. diversion to alternate at cruise flight level.

(3) Tables have been prepared of Total C.P. Fuel Required for DC9 aircraft. These tables are included in the flight planning folders at ATC centres and show, for total stage distances and wind components, the flight planned fuel required (including reserves) to cover both Asym. and Depress. Critical Points.

(4) Tabulated Asym. C.P. fuel includes block burn–off plus a reserve of 10% plus 20 min and allows for drift down from F/L 310 to F/L 170 and L.R.D. from F/L 170 to S.L.

Depress. C.P. fuel includes block burn–off plus a reserve of 20 min and allows for L.R.D. from F/L 130 to S.L.

(5) When planning for a fixed reserve of 30 min, with no suitable en–route airfield available, the calculated total fuel required must be checked against the tabulated C.P. fuel to ensure that the nominated fuel load will also cover both C.P. requirements. When necessary, additional fuel should be carried to meet the C.P. requirements.

(6) Example:

With no suitable en–route airfield available –

DC9, M.76, SY–MK (Alt CS)
Wind Comp. SY–MK T/W 40 kt
MK–CS T/W 40 kt

Diversion	(1) M.76	(2) LRC	(3) Cruise Level
B/off SY–MK	11200 lb	11200 lb	11800 lb
MK–CS	4800 lb	4700 lb	3200 lb
	16000 lb	15900 lb	15000 lb
Var. Res. (10%)	1600 lb	1600 lb	1500 lb
Fix. Res. (30 min)	2600 lb	2600 lb	2600 lb
TOTAL FUEL	20200 lb	20100 lb	19100 lb

Distances (SY–MK) 791 plus (MK–CS) 336 = 1127 nm
From C.P. Fuel Requirements Table:
Total C.P. fuel required = Asy. 19300 lb, Depress. 19900 lb.

i.e. fuel required including (1) M.76 and (2) LRC diversions cover both C.P.'s but (3) Cruise level diversion requires additional fuel (i.e. 800 lb).

DC9

CP FUEL REQUIREMENTS TABLE

TOTAL STAGE	H/W 120		H/W 80		H/W 40		ZERO		T/W 40		T/W 80		T/W 120	
DIST. (nm)	Asy.	Depress.	Asy.	Depress.	Asy.	Depress.	Asy.	Depress.	Asy.	Depress.	Asy.	Depress.	Asy.	Depress.
400	11400	11900	10700	11200	10200	10700	9800	10400	9500	10200	9300	10100	9200	10000
500	13200	13600	12400	12800	11700	12200	11200	11800	10800	11500	10500	11300	10300	11100
600	15100	15300	14100	14400	13300	13700	12700	13200	12200	12800	11800	12500	11500	12300
700	17000	17000	15800	16000	14900	15200	14100	14600	13500	14100	13000	13700	12600	13400
800	18900	18800	17600	17700	16500	16800	15600	16100	14900	15500	14300	15000	13800	14600
900	20800	20500	19400	19400	18100	18300	17100	17500	16200	16800	15500	16200	14900	15700
1000	22800	22300	21200	21000	19800	19900	18600	19000	17600	18200	16800	17500	16100	16900
1100	—	24100	23000	22600	21400	21400	20100	20400	18900	19500	18000	18700	17200	18000
1200	—	—	—	—	23100	23000	21600	21900	20300	20900	19300	20000	18400	19200

NOTE: The above figures show total CP fuel required (lb) including mandatory reserves:

Asy. — 10% plus fixed reserve 1500 lb.
Depress — Fixed reserve 1750 lb.

Flight planning and cruise control (continued)

14. PNR TABLES

(1) PNR tables have been produced for DC9 operations on the CS–GV–DN–PD–PH routes.

(2) The PNR's are tabulated as time intervals (min) related to check points en–route and are listed for normal fuel loads for each route.

(3) The calculations are based on normal climb, cruise M.76, normal descent and allow for flight to PNR and return, plus 10% of block fuel and 30 min fixed reserve (2600 lb).

(4) The tables are included in flight planning folders at ATC centres and are intended for use at the flight planning stage. However, as they include 30 min fixed reserve, the figures are valid when the aircraft becomes airborne.

(5) The PNR tables have a further application on fuel critical flights in providing a means of assessing whether or not, at the planned PNR, the Captain could expect to meet the minimum fuel requirements to permit the flight to continue to its destination.

(6) Example:

PD–PH (ALT. KG) – W/C Zero – M.76

Minimum flight plan fuel	19300 lb
Maximum fuel available	18500 lb

From PNR table –

PNR (Return to MR) = UPS + 9 min.

Est. Burn–off to PNR = 9500 lb

To allow for variations en–route increase burn–off to PNR to 105% of flight plan figure i.e.

Estimated fuel remaining at PNR = 8500 lb

Est. Burn–off PNR–PH	= 1400 lb
Est. Burn–off PH–KG (LRC)	= 4300 lb
Var Res (10%)	600 lb
Fix Res (30 min.)	2600 lb
Total fuel required	8900 lb
Est. fuel available at PNR	= 8500 lb

At the planning stage, diversion to KG from circuit altitude PH would not be possible and it would be necessary to plan for diversion at cruise level. However, fuel savings en–route could be sufficient to cover subsequent descent to circuit altitude at PH plus LRC diversion to KG.

Continued on next page

Flight planning and cruise control (continued)

POINT OF NO RETURN – DC9

ROUTE: PD – PH (RETURN TO PD)

ALL TEMPS: TIME TO PNR (minutes) CRUISE: M.76

FUEL LOAD (lb)	CRUISE WIND COMPONENTS (kt)				
	H/W 80	H/W 40	ZERO	T/W 40	T/W 80
24000	BIU +5	BIU +6	BIU +6	BIU +5	BIU +3
22000	UPS +5	UPS +6	UPS +7	UPS +6	UPS +4
20000	YDG +23	YDG +22	YDG +21	YDG +19	YDG +16
18000	YDG +12	YDG +12	YDG +12	YDG +11	YDG +9
16000	YDG +1	YDG +2	YDG +3	YDG +3	YDG +2

ROUTE: PD–PH (RETURN TO MR VIA YDG)

24000	PH	PH	PH	PH	PH
22000	BIU +14	BIU +15	BIU +15	BIU +15	BIU +14
20000	BIU +3	BIU +5	BIU +6	BIU +7	BIU +7
18000	UPS +3	UPS +5	UPS +7	UPS +8	UPS +9
16000	YDG +21	YDG +21	YDG +21	YDG +21	YDG +21

The above calculations include normal climb – M.76 cruise – normal descent and allow for burn–off to PNR and return plus 10% of block fuel plus fixed reserve 30 min. (2600 lb).

Effective 7–2–79

TYPICAL PNR TABLE

ANSETT
AIRLINES OF AUSTRALIA

DOUGLAS DC9 FLIGHT STUDY GUIDE

SECTION 11 – PERFORMANCE

1. GENERAL

(1) This section provides a set of definitions pertaining to the performance requirements of this aircraft; details concerning the performance certification of the aircraft, and the operational requirements are given in the series of charts.

(2) The performance charts given in Section 5 of the Company Operating Manual are based on the requirements specified in this section.

2. DEFINITIONS

(1) Accelerate-Stop Distance:

(a) The accelerate-stop distance is the sum of the following:–

(i) All engine acceleration distance from brake release to speed V_1.
(ii) Distance from V_1 to application of full braking.
(iii) Distance with full braking applied to stop. (One braking aid not considered.)

(b) A recognition time, i.e. between actual engine failure and recognition by the pilot (V_1) is built into the accelerate-stop distance.

(2) Approach Climb Requirement:

The approach climb requirement covers the engine-out overshoot case. The requirement must be satisfied with one engine inoperative, gear up and flap at the basic aproach setting.

(3) Balanced Field Length:

The balanced field length occurs when the accelerate-stop distance required equals the engine-out distance to 35 ft.

(4) Calibrated Airspeed (CAS):

Calibrated airspeed is equal to the true indicated airspeed corrected for airspeed indicator system errors (i.e. position errors). Calibrated airspeed is equal to true airspeed under sea level and ISA conditions.

(5) Clearway:

Clearway is a controlled area, beyond the end of a runway, over which an aircraft may climb to the 35 ft point. When included in the available take-off distance the take-off run requirements (distance from brakes release to lift-off) must also be examined.

(6) Decision Speed (V_1):

(a) The V_1 speed is the speed which the pilot uses as a reference in deciding whether to continue the take-off or to abort.

Performance (Continued)

(i) V_1 cannot be less than V_{MCG} or greater than V_R.
(ii) The speeds given for V_1 have been selected so that:

1. if an engine failure is recognised at or above the V_1 speed, the take-off may be continued to a height of 35 ft above the available take-off distance, or:

2. a stop may be made on the runway from V_1, or at speeds less than V_1 and without, in either case, exceeding the scheduled accelerate-stop distance.

(b) The scheduled take-off field lengths are based on stopping if engine failure is recognised before reaching V_1 and on continuing the take-off if engine failure is recognised after V_1.

(c) Appropriate reaction time is allowed between the failure and recognition of the failure.

(d) When stopping, appropriate time is allowed between recognition of the failure and completion of all actions required for rejection. It is also required that one of the available braking systems (e.g. reverse thrust) must not be used during certification or if all braking devices used that an additional distance factor (e.g. F.28: + 10%) be applied.

(7) Equivalent Airspeed (EAS):

Equivalent airspeed is the calibrated airspeed corrected for compressibility errors.

(8) Final Segment Climb Speed or En-route Climb Speed (V_{CL}):

V_{CL} is the speed which gives maximum gradient of climb with the critical engine inoperative when the aircraft is in the clean configuration and the operating engine(s) at maximum continuous power.

(9) Flap Retraction Speed (V_{FR}):

V_{FR} is the speed at which flap retraction is initiated. The flap retraction speed schedule for the aircraft is selected to ensure 1.2 V_S protection at the flap setting selected.

(10) Gradient of Climb:

The gradient of climb is the ratio of:

$$\frac{\text{Change in Height}}{\text{Horizontal Distance Travelled in Same Time}}$$

or approximately equal to

$$\frac{\text{Rate of Climb (fpm)}}{\text{True Airspeed (kt)}} \%$$

It is usually expressed as a percentage.

Performance (Continued)

(11) Gross Gradient of Climb:

A gross gradient of climb refers to the actual flight test gradients established for certification.

(12) Indicated Airspeed (IAS):

Indicated airspeed is equal to the airspeed indicator reading as installed in the aircraft without correction for airspeed indicator system errors or mechanical instrument errors. The indicated airspeed corrected for instrument mechanical errors is known as true indicated airspeed.

(13) Indicated Outside Air Temperature (IOAT):

IOAT is the static outside air temperature uncorrected for compressibility (ram) rise.

(14) International Standard Atmosphere (ISA):

The international standard atmosphere is a theoretical atmosphere in which density and pressure variations with height are specified. It assumes a mean sea level temperature of $15^{o}C$, a pressure of 1013.2 mb, and a lapse rate of $-1.98^{o}C$ per thousand feet up to 36,089 feet pressure altitude, above which the temperature is assumed constant at $-56.5^{o}C$.

(15) Landing Climb Requirement:

The landing climb requirement covers the all engine overshoot case. The requirement is satisfied with landing flap, gear down and all engines at maximum power or thrust.

(16) Lift-Off Speed (V_{LOF}):

The lift-off speed is the speed the aircraft first becomes airborne.

(17) Mach Number (M):

Mach number is the ratio of the true airspeed to the local speed of sound.

(18) Maximum Operating Limit Speed (V_{MO} – M_{MO}):

Maximum operating limit speed may only be exceeded on specifically authorised flights. M_{MO} is this speed expressed as a mach number.

(19) Minimum Control Speed – Air (V_{MCA}):

V_{MCA} is the minimum speed at which the aircraft can be kept within certain specified limits of attitude and heading, when, in the second segment configuration and with take-off power on all engines, the critical engine experiences sudden, complete failure.

(20) Minimum Control Speed – Ground (V_{MCG}):

V_{MCG} is the minimum speed on the ground, at which the aircraft can be kept within certain specified limits of heading using primary aerodynamic controls alone, when, in the take-off configuration and at maximum power or thrust on the operating engines, the critical engine experiences sudden, complete failure.

Performance (Continued)

(21) Minimum Unstick Speed (V_{MU}):

The minimum unstick speed is the minimum speed at which an aircraft can be made to lift off the ground and, maintaining a positive climb, continue the take-off without displaying any hazardous characteristics. Certification requires demonstration with all engines operating and with the critical engine inoperative.

(22) Net Gradient of Climb:

A net gradient is the gross gradient of climb diminished by a specific margin to allow for specified deterioration in performance.

	Basic Aircraft Configuration		
The margins are:	2 Engine	3 Engine	4 Engine
Take-off to obstacle clearance	0.8%	0.9%	1.0%
3 engine en-route obstacle clearance	–	–	1.4%
2 engine en-route obstacle clearance	–	1.3%	0.5%
1 engine en-route obstacle clearance	1.1%	0.3%	–

(23) Outside Air Temperature (OAT):

Outside air temperature is the static ambient air temperature.

(24) Pressure Height:

Pressure height is the height in the international standard atmosphere at which the pressure is the same as that prevailing at the reference location.

(25) Ram Air Temperature (RAT):

Ram air temperature is equal to the ambient air temperature plus some ram temperature rise.

(26) Rotation Speed (V_R):

(a) Rotation speed is that speed at which the pilot begins to rotate the aircraft to the lift-off attitude.

(b) The rate of rotation can vary but it should normally be at the rate of $2^o - 3^o$ per second depending on the aircraft certification.

(c) Rotation at the maximum practical rate will result in a minimum lift-off speed. Rotation at the normal rate will result in attaining the V_2 speed at or below 35 ft, with one engine inoperative, or slightly exceeding the V_2 speed at 35 ft with all engines operating. V_R is such that it is not less than:–

(i) V_1
(ii) $1.05\ V_{MCA}$
(iii) a speed which permits the attainment of V_2 prior to reaching 35 ft.

Performance (Continued)

(iv) a speed which will result in at least the minimum required lift-off speed. This speed must have a margin over V_{MU}.

(v) a speed which will not result in increasing the take-off distance if rotation is commenced 5 kt lower than the scheduled V_R during one-engine-inoperative acceleration, or 10 kt lower than the scheduled V_R during all-engine-acceleration.

(27) Stopway:

A stopway is a controlled area beyond the runway end which may, depending on the aircraft type, be assessed as part of the accelerate-stop or landing distance.

(28) Take-Off Distance Available:

The available take-off distance available for an aircraft to accelerate from brake release to the 35 ft point either with or without engine failure at V_1.

(29) Take-off Safety Speed and Initial Climb Speed (V_2):

V_2 is the take-off safety speed and is achieved prior to 35 ft. This speed must not be less than:

(a) 1.1 V_{MCA}

(b) 1.2 V_S (or 1.15 V_S – 4 engine propeller aircraft)

The correct V_2 is a result of proper rotation and lift-off procedures and it allows the aircraft to maintain a specified gradient in the climb-out flight path.

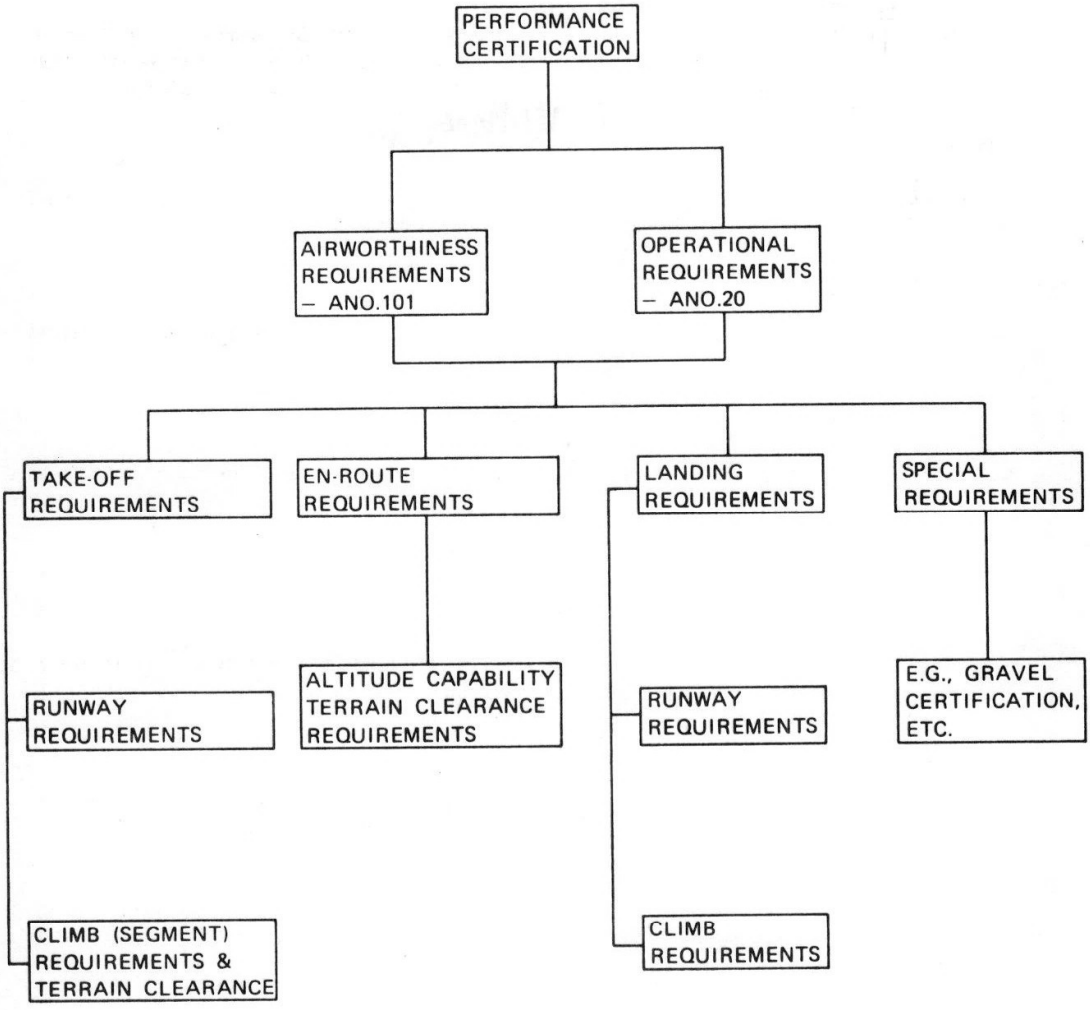
(30) Total Air Temperature (TAT):

Total air temperature is equal to the ambient air temperature plus all the ram temperature rise. TAT is equal to RAT when the recovery factor of the temperature sensor is equal to 1.00.

(31) True Airspeed (TAS):

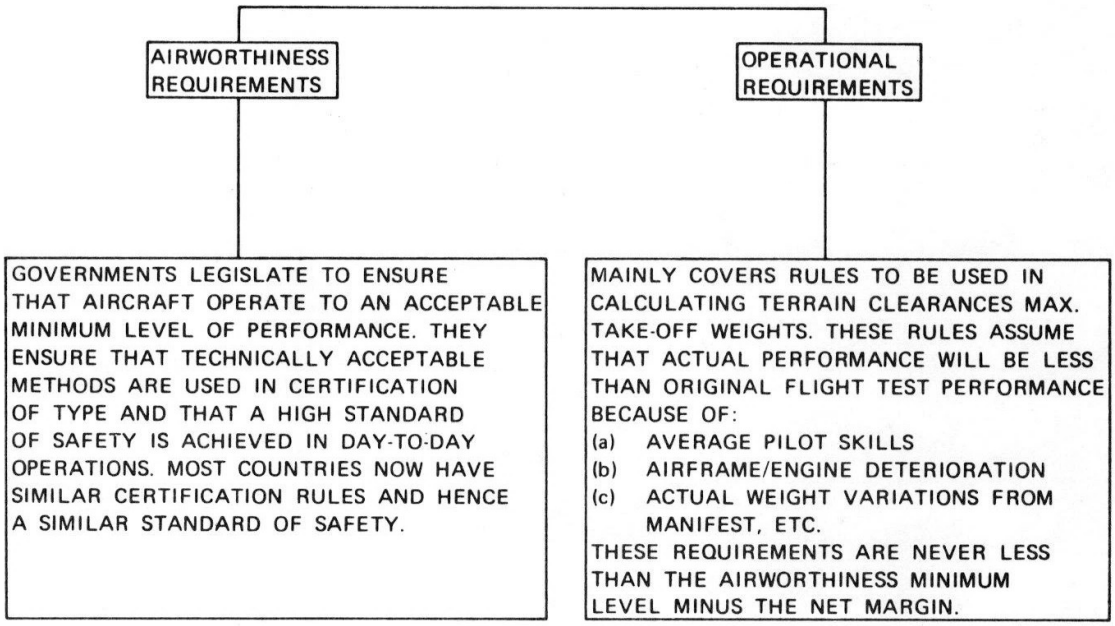
True airspeed is the speed of the aircraft relative to undisturbed air and is equal to the equivalent airspeed corrected for density effects.

Performance (Continued)

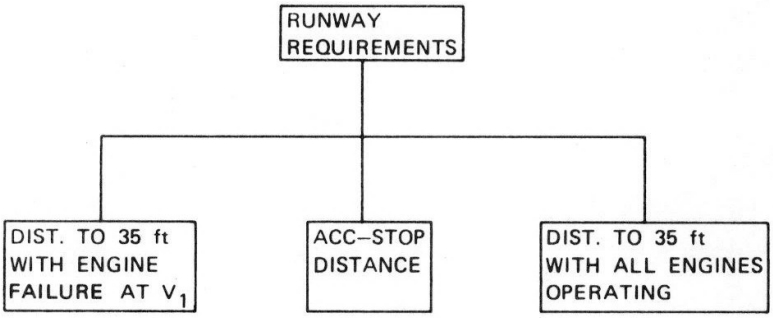


PERFORMANCE CERTIFICATION

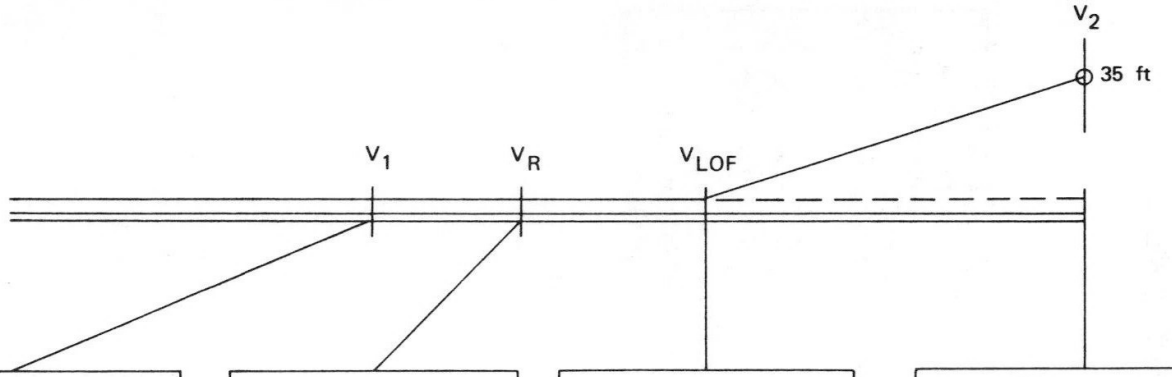
Performance (Continued)



AIRWORTHINESS AND OPERATIONAL REQUIREMENTS



RUNWAY REQUIREMENTS

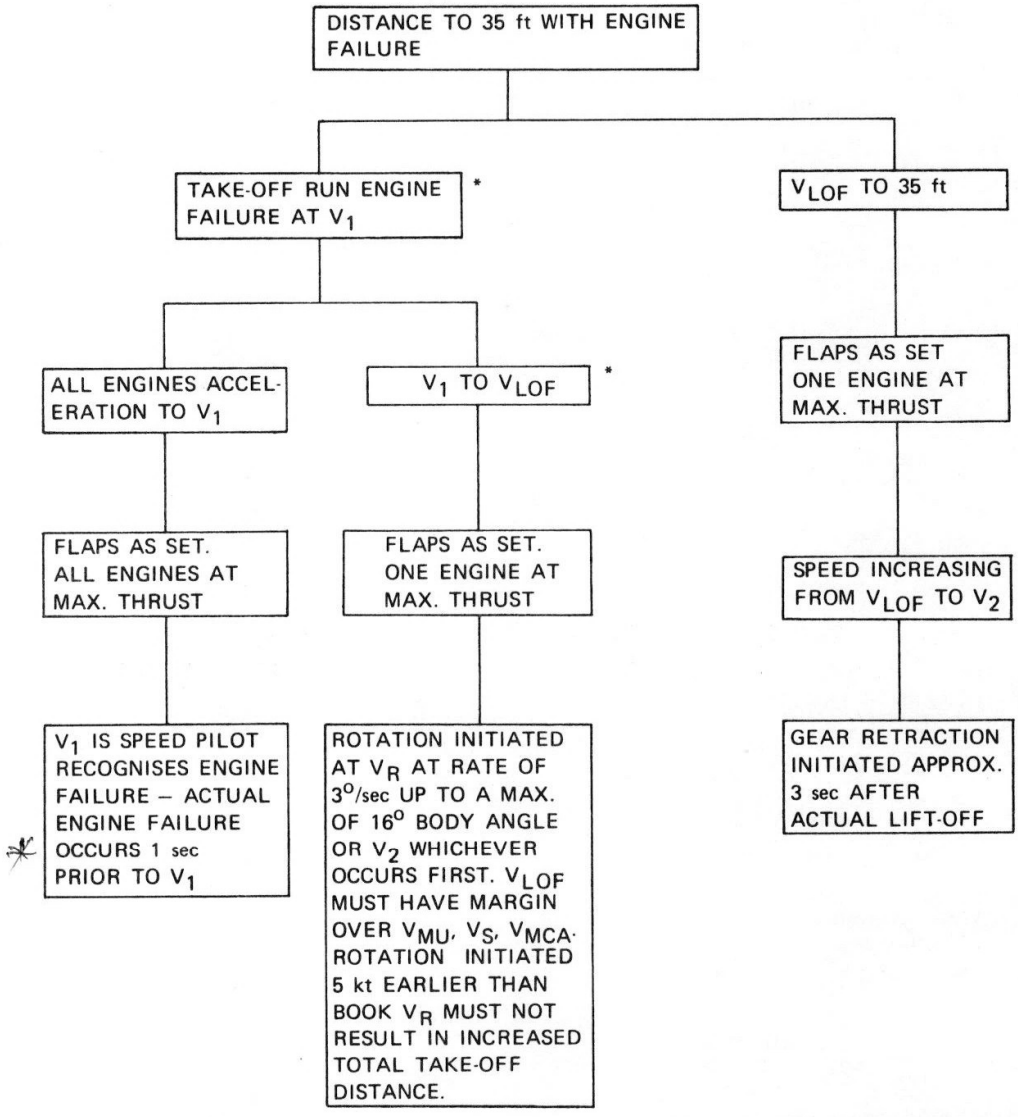


*V_1 DECISION SPEED	V_R~ ROTATION SPEED	V_{LOF}~ LIFT-OFF SPEED	V_2~ INITIAL CLIMB-OUT SPEED
MOST CRITICAL SPEED AT TAKE-OFF WHERE ENGINE FAILURE RECOGNITION CAN OCCUR. ENGINE FAILURE RECOGNITION PRIOR TO V_1 REQUIRES PILOT TO STOP AIRCRAFT ON GROUND. ENGINE FAILURE RECOGNITION AFTER V_1 REQUIRES PILOT TO CONTINUE TAKE-OFF. WITH ENGINE FAILURE RECOGNITION AT V_1 THE PILOT CAN EITHER STOP OR GO. REFER TO TAKE-OFF REQUIREMENTS FOR INFLUENCE OF V_1 SPEED AND LIMITS ON ITS CHOICE.	MOST IMPORTANT SPEED IN TAKE-OFF. ROTATION MUST BE POSITIVE, AT THE RIGHT SPEED AND USING THE CORRECT TECHNIQUE IF TAKE-OFF PERFORMANCE, AS PER THE BOOK, IS TO BE ACHIEVED. V_R MUST NOT BE LESS THAN V_1; 1.05 V_{MCA}; A SPEED WHICH PERMITS ATTAINMENT OF V_2 PRIOR TO 35 ft; A SPEED WHICH ENSURES THE CORRECT V_{LOF} SPEED.	SPEED AT WHICH AIRCRAFT FIRST BECOMES AIRBORNE. IT MUST HAVE AN ADEQUATE MARGIN (5%–10%) OVER THE V_{MU} SPEED. THE CORRECT V_{LOF} IS ACHIEVED BY ROTATING THE AIRCRAFT AT THE CORRECT V_R SPEED USING THE CORRECT TECHNIQUE.	V_2 MUST NOT BE LESS THAN 1.1 V_{MCA}; 1.2 V_S (TAKE-OFF CONFIGURATION CONSIDERED) OR THE SPEED ACHIEVED BY THE 35 ft POINT USING THE REQUIRED V_R SPEED. V_2 FOR THE DC9 IS APPROXIMATELY 1.27–1.29 V_S (SPEED AT 35 ft POINT) AND WAS SO CHOSEN TO IMPROVE THE CLIMB-OUT CAPABILITY IN THE SECOND SEGMENT. V_{2MIN} SPEEDS MAY BE USED (WITH APPROVAL) ON SPECIAL SHORT RUNWAY OPERATIONS

*V_1 GENERALLY PROVIDES BALANCED FIELD LENGTHS.

CHARACTERISTIC SPEEDS IN TAKE-OFF

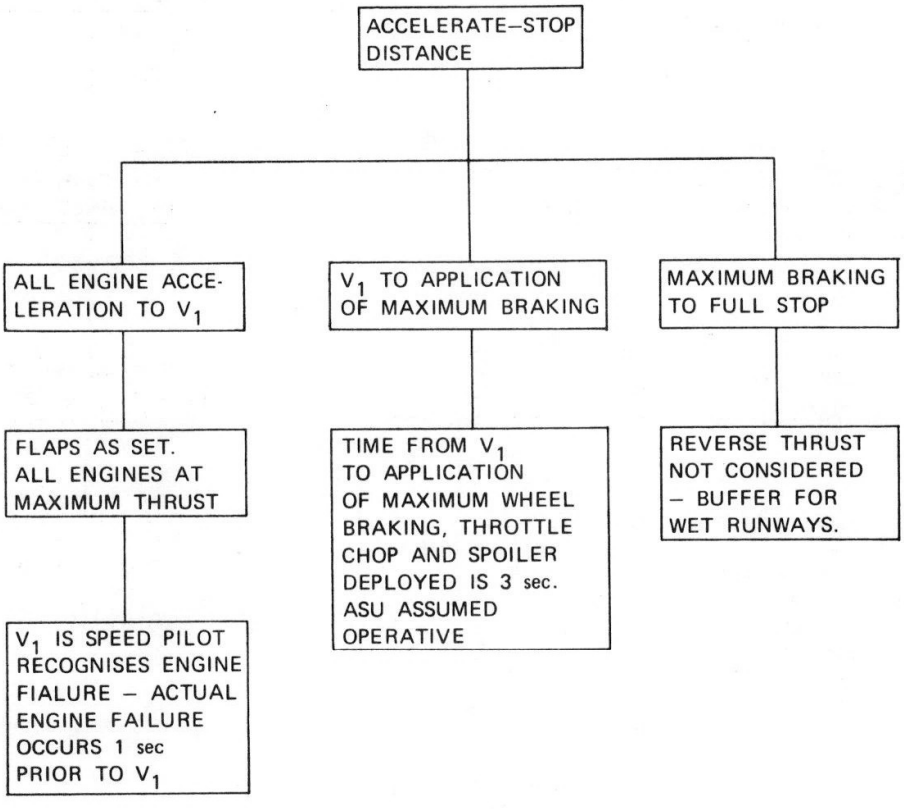
Performance (Continued)



*NOTE: FOR THE PURPOSES OF CERTIFICATION THE TAKE-OFF RUN IS ASSUMED TO BE THE DISTANCE FROM BRAKE RELEASE TO A POINT MID-WAY BETWEEN THE SCHEDULED LIFT-OFF POINT AND THE 35ft POINT.

DISTANCE TO 35 ft WITH ENGINE FAILURE AT V_1

Performance (Continued)

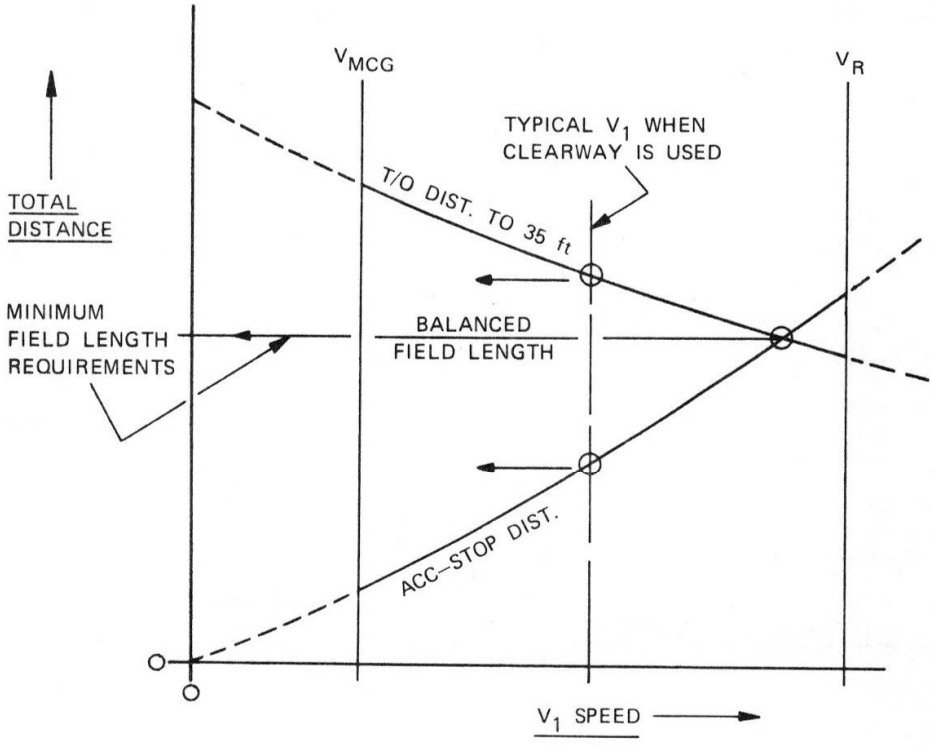


ACCELERATE–STOP DISTANCE

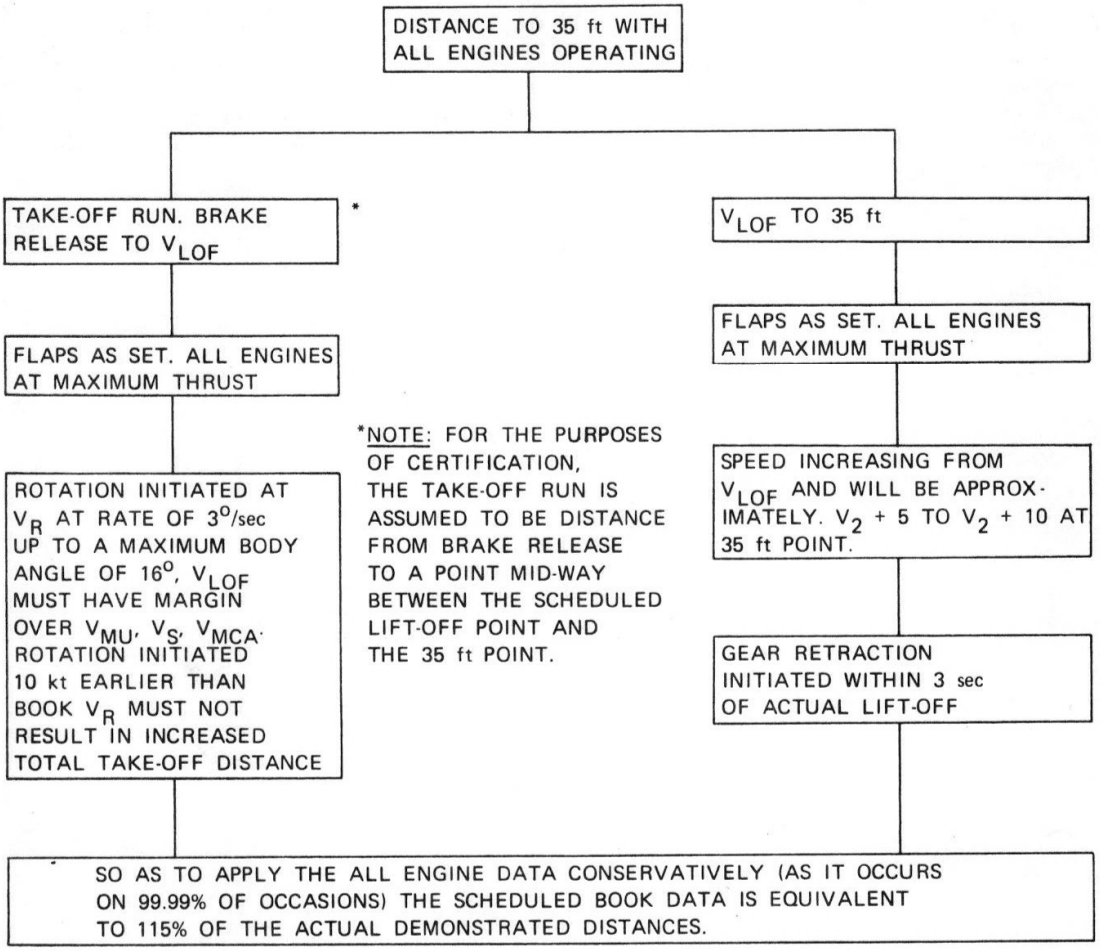
RELATIONSHIP BETWEEN ACCELERATE–STOP DISTANCE AND TAKE-OFF DISTANCE TO 35 ft (ENGINE FAILURE RECOGNITION AT V_1)

V_1 SPEED MAY BE SELECTED BY THE OPERATOR (BETWEEN A MINIMUM OF V_{MCG} AND A MAXIMUM OF V_R) SO AS TO ACHIEVE, FOR A GIVEN TAKE-OFF WEIGHT AND CONDITIONS, VARYING ACCELERATE–STOP AND TAKE-OFF DISTANCES WHICH MAY BEST FIT A PARTICULAR RUNWAY CONFIGURATION. THIS CAN BE VERY IMPORTANT WHEN A RUNWAY HAS CLEARWAY AVAILABLE WHICH PROVIDES A MUCH GREATER AVAILABLE TAKE-OFF DISTANCE THAN ACCELERATE–STOP DISTANCE. THE GRAPH BELOW ILLUSTRATES THE RELATIONSHIP BETWEEN THE TWO DISTANCES FOR A GIVEN V_1 SPEED.

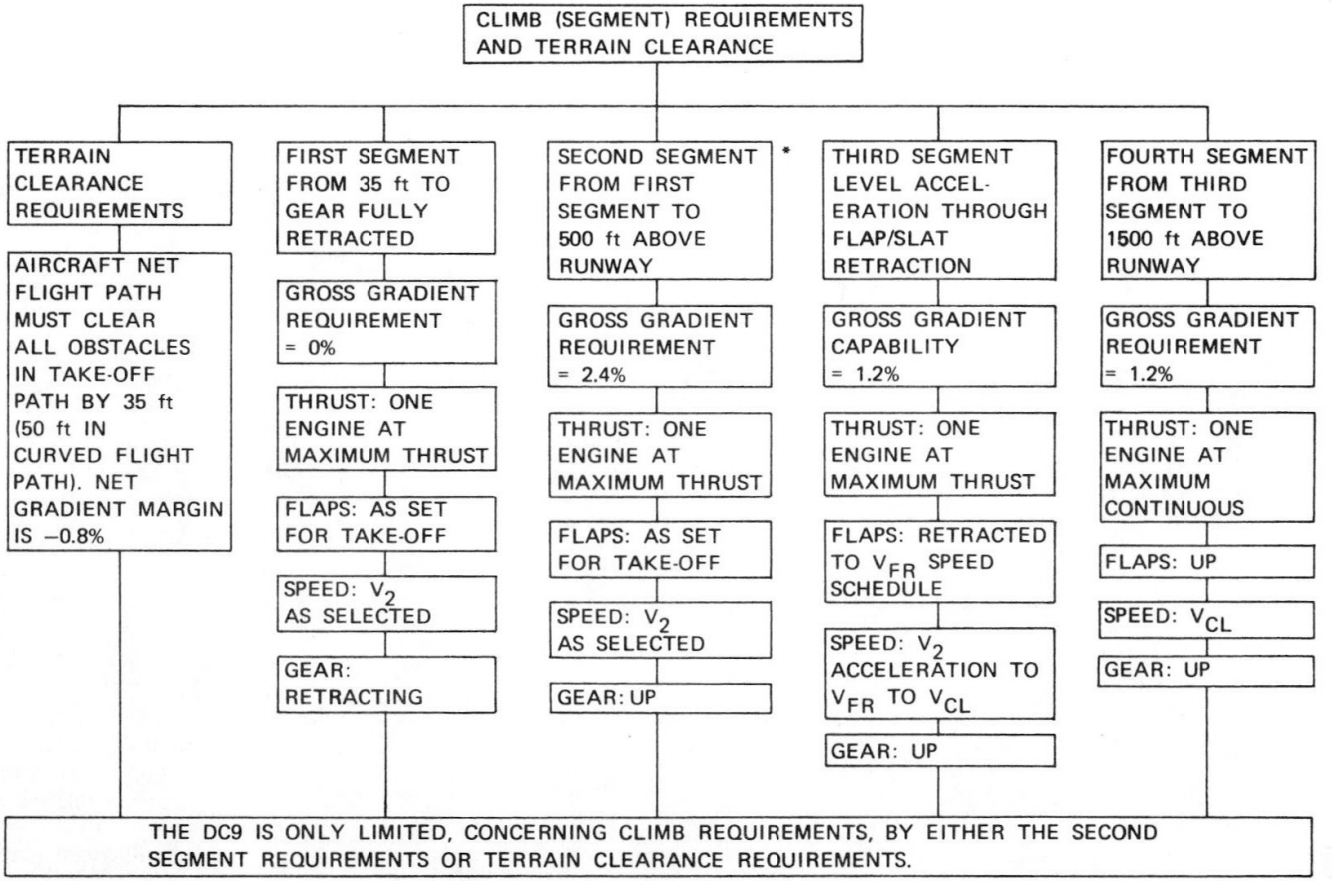
GRAPH REPRESENTS ONE WEIGHT AND AMBIENT CONDITIONS



Performance (Continued)



DISTANCE TO 35 ft WITH ALL ENGINES OPERATING



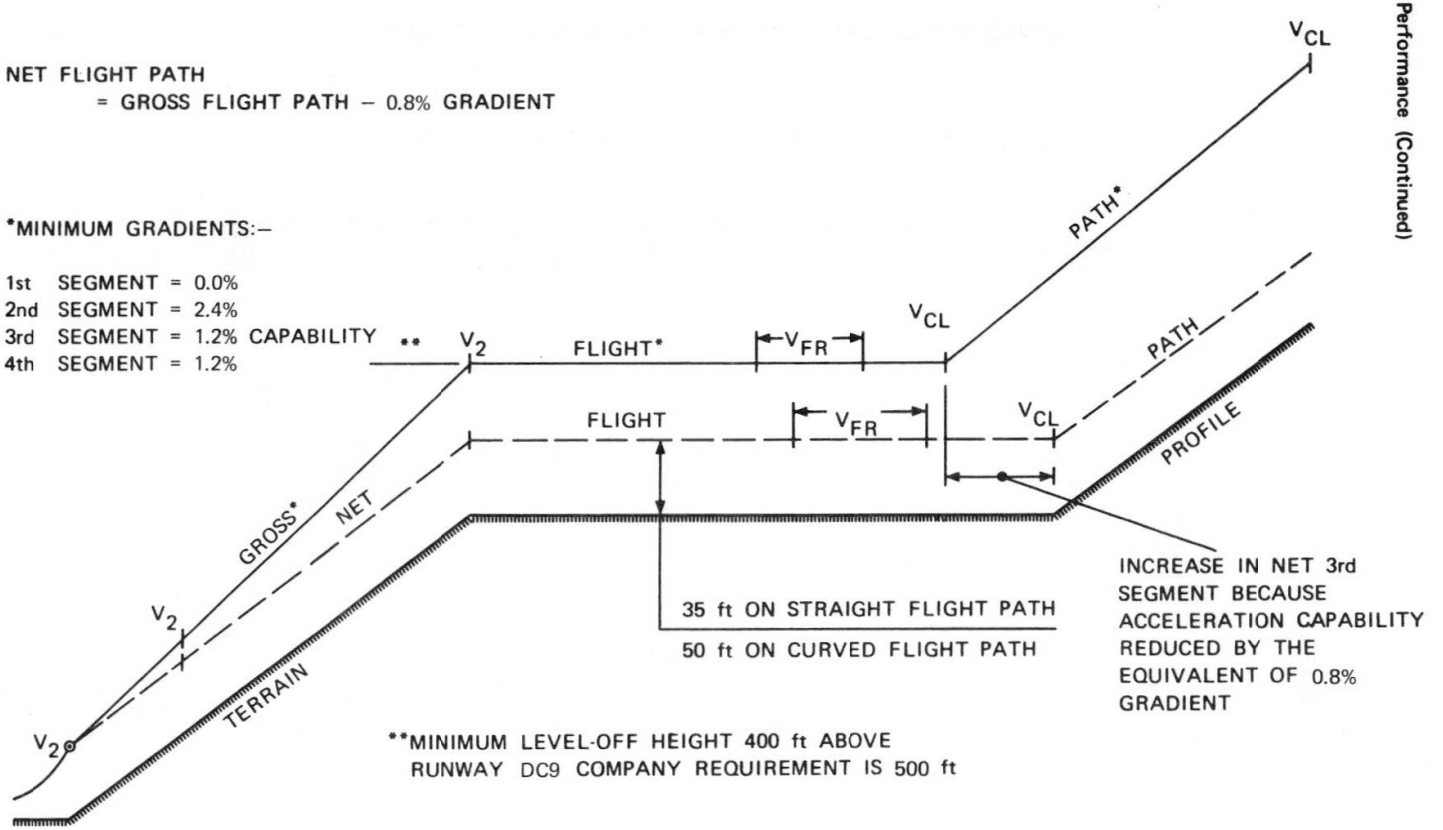
*500 ft IS COMPANY REQUIREMENT; 400 ft IS D.O.T. REQUIREMENT.

CLIMB (SEGMENT) REQUIREMENTS AND TERRAIN CLEARANCE

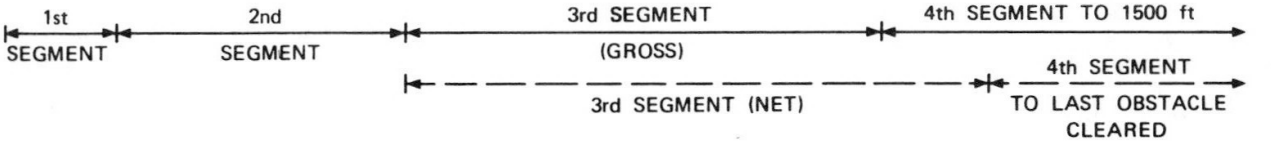
NET FLIGHT PATH
= GROSS FLIGHT PATH – 0.8% GRADIENT

*MINIMUM GRADIENTS:–

1st SEGMENT = 0.0%
2nd SEGMENT = 2.4%
3rd SEGMENT = 1.2% CAPABILITY
4th SEGMENT = 1.2%

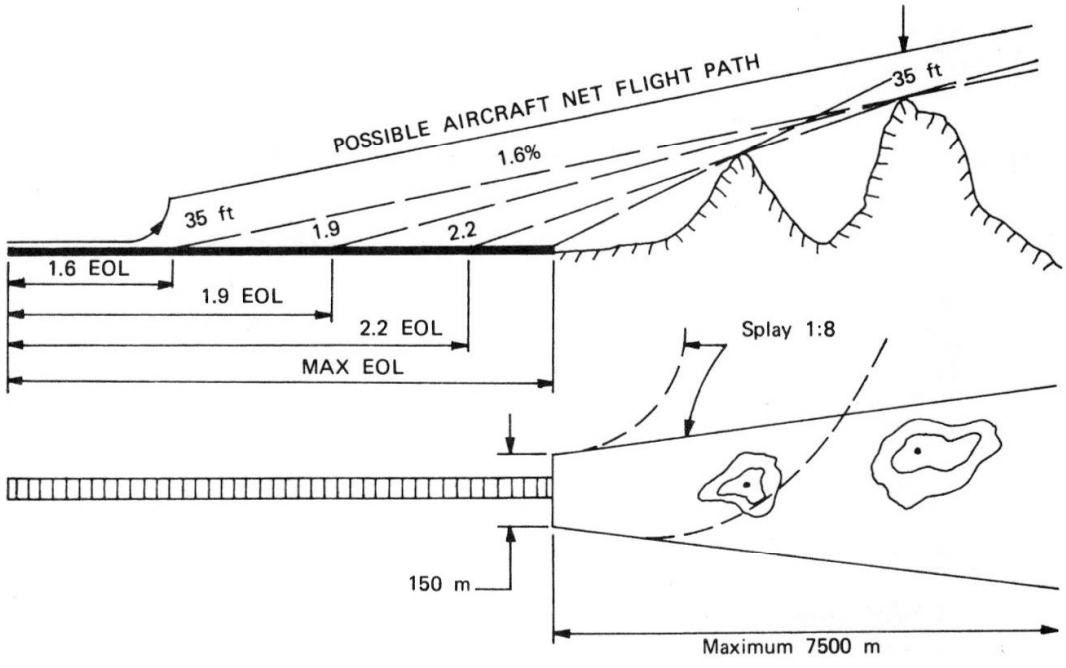


**MINIMUM LEVEL-OFF HEIGHT 400 ft ABOVE RUNWAY DC9 COMPANY REQUIREMENT IS 500 ft



CLIMB SEGMENTS AND TERRAIN CLEARANCE

Performance (Continued)



RUNWAYS AND OBSTRUCTIONS

TWO SYSTEMS USED TO FIND MAXIMUM TAKE-OFF WEIGHT WITH OBSTACLES:–

(1) D.O.T. AGA SYSTEM (2) OBSTACLE ANALYSIS

(1) D.O.T. AGA's:

A series of new gradient lines (1.6, 1.9, 2.2, 2.5 etc.) are drawn from the obstacle(s) back to the runway and result in combinations of runway and gradient which will clear all obstructions, e.g. If the aircraft is capable of attaining 35 ft within (say) the 2.2% EOL (with engine failure at V_1) and can attain at least a 2.2% net gradient of climb in 2nd Segment (extended if necessary above 400 ft), then it will obviously clear the obstructions. The system's main advantage is it can be used, although conservatively, with general take-off charts but its major deficiency is the lack of coverage beyond 7500 m.

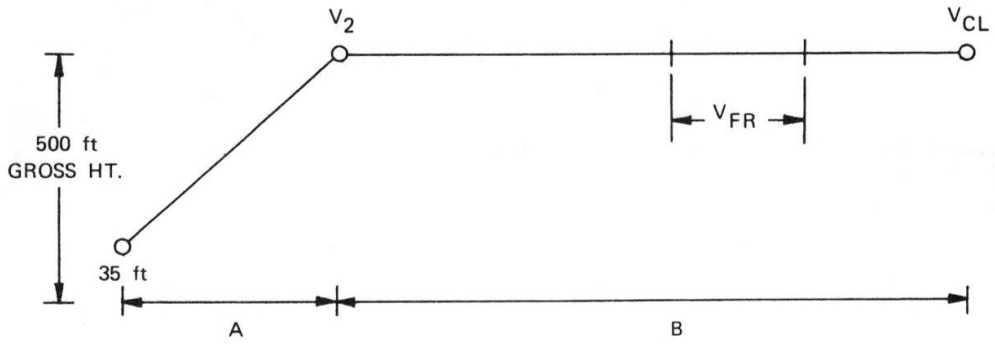
(2) OBSTACLE ANALYSIS:

This system, either using computers or complex graphical systems, exactly matches the take-off distance to the net gradient required to clear the obstacles. This system is used to compute BRW's for DC-9 and B.727 charts and it is very accurate. This system can take into account obstacles at any point in the take-off path.

NOTE: CURVED FLIGHT PATHS:

Obstacle splays, similar to straight flight path splays, are determined around an appropriate radius of turn until obstacles are cleared. Appropriate loss of performance in turn is taken into account when calculating maximum Brake Release Weights. This is approx. 0.6% gradient loss with 15° bank angle.

Performance (Continued)



FIRST CASE: SEA LEVEL; 45360 kg; 29°C

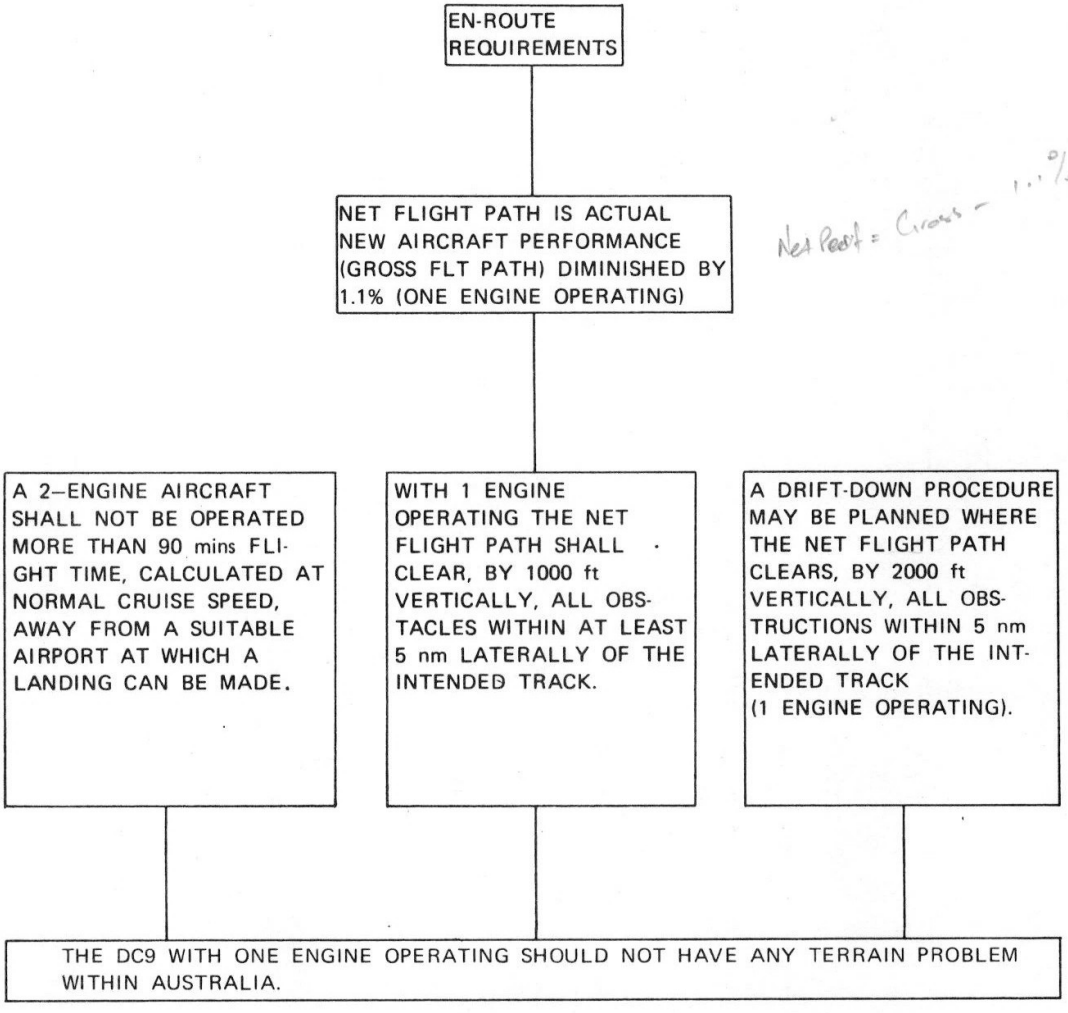
	15° FLAP	5° FLAP
NET GRADIENT	1.75%	2.5%
DISTANCE 'A'	5974 m	4572 m
DISTANCE 'B'	14020 m	10970 m

SECOND CASE: SEA LEVEL; 36°C

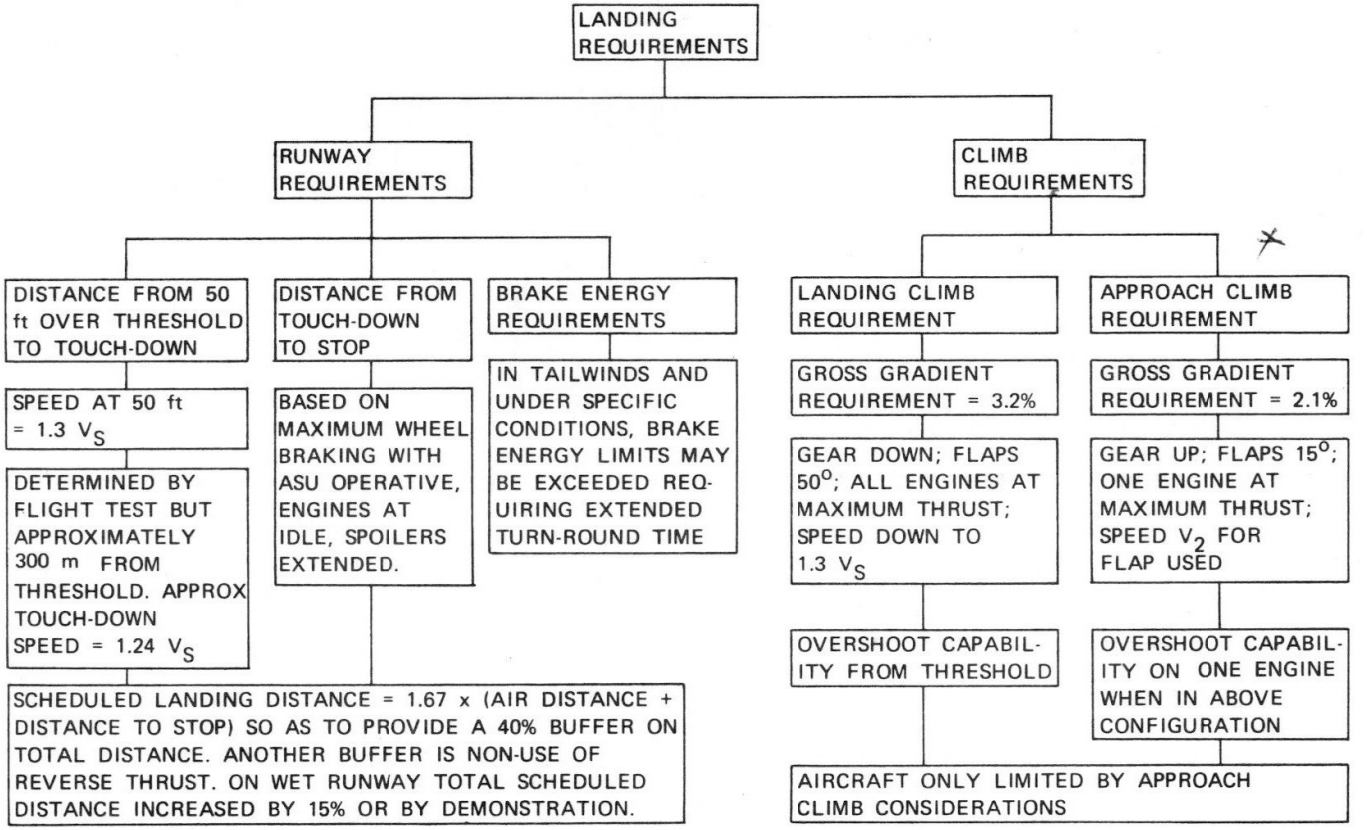
GROSS WEIGHT	43540 kg	46720 kg
NET GRADIENT	1.6%	1.6%
DISTANCE 'A'	6400 m	6400 m
DISTANCE 'B'	15550 m	21640 m

SAMPLE OF ACTUAL PERFORMANCE

Performance (Continued)



EN-ROUTE REQUIREMENTS



IX-9 only App/Climb limited

LANDING REQUIREMENTS

APPENDIX 1 - SCAN PATTERNS

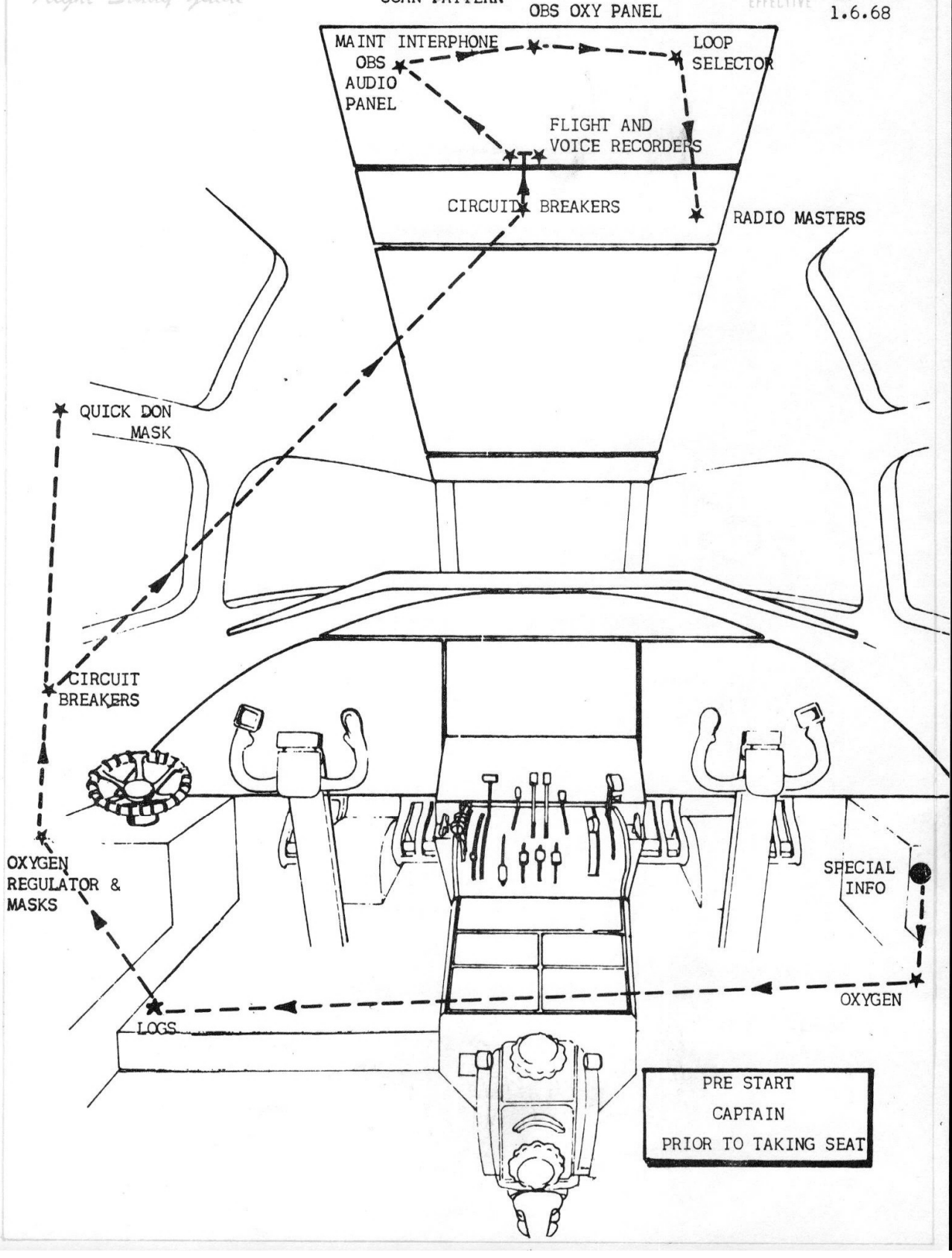
1. Pre Start - Captain - Prior to taking seat
2. Pre Start - Captain
3. After Start - Captain
4. After Start - First Officer
5. Before Taxi - Pre Take-off - Captain
6. Before Taxi - Pre Take-off - First Officer
7. After Take-off - Captain
8. After Take-off - First Officer
9. Pre Landing Check After Gear Selected Down - Captain
10. After Landing - Captain
11. After Landing - First Officer
12. Parking - Captain
13. Parking - First Officer

APPENDIX 2 -

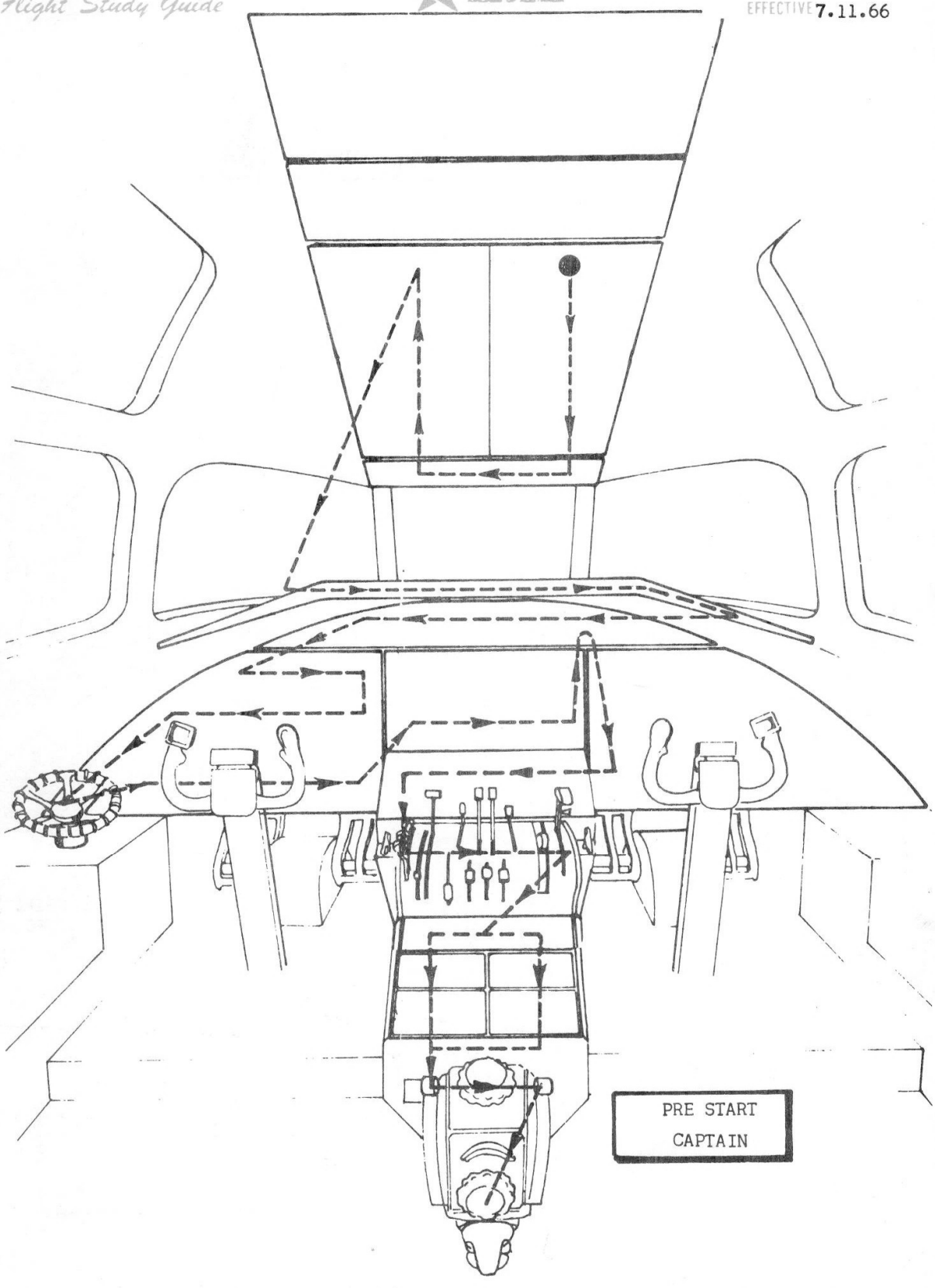
1. Ground Manoeuvering and Turning Radii
2. Take-off (Normal)
3. Take-off (Engine Out)
4. Seat Speed Schedule
5. Stall Speeds -
   (a) Slats Retracted
   (b) Slats Extended
6. Stick Shaker Versus Bank Angle (To be issued)
7. Speed Brake Effect on Stall
8. Intentionally Left Blank
9. Manoeuvre Limits (to be issued)
10. Engine Spin Up
11. Estimated Thrust Required
12. Estimated Angle of Attack
13. Buffet Boundary Chart (a) 1G
14. " " " (b) 1.3G
15. " " " (c) 1.6G
16. Holding Patterns
17. Rapid Descent
18. ILS (2 Engine)
19. ILS (1 Engine)
20. Approach and Landing (Normal)
21. " " " (Single Engine)
22. " " " (Flapless)
23. " " " (Jammed Stabiliser)
24. Inoperative Stabiliser - Landing Chart
25. Threshold Gear Heights - Flapless Approach
26. Effect on Landing Distance of Reduced Flap Angles & Retracted Slats
27. Circuit Diagram - Low Ceiling Entry
28. 2 Engine Landing Diagram - Low Ceiling

APPENDIX 3 -

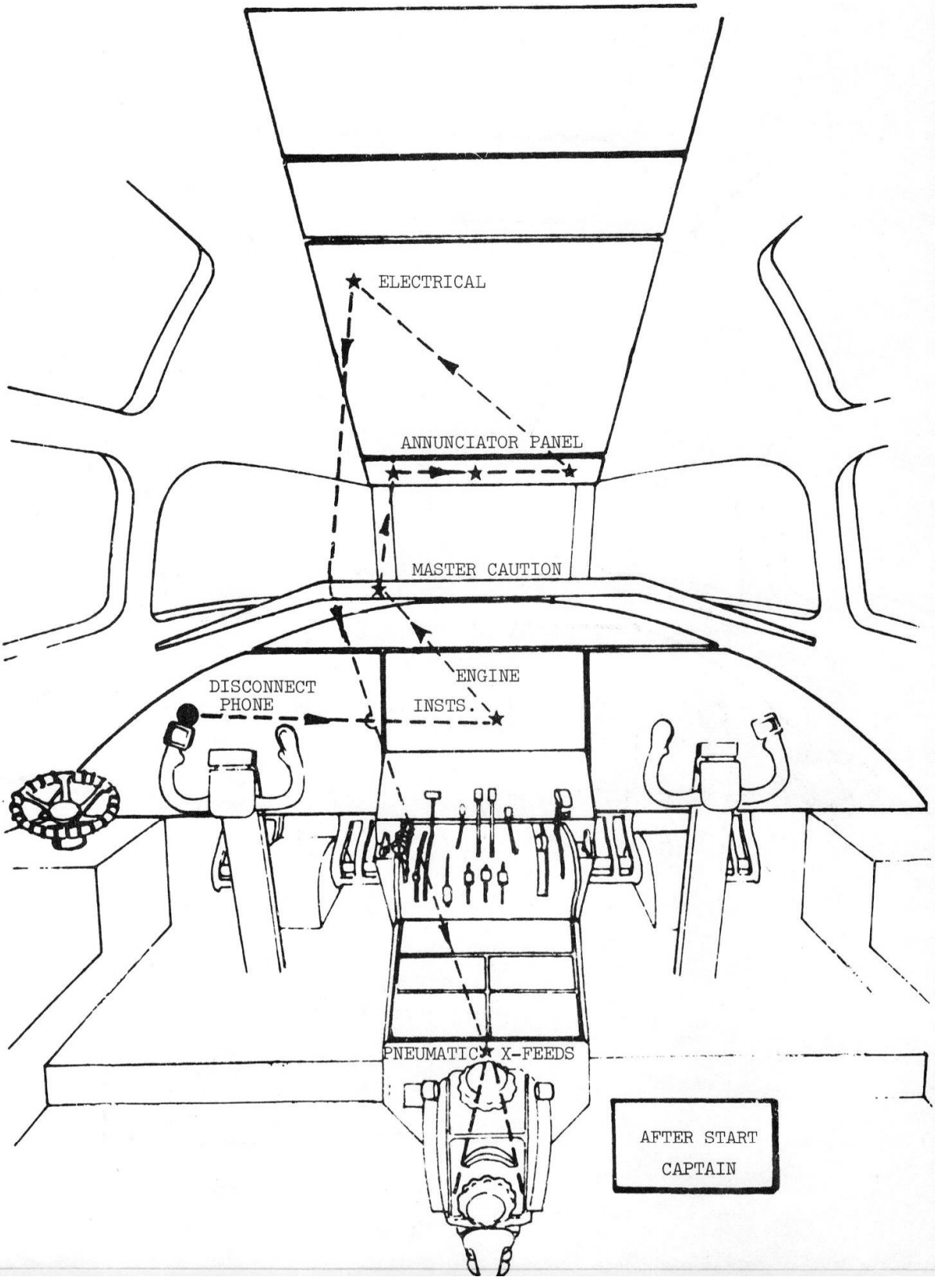
Oxygen Pages 1 - 4


SCAN PATTERN
OBS OXY PANEL
MAINT INTERPHONE
OBS AUDIO PANEL
LOOP SELECTOR
FLIGHT AND VOICE RECORDERS
CIRCUIT BREAKERS
RADIO MASTERS
QUICK DON MASK
CIRCUIT BREAKERS
OXYGEN REGULATOR & MASKS
SPECIAL INFO
OXYGEN
LOGS
PRE START
CAPTAIN
PRIOR TO TAKING SEAT

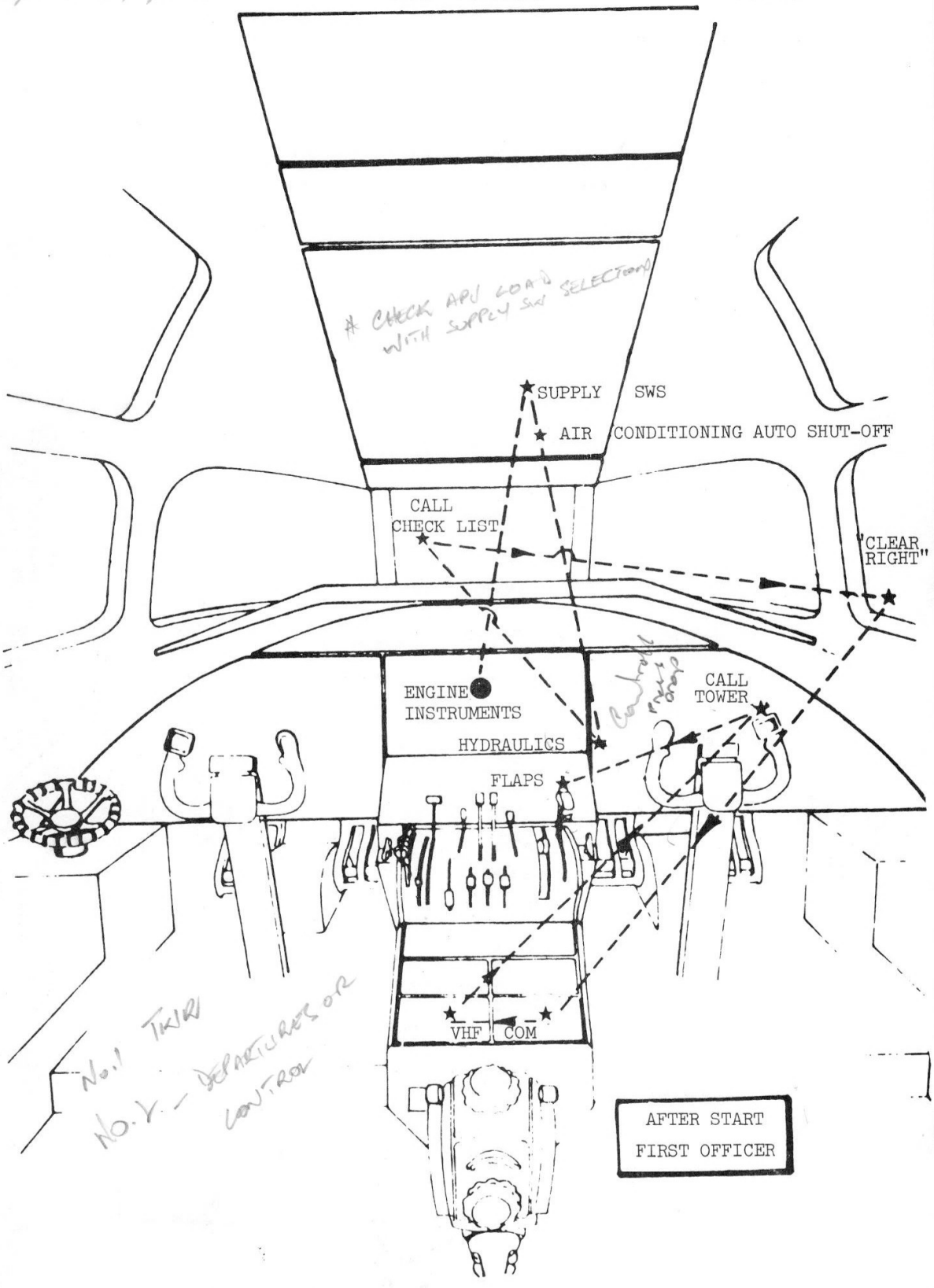
SCAN PATTERN



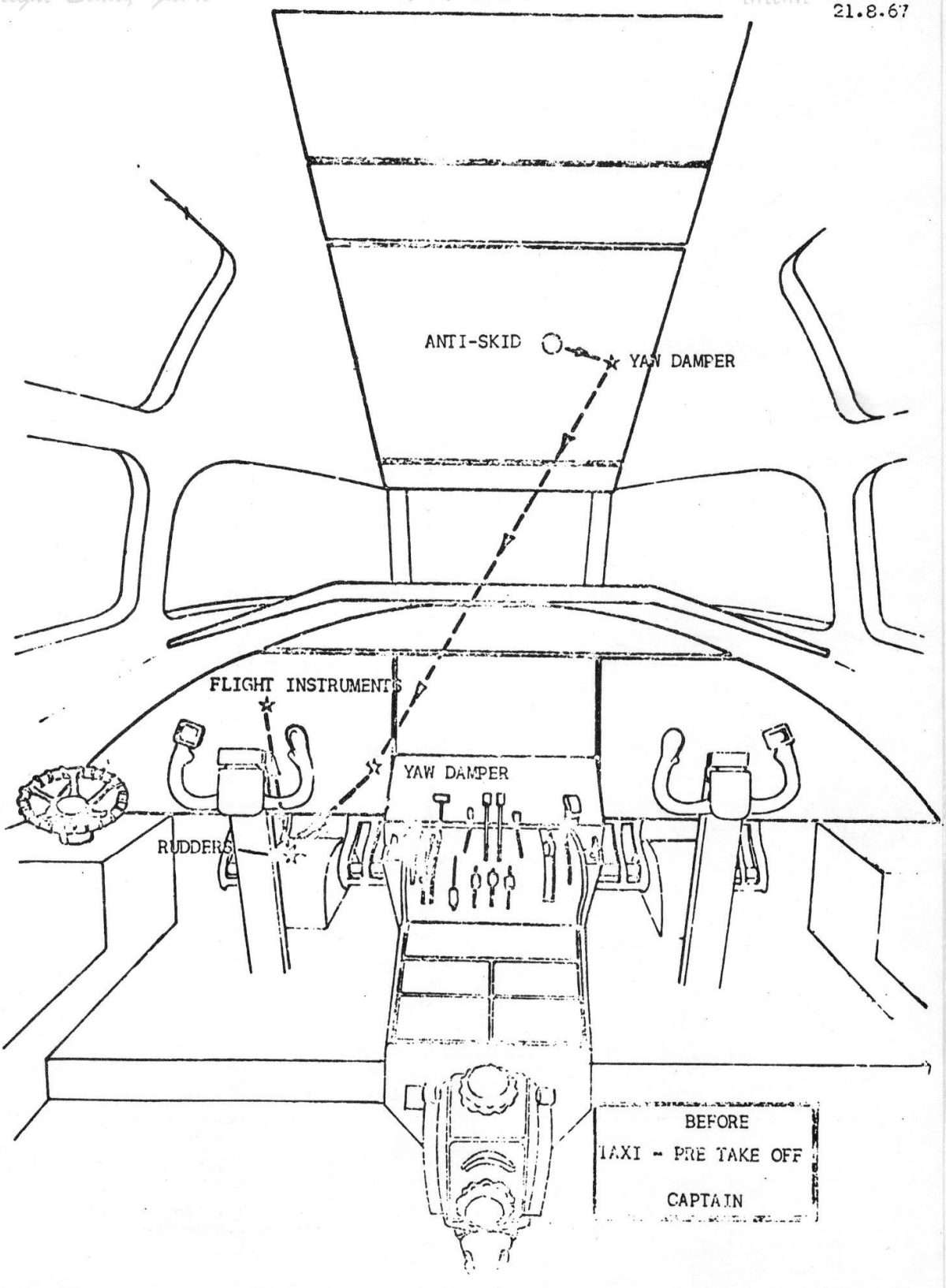
SCAN PATTERN



SCAN PATTERNS



SCAN PATTERN



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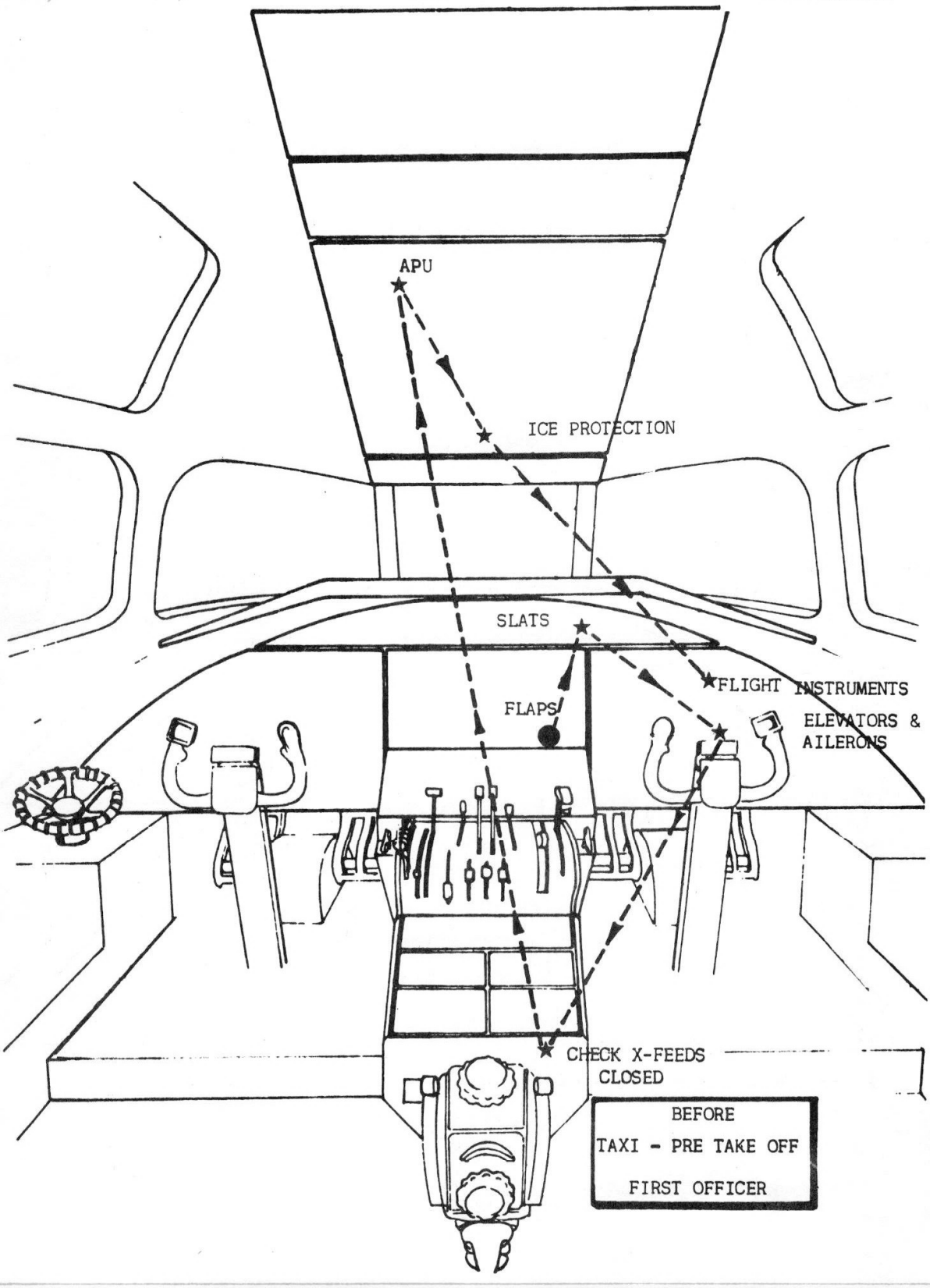

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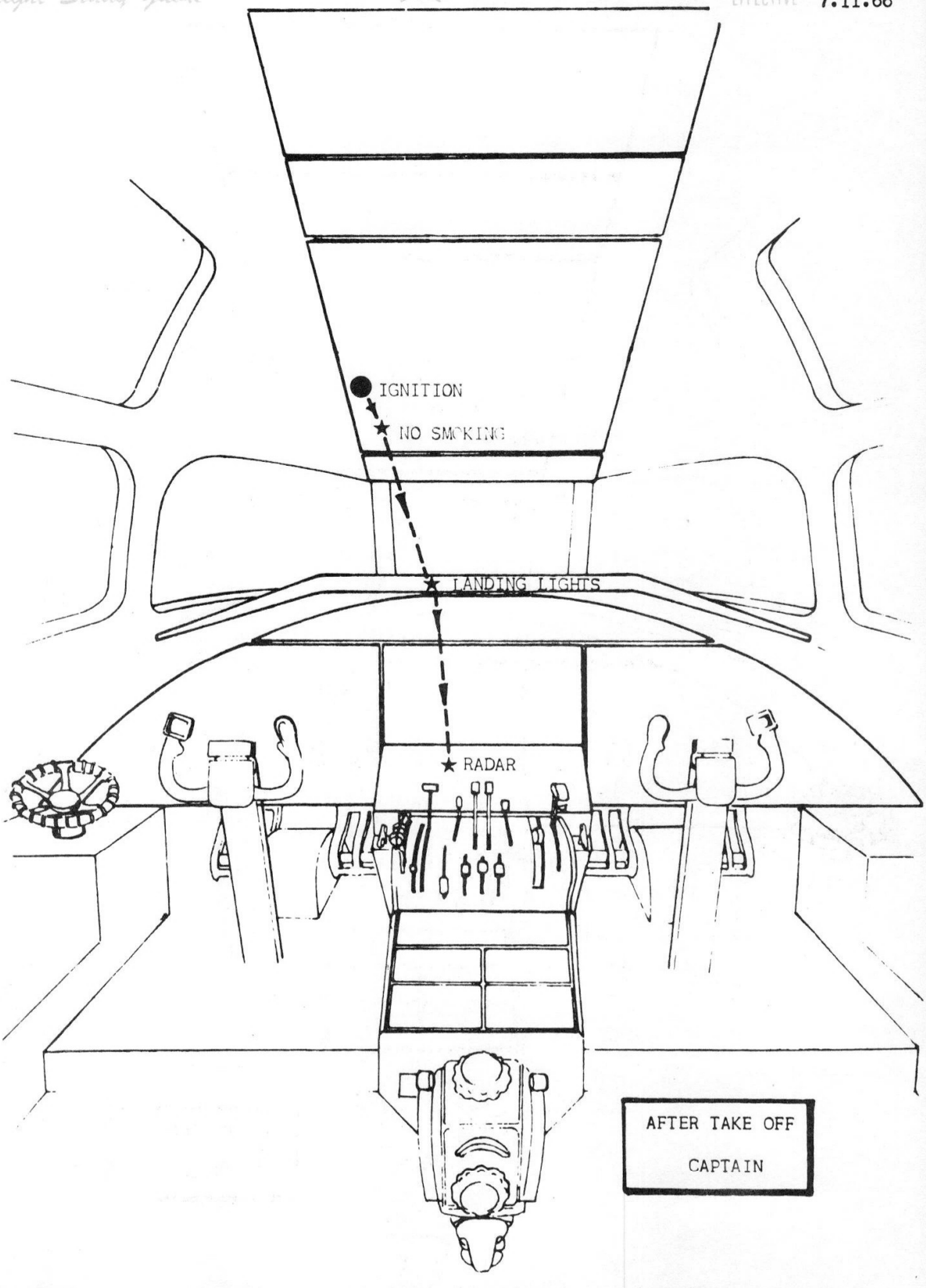
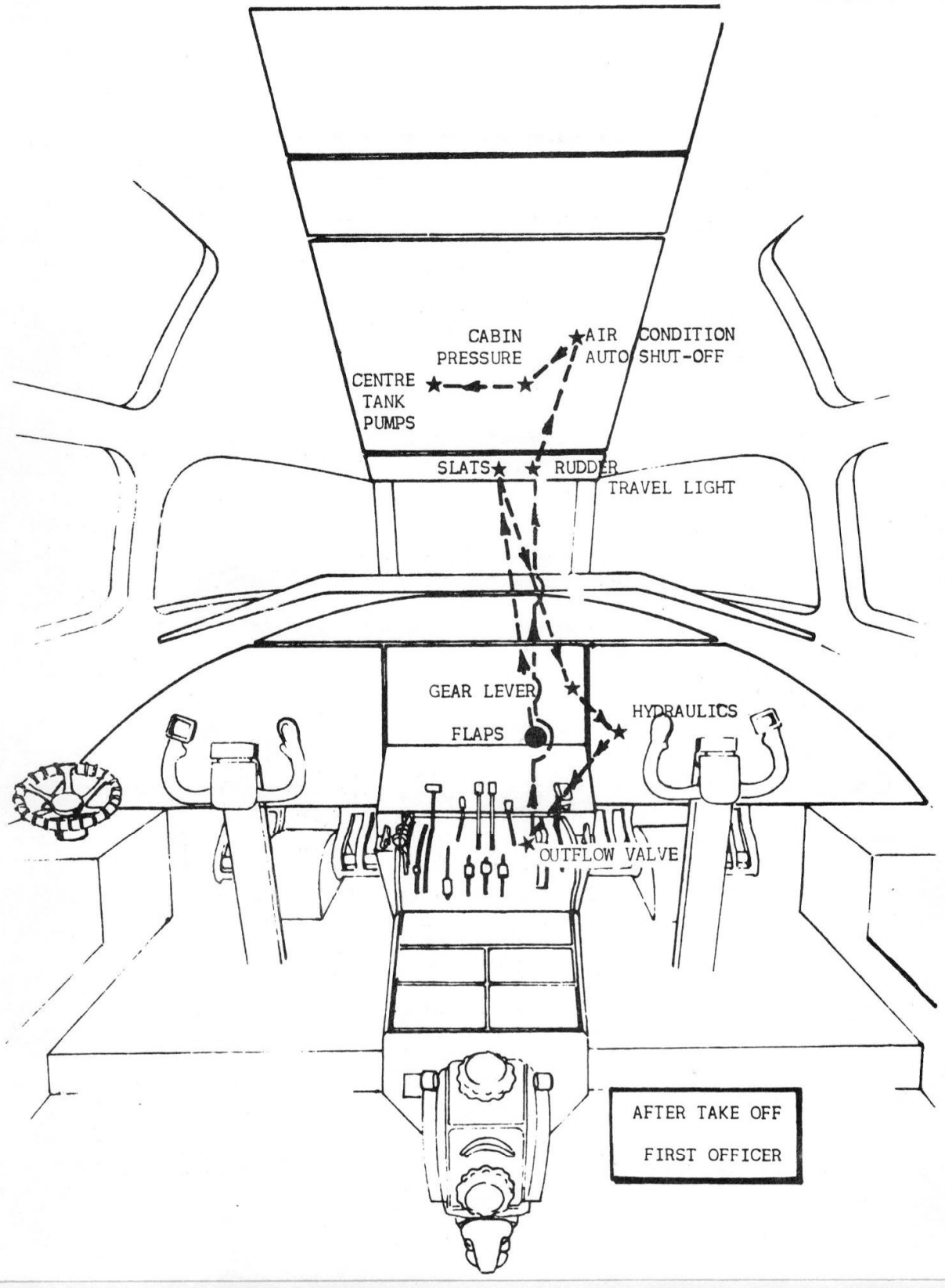


ANSETT

SCAN PATTERN



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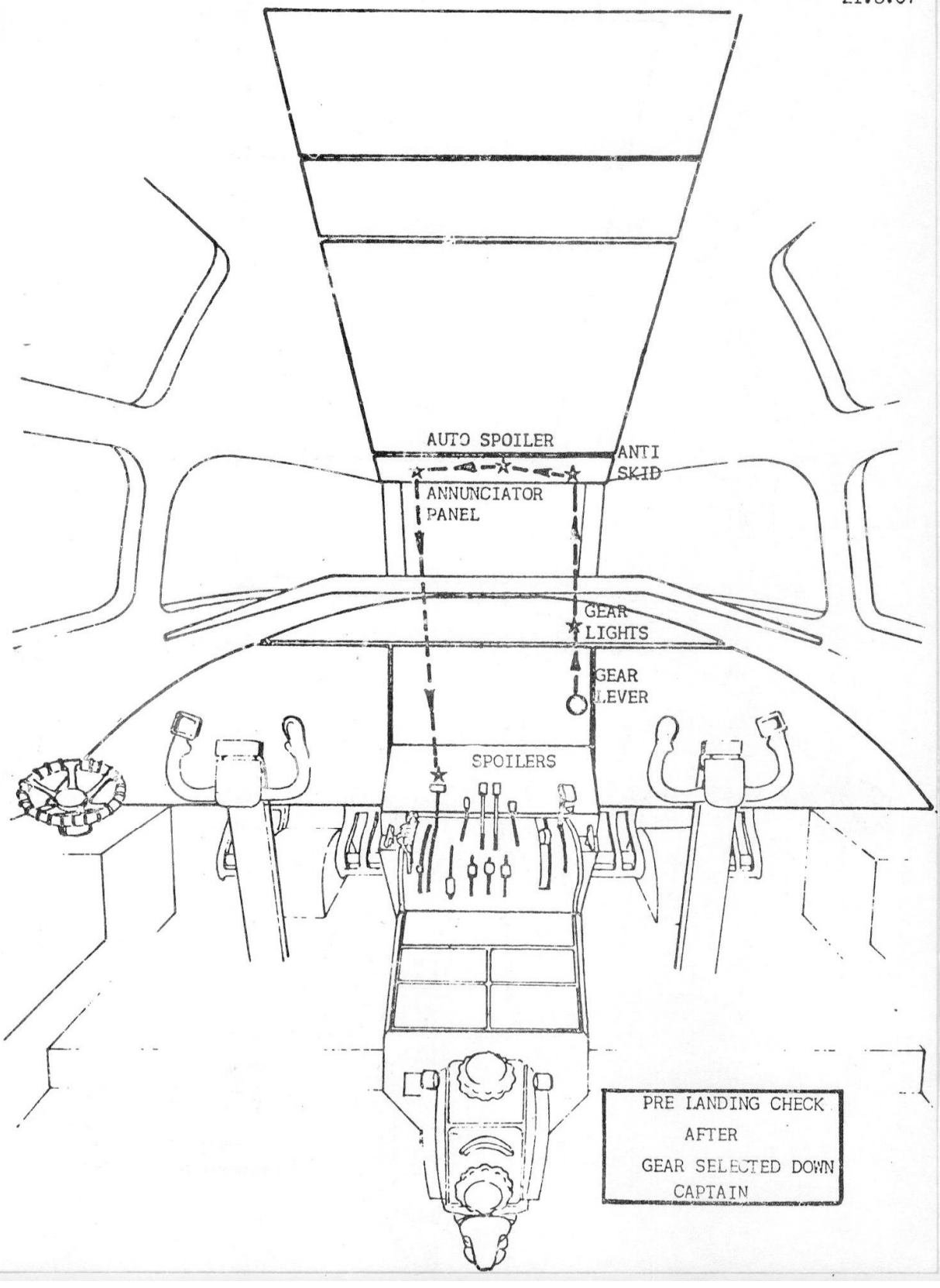

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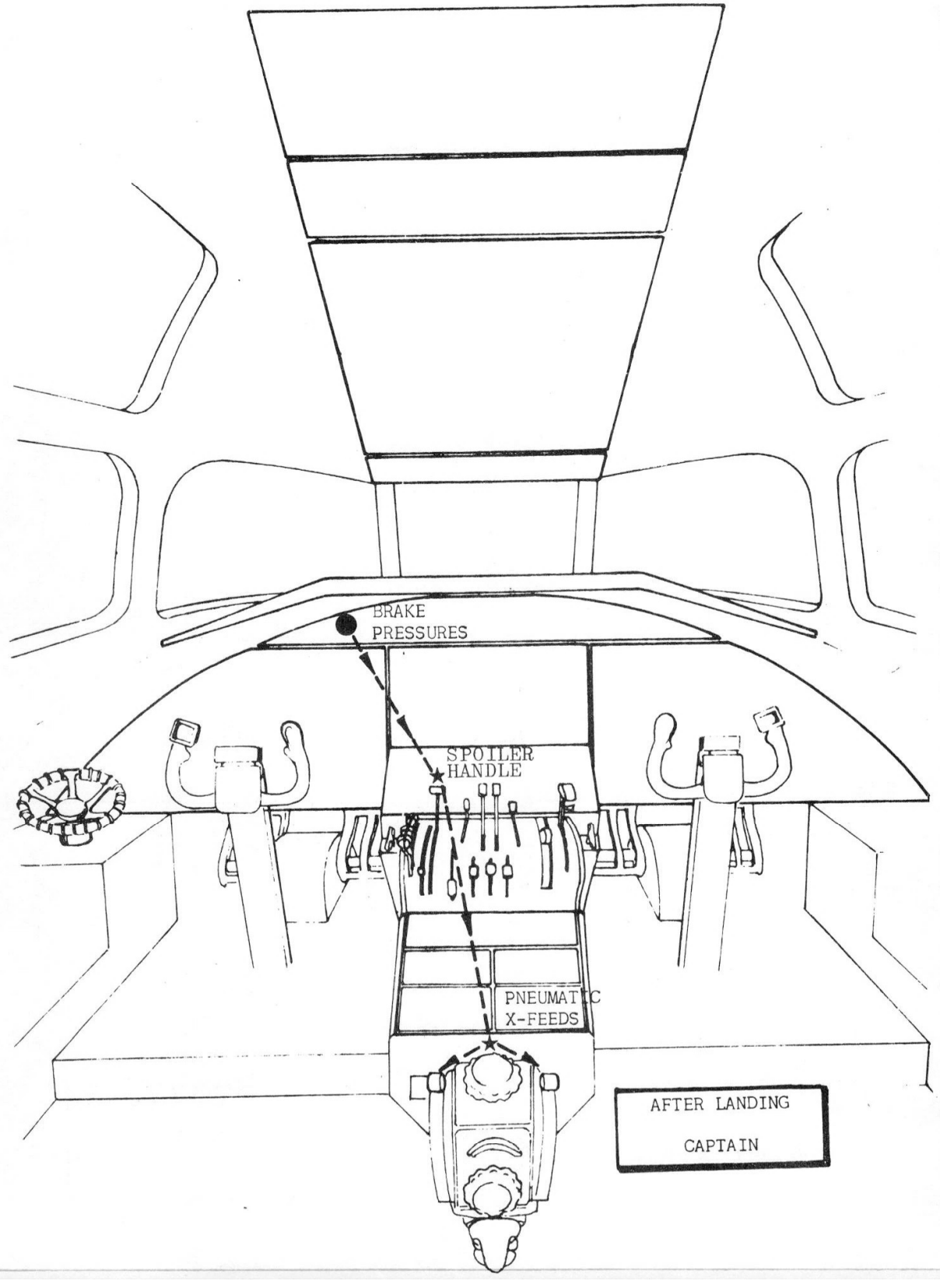

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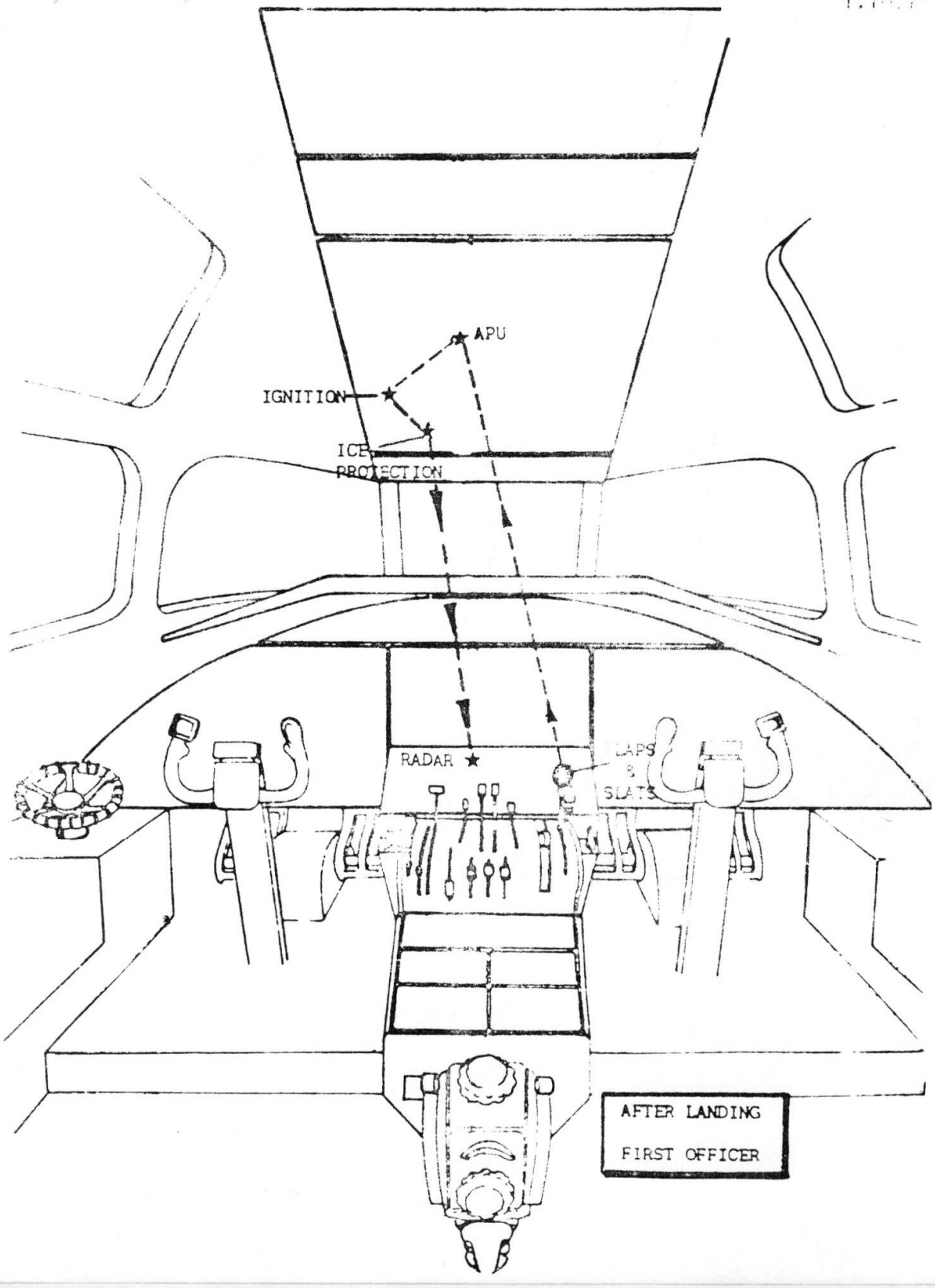

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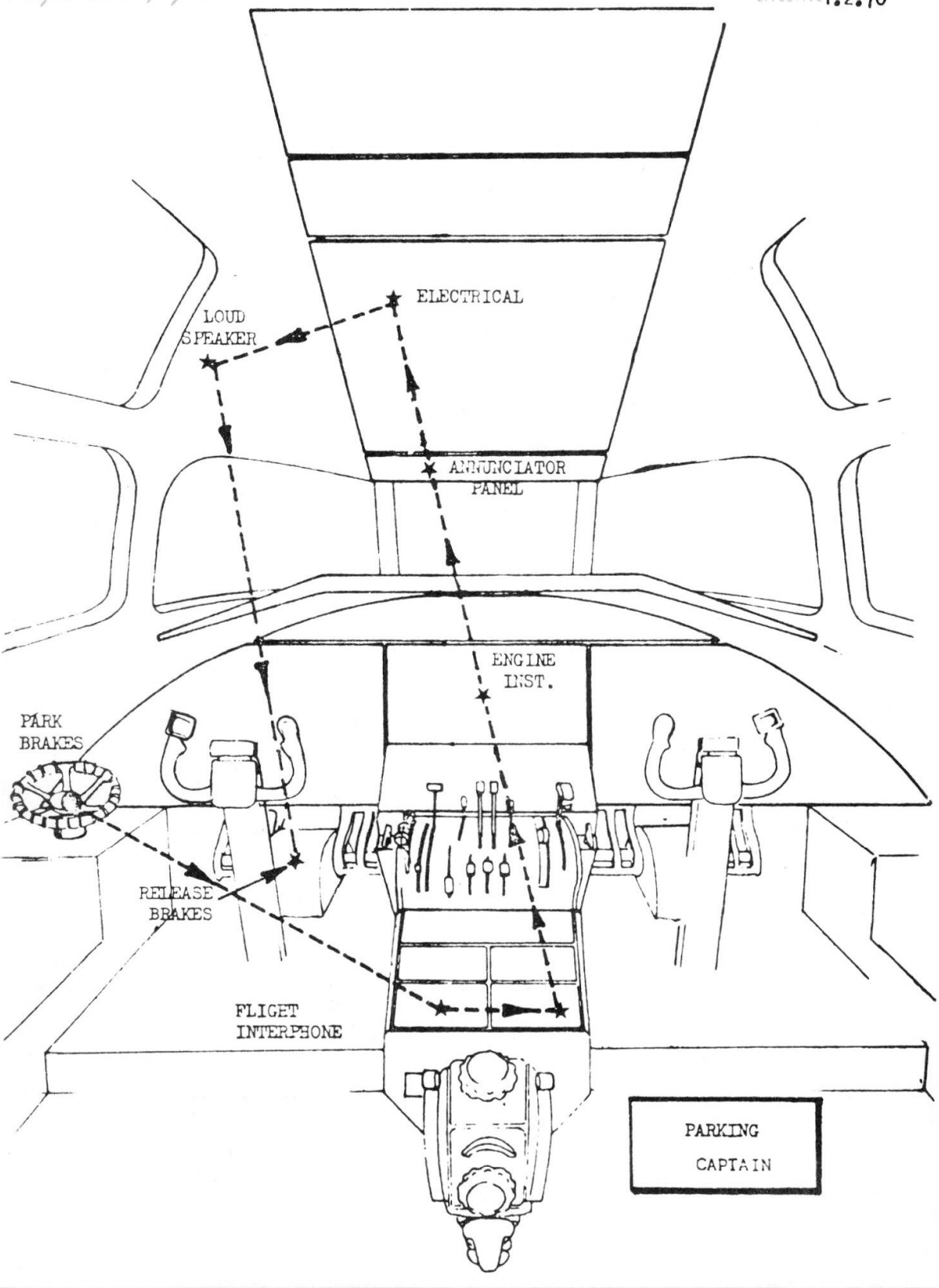

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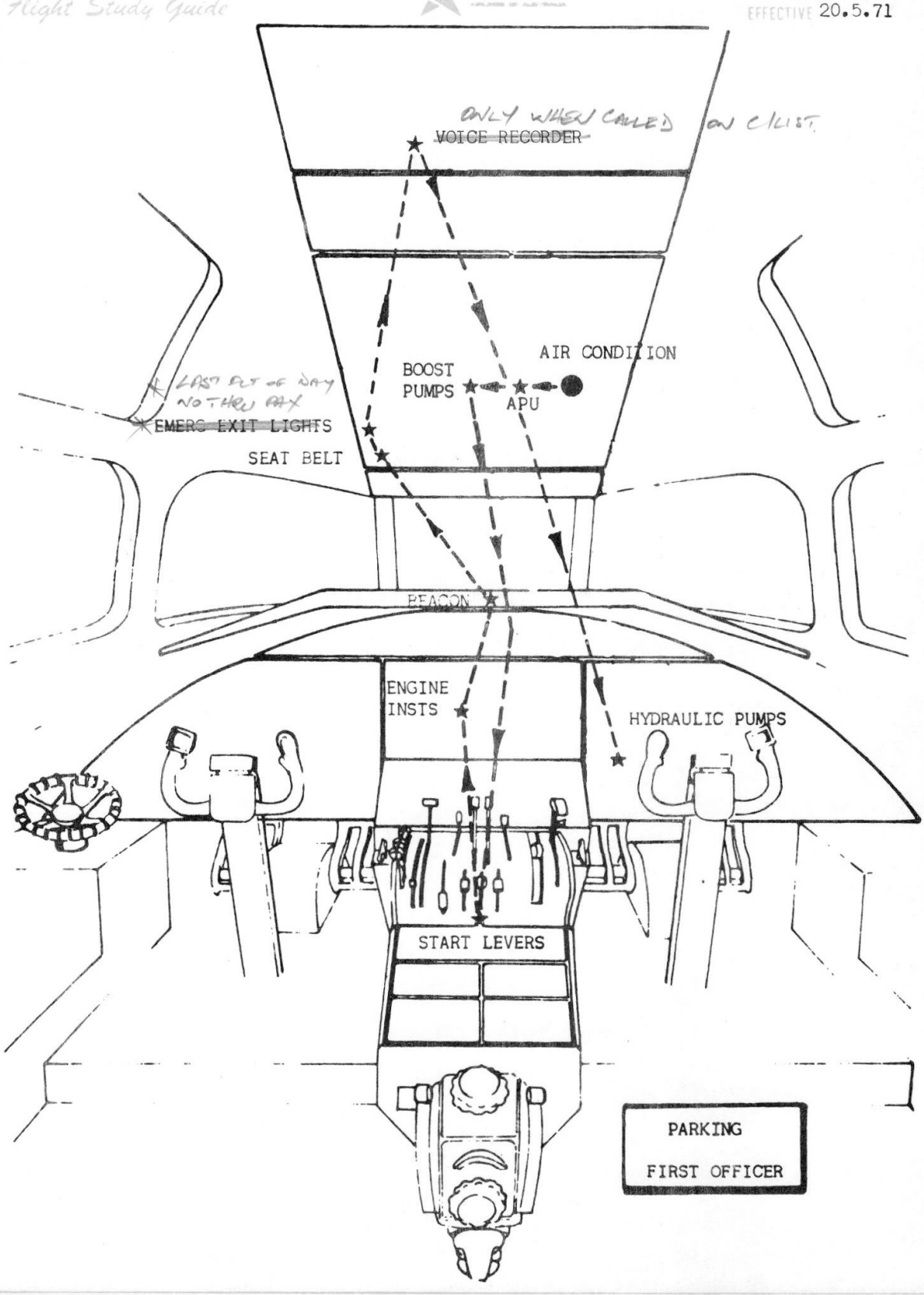
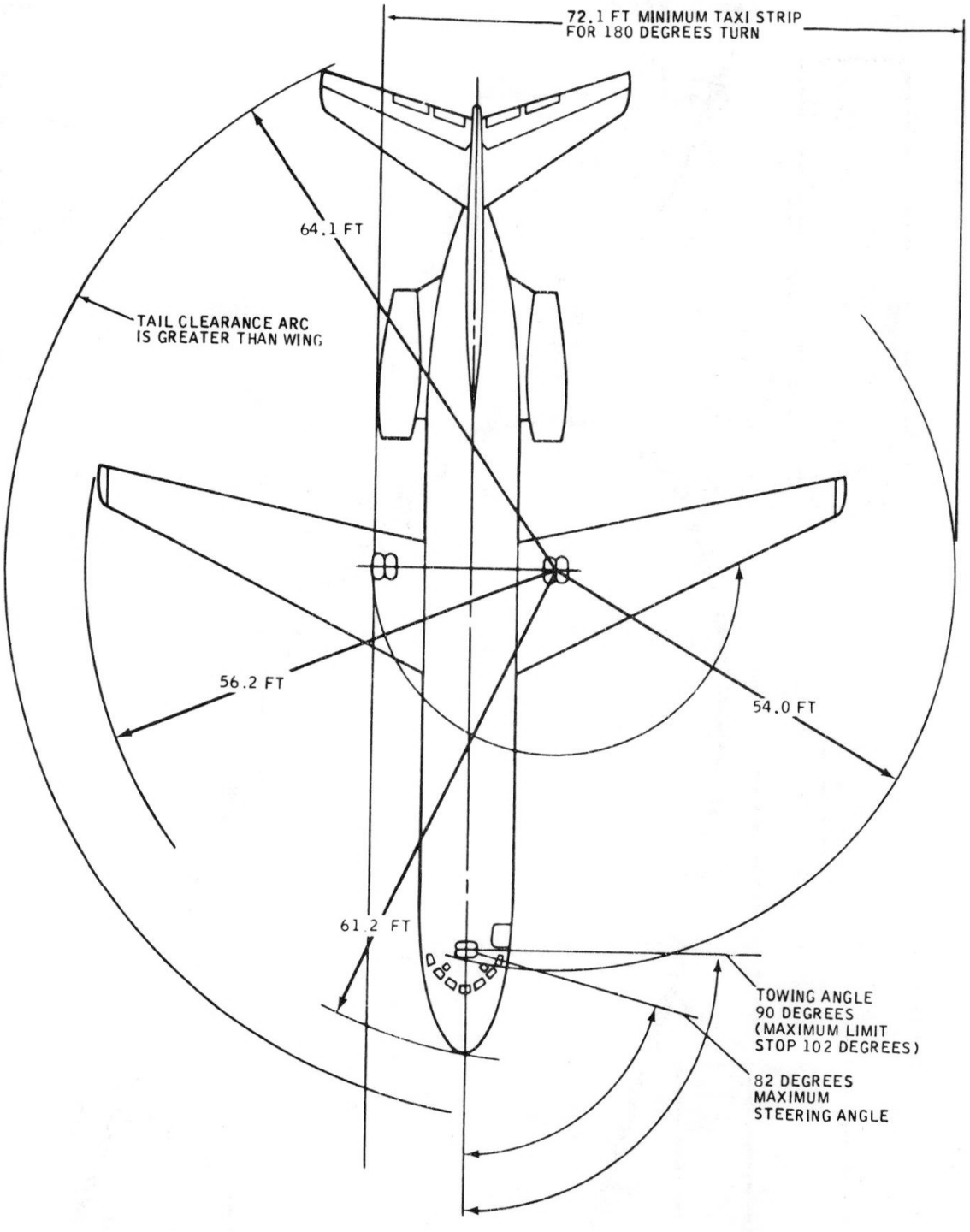
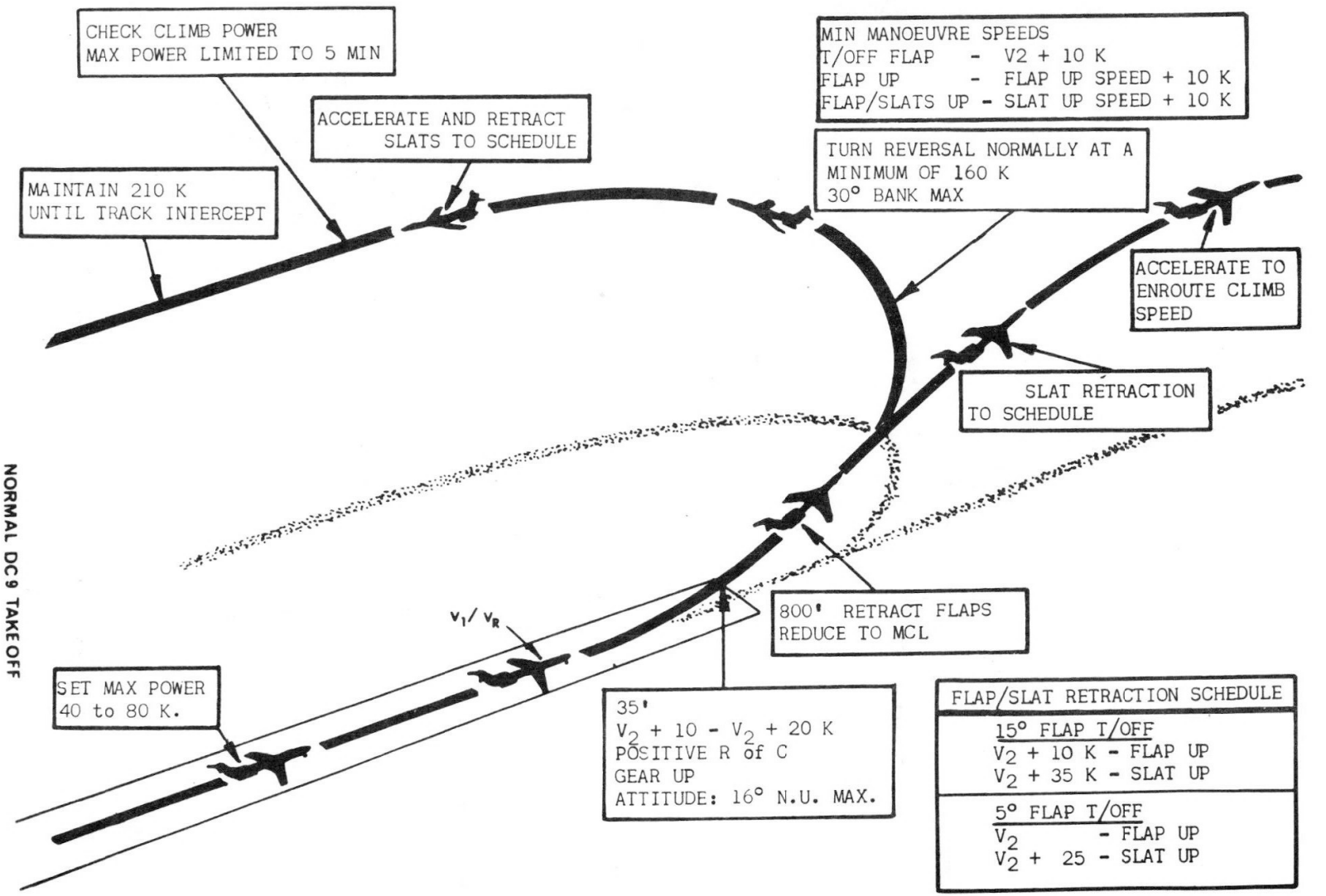




GROUND MANOEUVERING & TURNING RADII



NORMAL DC9 TAKEOFF

MINIMUM MANOEUVRE SPEEDS

T/OFF FLAP - V2 + 10 KTS.
FLAP UP - FLAP UP SPEED + 10 K.
FLAP/SLATS UP - SLATS UP SPEED + 10 K.

FLAP/SLAT RETRACTION SCHEDULE

15° FLAP TAKE-OFF
V2 + 10 K. - FLAP UP
V2 + 35 K. - SLAT UP

5° FLAP TAKE-OFF
V2 - FLAP UP
V2 + 25 K. - SLAT UP

CAUTION

DO NOT MAKE LARGE ATTITUDE CHANGES TO GAIN IAS AS SINKING WILL RESULT

CONTINUE ACCELERATION IN LEVEL FLIGHT TO GW + 100 KTS, AND RESUME CLIMB TO 1500 FEET.

IF NECESSARY TO CONTINUE CLIMB, MAINTAIN GW + 100 KTS. OTHERWISE ACCELERATE TO ENROUTE CLIMB SPEED.

WARNING

LIMIT BANK TO 15° WHILE BELOW MINIMUM MANOEUVERING SPEED.

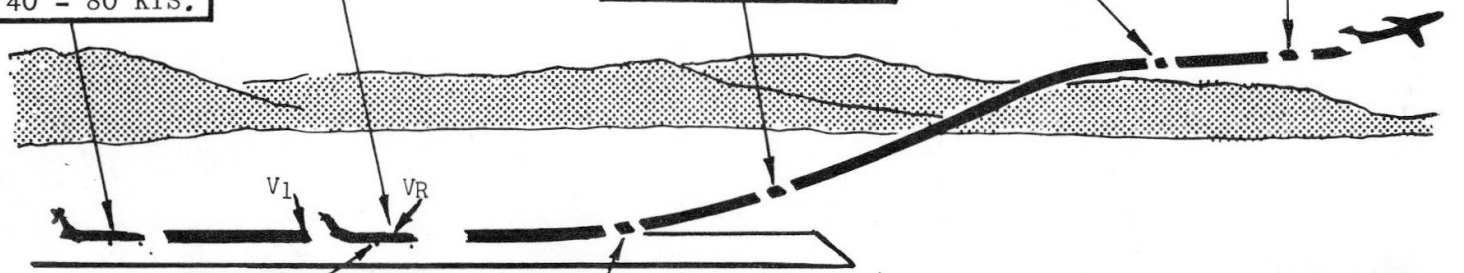
AT 500 FEET REDUCE ATTITUDE 2° - 3° AND ACCELERATE WITH ZERO RATE OF CLIMB. RETRACT FLAPS/SLATS TO SCHEDULE.

REDUCE TO MCT WHEN FLAP RETRACTION COMPLETE OR AT END OF 5 MINUTES.

START SMOOTH ROTATION AT V_r SO AS TO REACH V_2 AT 35 FEET TARGET ATTITUDE 16°

CLIMB AT V_2 UNTIL REACHING 500 FEET. ATTITUDE 13° - 15°

TRIM MAX. POWER AT 40 - 80 KTS.



ENGINE FAILURE AFTER V_1

WITH POSITIVE RATE OF CLIMB, RETRACT GEAR.

ON ALL ENGINE OUT MANOEUVERS BE ALERT ON THE RUDDER AND KEEP THE BALL NEARLY CENTERED WITH ZERO LATERAL INPUT.

TABLE I

SCAT SPEED SCHEDULE

	LANDING APPROACH		TAKEOFF - GO-AROUND	
Flaps	Slats Open	Slats Closed	Slats Open	Slats Closed
0	$1.5\ V_{S_{MIN}}$	$1.62\ V_{S_{MIN}}$	$V_2 = 1.31\ V_{S_{MIN}}$	$1.30\ V_{S_{MIN}}$
5	$1.45\ V_{S_{MIN}}$	$1.56\ V_{S_{MIN}}$	$V_2 = 1.30\ V_{S_{MIN}}$	$1.28\ V_{S_{MIN}}$
15	$1.4\ V_{S_{MIN}}$	$1.43\ V_{S_{MIN}}$	$V_2 = 1.27\ V_{S_{MIN}}$	$1.23\ V_{S_{MIN}}$
25	$1.32 V_{S_{MIN}}$	$1.30\ V_{S_{MIN}}$	$V_2 = 1.26\ V_{S_{MIN}}$	$1.20\ V_{S_{MIN}}$
50	$1.3\ V_{S_{MIN}} + 5$ KT	$1.33 V_{S_{MIN}}$	$1.3\ V_{S_{MIN}} + 5$ KT	$1.29\ V_{S_{MIN}}$

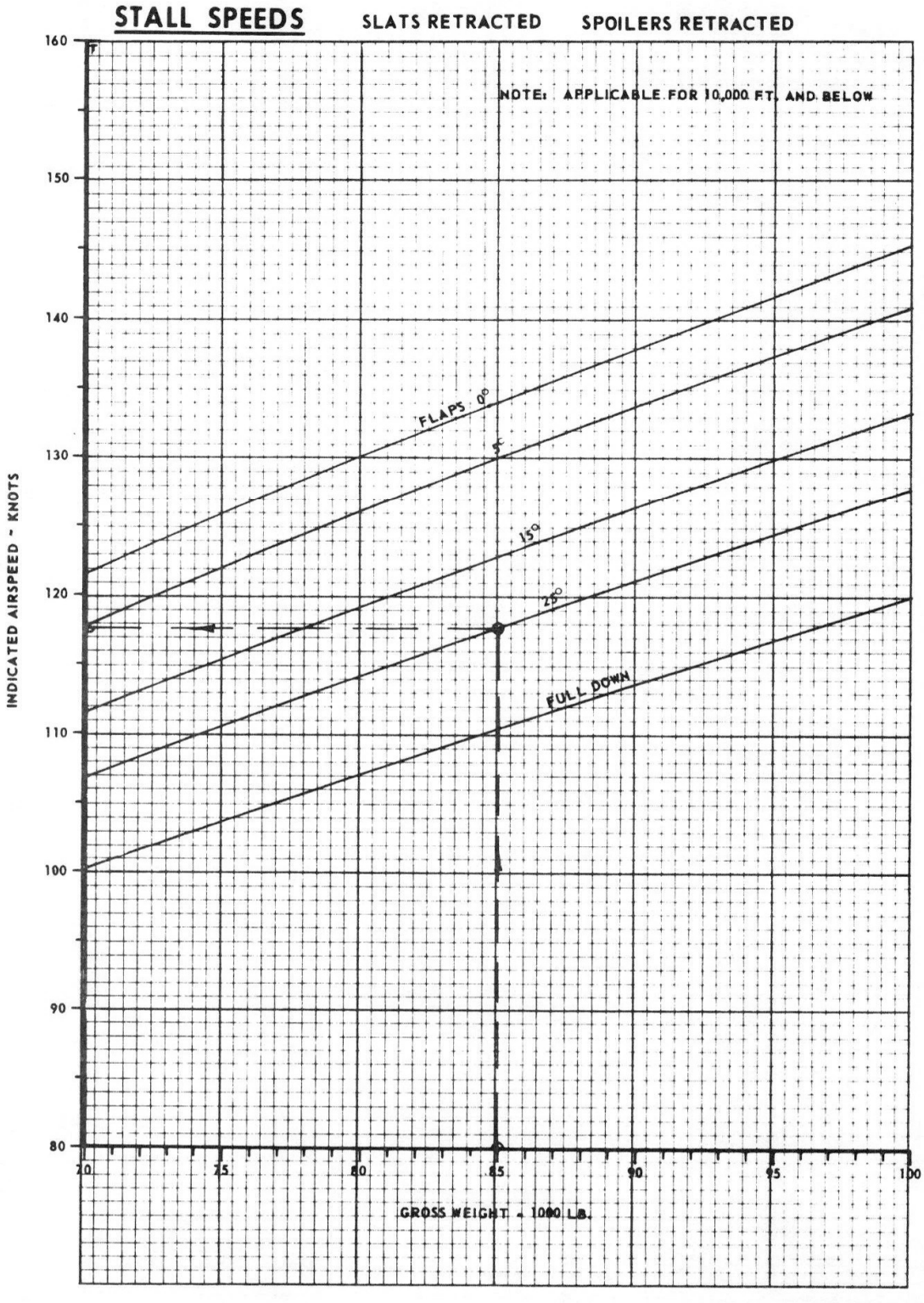
2. CLIMB ANGLE

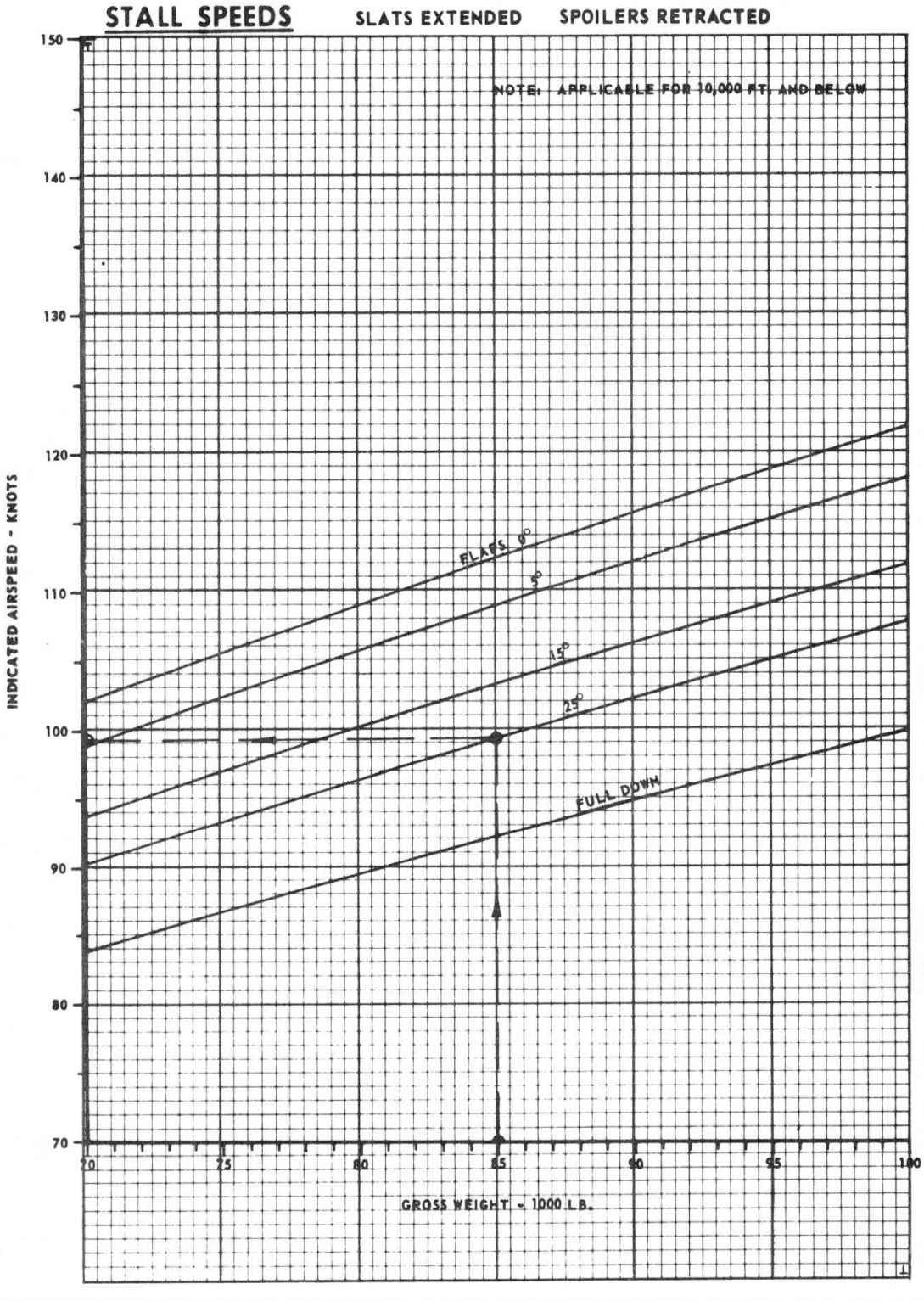
The following table gives the speeds for best angle (gradient) and best rate of climb.

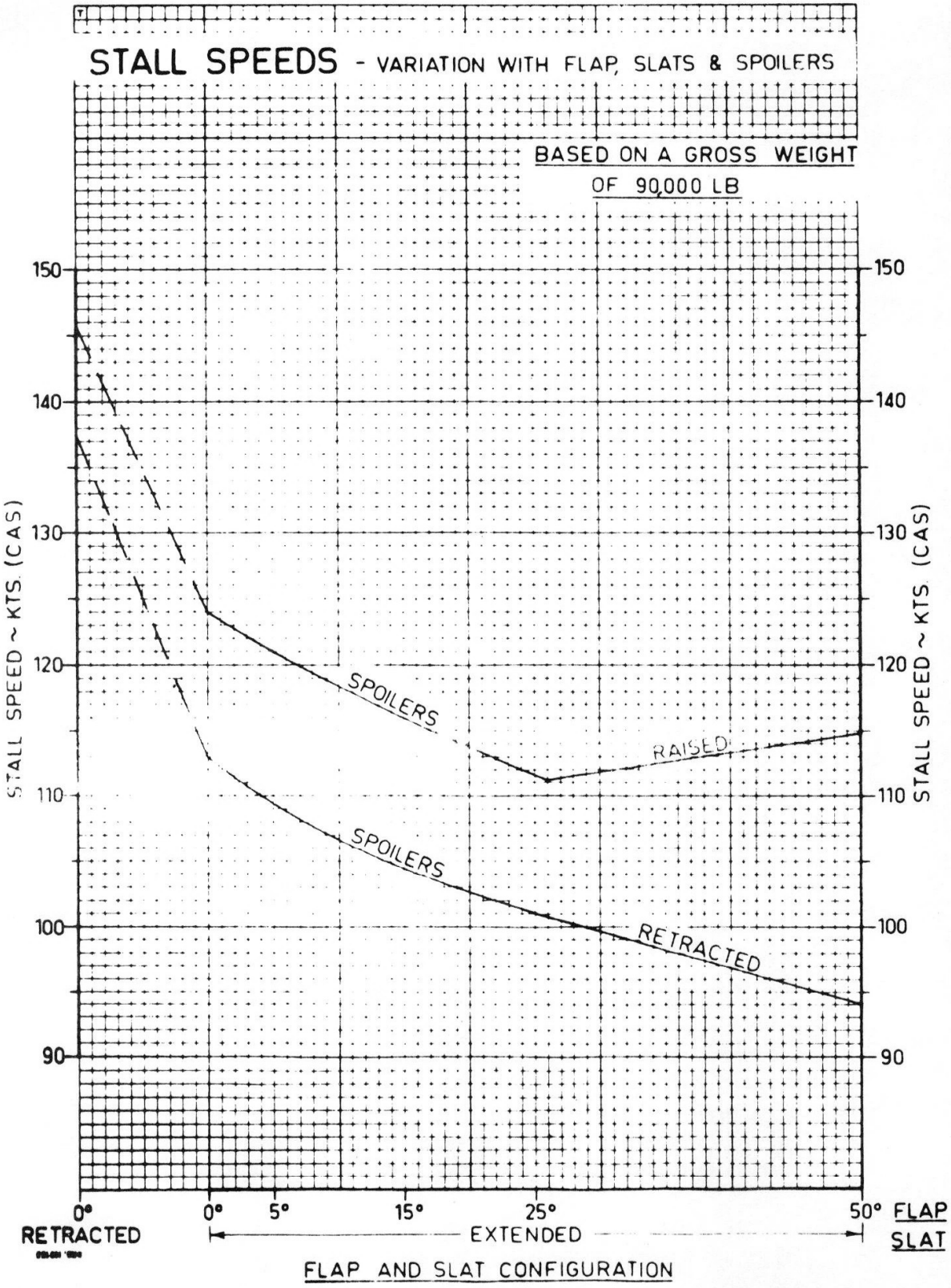
TABLE II

SPEED (Knots, EAS)

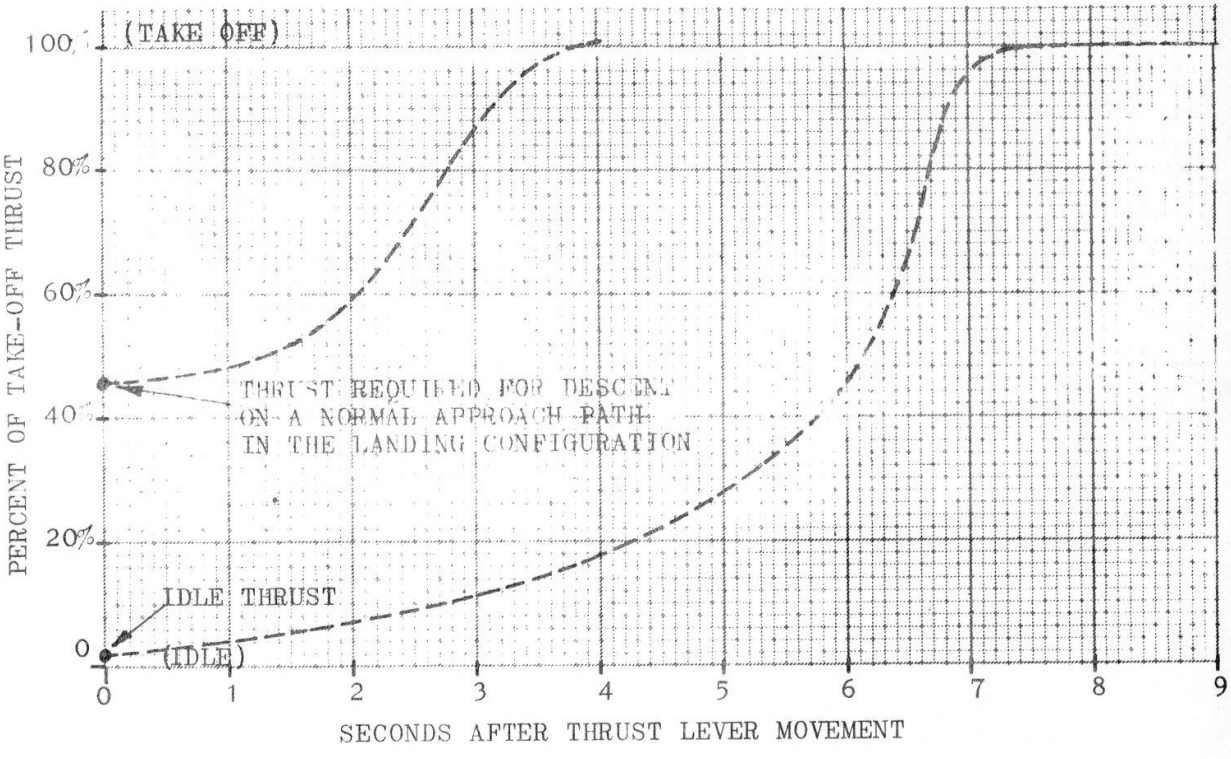
	Rate of Climb				Gradient			
	1 Engine Inoperative		All Engines		1 Engine Inoperative		All Engines	
Weight (Lbs)	0°Flaps Slats Retr.	15°Flaps Slats Ext.	0°Flaps Slats Retr.	15°Flaps Slats Ext.	0°Flaps Slats Retr.	15°Flaps Slats Ext.	0°Flaps Slats Retr.	15°Flaps Slats Ext.
100,000	215	171	220	172	203	163	205	163
80,000	192	153	197	154	181	146	183	146
60,000	167	132	170	133	157	126	159	126


STALL SPEEDS
SLATS RETRACTED
SPOILERS RETRACTED
NOTE: APPLICABLE FOR 10,000 FT. AND BELOW
FLAPS 0°
5°
15°
25°
FULL DOWN
INDICATED AIRSPEED - KNOTS
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
GROSS WEIGHT - 1000 LB.
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

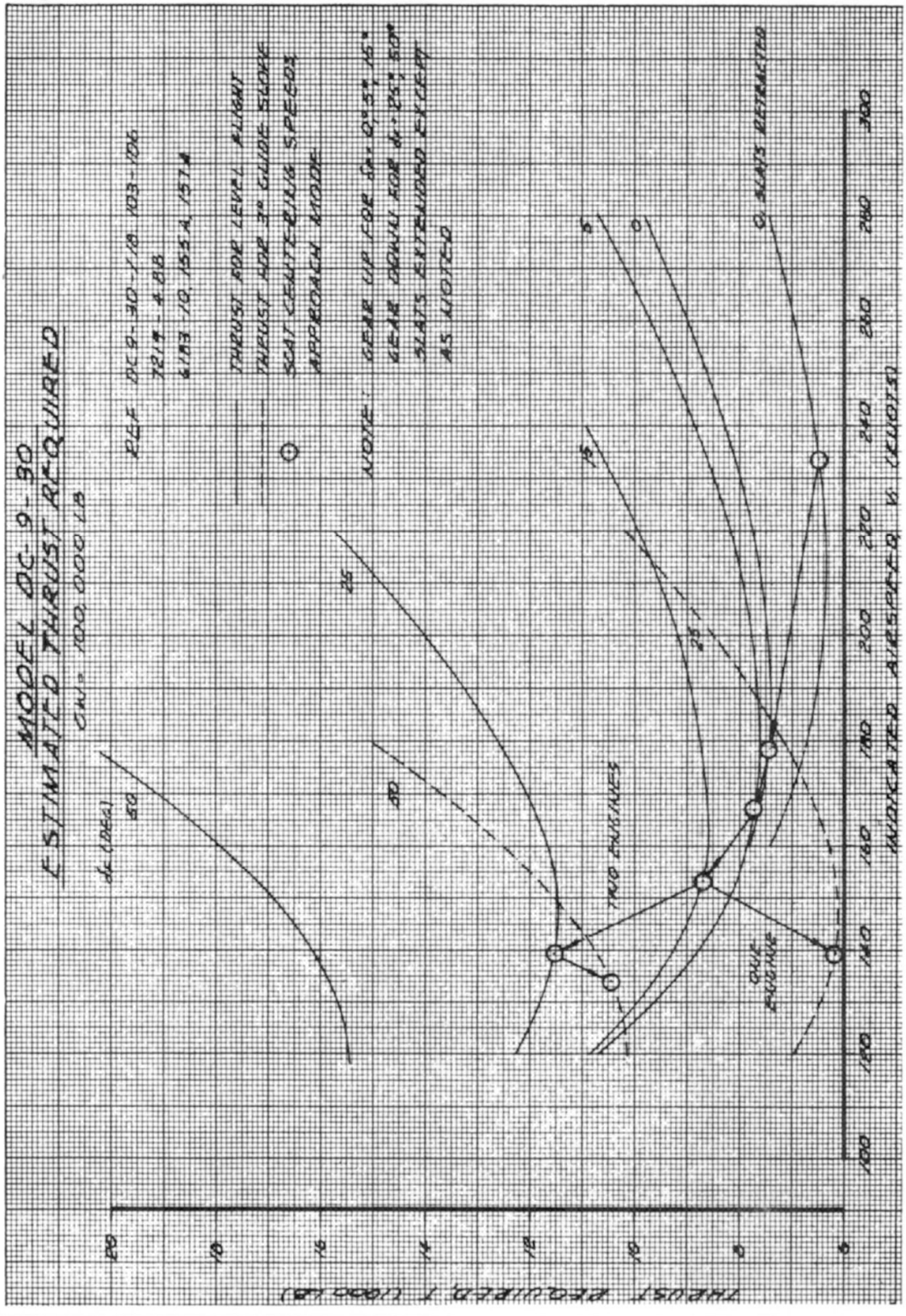

STALL SPEEDS
SLATS EXTENDED
SPOILERS RETRACTED
NOTE: APPLICABLE FOR 10,000 FT. AND BELOW
INDICATED AIRSPEED - KNOTS
150
140
130
120
110
100
90
80
70
FLAPS 0°
5°
15°
25°
FULL DOWN
70
75
80
85
90
95
100
GROSS WEIGHT - 1000 LB.

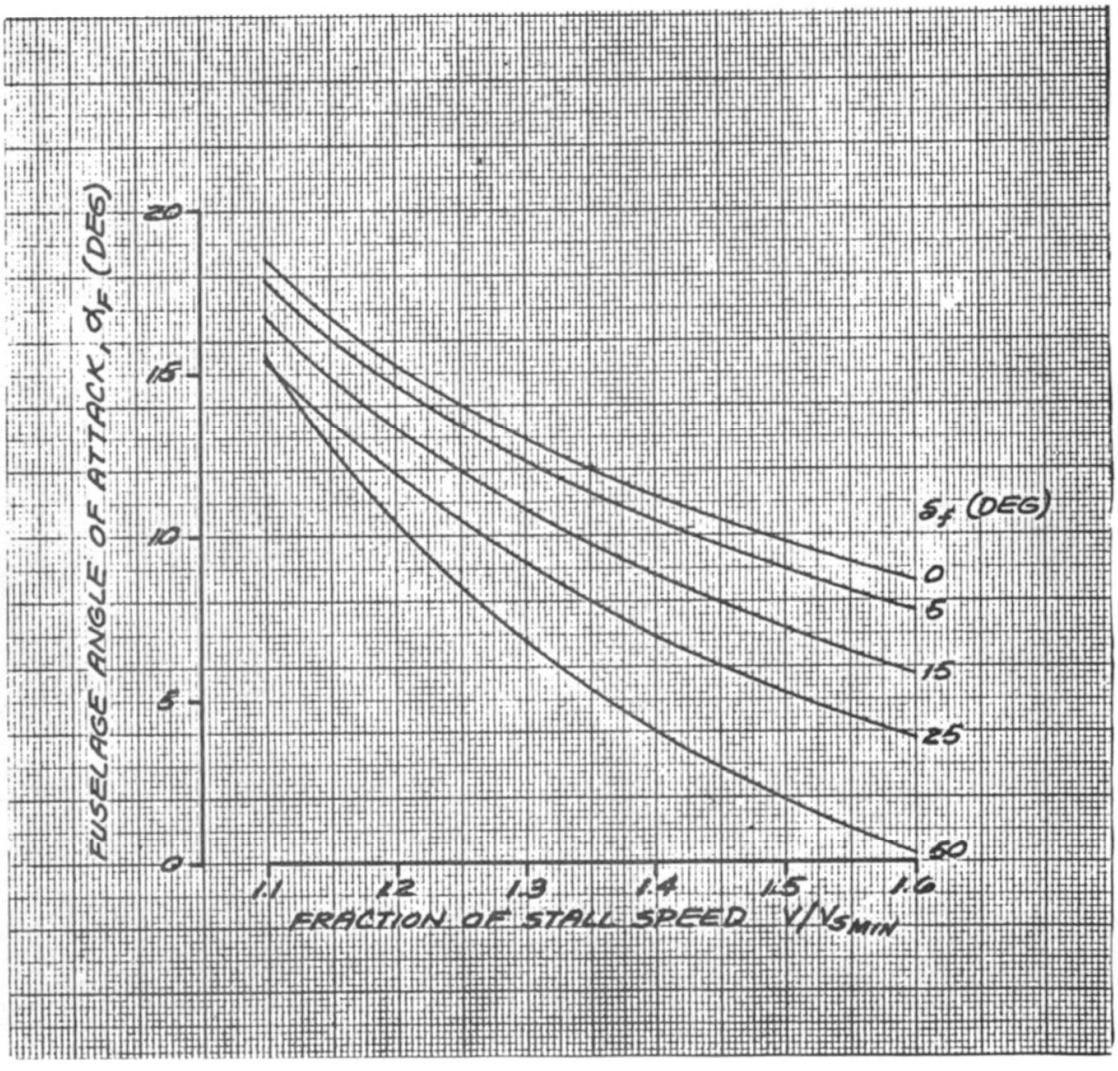

STALL SPEEDS - VARIATION WITH FLAP, SLATS & SPOILERS
BASED ON A GROSS WEIGHT OF 90,000 LB
STALL SPEED ~ KTS. (CAS)
150
140
130
120
110
100
90
SPOILERS RAISED
SPOILERS RETRACTED
0° RETRACTED
0° 5° 15° 25° 50° FLAP SLAT
EXTENDED
FLAP AND SLAT CONFIGURATION

JET ENGINE
ACCELERATION CHARACTERISTICS



ESTIMATED THRUST REQUIRED

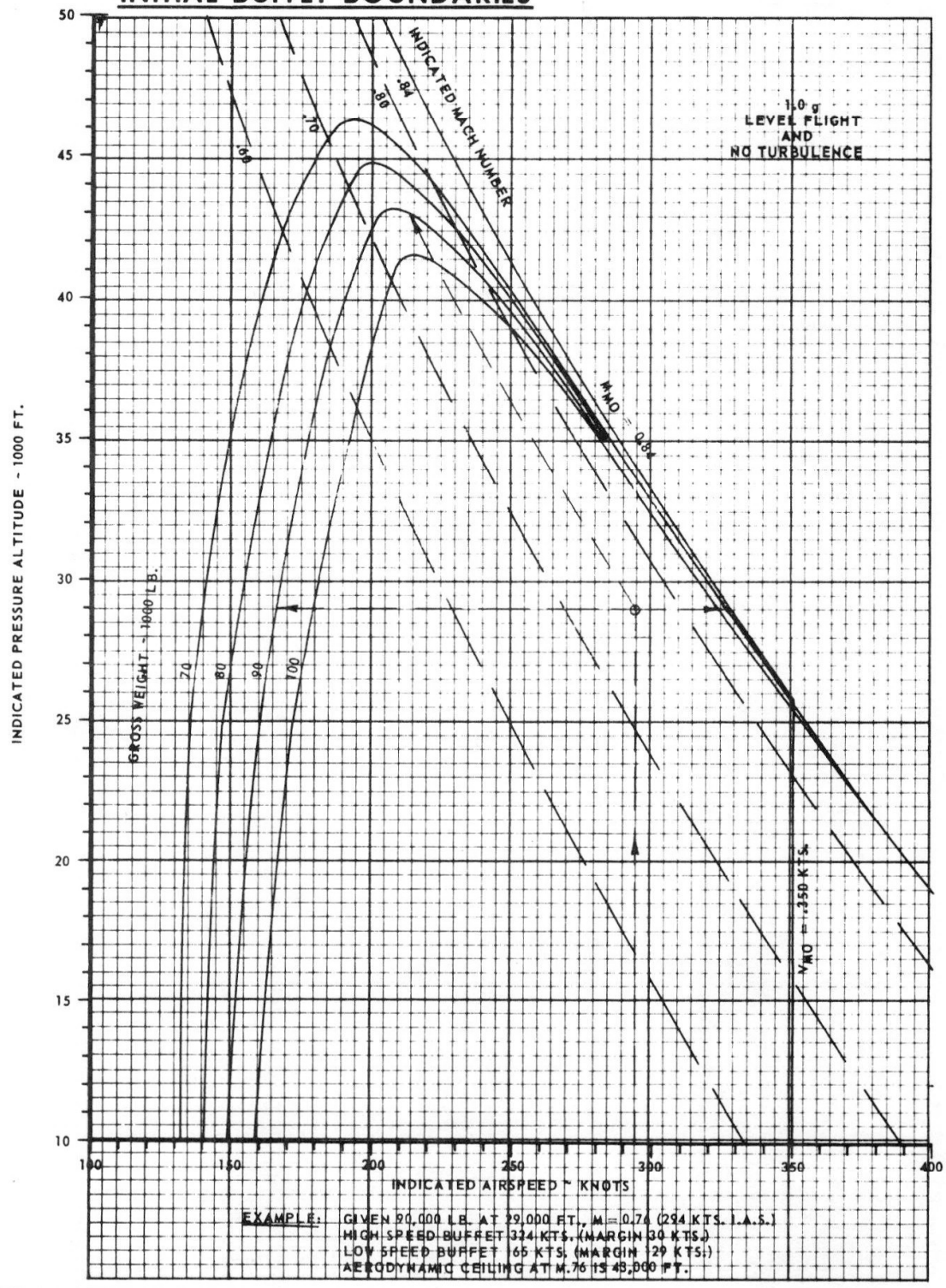




ESTIMATED ANGLE OF ATTACK NECESSARY TO MAINTAIN A FRACTION OF THE MINIMUM STALL SPEED.

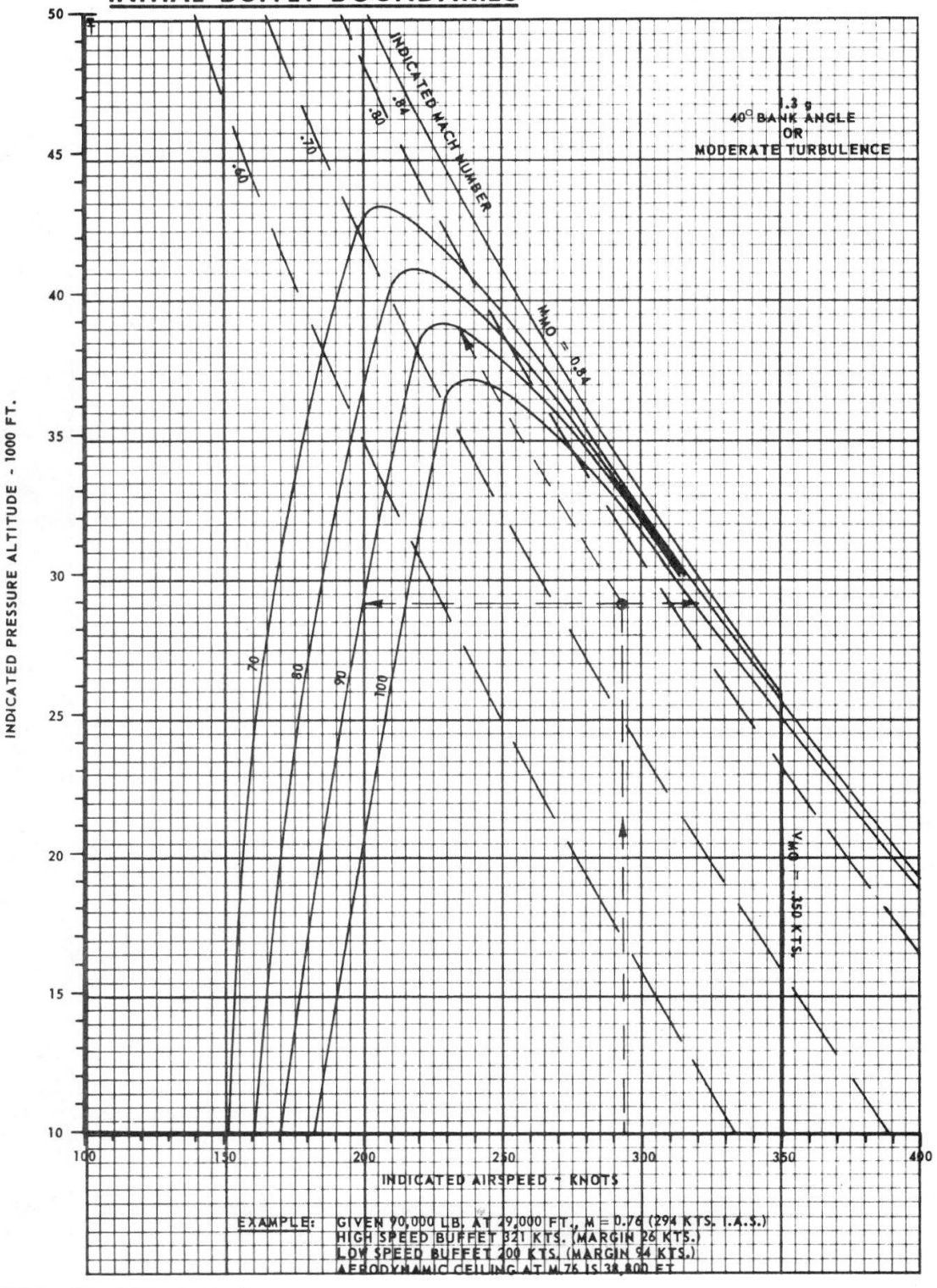
ZERO THRUST - SLATS OPEN - MID C.G.

INITIAL BUFFET BOUNDARIES

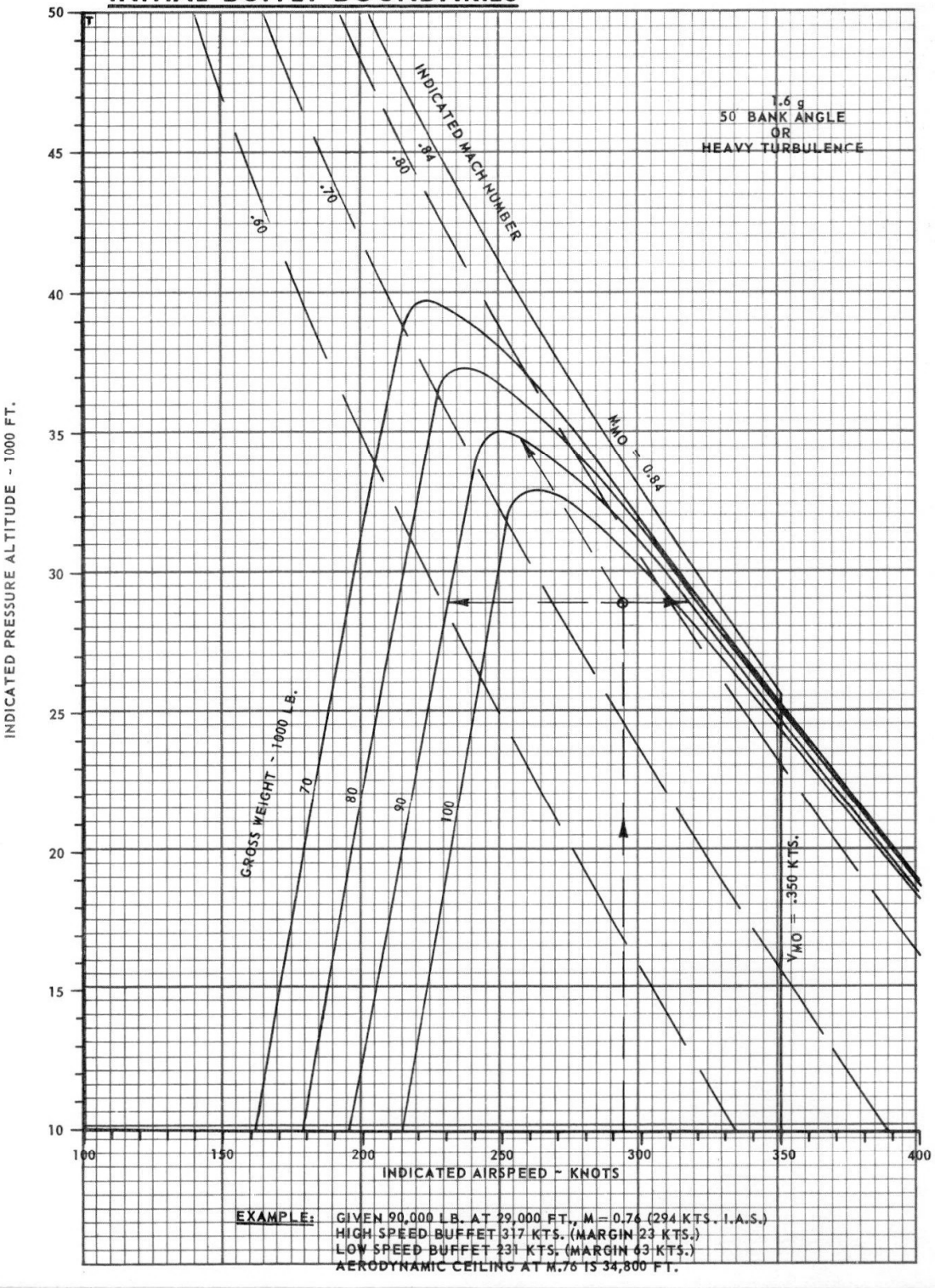


EXAMPLE: GIVEN 90,000 LB. AT 29,000 FT., M = 0.76 (294 KTS. I.A.S.)
HIGH SPEED BUFFET 324 KTS. (MARGIN 30 KTS.)
LOW SPEED BUFFET 265 KTS. (MARGIN 29 KTS.)
AERODYNAMIC CEILING AT M.76 IS 43,000 FT.

INITIAL BUFFET BOUNDARIES



INITIAL BUFFET BOUNDARIES



EXAMPLE: GIVEN 90,000 LB. AT 29,000 FT., M = 0.76 (294 KTS. I.A.S.)
HIGH SPEED BUFFET 317 KTS. (MARGIN 23 KTS.)
LOW SPEED BUFFET 231 KTS. (MARGIN 63 KTS.)
AERODYNAMIC CEILING AT M.76 IS 34,800 FT.

DC-9 Flight Study Guide
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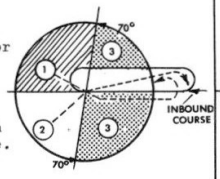
PAGE
EFFECTIVE

DC-9 HOLDING PATTERNS AND PROCEDURES (F.A.A.)

Entry into Holding Patterns

STANDARD PATTERN



(1) Parallel Procedure

Parallel holding course, turn left, and return to holding fix or intercept holding course.

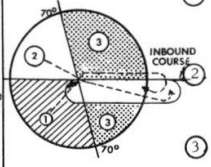
(2) Tear Drop Procedure

Proceed on outbound track of 30° (or less) to holding course, turn right to intercept holding course.

(3) Direct Entry Procedure

Turn right and fly the pattern.

NON-STANDARD PATTERN



(1) Parallel Procedure

Parallel holding course, turn right and return to holding fix or intercept holding course.

Tear Drop Procedure

Proceed on outbound track of 30° (or less) to holding course, turn left to intercept holding course.

(3) Direct Entry Procedure

Turn left, and fly the pattern.

ANSETT-A.N.A. HOLDING PROCEDURES

A. Hold clean at all altitudes between 195 & 215 Kts. depending on weight.

B. When approach is imminent extend slats/flaps 15° and slow to Bug + 25 Kts.

F.A.A. MAXIMUM AIR SPEEDS

A. Holding in holding pattern - Arrivals.

1. Thru 6,000 feet MSL - 200 Kts IAS.
2. Above 6,000 feet thru 14,000 feet MSL - 210 Kts IAS.
3. Above 14,000 feet MSL - 230 Kts IAS.

B. Climbing in holding pattern - Departure - 310 Kts Maximum Speed limited by buffer zone around holding pattern.

D.C.A. MAXIMUM AIR SPEEDS

A. Holding in holding pattern - Arrivals.

1. Thru 6,000 feet MSL - 210 Kts IAS.
2. Above 6,000 feet thru 14,000 feet MSL - 220 Kts IAS.
3. Above 14,000 feet MSL - 240 Kts IAS.

B. All turns are to be made at a bank angle of 25° or a rate of 3° per second (rate 1), whichever requires the lesser bank.

PILOT ACTION

A. Begin speed reduction 3 minutes before estimate for holding fix.

B. Make all turns during entry and while holding at:

(1) 3° per second or,
(2) 30° bank angle or,
(3) 25° bank angle using a flight director system; use whichever requires the least bank angle.

C. Compensate for known effect of wind, except when turning.

D. Advise ATC immediately if increase in airspeed is necessary due to turbulence, or if unable to accomplish any part of the holding procedure.

TIMING

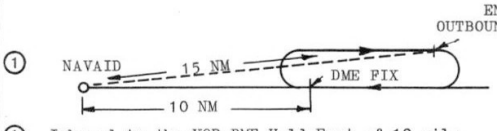
A. Inbound Leg

14,000 MSL or below	Above 14,000 MSL
1 Minute	1½ Minutes

The initial outbound leg should be flown for 1 minute or 1½ minutes (as required by altitude). Timing for subsequent outbound legs should be adjusted as necessary to achieve proper inbound leg time.

B. Outbound timing begins over or abeam the fix whichever is later. If the abeam position cannot be determined start timing when turn to outbound is completed.

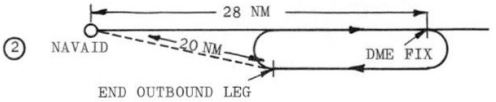
DME HOLDING (F.A.A.)



(1) Inbound to the VOR-DME Hold East of 10 mile (name of fix) DME fix on 90° radial of JFK VOR-(DME) 5 mile leg Right (Left) turns.

EXAMPLE #1 - SEE ABOVE

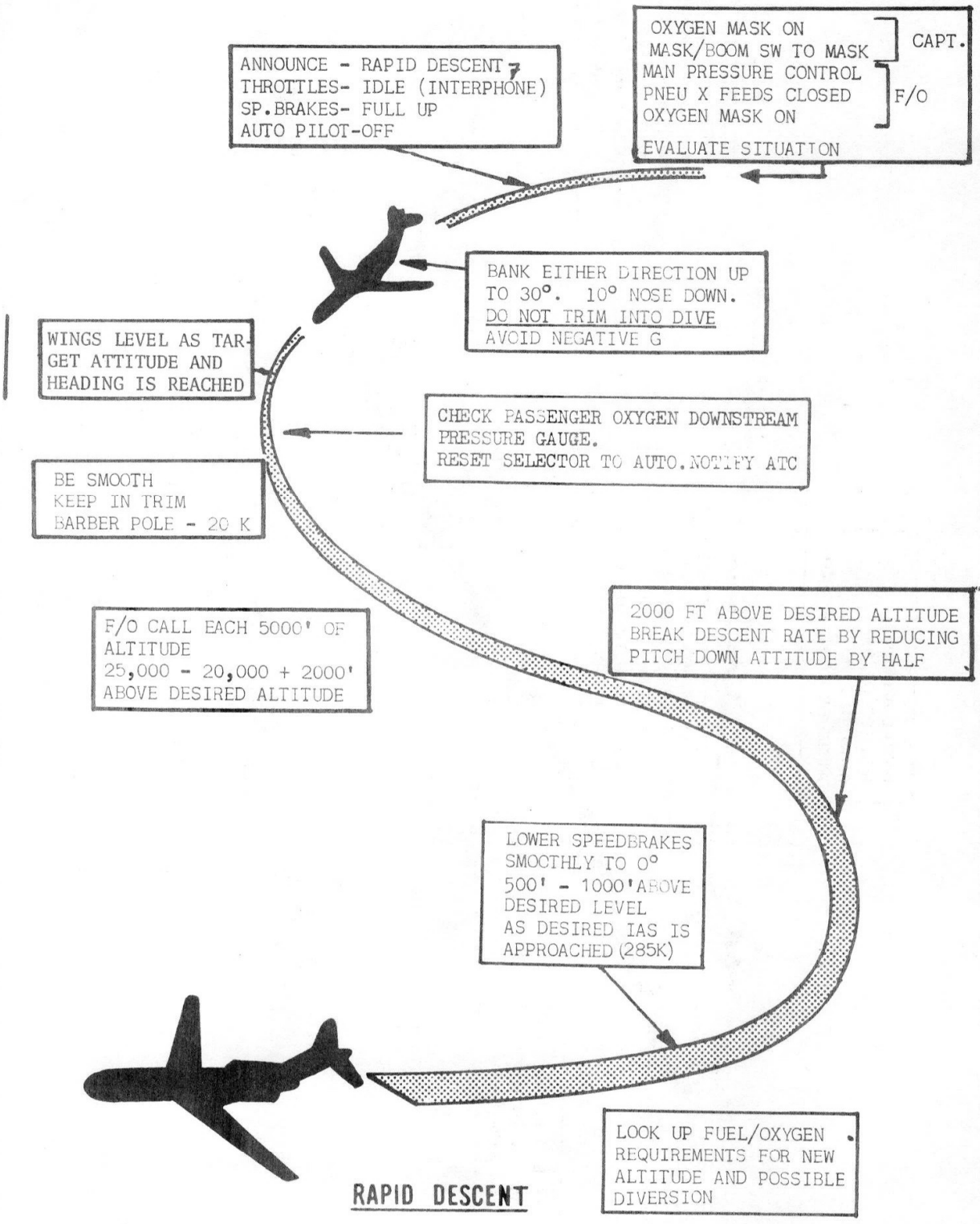
When the inbound course is toward the navaid; the fix distance is 10 NM and the leg length is 5 NM, then the end of the outbound leg will be reached when the DME reads 15 NM.



(2) Inbound away from the VOR-DME Hold West of 28 mile (name of fix) DME fix on 90° radial of JFK VOR-(DME) 8 mile leg Right (Left) turns.

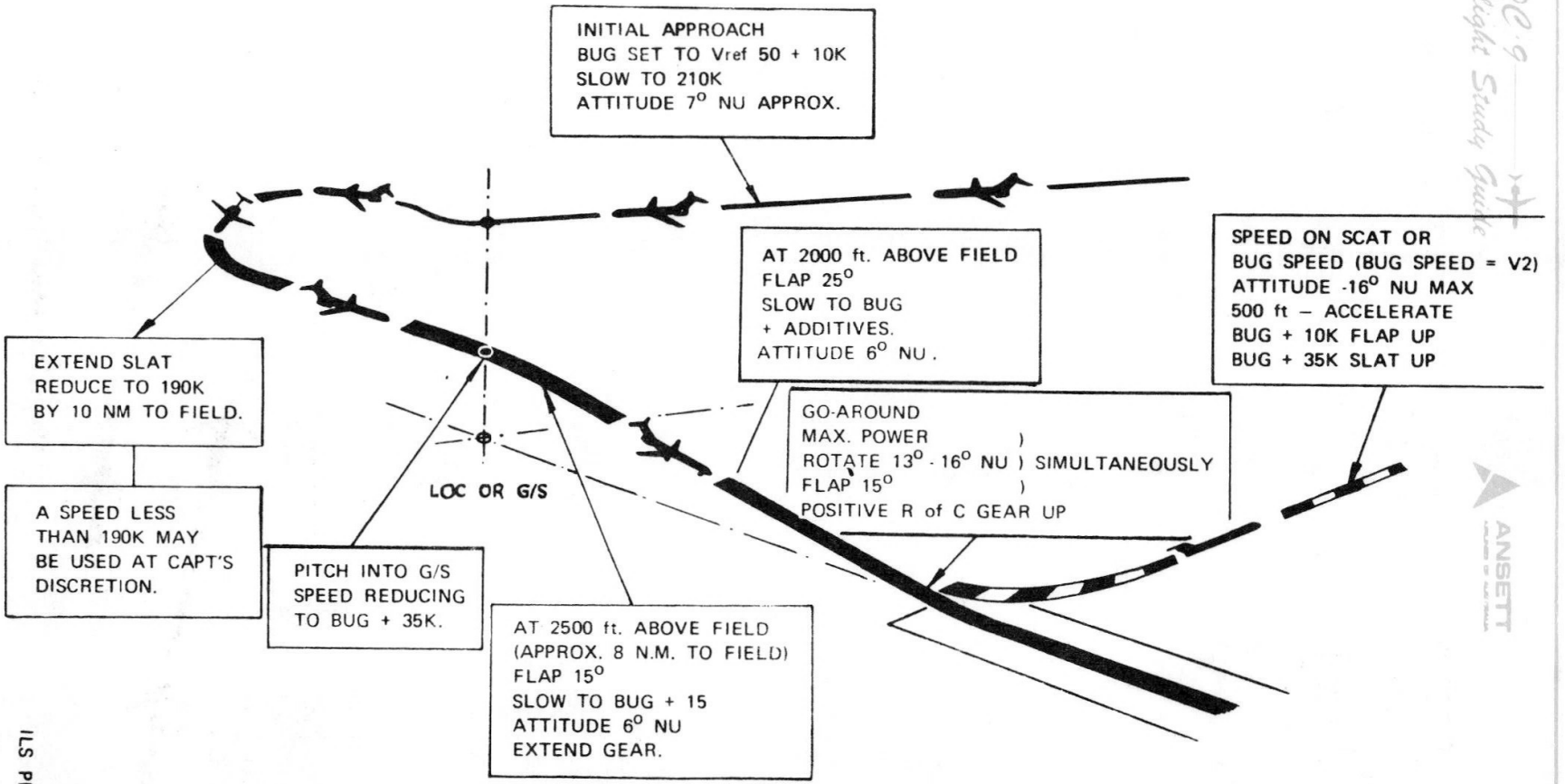
EXAMPLE #2 - SEE ABOVE

When the inbound course is away from the navaid; the fix distance is 28 NM and the leg length is 8 NM, then the end of the outbound leg will be reached when the DME reads 20 NM.

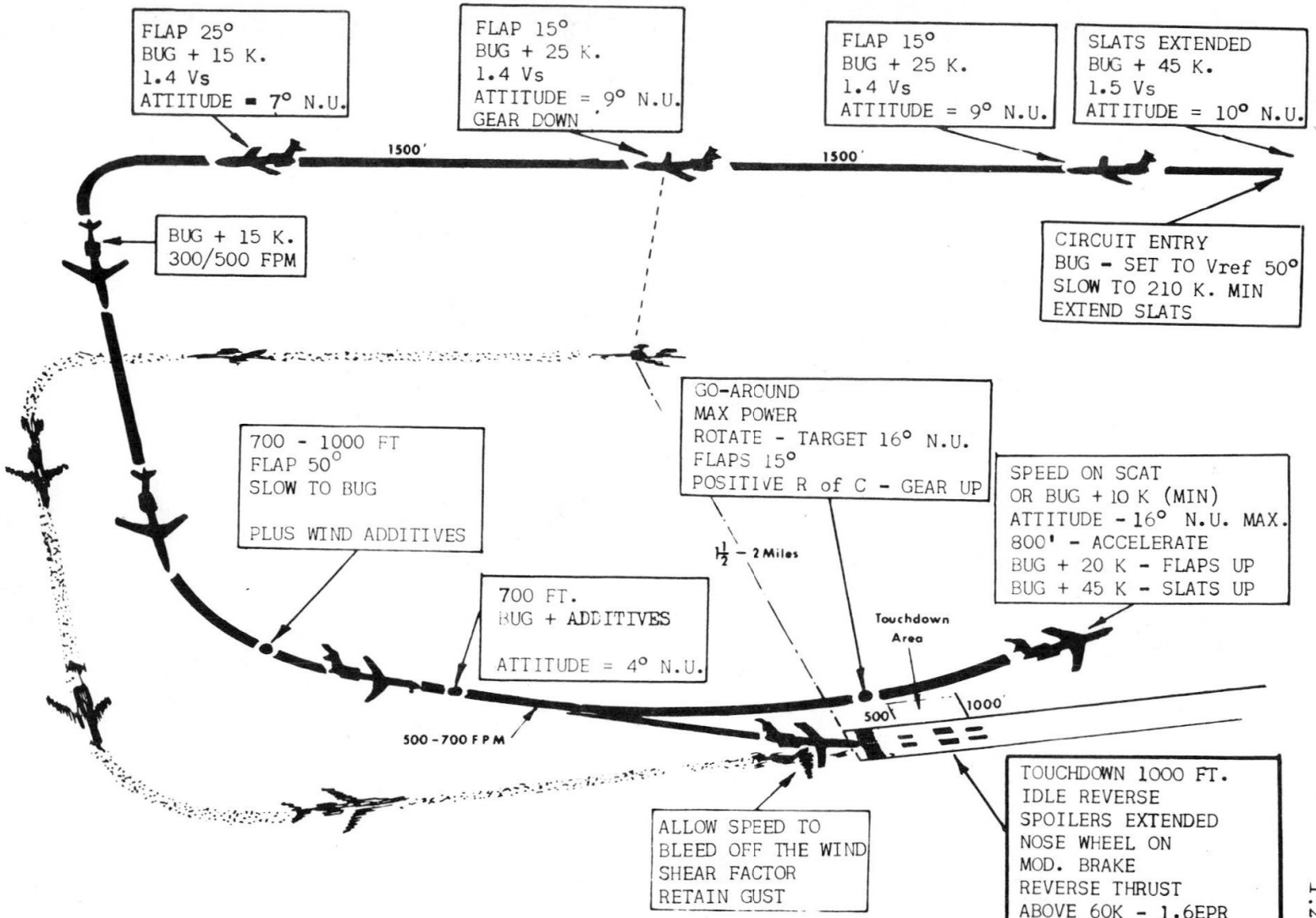


RAPID DESCENT

ILS PROCEDURE 2 Engines

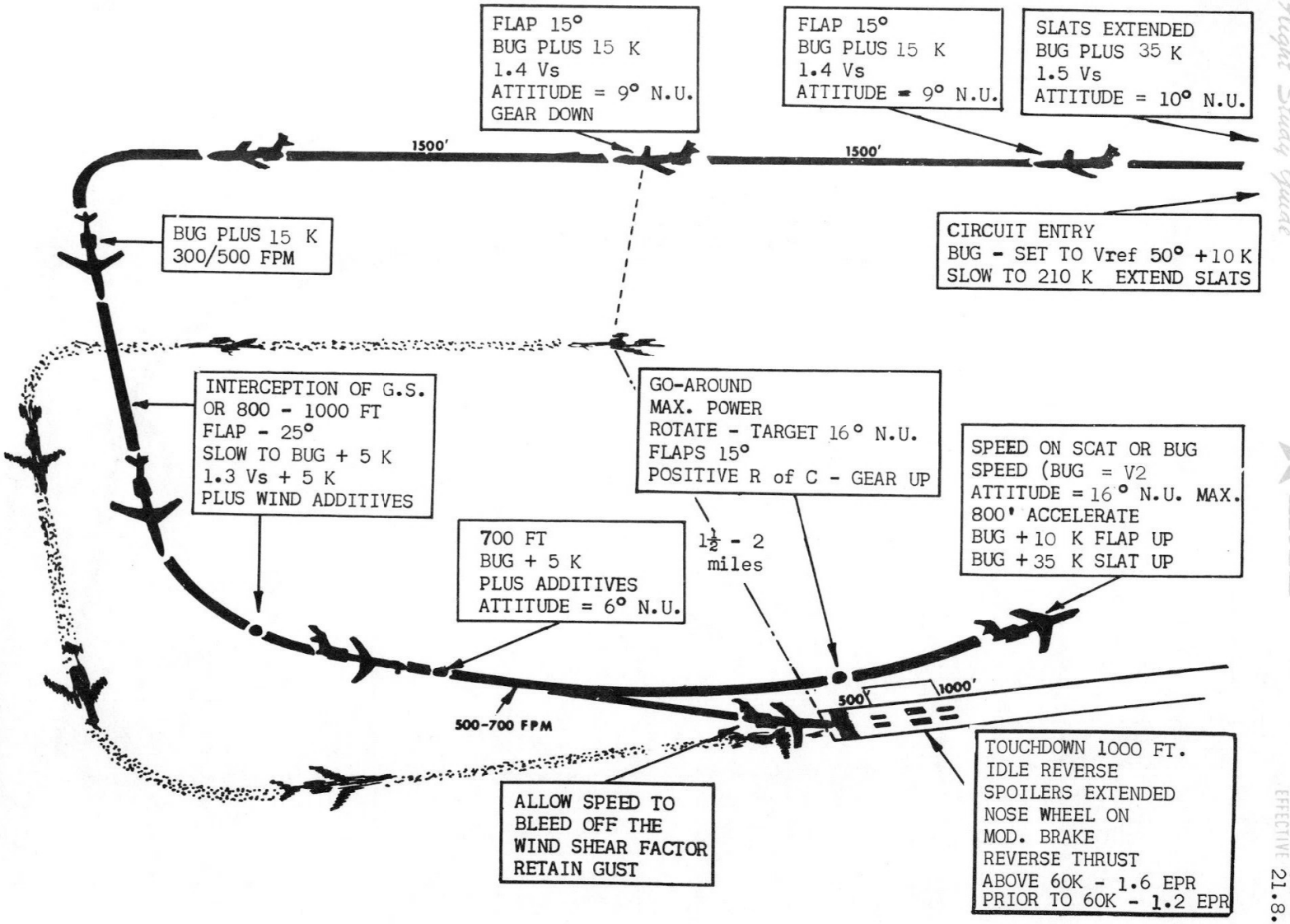


ILS PROCEDURE 1 Engine

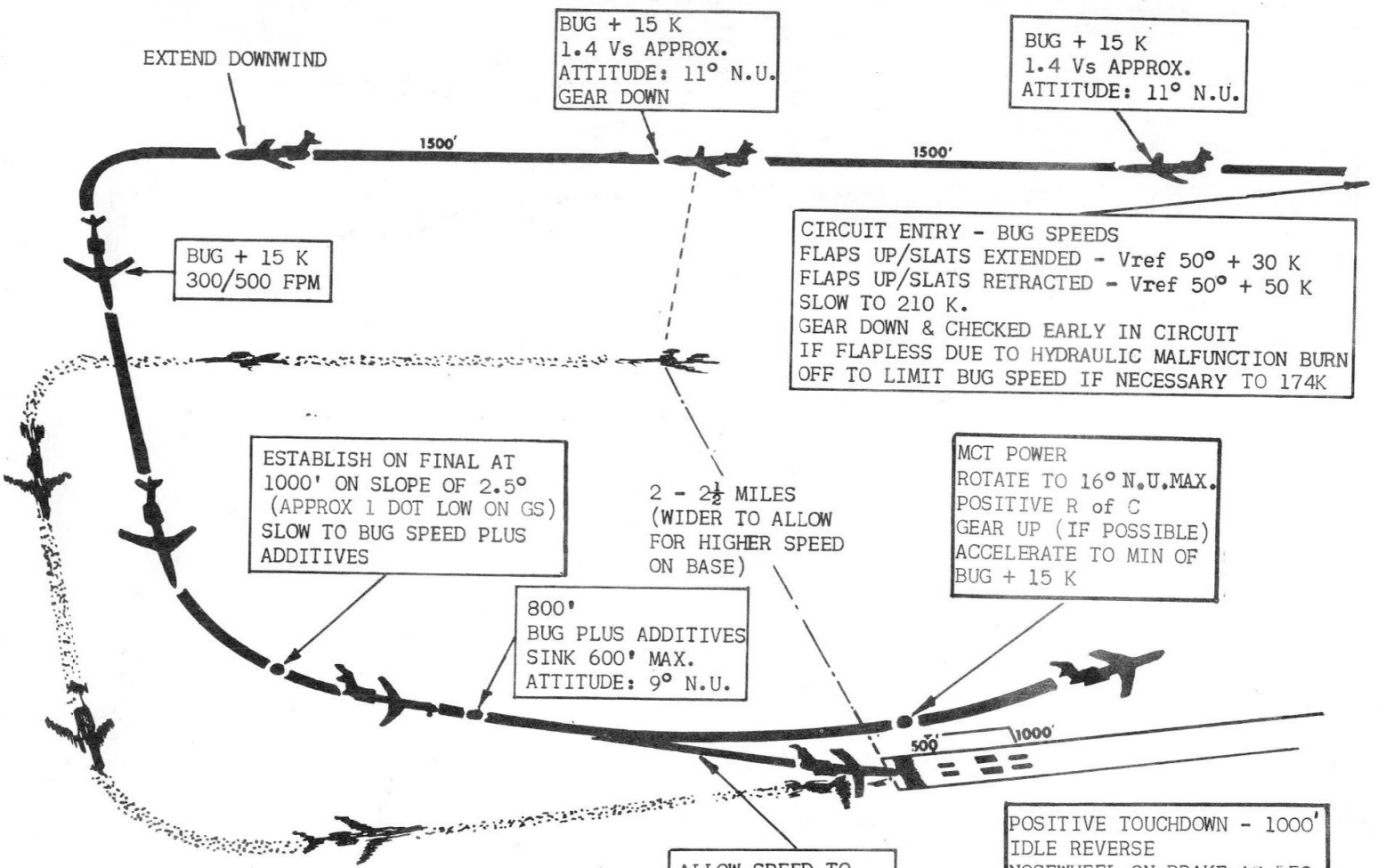


LANDING DIAGRAM: 2 Engines

ANSETT



LANDING DIAGRAM; 1 Engine



LANDING DIAGRAM; No Flap

BULLETIN NO. 3

(Insert to face Page 22 App. 2)

ASYMMETRIC SLATS:

If an asymmetric slat configuration existed, the following flight characteristics would be apparent. At the placard speed of 280 kt IAS if one slat extended while the other remained retracted, an easily controllable roll rate of approximately 15^{o} per second would be experienced. To compensate for this roll rate and asymmetric slat condition the control wheel would have to be displaced approximately 30^{o} in the opposite direction of the extended slat. As the aircraft slowed down the aileron requirement would become less and less until at approximately 150 kt there would be no lateral requirement. The pilot, slowing the aircraft beyond this point would note a reverse aileron requirement. This change in lateral requirement can best be described when one realises that the slat at high speed acts as a canard and at slow speed acts as a high lift device. At all speeds the lateral requirement may be trimmed out with aileron trim. In following the procedure all approach speeds and reference speeds should be increased 25 kt to provide adequate margin over stall. Prior to approach, in order to gain the benefit of flaps without using slats, the Flap/slat handle should be split.

The faster approach speed means that there will be a substantial change in body angle. Instead of being 3^{o} nose-up with slats extended, the pilot will now see approximately 2^{o} nose-down. Adding 25 kt to all of the speeds makes the new V_{REF} speed equal to 1.3 V_{S} 50^{o}/slats retracted.

PROCEDURE

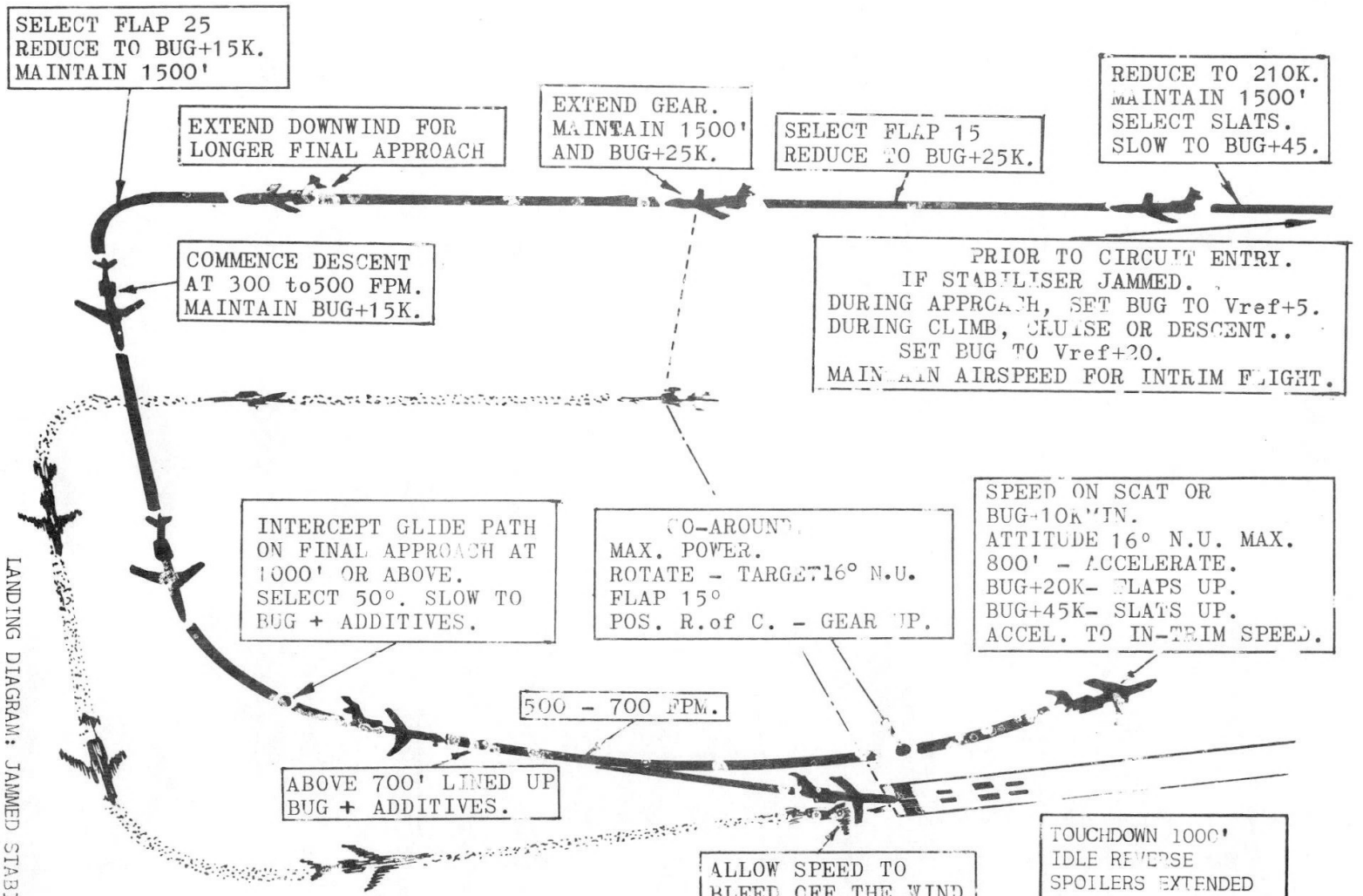
ASYMMETRIC SLAT CONDITION:

If asymmetry in the slats exists as evidenced by slat disagreement light and lateral trim change:

a. The Flap/slat handle should be placed in the position where slats are symmetrical.
b. If the slats are retracted, the flaps may be extended by splitting the Flap/slat handle.
c. Approach and landing speeds should be increased 25 kt to compensate for asymmetric slats or flaps extended/slats retracted configurations.

NOTE: 1. If desired, lateral forces may be trimmed out.
2. A trim reversal will occur at approximately 150 kt.

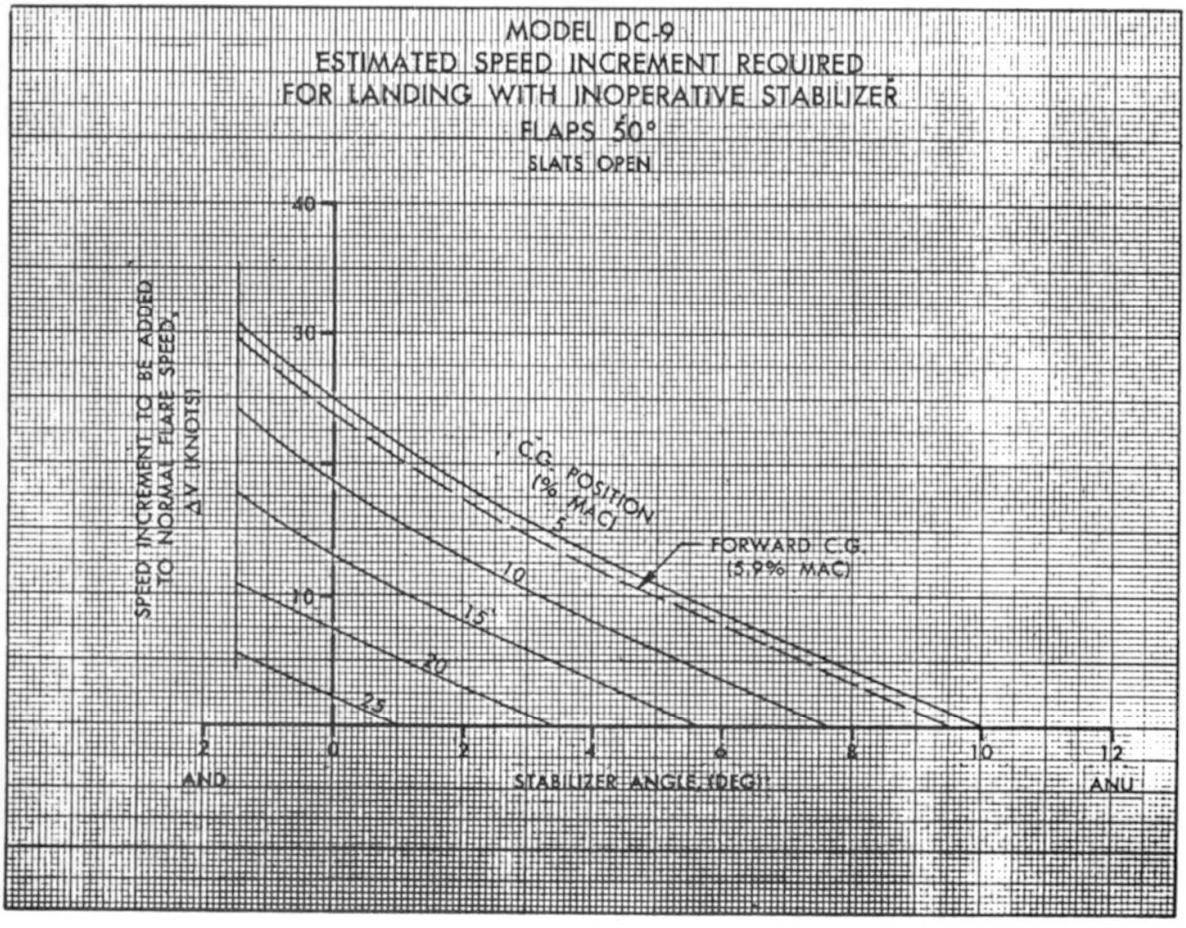
Page 58A of Section 4 in the Operating Manual shows the Asymmetric Slat circuit diagram.



LANDING DIAGRAM: JAMMED STABILISER

INOPERATIVE STABILISER LANDING CHART

NOTE: If the C.G. is known and time and conditions permit, the speed increment for the flare speed may be determined from the curve below.



	TOUCHDOWN POINT		
GLIDE SLOPE	500 FT.	1000 FT.	1500 FT.
2.0° R/D = 626	HT = -1.7	HT = 15.2	HT = 33.2
2.5° R/D = 783	HT = 2.1	HT = 23.9	HT = 45.7
2.75° R/D = 861	HT = 4.3	HT = 28.3	HT = 52.3
3.0° R/D = 940	HT = 6.5	HT = 32.7	HT = 58.9

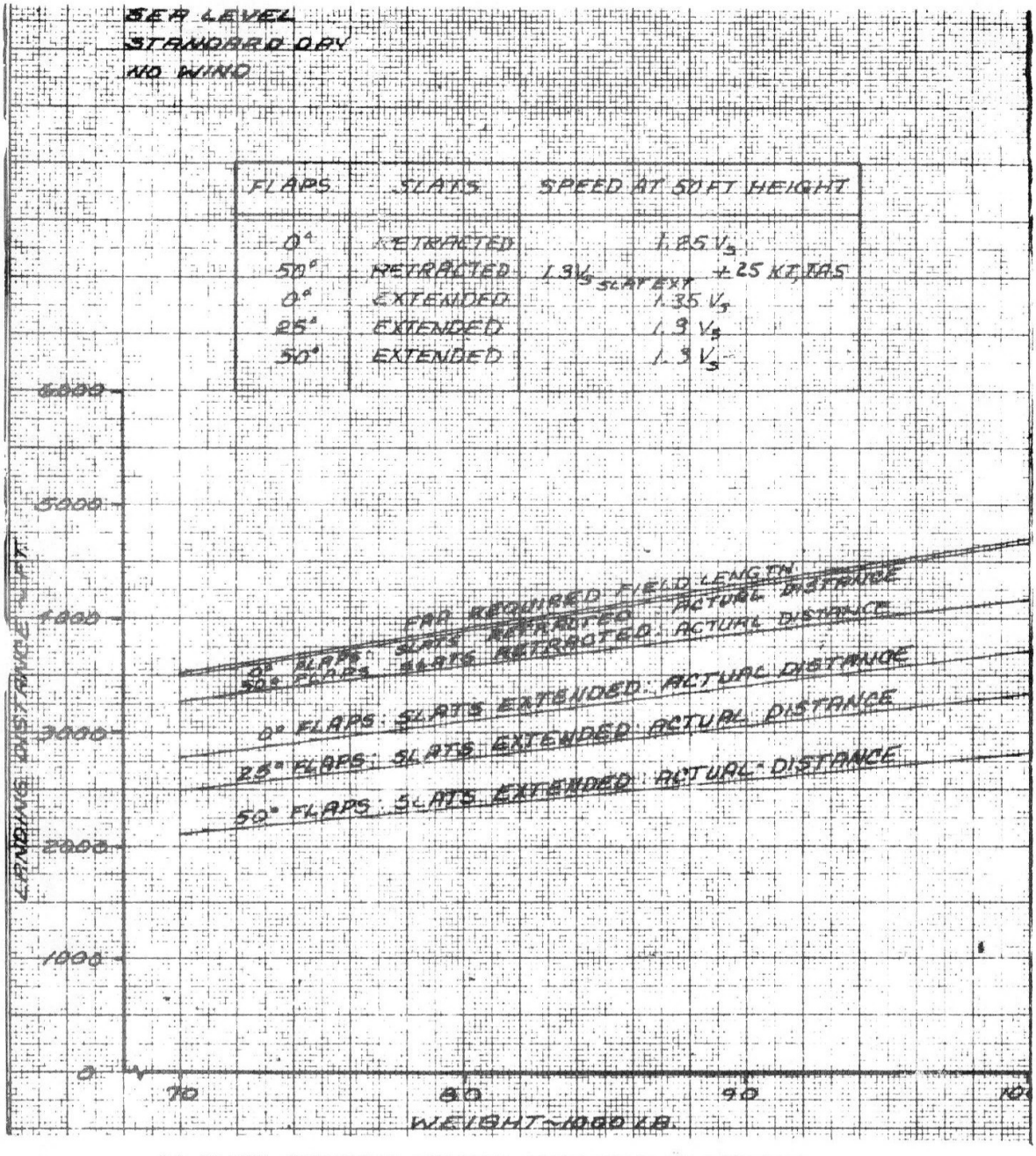
HT = GEAR HEIGHT.

EYE HEIGHT
= 19.7 ABOVE GEAR HEIGHTS. USING 9° BODY ANGLE

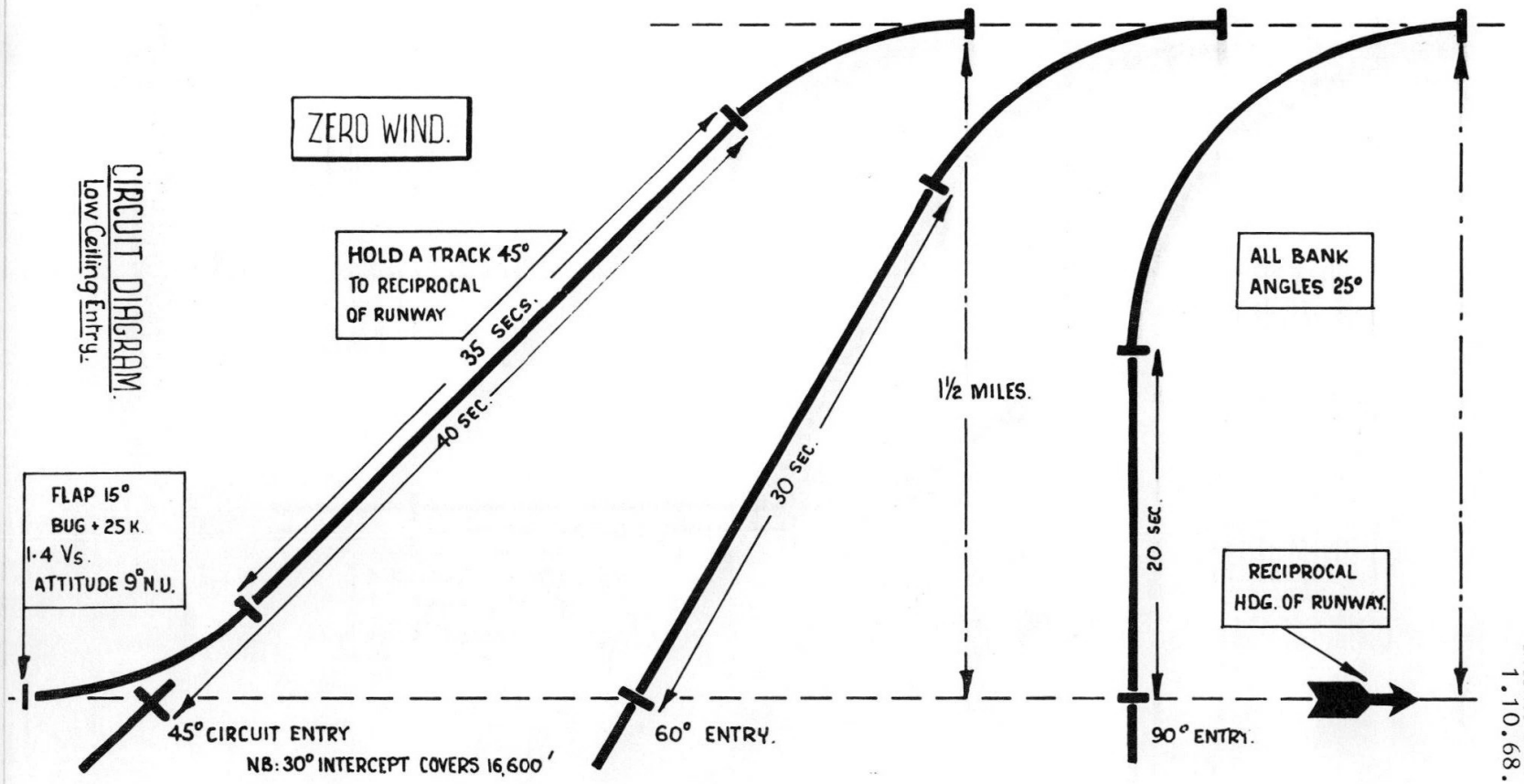
BASIS: VREF = 174 KTS IAS, SL, ISA + 10.

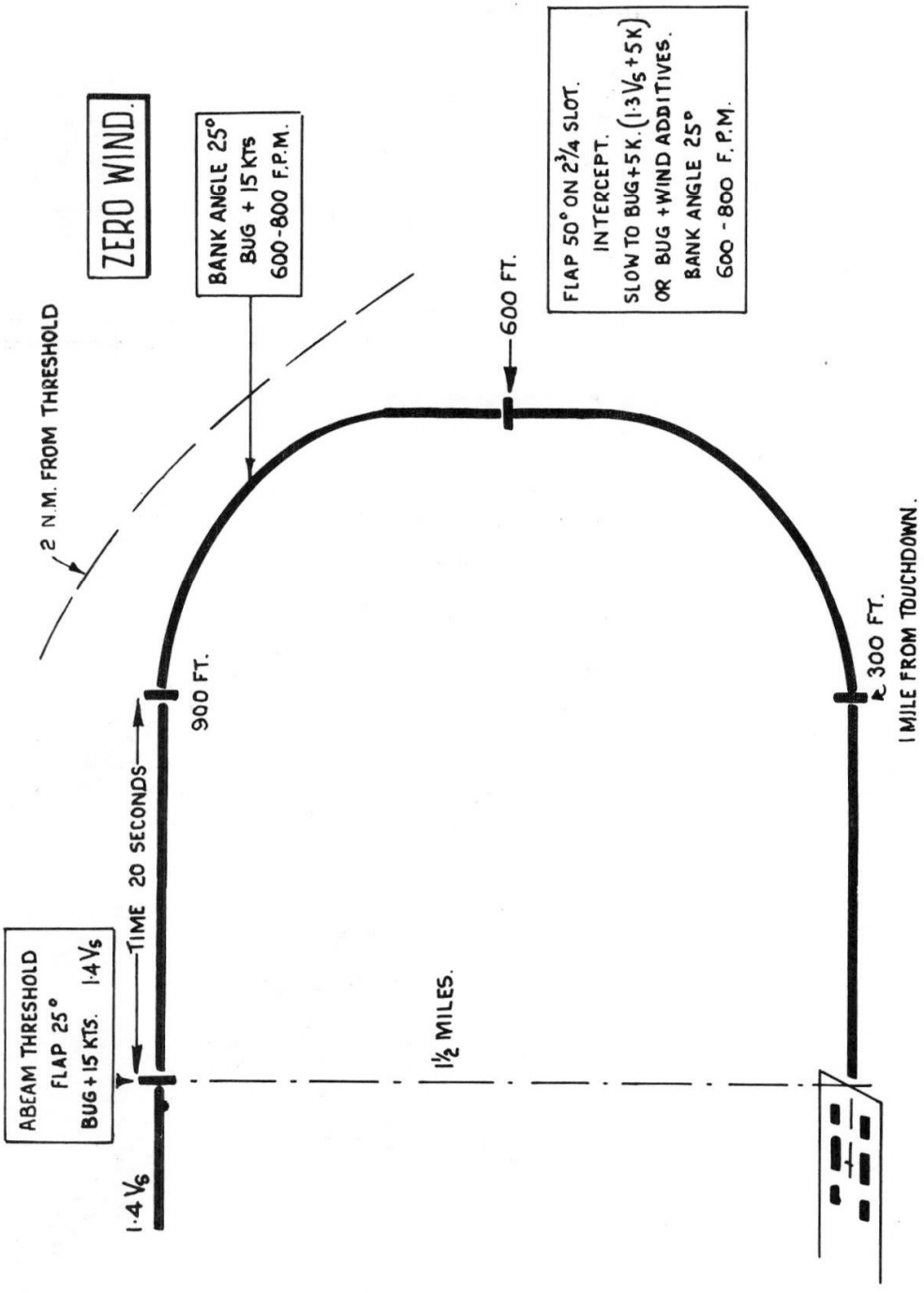
THRESHOLD GEAR HEIGHT FLAPLESS APPROACH

ESTIMATED EFFECT ON LANDING DISTANCE OF REDUCED FLAP ANGLES AND RETRACTED SLATS:



0° FLAPS INCLUDES SPOILER, ANTI-SKID, NO REVERSE.


CIRCUIT DIAGRAM.
Low Ceiling Entry.
ZERO WIND.
HOLD A TRACK 45° TO RECIPROCAL OF RUNWAY
35 SECS.
40 SEC.
FLAP 15°
BUG + 25 K.
1·4 Vs.
ATTITUDE 9° N.U.
45° CIRCUIT ENTRY
NB: 30° INTERCEPT COVERS 16,600'
60° ENTRY.
30 SEC.
1½ MILES.
90° ENTRY.
20 SEC.
ALL BANK ANGLES 25°
RECIPROCAL HDG. OF RUNWAY.



2 ENGINE LANDING DIAGRAM ~ LOW CEILING.

OXYGEN

A person must have supplemental oxygen when flying at pressure altitudes above 10,000 feet for the body to function normally.

It is routine for jet transport aircraft to fly up to 42,000 ft, where the loss of cabin pressure oxygen can become serious to the crews and passengers in a few seconds.

To understand the safeguards and procedures provided for such an emergency, the crews should understand the physiological changes that occur with loss of oxygen, and during a rapid decompression.

The atmosphere is a layer of gas which surrounds the earth, making possible life as we know it. The composition of the atmosphere is relatively constant as follows:

Nitrogen	78%
Oxygen	21%
Carbon Dioxide and rare gases	1%

Nitrogen - This gas is responsible for the major portion of the total atmospheric pressure. The gas itself is useless as far as the human body is concerned. However, under conditions of low pressure this gas may cause serious physiological troubles. Most of us are familiar with the term "bends". These are pains which occur primarily in the joints of the body and are attributed to Nitrogen coming out of the solution whenever the normal pressure around the body is greatly and rapidly lowered. The "bends" rarely occurs with rapid drop in air pressure below pressure altitudes of 25,000 to 30,000 feet and should not be a problem in airline operations.

Oxygen - This odorless gas is essential for life. When the body is deprived of oxygen, serious complications or even death follows a short time later. Each time we breathe, 21% of that breath is oxygen. In the lungs this gas is absorbed into the blood and is carried to all parts of the body and is used to burn or oxidize food material for the production of heat and energy.

Pressure Characteristics of the Atmosphere:

The layer of gas (atmosphere) surrounding the earth is affected by the earth's gravitational pull. We are all familiar with ways we express atmospheric pressure such as 14.7 lbs. p.s.i., 29.92 inches of mercury or 760 millimeters of mercury

Because the absorption of oxygen in the blood is dependent upon the differential pressure inside the lungs, and atmospheric pressure, it is important to remember the density ratio of atmospheric pressure at various altitudes.

OXYGEN: (Cont'd)

Altitude (Feet)	Pressure p.s.i.	Pressure mm Hg.	Density Ratio
63,000	.9	47	1/16
50,000	1.7	87	1/10
45,000	2	111	1/7
38,000	3	155	1/5
34,000	3.6	190	1/4
27,000	5	253	1/3
18,000	7 3	379	1/2
Sea Level	14.7	760	1

At sea level when we take a breath, air fills the lungs because of the lowered pressure inside the lungs created by the lowering of the diaphragm and expanding of the rib cage. The volume inside the lungs is increased and the pressure then decreases. Atmospheric pressure now being greater causes air to flow through the mouth or nose and into the lungs creating a partial pressure of oxygen of about 103 mm of Hg. This is sufficient to cause the O_2 to move across the very thin membranes and over into the blood where it combines with hemoglobin in the red blood cells. As the blood circulates throughout the body, oxygen is supplied to all the cells.

If one ascends to a pressure altitude of 18,000 feet, ambient air pressure is only 1/2 that at sea level. The partial pressure of oxygen in the lungs is about 1/2 normal and the person will suffer from lack of oxygen. This deficiency of oxygen to the body cells is known as hypoxia. Since the brain cells are first affected, followed very closely by the eyes, one's ability to perform normally deteriorates rapidly. Some of the more common signs and symptoms of hypoxia in a normal person at different altitudes, and the percent of arterial blood oxygen saturation are shown in the following table:

SIGNS AND SYMPTOMS OF ALTITUDE HYPOXIA IN A NORMAL PERSON

Altitude (Feet)	Arterial O_2 Saturation %	Clinical Condition
Sea Level	95-98	Normal
10,000	88-90	Headache - Fatigue on long exposure
14,000	80-81	Sleepiness - Headache - Dizziness - Vision impaired - Personality changes - Loss of muscular coordination - Cyanosis (blueing of fingernails)
18,000	74-75	All of above, only more marked.
22.000	67-68	Convulsions; Collapse and coma
25,000	55-60	Collapse and coma in about 5 minutes

At higher pressure altitudes the time of useful consciousness (T.U.C.) is quite brief, T.U.C. may be defined as that time that one can do something for himself, such as properly fitting his oxygen mask, turning on oxygen regulators, etc.

OXYGEN: (Cont'd)

The following table shows T.U.C. at various altitudes. These times were arrived at by studying thousands of cases of military personnel in altitude chambers. They show average T.U.C. at each altitude when the O_2 mask was removed, under conditions of rest, moderate activity, and rapid decompression.

TIMES OF USEFUL CONSCIOUSNESS AT VARIOUS ALTITUDES

Altitude (Feet)	Sitting Quietly	Moderate Activity	Rapid Decompression (at rest)
22,000	10 minutes	5 minutes	3 minutes
25,000	5 minutes	3 minutes	2 minutes
30,000	1½ minutes	45 seconds	30 seconds
35,000	45 seconds	30 seconds	20 seconds
40,000	25 seconds	18 seconds	12 seconds

These are average T.U.C's. One's tolerance to hypoxia varies considerably from time to time. Intake into the lungs of carbon monoxide from excessive smoking, or other sources, greatly reduces available oxygen to the body tissue. Alcohol in the system, even though consumed as long as up to 18 hours previously, poisons the body cells and interferes with the utilization of oxygen. Fatigue lowers one's tolerance. The athletic, physically fit individual has a markedly higher altitude tolerance than the overweight person. O_2 consumption of the overweight non-athletic person is also greater during periods of stress

An average person in reasonably good physical condition will recover rapidly from hypoxia when an abundance of oxygen is supplied. Such an individual, on the threshold of unconsciousness, may regain his full faculties within 20 - 30 seconds.

Rapid Decompression:

In any pressurized aircraft, there is a remote possibility of a rapid loss of cabin pressurization through a rupture in the aircraft structure. The rate of decompression depends on: cabin volume, size of the opening, pressure differential and altitude.

Although there may be unaccustomed noise, fogging in the aircraft due to rapid cooling of the air, an out-rushing of air in the lungs or other rather abnormal conditions associated with a rapid decompression, the most critical need after a decompression is Oxygen. The fact that susceptibility to hypoxia is increased by some 30% to 50% due to rapid decompression serves to dramatize the critical need for O_2 immediately.

In cases of an extremely rapid decompression (explosive decompression) there is a possibility of lung damage due to over distention of pulmonary tissue, falling of blood pressure, and slowing of heart rate.

Crew Oxygen Equipment:

An automatic Diluter Demand Oxygen Regulator panel at each crew station provides supplemental breathing oxygen from sea level to a cabin altitude of 42,000 feet.

OXYGEN: (Cont'd)

The oxygen supply lever on the oxygen regulator panel controls the oxygen supply to the regulator. The lever has ON-OFF positions and must be placed in an ON position to provide flow through the regulator.

The Regulator Diluter Lever on the oxygen regulator has 100% oxygen and Normal positions. With the lever in the Normal position the regulator automatically supplies, upon demand, a correct mixture of cabin air and oxygen normally needed at any cabin pressure altitude up to 30,000 ft. As the cabin altitude increases, the pressure sensing Aneroid in the regulator opens the oxygen port and closes the cabin air port to provide a greater percentage of O_2 to air. At about 30,000 feet the cabin air intake port will close completely and the regulator will supply, upon demand, 100% O_2 up to 42,000 feet regardless of the position of the diluter lever.

When the Regulator Diluter Lever is placed in the 100% oxygen position the cabin air intake port is closed off and the regulator will deliver, upon demand, 100% O_2 at any cabin altitude.

In case of smoke, noxious fumes, or obnoxious odors in the aircraft, or if the pilot feels airsick, or recognizes symptoms of hypoxia, the Diluter Lever should immediately be placed on 100% oxygen at any cabin altitude up to 30,000 feet. Above 30,000 feet cabin pressure altitude the regulator will automatically supply 100% oxygen to the mask regardless of the position of the diluter lever so long as oxygen is turned on at the regulator.

Some aircraft are fitted with Pressure Demand Regulators. Up to 30,000 feet it works as a diluter demand regulator. Above 30,000 feet cabin pressure this regulator delivers 100% O_2 continuously under slight pressure as an added safety factor.

The Emergency Lever on either O_2 regulator has EMERGENCY and NORMAL positions. With the lever in the EMERGENCY position a continuous flow (not on demand) of O_2 is provided at any cabin pressure altitude. Thus, an abundance of oxygen is supplied for an emergency such as poor mask fit, hypoxia, rapid decompression, shock, etc.

With the Oxygen Supply Lever of either regulator turned ON, O_2 will flow through the regulator without the crew member inhaling only when the Emergency Lever is placed in EMERGENCY, or also in the case of Pressure Demand Regulator when the cabin pressure reaches approximately 30,000 ft there will be a continuous flow of 100% O_2.

OXYGEN: (Cont'd)

Factors Influencing the Time of Safe Unconsciousness (TSU) for Commercial Jet Passengers Following Cabin Decompression:

A review of the need for passenger emergency oxygen for cabin decompressions is worthy of detailed analysis from a physiological point of view. Statistical analysis of the result of past decompressions in aircraft is not sufficient to make the decision to eliminate emergency oxygen. In performing such an analysis, many physical and physiological variables must be considered. The Time of Useful Consciousness (TUC) and the time it takes to becoming unconscious are guidelines that have been used in the past for flight crew members. These criteria are not applicable to the passengers situation. The analysis delineates and discusses those factors involved in determining a Time of Safe Unconsciousness (TSU) permissible for passengers after cabin decompression. Simply stated, the degree of hazard is directly proportional to the time the passenger is unconscious from lack of oxygen.

As a practical consideration, high altitude aircraft may not require passenger emergency oxygen. A decision in this matter cannot be based only on statistical analysis of the results of past aircraft sudden decompressions. To effect a valid decision, detailed physiological analysis, with emphasis on the passenger, are required. Many variables must be considered while performing the necessary analysis. Basically, the variables can be divided into two catagories: physical and physiological. In addition to facilitating a decision on the basic problem, these studies should point to a quick reference guide for passenger safety to be used by the flight crew in the event of sudden decompressions.

Discussion

A study to establish a Time of Safe Unconsciousness for passengers requires detailed consideration of physical and physiological variables. The physical variables, not necessarily in the order of importance are:

1. Rate of decompression.
2. Maximum cabin altitude.
3. Rate of aircraft descent.
4. Rate of cabin descent.
5. Elapsed times above certain altitudes.(i.e. 33,000 feet, 25,000 feet, 15,000 ft)
6. Final cruise altitude prior to landing.
7. Elapsed time between critical altitudes and the return to a "recovery" altitude.

The latter will vary as a function of the first six.

The physiological variables are:

1. Changing partial pressure of oxygen in the atmosphere, alveoli, blood, and cells.

OXYGEN: (Cont'd)

2. Time spent in a critically hypoxic atmosphere.
3. Partial pressure of oxygen at the final cruise altitude following descent.
4. Time to recovery of consciousness following unconsciousness due to hypoxia.

The criterion used in the past in trying to make the decision to eliminate passenger emergency oxygen has been the standard curves used to depict the Time of Useful Consciousness (TUC), Figure 1, for air crews who must perform a task in the aircraft, whether it is military or civilian. The passenger in a commercial jet is not performing an operational task. Therefore, the TUC curve need not and should not apply for passengers. Rather, the Time to Unconsciousness, although also inadequate, would be a more suitable guide for use by carriers and manufacturers in determining the seriousness of the hazard to the passenger, Figure 2, Curve C. The standard TUC curve should apply only to the flight crew. It is well known that hypoxia due to decompression to high altitudes brings on unconsciousness more rapidly than merely removing one's oxygen mask at the same equilibrium altitude. It is important, therefore, to consider not only how long it takes a passenger to become unconscious, but also how long he is unconscious. For this reason, a new criterion is needed, and it is suggested that this can be called the Time of Safe Unconsciousness following decompression. It is also well known that short periods of unconsciousness due to hypoxia can be well tolerated, but that longer periods are intolerable Exact information as to how long this type of unconsciousness can be safely tolerated is not available because of the wide variability in individual tolerances and other factors, such as temperature.

A more accurate rule-of-thumb for safe exposure to decompression might be the time the cabin altitude is above a given level. Most subjects who have been exposed in altitude chambers can tolerate several minutes of hypoxia at altitudes up to 25,000 feet without becoming unconscious. Below 25,000 feet is considered relatively

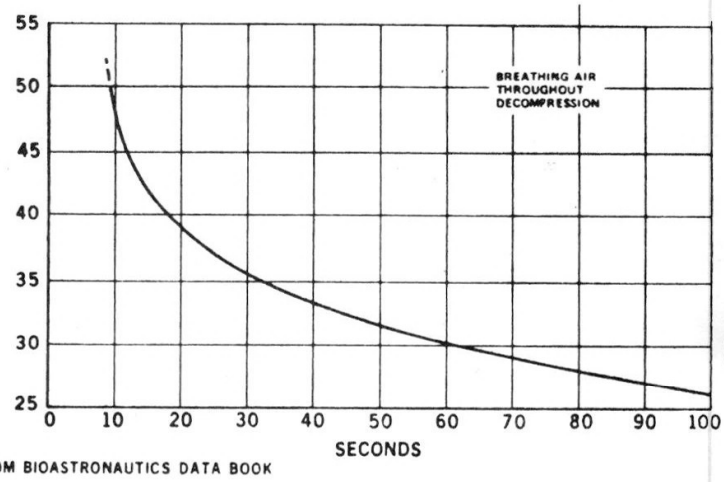


Fig. 1. Time of useful consciousness (TUC)

OXYGEN: (Cont'd)

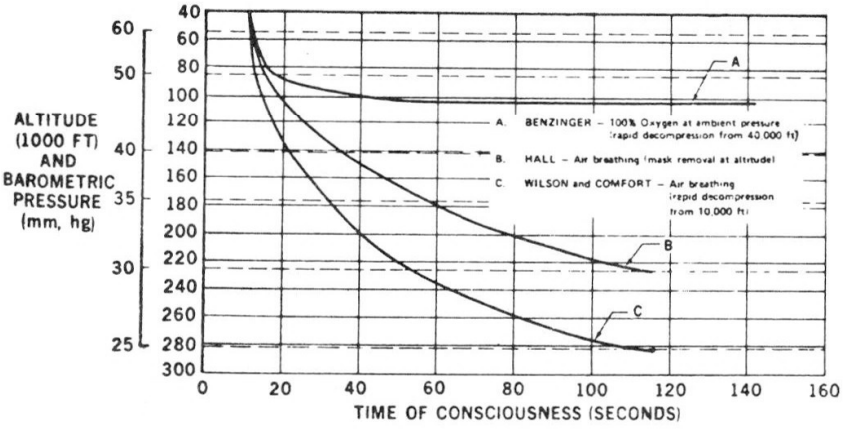


Fig. 2. Time of consciousness with varying types of exposure at high altitude.

safe without becoming unconscious. Also, below this altitude is considered relatively safe with regard to the syndromes of dysbarism such as bends, chokes and neuro-circulatory collapse. Although these conditions have been known to occur below 25,000 feet, they are not common below this level. Therefore, a better set of criteria for passenger safety would consider the following factors:

1. Rate of decompression,
2. Maximum cabin altitude, or equilibrium altitude.
3. Time cabin is at maximum altitude.
4. Time cabin altitude is above 25,000 feet.
5. Rate of descent.
6. Final altitude.

These factors can be plotted on a graph indicating altitude and time. Simply stated, the degree of hazard is directly proportional to the time the passenger is unconscious, which is a function of the factors listed above. The safe altitude after a given decompression event is a function of the severity of the deprivation or loss of oxygen from the body, or the hypoxidosis. This is also determined by the six factors above. Whenever the partial pressure of oxygen in the atmosphere is reduced to a level below that in the lungs and blood, the oxygen flow in the lungs will be reversed; that is, oxygen will diffuse from the pulmonary capillaries to the alveoli and will be lost to the atmosphere during expiration. When the atmospheric partial pressure of oxygen is lower than that in the blood, oxygen will not be absorbed on inspiration. This reverse diffusion will continue until equilibrium is established between the atmosphere and the blood. The rate of reverse diffusion is dependent on the atmospheric partial pressure of oxygen, which in turn, is dependent on the maximum altitude change above 33,000 feet. Time to unconsciousness and time of unconsciousness will depend on the magnitude of the

OXYGEN: (Cont'd)

oxygen loss from the blood. The rapidity and degree of recovery of adequate blood oxygenation will depend on the partial pressure of oxygen in the atmosphere of the aircraft as it descends and after it levels off following descent.

If the maximum cabin altitude during decompression is 35,000 feet or more, it is questionable whether passengers would survive the hypoxia without brain damage if the aircraft levels off at 15,000 feet after descent. At 15,000 feet the partial pressure of oxygen is less than 90 mm. Hg. After the severe loss of oxygen from the blood that would occur in the first two minutes after cabin altitude is exceeded 35,000 feet, it is questionable whether this partial pressure of

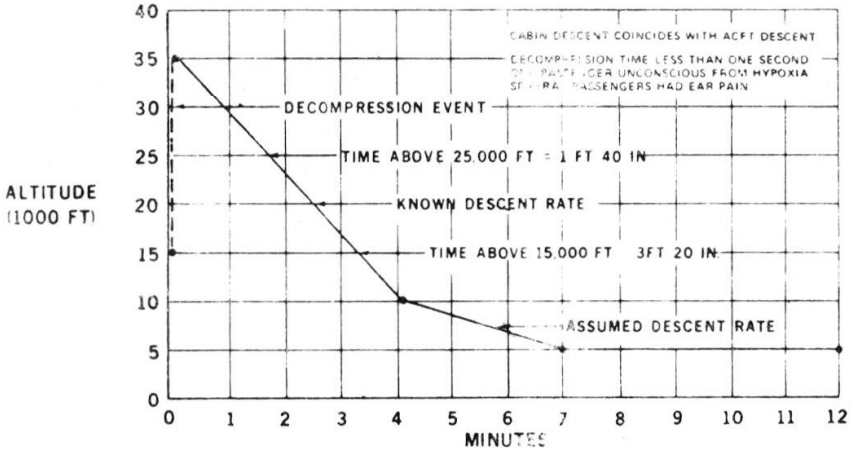


Fig. 3. Cabin altitude profile.

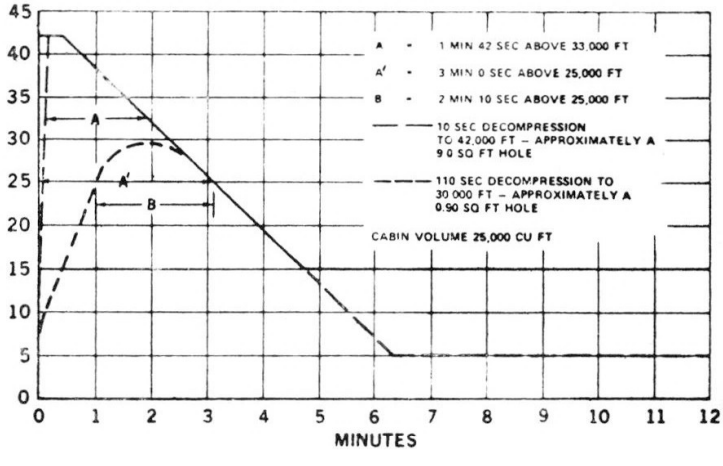


Fig. 4. Critical altitude vs. time.

OXYGEN: (Cont'd)

oxygen would suffice for complete and unharmed recovery. For these reasons, in a decompression occurring from an 8,000 feet cabin altitude, it is desirable and mandatory that the cabin altitude be maintained below 25,000 feet, or permitted to exceed that level for only a minute or two before descending below this altitude.

The higher the maximum altitude above 25,000 feet, the more critical is the need to descend more rapidly. If above 25,000 feet too long it will be necessary to descend below 15,000 feet, perhaps as low as 5,000 feet, and to land as quickly as possible. The interactions of the variables involved make it quite difficult to determine exact criteria. If the cabin altitude, however, does not at any time exceed 25,000 feet, and a normal descent is made to 12,000 feet, this profile may be adequately safe. Twenty-five thousand feet may be considered as a critical altitude when a subject ascends to and remains at that altitude. If decompressed to higher altitudes, this "safe" level may no longer be considered as such because the recovery time after receiving "adequate" oxygen found at 15,000 feet may be too long to be safe. There can always be exceptions in the case of cardiopulmonary disease and other pathophysiological factors which enter into the determination of individual safety among passengers. The analysis of passenger health performed for the supersonic transport revealed that approximately 10 percent of the passenger list would be affected by potentially significant cardiorespiratory disease.

Figure 3 shows an example of the method of estimating the times that a decompressed cabin is above certain critical altitudes. In this actual case, all passengers survived with only relatively minor effects. The time history explains why. It should be noted that the rate of descent was more rapid than "normal" and that the final altitude of 5,000 feet provided adequate oxygenation for rapid recovery of the one unconscious passenger. By plotting other known decompression events in a similar matter a data bank can be accumulated which eventually would make it possible to judge the average TSU for any given decompression event. Such events can then be related to pressure system failures of different origins and time histories and whether that decompression event and recovery will be within the tolerable limits of the TSU.

Figure 4 shows two theoretical examples of an aircraft cruising at 42,000 feet, with a 25,000 cubic foot cabin decompressed from 8,000 feet altitude as a result of hole sizes of approximately 9.0 sq. ft. and 0.90 sq. ft. respectively. The more rapid decompression (to 42,000 feet) could be quite serious for any passenger without oxygen, whereas the slower decompression is most likely survivable without physiological damage even though the aircraft should level off at 15,000 feet. Following the rapid decompression to 42,000 feet, aircraft should descend to 5,000 feet for final cruise altitude for adequate recovery of unconscious passengers, terrain permitting.

XYGEN: (Cont'd)

In all examples, a constant or average rate of descent has been assumed. In figure 4, a 10-second decompression plus a 17-second pilot reaction time has also been assumed.

The cabin stay time above certain altitudes (e.g., 25,000 feet) can be obtained mathematically for a very rapid decompression, if one assumes a constant rate of descent, by using the formula:

$$T_{25} = \frac{H_o - H_{25}}{\bar{R}}$$

where $\bar{R}$ is the constant rate of descent, H_o is the cruising altitude of the aircraft, and H_{25} is 25,000 feet.

Where the decompression is slow (Figure 4,B) the time above 25,000 feet may be solved for by using the equation.

$$T_{25} = T_2 - T_1$$

where

T_{25} = time cabin is above 25,000 feet
T_1 = time required for the cabin to reach 25,000 feet from the start of the decompression
T_2 = time the aircraft is above 25,000 feet.

If sufficient data are available for a given decompression event, the cabin altitude profile can be plotted, and the T factors can be read directly from the graph.

The rate of descent for an aircraft is a function of time. Therefore, by using realistic values for descent rate, initial altitude prior to descent, hole size, etc., the time above other critical altitudes (e.g. 15,000 feet) can be determined. Also, if these values are known or assumed the descent time to an adequate recovery altitude can be solved for and specified. If the specified time cannot be met by a particular aircraft because of structural damage or other reason, the passengers must rely on an emergency oxygen system for survival without physiological damage.

Conclusion

In the event of an aircraft cabin decompression, it is suggested that a quick-reference guide for pilots to determine the safety of passengers be established as the time the cabin is above 25,000 feet. altitude. A relatively safe time may be considered as 1 minute and 40 seconds to 2 minutes. The passengers may become unconscious due to other influential factors such as decompression rate, maximum cabin altitude, rate of descent, and final cruise altitude. To be more accurate in determining the TSU, these factors must all be considered, assuming healthy passengers.

The preceding information is reproduced to indicate the time available to the crew at altitude. This time is partially utilised when following the Company procedure of attempting to correct a condition of rapid decompression before initiating the descent.

Operation at 25,000 feet and below, allows a more deliberate operation in respect to correction of the problem, clearance off the air route by A.T.C., initiation of the descent and rates of descent.

The information is based on operation without an automatically presented oxygen supply system such as that carried on all jet public transport aircraft. It assumes that passengers do not take oxygen at any time when depressurised. In Company jet aircraft, passengers would be taking oxygen and therefore it should not be necessary to descend to such low altitudes as stated in the article.

Insert following Appendix 3

DC9-10 SIMULATOR PROCEDURES

In order to permit the use of the same V_2 and Vref additives in the DC9-10 simulator as will be used in the series 30 aircraft, the following procedures have been devised:

1. The series 10 aircraft has flap settings of 10°, 20°, 30° and 50°. In training these positions can be substituted for the series 30 aircraft flap positions as follows -

   (a) 10° flap position = leading edge slats extended
   (b) 20° flap position = 15° flap/slats extended
   (c) 30° flap position = 25° flap/slats extended
   (d) 50° flap position = 50° flap/slats extended

   In approach to land the following procedures can be used on the series 10 simulator -

   (a) At 210K extend 10° flap (equivalent to L.E. slats extended on series 30 aircraft, and slow to bug + 45K)

   (b) Extend 20° flap equivalent to 15° flap/slats extended on series 30 aircraft (and slow to bug + 25K)

   (c) Extend 30° flap equivalent to 25° flap/slats extended on series 30 aircraft (and slow to bug + 15K)

   (d) Extend 50° flap (and slow to bug + 5K)

   The bug is to be set to the series 10 aircraft Vref 50° or, if on single engine, to Vref 50° + 8K.

These speeds and flap settings will result in a speed of 1.4 V_S in the various flap positions, which is very close to the function of the stall which applies on the series 30 aircraft, but will result in a pitch attitude about 4° less than that which applies on the series 30 aircraft - that is, approximately 5° rather than 9° nose up when level flying, and level attitude on approach to land rather than 4° nose up.

In training the student should call for the series 30 flaps position and the flaps should then be set to the series 10 equivalent. i.e. When the student calls for "leading edge slats extended" the flap should be extended to 10°.

For takeoff a similar procedure can be adopted -

(a) All takeoffs will be made in the simulator with the flap set to 20° which is the equivalent in series 30 aircraft of the 15° flap/slats extended position.

(b) As for landing the 10° flap position would be equivalent to the flaps up/slats extended position.

(c) For takeoff set the bug to the series 10 V_2 speed.

(d) After takeoff accelerate to V_2 + 15K and retract flaps to 10° (equivalent to flaps up/slats extended on series 30 aircraft)

(e) Accelerate further to V_2 + 40K and select flaps up (equivalent to flaps up/slats retracted on the series 30 aircraft)

As with approach to land calls should be for the series 30 equivalent flap position.

V_2 + 15K and flap retracted to 10° equals 1.26 V_S.

V_2 + 40K and flap retracted to zero equals 1.35 V_S.

DC9 series 10 V_2 plus Vref 50 speeds (K)

G.W.	VR	V_2	Vref	G.W.
60	110	117	114	60
65	115	122	119	65
70	121	127	123	70
75	127	131	128	75
80	132	135	132	80
85	137	139	136	85
90	141	143	140	90