

737 FLIGHT PATTERNS

GENERAL

Flap Usage

For takeoffs, when conditions permit, consider the use of flaps 5, 10, 15 or 25 to provide additional aft body clearance and shorter takeoff distance. For landings, when conditions permit, use flaps 40 to minimize landing distance and landing speed. Most operators, however, use flaps 30 for lower noise levels and fuel savings.

Fixed Flap-Speed Schedule/Maneuvering Speeds

The flap maneuvering speed schedule provides the recommended maneuvering speed for various flap settings. When recommended procedures are followed, the schedule provides adequate buffet margin for an inadvertent 15 degree overshoot beyond the normal 30 degree bank. The flap maneuvering speeds are shown in the table below.

The flap maneuvering speed schedule varies as a function of gross weight and will provide adequate maneuver margin above stall at all weights. The schedule provides speeds which are close to minimum drag and in climb are close to maximum climb gradient speed. In level flight it provides relatively constant pitch attitudes and requires little change in thrust at different flap settings.

Flap Position	B737-200	
	At & Below 117,000lbs (53,070 kgs)	Above 117,000 lbs (53,070 kgs)
Flaps Up	210 knots	220 knots
Flaps 1	190 knots	200 knots
Flaps 5	170 knots	180 knots
Flaps 10	160 knots	170 knots
Flaps 15	150 knots	160 knots
Flaps 25	140 knots	150 knots

During flap retraction/extension, selecting the next flap setting should be initiated when reaching the maneuver speed for the existing flap position. Normally the airplane should be accelerating when flaps are retracted to the next position.

Acceptable maneuver margin is, however, retained at a speed 20 knots below the recommended speed.

Flap Retraction

Acceleration Height - All Engines

The altitude selected for acceleration and flap retraction may be specified for each airport. Safety, obstruction clearance, airplane performance or noise abatement requirements are usually the determining factors. Some airlines have adopted a single climb profile for all of their operations based on the field which requires the greatest height for level-off to clear a close-in obstacle with an engine failure.

The minimum altitude for flap retraction is 400 feet or the engine out obstacle clearance height. Boeing has chosen 1000 feet as the standard flap retraction altitude used in training. This altitude is consistent with most world-wide noise abatement procedures.

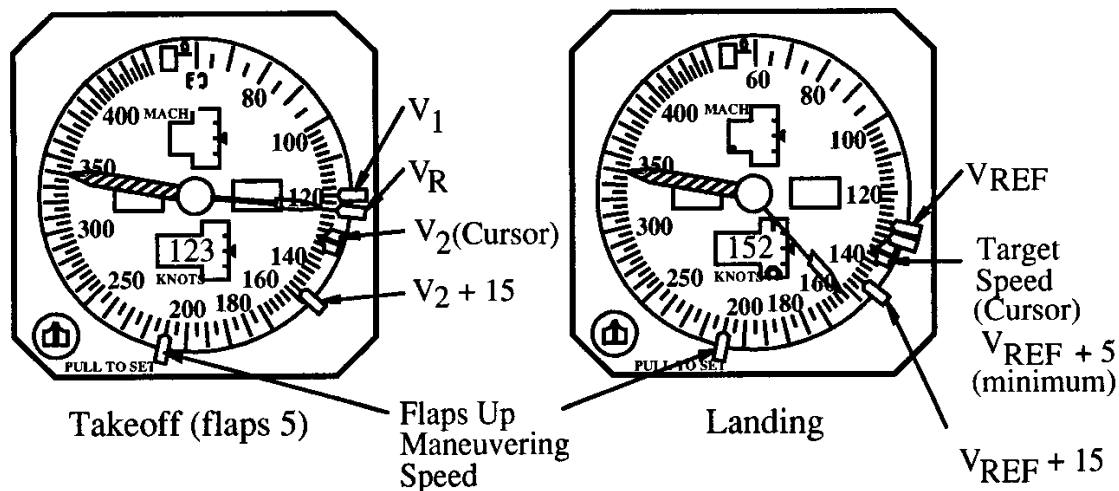
Acceleration Height - Engine Out

Acceleration height for a takeoff with an engine failure after V₁ is based on accelerating to the recommended flaps up speed using takeoff thrust while retracting flaps. Maximum continuous thrust must be selected within five minutes after initiating takeoff. Some combinations of high gross weight, takeoff flap selection and airport elevation may require initiating flap retraction as low as 400 feet after takeoff with an engine failure.

At typical training weights, adequate performance exists to climb to 1000 feet before beginning flap retraction. Therefore, during training, 1000 feet is used as the acceleration height for engine failure after V₁.

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Reference Bugs



Takeoff

White movable bugs are set at V_1 , V_R , $V_2 + 15$ speed and the flaps up maneuvering speed. The cursor is set to V_2 . $V_2 + 15$ is minimum maneuvering speed for all takeoff flaps and the initial flap retraction speed for takeoffs with flaps greater than 1.

Approach - Landing

Position two white bugs at V_{REF} for landing flaps and single white bug at $V_{REF} + 15$ speed and the flaps up maneuvering speed.

Severe Turbulent Air Penetration

The severe turbulent air penetration speed is: 280 KIAS/.70 Mach

The turbulent air penetration speed was selected to provide low/high speed maneuver margins in severe turbulent air. Below 15,000 feet, at less than maximum landing weight, a speed of 250 knots provides adequate buffet margin. Severe turbulence should be avoided if at all possible. If severe turbulence cannot be avoided, an increased buffet margin is recommended. This can be obtained by descending approximately 4,000 feet below optimum altitude. If the autopilot is engaged, leave it engaged in Control Wheel Steering (CWS) mode, unless airspeed, altitude or attitude deviations require use of manual control. The autothrottle should be off in severe turbulence. During manual flight, maintain wings level and smoothly control attitude. Use the attitude indicator as the primary instrument. In extreme vertical wind currents, large attitude changes may occur. Do not use sudden or large control inputs. After establishing the trim setting for penetration speed, do not change pitch trim. Allow altitude and airspeed to vary and maintain attitude. However, do not allow the airspeed to decrease and remain below the turbulent air penetration speed as buffet margin will be reduced and considerable time and fuel will be required to regain cruise speed. Maneuver at bank angles below those normally used. Set thrust for penetration speed and avoid large thrust changes. Continuous ignition (Flt position) should be on. Flap extension in an area of known turbulence should be delayed as long as possible because the airplane can withstand higher gust loads in the clean configuration. Normally, no changes to cruise altitude or airspeed are required when encountering moderate turbulence. If operating at cruise thrust limits, it may be difficult to maintain cruise speed.

Taxi Speed and Brakes

To begin taxi, release brakes, smoothly increase thrust to minimum required for the airplane to roll forward, then reduce thrust to idle. Do not start a turn until sufficient forward speed has been attained to carry the airplane through the turn at idle thrust.

To the pilot, the airplane appears to be moving slower than it actually is due to the flight deck height above the ground. Consequently, the tendency is to taxi faster than desired. This is especially true during runway turnoff after landing. The appropriate taxi speed will depend on turn radius and surface condition.

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Taxi speed should be closely monitored during taxi out, particularly when the active runway is some distance from the departure gate. Avoid "riding" the brakes to control taxi speed because brake heat build-up and wear could become excessive. Most operators avoid taxi speeds greater than 20 knots on long taxi routes.

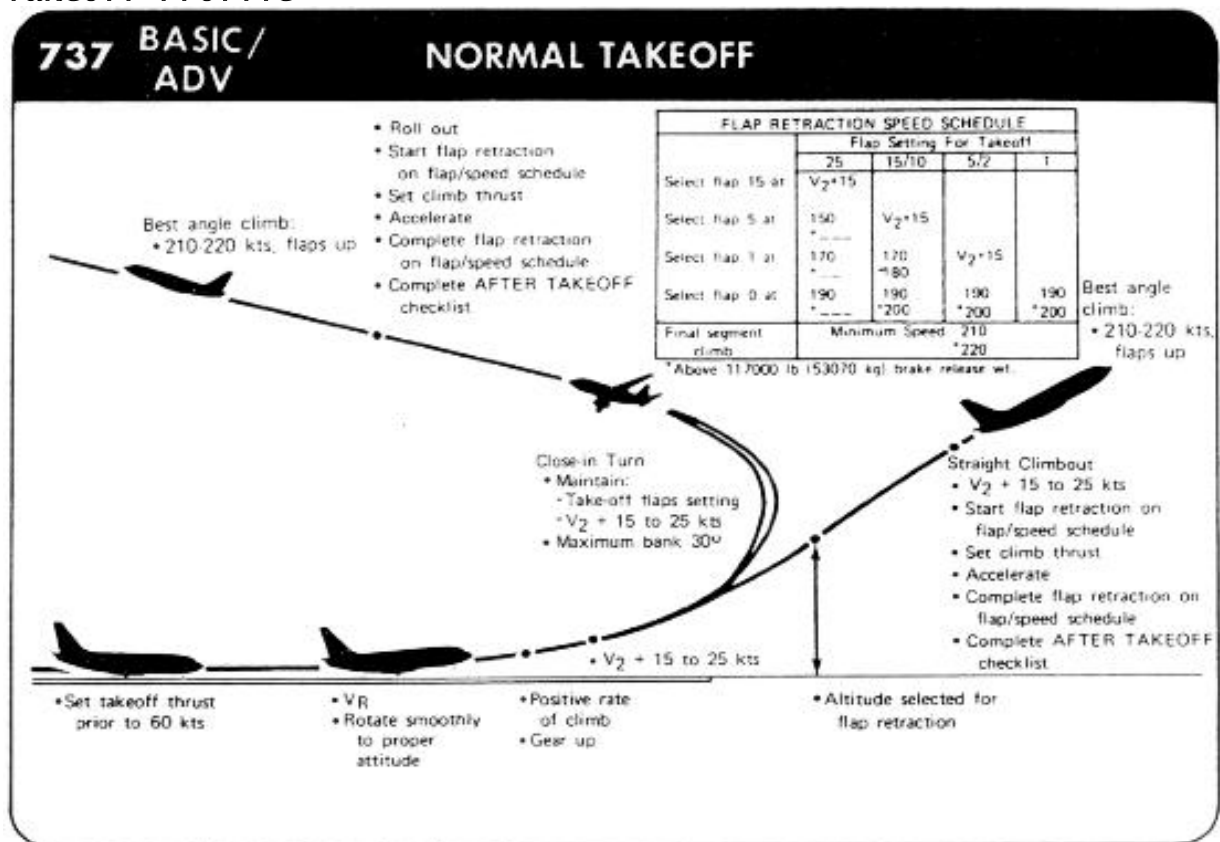
Some taxi speeds, usually between 10 and 20 knots, can cause an increase in airplane vibration, especially on rough taxiways. If this occurs, a slight increase or decrease in speed will reduce or eliminate the vibration and increase the passenger comfort.

If taxi speed is too high, reduce speed with a steady brake application and then release the brakes to allow them to cool. Braking to approximately 10 knots and subsequent release of the brakes will result in less heat build-up in the tires and brakes than when the brakes are constantly applied. Under normal conditions, differential braking and braking while turning should be avoided. Allow for decreased braking effectiveness on slick surfaces.

Idle reverse may be used on the 737-100/200 to slow taxi speed and reduce brake heating. Avoid following other aircraft too closely. Jet blast is a major cause of foreign object damage. Avoid use of reverse thrust while stopping or at low speeds to reduce the possibility of engine surge or foreign object damage.

Note: High taxi speed combined with heavy gross weight and a long taxi distance can result in tire sidewall overheating.

Takeoff Profile



Initiating Takeoff Roll

If the possibility exists of a windshear being encountered on takeoff, flight directors should be turned off for non-windshear alerting equipped airplanes. Otherwise, flight director use is recommended for all takeoffs.

A rolling takeoff procedure is recommended for setting takeoff thrust. It expedites takeoff and reduces risk of foreign object damage. Flight tests and analysis have proven the change in takeoff roll due to the rolling takeoff procedure is negligible (less than 50 feet) when compared to a standing takeoff.

Release the brakes and advance the thrust levers to approximately vertical. The engines should be stabilized momentarily before advancing thrust levers to takeoff thrust. This provides uniform engine acceleration to takeoff thrust and

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minimizes directional control problems. This is particularly important if crosswinds exist or the runway surface is slippery. The exact initial setting is not as important as setting symmetrical thrust. If thrust is to be set manually, smoothly advance thrust levers toward takeoff thrust. Final thrust adjustments should be made, with reference to the digital readouts, by 60 knots.

During takeoff, if EGT exceeds the limit after thrust is set beyond eighty knots, do not retard the thrust lever since this will affect the takeoff distance. When the PF judges that altitude (minimum four hundred feet AGL) and airspeed are acceptable, the thrust lever should be retarded until EGT is within limits, in accordance with the Engine Over temperature During Takeoff or In-flight nonnormal procedure.

The Captain should keep one hand on the thrust levers until V1 in order to respond quickly to a rejected takeoff condition.

Light forward pressure is held on the control column. Keep the airplane on centerline with rudder pedal steering and rudder. The rudder becomes effective between 40 and 60 knots. Maximum nose wheel steering effectiveness is available with rudder pedal steering when above taxi speeds.

CAUTION: The nose wheel steering wheel should not be used above normal taxi speeds (20 knots).

The pilot not flying should monitor engine instruments during the takeoff roll and announce any abnormalities. The pilot not flying should announce passing 80 knots and the pilot flying should verify that the airspeed indicators are in agreement.

As the airspeed approaches V1, the control column is moved to neutral or slightly aft of neutral. Be prepared to rotate when the airspeed indicator reaches VR. At VR, rotate the airplane smoothly. After liftoff adjust the pitch attitude to maintain the desired airspeed.

Rotation and Liftoff - All Engines

For optimum takeoff and initial climb performance, initiate a smooth continuous rotation at VR toward 15 degrees of pitch attitude. Rotate smoothly at an average pitch rate of 3 degrees/second. A 12 degree body attitude will be achieved in approximately 2.5 to 3 seconds.

Note: The flight director pitch command is not used for rotation.

Takeoff and initial climb performance depend on rotating at the correct airspeed and proper rate to the rotation target attitude. Early or rapid rotation may cause aft fuselage contact with the runway. Late, slow, or under-rotation increases takeoff ground roll. Any improper rotation decreases initial climb flight path. The pitch attitude for aft fuselage contact is 15.6 deg (wheels on the runway and Landing gear struts extended). CAUTION: Do not pressurize an airplane if fuselage runway contact is suspected. A landing at the nearest suitable airport is recommended. An inspection for structural damage is required before the next flight.

Do not apply brakes after becoming airborne. Braking is automatically applied when the Landing Gear Lever is placed in the UP position. The landing gear should be retracted when a positive rate of climb is indicated on the Vertical Speed Indicator and Altimeter.

Leave Landing Gear Lever in the UP position approximately 10 seconds after all red landing gear lights have extinguished to ensure positive uplock of the landing gear.

Initial Climb

After liftoff use the flight director as the primary pitch reference, cross checking indicated airspeed and other flight instruments. If the flight director is not used, indicated airspeed and attitude become the primary pitch references. Normally, if rotation rate is correct, a pitch attitude of approximately 15 to 20 degrees will result in an airspeed of approximately V2 + 20 knots for normal gross weights. If the vertical speed is acceptable, adjust the pitch attitude smoothly to maintain an airspeed of V2 + 15 to 25 knots up to flap retraction altitude. V2 + 15 approximates maximum angle climb speed with takeoff flaps. This results in the maximum altitude gain in the shortest distance from takeoff.

Acceleration to higher speeds will reduce the altitude gain. If airspeed exceeds V2 + 15 during the initial climb, stop the acceleration but do not attempt to reduce airspeed to V2 + 15. Any speed between V2 + 15 and V2 + 25 knots will not significantly affect the takeoff profile.

Retract the landing gear after a positive rate of climb is established as indicated on the flight instruments. After gear and flaps are retracted, the PNF should verify the gear and flaps

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indications are normal and place the gear lever to OFF. Note: Do not apply brakes after becoming airborne. Braking is automatically applied when the landing gear lever is placed in the up position.

DEPARTURE AND CLIMB SPEEDS				
	CONDITION	CLIMB PERFORMANCE +	CONFIGURATION	IAS
TWO ENGINES	Turn After Takeoff(Max Bank 30deg)	Best Angle - Minimum Radius	Takeoff Flaps *	V2 + 15 kts
	Area Dept - Close In(Max Bank 30deg)	Best Angle - Minimum Radius	Flaps Up	210 kts
	Low Speed - Enroute	Turbulent Air Penetration	Flaps Up	▲280 kts to M.70
	High Speed- Enroute	Minimum Time	Flaps Up	▲320 kts to M.70
	Departure-Climb in Holding	Turbulent Air Penetration	Flaps Up	▲280 kts

* Takeoff Flaps - 1, 2, 5, 10, 15, or 25 using appropriate V2

+ Average best rates

▲ 250 kts below 10,000ft (US FAA limit)

Immediate Turn After Takeoff

Obstruction clearance, noise abatement, or departure procedures may require an immediate turn after takeoff. Initiate the turn at the appropriate altitude and maintain V2 + 15 to V2 + 25 with takeoff flaps. Climb performance is slightly reduced while turning. A maximum bank angle of 30 degrees is permitted at V2 + 15 knots with takeoff flaps. After completing the turn, and at or above flap retraction altitude, accelerate and retract flaps while climbing.

Takeoff Roll Modes

On airplanes with wings level takeoff mode and an immediate turn after takeoff is necessary, heading may be preselected prior to takeoff. Use HDG SEL when the turn is desired (minimum 400 feet AGL).

Autopilot Engagement

The autopilot is FAA certified to allow engagement at 1000 feet or takeoff. Other regulations or airline operating directives may specify a different minimum altitude. The airplane should be in trim, and the flight director commands should be satisfied prior to autopilot engagement. This will prevent unwanted changes from the desired flight path during autopilot engagement.

Flap Retraction Schedule - All Engine

At flap retraction altitude, normally 1,000 AGL, PF will call for climb thrust, flaps up maneuvering speed, and flap retraction. The PNF will set climb thrust. For all airplanes, begin flap retraction at V2 + 15 knots, except for flaps 1 takeoff. For flaps 1 takeoff, begin flap retraction when reaching the flap 1 maneuvering speed. With airspeed increasing, additional flap retraction should be initiated: when reaching the fixed maneuvering speed for the existing flap position.

For flaps up maneuvering, maintain: Fixed Target Speed

Noise Abatement Takeoff

The noise abatement profile, satisfies the guidelines established by U.S. FAA A.C. 91-53 and is used as a typical noise abatement takeoff for the 737-100/200.

Takeoff procedures up to flap retraction altitude are the same as normal takeoff.

Note: Some airports may have special procedures which require modification of this profile.

At flap retraction altitude, reduce pitch attitude to maintain approximately 500 to 1,000 feet per minute rate of climb while accelerating. Do not lower the nose to less than 50% of the pitch attitude required to maintain the initial climb of V2 + 20 knots. Accelerate and retract the flaps on schedule. At 210/220 knots, set reduced thrust and continue to climb to 3,000 feet.*

The table below shows target cleanup attitude and reduced thrust (cutback) EPR settings for several airplane weights.

At 3,000 feet, when noise is no longer a factor, select PDCS speed.

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Gross weight	Target Cleanup Attitude	Cutback EPR
80,000 lbs	13	1.50
85,000 lbs	13	1.53
90,000 lbs	12	1.55
95,000 lbs	12	1.58
100,000 lbs	11	1.61
105,000 lbs	11	1.65
110,000 lbs	11	1.69
115,000 lbs	10	1.73
120,000 lbs	10	1.77
125,000 lbs	10	1.81

Maximum Rate Climb

Gross weight	Speed
80,000 lbs (36,288 kgs)	260 knots/.72 mach
110,000 lbs (49,896 kgs)	270 knots/.72 mach
130,000 lbs (58,968 kgs)	280 knots/.72 mach

Enroute Climb

Maintain flaps up maneuvering speed until clear of obstacles or above minimum crossing altitudes. If there are no altitude or airspeed restrictions, accelerate to the desired climb speed schedule. The sooner the airplane can be accelerated to the climb speed schedule, the more time and fuel efficient the flight.

Economy Climb Schedule

280 knots/.74 mach

Maximum Altitude

The highest altitude at which the airplane can be operated is determined by three basic characteristics which are unique to each airplane model. They are the engine thrust capability, the airframe maneuver margin requirements, and the maximum certified altitude capability.

The thrust limited altitude capability is determined by the engine thrust available.

Depending on the thrust rating of the engines, the thrust limited altitude may be above or below the maneuver limited altitude capability.

Maximum altitudes determined by maneuver margin requirements will provide specific "g" or bank angle margins to airframe buffet or stickshaker. These specific margins, which may vary from one operator to another, nominally provide 1.2 g or 33 to 44 degrees of bank angle protection to buffet or stickshaker. The maneuver limited altitude capability is also affected by airplane center of gravity.

Although the airplane can be flown to intentionally exceed the maneuver limited maximum altitudes, it is not usually done since the risk of encountering stall buffet and/or Mach buffet is increased.

The maximum certified altitude capability of the airplane is determined during certification and is usually set by the pressure load limits on the fuselage. The maximum certified altitude limit may not be exceeded.

Optimum Altitude

Optimum Altitude is the cruise altitude for minimum cost when operating in the

ECON mode and for minimum fuel burn when in the LRC or pilot-selected speed modes. In ECON mode, Optimum Altitude increases as either airplane weight or Cost Index decrease. In LRC or selected speed modes, Optimum Altitude increases as either airplane weight or speed decrease. On each flight, Optimum Altitude is the lowest at TOC and will continue to increase as weight decreases during the flight.

For trips shorter than 250 nm, optimum altitude as defined above may not be achievable, since the top of descent point will occur prior to completing the climb to optimum altitude.

Minimum fuel flight plans not constrained by short trip distance are typically based on conducting the cruise portion of the flight within plus or minus 2000 ft. of Optimum Altitude. Since the Optimum Altitude increases as fuel is consumed during the flight, on light flights it is necessary to climb to a higher cruise altitude every few hours to achieve the flight plan fuel burn. This technique, referred to as Step Climb Cruise, is typically accomplished by

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initially climbing 2000 ft. above Optimum Altitude and then cruising at that flight level until you are 2000 ft. below Optimum. For most 737 flights, only one such step is required before reaching TOD. It may be especially advantageous to request an initial cruise altitude above optimum if altitude changes are difficult to obtain on specific routes, thereby minimizing the possibility of being held at a low altitude/high fuel consumption condition for most of the flight. The requested/accepted initial cruise altitude should be compared to the cruise thrust limited or the maneuver margin limited altitudes. If altitude choice will be limited by thrust limits, it is important to remember that the temperature at the cruise altitude must also be considered. Some loss of buffet margin can be expected above optimum altitude. Levels 2000 feet above optimum altitude will normally allow approximately 45 degrees bank prior to buffet onset. The higher the airplane flies above optimum altitude, the more the buffet margin is reduced. Before accepting an altitude above optimum, determine that it will continue to be acceptable as the flight progresses under projected conditions of temperature and turbulence. On airplanes with higher thrust engines, the altitude selection will most likely be limited by maneuver margin limits, and will generally provide a minimum of 33 to 44 degrees bank angle margin (1.2 to 1.4 g's) to buffet or stickshaker. Projected temperature and turbulence conditions along the route of flight should be reviewed when requesting/accepting initial cruise altitude as well as subsequent step climbs.

For cruise within 2,000 feet of optimum, long range cruise speed can be approximated by M.74 for 737-200,

Fuel for Enroute Climb

The additional fuel required for a 4,000 foot enroute climb varies from 300 to 500 pounds (depending on the airplane gross weight). This additional fuel is offset by the savings in the descent. It is usually beneficial to climb to a higher altitude if recommended by the flight plan, provided the wind information used is reliable.

Note: The fuel saved at higher altitude does not normally justify a step climb unless the cruise time of the higher altitude is approximately 20 minutes.

Descent Planning

Flight deck workload increases as the airplane descends into the terminal area. Distractions must be minimized and administrative and nonessential duties completed before descent or postponed until after landing. The earlier that essential duties can be performed, the more time will be available for the critical approach and landing phases.

Descent at .70/280/250

PRESSURE ALT (1000FT)	5	10	15	17	19	21	23	25	27	29	31	33	35	37
DISTANCE (NM)	24	44	60	66	72	79	85	92	98	103	109	114	119	125
TIME (MINUTES)	7	11	14	15	16	17	18	19	19	20	21	22	22	23

Operational factors and/or terminal area procedures may not permit following the optimum descent schedule. Terminal area requirements can be incorporated into basic flight planning but ATC, weather, icing and other traffic may require adjustments to meet the requirements. Proper descent planning is necessary to arrive at the desired altitude at the proper speed and configuration. The distance required for the descent is approximately 3 NM/1000 feet altitude loss for no wind conditions using .70/280 (250kts below 10000ft) speed. Rate of descent is dependent upon thrust, drag, airspeed schedule and gross weight. The approximate descent rates available below 15,000 feet with idle thrust, clean or with speedbrakes are shown below.

Descent Rates

Target Speed	Rate of Descent (approximate)	
	Clean	Speed Brake Deployed
M 0.78 / 280 / 250	2100 fpm	3000 fpm
250	1700 fpm	2300 fpm
210	1400 fpm	1900 fpm

Normally, descend with idle thrust and in clean configuration (no speed brakes). Maintain cruise altitude until the proper distance or time out for the planned

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descent and then hold the selected airspeed schedule during descent. Deviations from this schedule may result in arriving too high at destination and require circling to descend, or arriving too low and far out requiring extra time and fuel to reach destination.

The speedbrakes may be used to correct the descent profile if arriving too high or too fast. Figure 3-3 provides typical rates of descent for speed brake down and speed brake up conditions. The Descent - Approach Checklist is normally commenced during descent and should be completed passing transition level.

Plan the descent to arrive at traffic pattern altitude at flaps up maneuvering speed approximately 12 miles from the runway when proceeding straight-in or about 8 miles out when making an abeam approach. A good crosscheck is to be at 10,000 feet AGL, 30 miles from the airport, at 250 knots.

Losing airspeed can be difficult and may require a level flight segment. For planning purposes, it requires approximately 35 seconds and 3 NM to decelerate from 290 to 250 knots in level flight without speedbrakes. It requires an additional 35 seconds and 3 NM to decelerate to 210 knots at average gross weights.

Maintaining the desired descent profile and using the map mode (if installed) to maintain awareness of position will ensure a more efficient operation. The crew should maintain an awareness of the destination weather and traffic conditions and consider the requirements of a potential diversion. They should review the airport approach charts and discuss the plan for the approach and landing. Complete the approach briefing as soon as practical, preferably before arriving at top of descent.

This allows the crew to give full attention to airplane control.

Speedbrakes

The pilot flying (PF) should keep his hand on the speedbrake lever when they are used in-flight. This will preclude leaving the speedbrakes extended. Use of speedbrakes between the down detent and flight detent can result in rapid roll rates. Do not use the full UP position in-flight. While using the speedbrakes in descent, allow sufficient altitude and airspeed margin to level off smoothly.

Lower the speedbrakes before adding thrust.

The use of speedbrakes with flaps extended should be avoided, if possible, with flaps greater than 15, the speedbrakes should be retracted. If circumstances dictate the use of speedbrakes with flaps extended, high sink rates during the approach should be avoided. Speedbrakes should be retracted before reaching 1000 feet AGL.

Vertical Speed Indicator

The vertical speed indicator interprets a change of acceleration as a change to vertical speed. Rapid increase in "g" forces as a steep turn is entered causes a transient display of approximately 200 FPM climb, even though the airplane is maintaining altitude perfectly. A 200 FPM descent appears because of the reduction in "g" force during a fast rollout. The VSI gives correct indications only during periods of steady "g" force.

Delayed Flap Approach

The final flap selection may be delayed to conserve fuel if the approach is not being conducted in icing or other adverse conditions.

Intercept the glide slope with gear down and flaps 15 at flaps 15 maneuvering speed. The thrust required to descend on the glide slope may be near idle.

Approaching 1,000 feet AGL, select landing flaps, allow the speed to bleed off to the final approach speed, then adjust thrust to maintain it. Complete the Landing Checklist. The approach should be stabilized by 500 feet AGL.

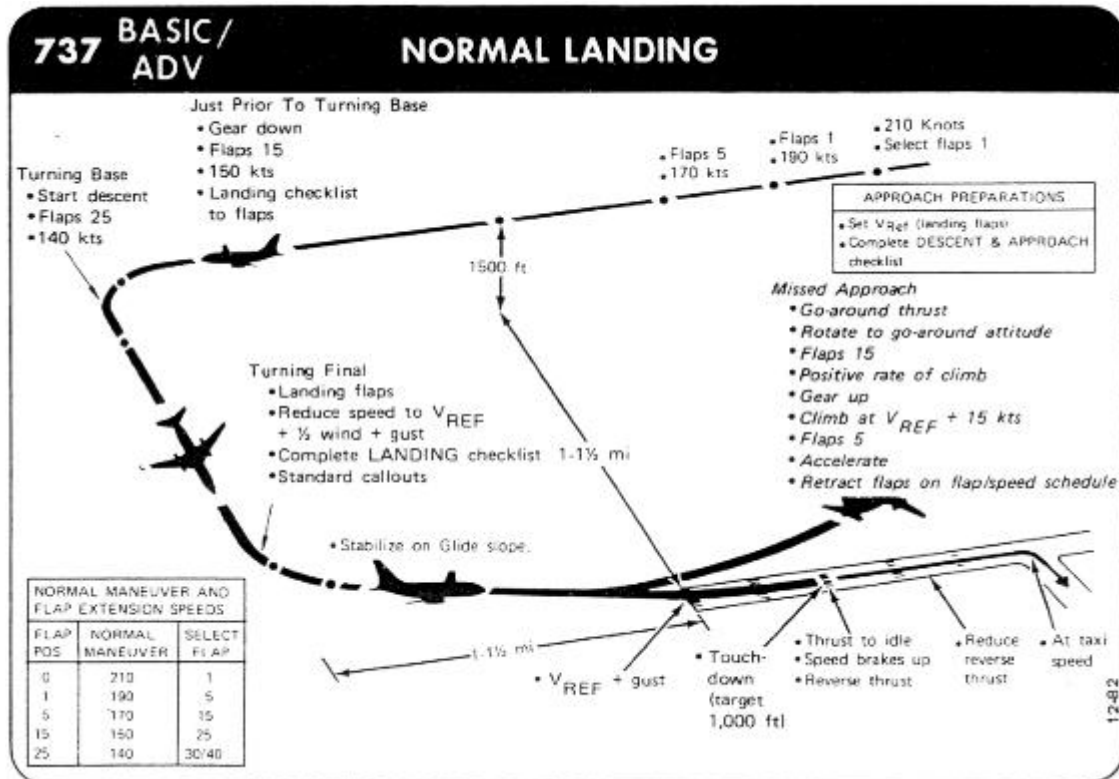
Flaps and Landing Gear

Extend the flaps when in the terminal area and conditions require a reduction in airspeed below flaps up maneuvering speed. Normally select flaps 5 prior to the approach fix going outbound, or just before entering downwind on a visual approach.

Normal descents are made in the clean configuration to pattern or instrument approach altitude. If greater descent rates are desired, extend the speedbrakes.

When thrust requirements for anti-icing result in less than normal descent rates with speedbrakes extended, or if higher than normal descent rates are required by ATC clearance, the landing gear can be lowered to increase the rate of descent.

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Visual Approach

The recommended landing approach path is approximately 2 1/2 to 3 degrees. Once the final approach is established, the airplane configuration remains fixed and only small adjustments to the glide path, approach speed and trim are necessary. This results in the same approach profile under all conditions.

Thrust

Engine thrust and elevators are the primary means to control attitude and rate of descent. Adjust thrust slowly using small increments. Sudden large thrust changes make airplane control more difficult and are indicative of an unstable approach.

No large changes should be necessary except when performing a go-around. Large thrust changes are not required when extending landing gear or flaps on downwind and base leg. A thrust increase may be required when stabilizing on speed on final approach.

Flap Extension

Extend flaps to the next position before decelerating below the recommended speed for the current flap setting. For example, select flaps to 1 before decelerating below flaps up speed, and select flaps to 5 before decelerating below flaps 1 speed.

Downwind and Base Leg

Fly at an altitude of 1500 feet above the runway elevation and enter downwind with flaps 5 at flaps 5 maneuvering speed. Maintain a track parallel to the landing runway approximately 1.5 NM abeam.

Prior to turning base leg, extend the landing gear, select flaps 15 and slow to flaps 15 maneuvering speed. With one engine inoperative this is the final flap setting for landing. If the approach pattern must be extended, delay lowering gear and selecting flaps 15 until approaching the normal visual approach profile. Turning on base leg, select flaps 25 and adjust thrust as required, to maintain flaps 25 maneuvering speed while descending at 600-700 FPM. Extend landing flaps prior to turning final. Allow the speed to decrease to the proper final approach speed and trim the airplane. Complete the landing checklist.

Final Approach

Roll out of the turn to final on the extended runway centerline and maintain the appropriate approach speed. Attempt to keep thrust changes small to avoid large trim changes. With the airplane in trim and at target airspeed, pitch

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attitude should be approximately the normal approach body attitude. At higher airspeeds, the approach body attitude will be less. At slower airspeeds the approach body attitude will be greater. Slower speed reduces aft body clearance at touchdown.

Stabilize the airplane on the selected approach airspeed with a constant rate of descent between 600 and 800 feet per minute on the desired glide path, in trim. Stabilize on the profile by 500 feet above touchdown.

Note: Descent rates above 1000 fpm should be avoided.

With one engine inoperative, maintain flaps 15 maneuvering speed until on final approach, then reduce to final approach speed. Centering the rudder trim prior to landing allows most of the rudder pedal pressure to be removed when the thrust of the operating engine is retarded to idle at touchdown.

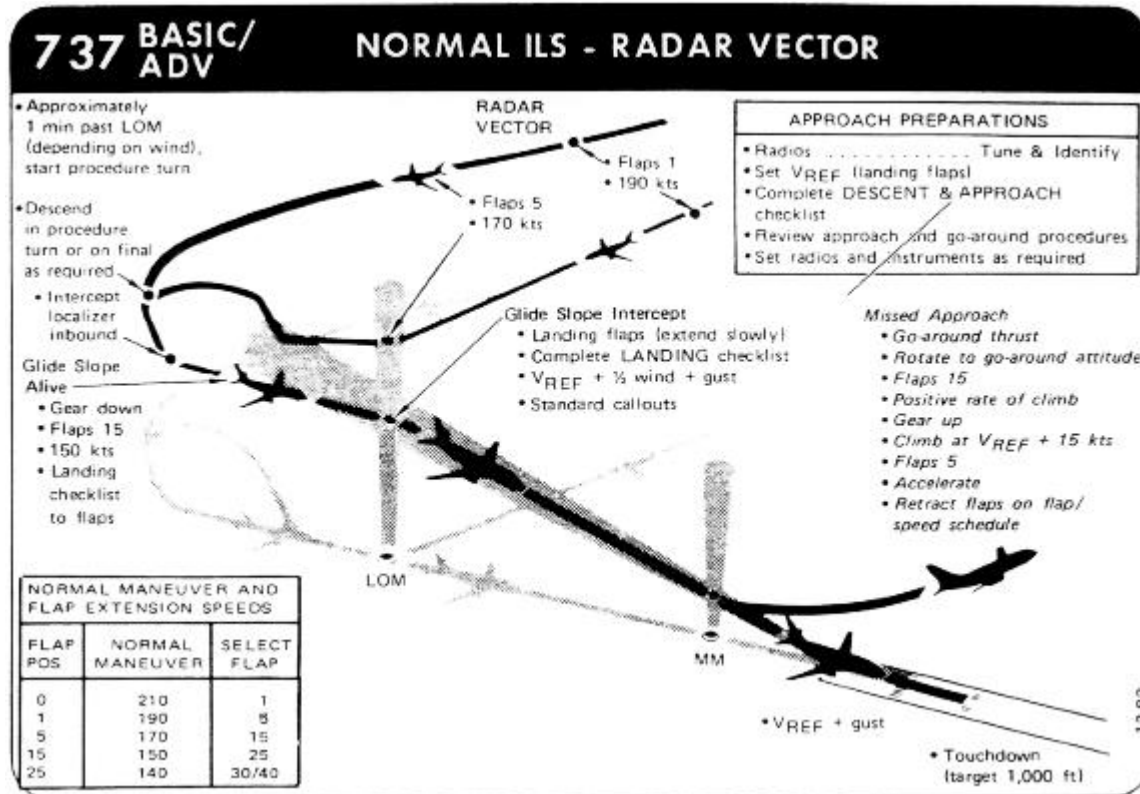
Full rudder authority and rudder pedal steering capability are not affected by rudder trim. Because of crew workload and the possibility of a missed approach, it may not be advisable to zero the rudder trim. If touchdown occurs with the rudder still trimmed for the approach, be prepared for the higher rudder pedal forces required to track the centerline on rollout.

Note: Descent rates above 1000 fpm should be avoided.

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ILS Approach

ILS navigation signals are displayed on the ADI. Set the NAV switches so that ILS navigation signals are displayed on the HSI. Course deviation displays on the HSI indicate 2 dot deviation from the ILS center beam. Use the HSI as the primary navigation instrument during a raw data ILS approach.

Maneuvering the airplane to place the symbolic airplane on the center of the HSI will center the course deviation bar. The course deviation bar represents the ILS localizer after the front course is selected.

During initial course intercept, crosscheck the magnetic bearing information on the RMI. As the course deviation bar starts to center, turn the airplane to keep the nose of the symbolic airplane pointed at the top of the course deviation bar. This technique will provide a smooth intercept and rollout on course. In a crosswind it will be necessary to adjust the heading into the wind. The drift angle pointer on the HSI may be used to maintain the localizer.

Large bank angles will rarely be required while tracking inbound on the localizer. Use 5 to 10 degrees of bank angle.

When the glideslope pointer begins to move (glideslope alive), lower the landing gear, extend flaps 15 and decelerate to flaps 15 speed. This may be done in steps, pausing at intermediate settings so that large trim changes are not required at once.

Intercepting the glide slope, extend landing flaps and establish the final approach speed. When established on the glideslope, preset the missed approach altitude in the altitude window. On final approach maintain $V_{REF} + 5$ knots or an appropriate correction for headwind component. Check altitude and time crossing the FAF. To stabilize on the final approach speed as early as possible, it is necessary to exercise good speed control during the glide slope intercept phase of the approach. The rate of descent will vary with the glide slope angle and groundspeed. Expeditionary and smooth corrections should be made based on the ILS course and glide slope indications. Apply corrections at approximately the same rate and amount as the flight path deviations.

To accomplish the missed approach procedure simultaneously apply go-around thrust, call for flaps 15 and rotate towards 15 degrees pitch attitude. At a positive rate of climb call "gear up" and adjust the pitch attitude to maintain bug speed.

Retract flaps as airspeed increases. Accomplish the missed approach procedure as illustrated on the approach chart. If a turning missed approach is required,

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accomplish the missed approach procedure through gear up before initiating the turn. Delay further flap retraction until a safe altitude and appropriate speed are attained. The minimum altitude for flap retraction during takeoff is not normally applicable to a missed approach; however, obstacles in the missed approach path must be taken into consideration.

Visual Aim Point

During visual approaches many techniques and methods are used to ensure main landing gear touchdown at the desired point on the runway. One of the most common methods used is to aim at the desired gear touchdown point on the runway, then adjust the final approach glide path until the selected point appears stationary in relation to the airplane (the point does not move up or down in the pilot's field of view during the approach).

Visual aim points versus gear touchdown point differences increases as glide path angle decreases as in a flat approach. For a particular visual approach, the difference between gear path and eye level path in the 737 must be accounted for by the pilot.

Threshold Height

Threshold height is a function of glide path angle and landing gear touchdown target. During a typical 3 degree visual approach, with a 1,000 foot touchdown, the main landing gear will cross the threshold at approximately 35 feet for all normal glide path angles. Special attention must be given to establishing a final approach that will assure safe threshold clearance and gear touchdown at least 1,000 feet down the runway. Recommended standard callouts will assist the pilot in determining a proper profile.

Recommended Callouts from 100 Feet if automatic callouts are not available, the radio altimeter should be used to assist the pilot in judging terrain clearance, threshold height and flare initiation height.

The PNF may call out radio altitudes at 100 feet, 50 feet, and 30 feet to aid in developing an awareness of eye height at touchdown.

Flare and Touchdown

These techniques discussed are applicable to all landings including crosswind landings and slippery runway conditions. Unless an unexpected or sudden event occurs, such as windshear or collision avoidance situation, it is not appropriate to use sudden, violent or abrupt control inputs during landing. Begin with a stabilized approach on speed, in trim and on glide path.

When the threshold passes under the airplane nose and out of sight, shift the visual sighting point to approximately 3/4 the runway length. Maintain a constant airspeed and descent rate. Initiate the flare when the main gear is approximately 15 feet above the runway by increasing pitch attitude approximately 3 degrees.

This will slow the rate of descent. After the flare is initiated, smoothly retard the thrust levers to idle, and make small pitch attitude adjustments to maintain the desired descent rate to the runway. Ideally, main gear touchdown should occur simultaneously with thrust levers reaching idle. A touchdown attitude of 4 to 6 degrees is normal with an airspeed of approximately VREF plus any gust correction. Do not trim the stabilizer during flare or after touchdown.

Typically, the pitch attitude will increase slightly during the actual landing, but avoid over-rotating. Do not increase the pitch attitude after touchdown; this could lead to a tail strike. The Landing Flare Profile (Figure 4-12) shows a normal approach and touchdown.

Shifting the visual sighting point down the runway assists in controlling the pitch attitude during the flare. A smooth power reduction to idle also assists in controlling the natural nose down pitch change associated with thrust reduction.

Hold sufficient back pressure on the control column to keep the pitch attitude constant. Avoid rapid control column movements or trimming during the flare to avoid increasing the pitch attitude after touchdown. Such actions are likely to cause pitch to increase at touchdown and increase the potential for a tailstrike. Do not allow the airplane to float. Fly the airplane onto the runway and accomplish the landing roll procedure. Do not attempt to extend the flare by increasing pitch attitude in an attempt to achieve a perfectly smooth touchdown. Do not attempt to hold the nose wheel off the runway.

If the airplane should bounce, hold or re-establish a normal landing attitude and add thrust as necessary to control the rate of descent. Thrust need not be added for a shallow bounce or skip. When a high, hard bounce occurs, initiate a go-around. Apply go-around thrust and use normal go-around procedures. A second touchdown may occur during the go-around. Do not retract the landing gear until

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a positive rate of climb is established.

Wind Corrections Final Approach

On final approach, the airplane will react to windshear and gusts for both the headwind and crosswind components of the wind. Unless compensated for, these factors may cause the airplane to land short.

Use an approach speed wind correction of 1/2

the steady headwind component plus all of the gust increment above the steady wind, based on tower reported winds. The maximum wind correction should not exceed 20 knots. In all cases, the gust correction should be maintained to touchdown while the steady headwind correction may be bled off as the airplane approaches the runway threshold.

When the wind is reported calm or light and variable, VREF + 5 knots is the recommended airspeed on final. Bleed off the 5 knots as the airplane approaches the runway threshold. Do not add any additional speed for a headwind component of up to 10 knots.

Do not apply a wind correction for tailwinds.

Example:

Headwind component = 18 knots, gusting to 25 knots. Add 9 knots for headwind component and 7 knots for gust effect, resulting in an approach speed equal to VREF + 16 knots. If the total correction exceeds 20 knots, use a maximum of 20 knots.

Wind Additive Example (Runway Heading 360°)

Tower Report	Wind Additive	Approach Speed
360 at 16 kts	8	VREF + 8 kts
CALM	0	VREF + 5 kts
360 at 16 kts Gust 24	8 + 8	VREF + 16 kts
060 at 24 kts	6	VREF + 6 kts
090 at 15 kts	0	VREF + 5 kts

After Touchdown and Landing Roll

Avoid touching down with thrust above idle since this may establish an airplane nose up pitch tendency and will increase landing roll.

If the speedbrakes do not extend automatically, after the airplane settles onto the runway, move the speedbrake lever to the UP position, and initiate reverse thrust.

Fly the nosewheel down to the runway smoothly by relaxing aft control pressure.

Do not attempt to hold the nosewheel off the runway. Holding the nose up after touchdown for aerodynamic braking is not an effective braking technique.

To avoid the risk of tailstrike, do not allow the pitch attitude to increase after touchdown. However, applying excessive nose down elevator during landing can result in substantial forward fuselage damage. Do not use full down elevator.

Apply wheel brakes smoothly with steadily increasing pedal pressure as required for runway condition and runway length available. Maintain deceleration rate with constant or increasing brake pressure as required until stopped or desired taxi speed is reached.

Speedbrakes

The speedbrakes can be fully raised after touchdown while the nose wheel is lowered to the runway, with no adverse pitch effects. The speedbrakes spoil the lift from the wings, which places the airplane weight on the main landing gear, providing excellent brake effectiveness.

Unless speedbrakes are raised after touchdown, braking effectiveness may be reduced initially as much as 60%, since very little weight will be on the wheels and brake application may cause rapid anti-skid modulation.

Normally, speedbrakes will be armed to extend automatically. Both pilots should monitor speedbrake extension after touchdown. In the event auto extension fails, the Captain should immediately extend them manually.

Rudder Control, Braking, and Nose wheel Steering After

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Touchdown

If the nose wheel is not promptly lowered to the runway, braking and steering capability are significantly degraded and no drag benefit will be gained. Rudder control is effective to approximately 60 knots. Rudder pedal steering is sufficient for maintaining directional control during the rollout. Do not use the nose steering wheel until reaching taxi speed. In a crosswind, displace the control wheel into the wind to maintain wings level which aids directional control. Perform the landing roll procedure immediately after touchdown. Any delay will markedly increase the stopping distance. Stopping distance varies with wind conditions and any deviation from recommended approach speeds.

Factors Affecting Landing Distance

The field length requirements are contained in the Performance Section of the Operations Manual. Actual stopping distances for a maximum effort stop are approximately 60% of the dry runway field length requirement. Factors that affect stopping distance are: height and speed over the threshold, glide slope angle, lowering the nose to the runway after landing, use of reverse thrust, speed brakes and wheel brakes, etc.

Note: Reverse thrust and speedbrake drag are most effective during the high speed portion of the landing. Make the speedbrake actuation and reverse thrust lever manipulation rapidly with as little time delay as possible.

Floating just off the runway surface before touchdown must be avoided, because it uses a large portion of the available runway. The airplane should be landed as near the normal touchdown point as possible rather than allowed to float in the air to bleed off speed. Deceleration rate on the runway is about three times greater than in the air.

Height of the airplane over the end of the runway also has a significant effect on total landing distance. For example, on a 3 degree glide path, passing over the end of the runway at 100 feet altitude rather than 50 feet could increase the total landing distance by approximately 1000 feet. This results in a longer touchdown with less runway available for stopping.

Glide path angle also affects total landing distance. As the approach path becomes flatter, even while maintaining proper height over the end of the runway, total landing distance is increased. When landing on runways contaminated with ice, snow, slush or standing water, the braking action reported must be taken into account.

Reverse Thrust Operation

After touchdown and thrust levers idle, rapidly raise the reverse thrust levers up and aft.

Move them aft to the interlock position, then to the number 2 reverse thrust detent.

Conditions permitting, limit reverse thrust to the number 2 detent. The PNF will monitor engine operating limits and call out any engine operational limits being approached, exceeded, or any other abnormalities.

Maintain reverse thrust as required until the airspeed approaches 60 knots. At this point start reducing the reverse thrust so that the reverse levers are moving down at a rate commensurate with the deceleration rate of the airplane. The thrust levers should be positioned to reverse idle by taxi speed, then to full down after the engines have decelerated to idle. The pilot not flying should call out 60 knots to assist the pilot flying in scheduling the reverse thrust. If an engine surges during reverse thrust operation, quickly select reverse idle on both engines.

Crosswind Landing

Four methods of performing crosswind landings are presented. They are the sideslip, de-crab technique (with removal of crab in flare), crab technique and combination crab/sideslip technique. When a crab is maintained during a crosswind approach, offset the flight deck on the upwind side of centerline so that the main gear touches down on the runway centerline.

Sideslip (wing Low)

The sideslip crosswind technique aligns the aircraft with the extended runway course so that main gear touchdown occurs on the runway centerline. The initial phase of the approach to landing is flown using the crab method to correct for drift. Prior to the flare the airplane centerline is aligned on or parallel to the runway centerline. Downwind rudder is used to align the longitudinal axis to the desired track as aileron is applied into the wind to

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prevent drift. A steady sideslip is established with opposite rudder and low wing into the wind to hold the desired course. Touchdown is accomplished with the upwind wheels touching just before the downwind wheels. Overcontrolling the roll axis must be avoided because overbanking could cause the engine nacelle or outboard wing flap to contact the runway. Properly coordinated, this maneuver will result in nearly fixed rudder and aileron control positions during the final phase of the approach, touchdown, and beginning of the landing roll.

De-Crab During Flare

The objective of this technique is to maintain wings level throughout the approach, flare, and touchdown. On final approach, a crab angle is established with wings level to maintain the desired course. Just prior to touchdown while flaring the airplane, downwind rudder is applied to eliminate the crab and align the airplane with the runway centerline. As rudder is applied, the upwind wing will sweep forward, developing roll. Hold wings level with simultaneous application of aileron control into the wind. The touchdown is made with cross controls and both gear touching down simultaneously. Throughout the touchdown phase upwind aileron application is utilized to keep the wings level.

Crab

On very slippery runways the crosswind crab angle may be maintained to touchdown. This will reduce drift toward the downwind side when touching down. Since the aircraft does not have to be decrabbed, pilot workload is reduced. Proper rudder and upwind aileron must be maintained to ensure directional control is maintained. On slippery runways, crosswind capability is a function of runway surface conditions, airplane loading and pilot technique.

Combining Crab and Sideslip

It may be necessary to combine crab and sideslip during strong crosswinds. Main gear touchdown is made with the wing low and crab angle applied. As the upwind gear touches first, a slight increase in downwind rudder is applied to straighten the nose. A simultaneous application of aileron is applied to maintain wings level.