STALL PROFILES

747 Vibration / Buffet Differences

Flight crews are routinely required to interpret various types of airframe vibration or buffet in order to determine if any corrective action is required. Among the common types of vibration / buffet encountered by the flight crew are nose gear tire unbalance, engine vibration and airframe buffet associated with approach to stall or Mach buffet.

Airframe vibration from nose gear fire unbalance will normally be felt during the takeoff roll with vibration frequency and amplitude increasing with speed. The vibration will continue after takeoff until the landing gear is retracted and the nose gear wheels are braked. The level of vibration is a function of the amount of fire unbalance.

Mach buffet is normally encountered at the higher attitudes and at the higher Mach numbers. It is characterized by a fairly constant low frequency and low amplitude airframe vibration. It is usually triggered by turbulence or increased wing loading due to bank angle. Mach buffet can be terminated by reducing altitude or reducing the load factor.

The vibration / buffet that is encountered during approach to stall is recognized by airframe vibration or shaking that increases in amplitude as the airspeed decreases. Initial buffet can be differentiated from turbulence in that buffet vibration is more or less a constant frequency with increasing amplitude while turbulence has a random frequency and amplitude.

Initial Buffet

Airframe buffet occurs when the smooth airflow around some portion of the airplane separates. Initial buffet is caused by random intermittent flow separation on the wing. Low speed buffet will occur when angle of attack is increased to the point where the airflow cannot remain attached to the wing in a smooth flowing pattern. Flow separation also occurs at high Mach numbers when local flow velocities on the upper portion of the wing reach the sped of sound. These local sonic velocities produce a shock wave which in itself is an abrupt discontinuity in flow parameters and imposes a strong pressure gradient on the airfoil. Normally, flow separation and buffet result (Mach buffet). A very light Mach buffet may occur near MMO under certain conditions of wing loading such as large bank angles and / or turbulent flight conditions.

APPROACHES TO STALLS

Initial Conditions

Keep the airplane in trim. The airplane is trimmed to stick shaker or initial buffet to simulate an inadvertent approach to a stall.

Approach to Stall

Maintain the approximate entry altitude or a slight rate of climb and note the pitch attitude at stick shaker or initial buffet.

Stall Warning, Flaps Up

With flaps up, stall warning is first apparent as a very light buffet. This buffet occurs well above the required stall warning. Controls remain fully effective and performance is not significantly degraded. However, if a continued reduction in airspeed is tolerated, buffet intensity will increase and stick shaker will occur, followed by flight characteristics associated with the classic stall.

Stall Warning, Flaps Extended

With flaps extended, stall warning is indicated by stick shaker and initial buffet occurring almost simultaneously. At flaps 5 and flaps 10, stick shaker precedes initial buffet at low gross weight by a few knots and lags initial buffet by a few knots at high gross weight. For flaps 20 and flaps 30, stick shaker will precede initial buffet by a few knots at all gross weights.

Stall Recovery (Ground Contact Not a Factor)

Initiate recovery at the first indication of stall warning (buffet or stick shaker). The objective of the recovery is to accelerate to normal maneuvering speed with a minimum loss of altitude. This is accomplished by applying go-around thrust while decreasing pitch attitude to approximately 5 degrees on the ADI and leveling the wings. At altitudes above 20,000' recover with nose slightly below horizon. Accelerate to maneuvering speed. Stop the rate of descent. Less altitude is lost and the recovery is simplified by not changing flap position. Application of thrust causes a slight nose-up pitching moment and must be countered by a light forward control column pressure. Stabilizer trim should be used as required during the recovery. The airplane should be handled precisely and smoothly throughout the maneuver.

Stall Recovery (Ground Contact a Factor)

Initiate recovery at the first indication of stall warning (buffet or stick shaker). Apply emergency thrust and smoothly adjust the pitch attitude and level the wings to prevent ground contact. Avoid abrupt control inputs as they could induce a secondary stall. Do not alter the airplane configuration until normal maneuvering speed is regained and a positive rate of climb has been established.
'Emergency power is power levers to the mechanical stops. After the stick shaker has stopped, power should be reduced to max power.
With gear and flaps down, clean up is flaps 20 at V,,g-1 0, then gear up as the flaps pass from 25° to 20°.

Flight Characteristics

The airplane exhibits no unusual flight characteristics during stall warning or recovery. Response to control inputs is immediate and positive. Avoid abrupt controls inputs. Flight with the speedbrakes extended, flaps up, will increase the stick shaker speed but will not change the airplanes declared stall speed or the flight characteristics.
Entry
Stabilize in trim at 280 knots on heading and altitude. Avoid abrupt aileron inputs and roll smoothly into 45° of bank. The steep-tarn entry is accomplished in the same way as a normal turn entry. An increase in lift is required as the bank angle is increased at a constant airspeed and altitude to balance the increase in load factor ("g"). The additional lift is obtained by increasing the angle of attack (pitch attitude). The increased lift causes increased drag as the pitch attitude is increased to maintain altitude. An increase in thrust is required to maintain airspeed.

During Turn

Pitch and thrust control are the same as for a normal turn; however, larger pitch adjustments will be required for a given altitude deviation. Varying the angle of bank while turning makes pitch control more difficult. If altitude loss becomes excessive, reduce the angle of bank as necessary to regain positive pitch control. Precision is secondary to smooth and positive control. A rapid instrument scan is required to detect deviations early enough to be corrected by small adjustments.

Attitude Director Indicator (ADI)

-Do not depend absolutely on the pitch indication of the ADI since precessing may occur during steep turns. Cross check the altimeter and IVSI frequently.

Instantaneous Vertical Speed Indicator (IVSI)

This instrument interprets a change of acceleration and displays it as a change in vertical speed. Thus, an increase in "g" forces as a steep turn is entered causes a transient display of climb, even though the airplane is maintaining altitude; and a transient indication of descent appears due to the reduction in "g" force during a rollout. Allow for this feature by relying on the IVSI for correct indications only during periods of steady "g" force.

Altimeter

The altimeter is accurate and useful during the turn. Be alert to the direction and rate of altimeter needle movement, and make smooth minor changes to the pitch attitude for corrections.

Airspeed

The airspeed is very slow to change due to the relatively small changes in thrust and drag. Anticipate the requirements for thrust changes and apply them at the first positive indication of change on the airspeed indicator. Normally a slight increase in thrust will be required.

NOTE: If the Command Airspeed Bug is rotated to 280 knots on the airspeed indicator, the Airspeed Fast / Slow indicator on the ADI will indicate need for airspeed change and assist in airspeed control.

Rollout

Be alert to correct for the more than normal pitch attitude and power used during the turn. Roll out at the same rate as used with normal turns. Normally the desired heading should be led by 15 degrees, however, individual technique will determine the exact amount of lead.

UNUSUAL ATTITUDE RECOVERIES

Objective

The objective of unusual attitude recoveries is to gain experience in regimes of flight outside those normally experienced in airline operations and to develop techniques for returning the aircraft to level flight once an extreme attitude is encountered.

Aircraft Handling Characteristics

The aircraft handling characteristics discussed below are fairly typical of transport category aircraft. Remember, the ADI is the primary control instrument and should be used throughout the recovery.

High Bank Angle

The nose drops during high bank angles in transport aircraft, especially at lower airspeeds.

At low speed, smooth, non-violent control inputs are essential in obtaining the best performance from the aircraft when close to the ground. Smoothness with the flight controls with an awareness of "g" forces will assist in avoiding the accelerated stall and damage to the aircraft.

The coordinated use of rudder when rolling out of a high bank greatly reduces the amount of nose drop and improves the roll rate, especially at low speed.

An extreme nose-down attitude greatly reduces the amount of time available for recovery. Quickly rolling the aircraft toward the "sky pointer" on the ADI to attain wings level and then pulling the nose up carefully avoiding excessive "g" forces is an efficient technique for recovery. Avoid applying back pressure to the yoke while rolling the aircraft.

High Speed

Gentleness with the flight controls, especially the elevator, is imperative at high speeds to avoid structural damage.

At high speeds, the use of ailerons alone are all that is required in most cases to smoothly fly the aircraft back to an upright position from a high-bank or inverted attitude.

Excessive "g" forces are far more damaging to the aircraft than excessive airspeed.

It is important to remember that at very high speeds, the aircraft will pitch up with the deployment of the speedbrakes and will do so even more with lowering of the landing gear. Therefore, if the aircraft reaches an extreme nose down attitude, careful and smooth application of elevator alone is recommended for the recovery. Use care in avoiding excessive "g" forces.

Extreme Nose Up Attitude

Unless the extreme nose-up attitude is corrected quickly, flight control effectiveness will be lost due to low airspeed.

Rolling the aircraft into a high bank angle approaching 90° will facilitate lowering the nose of the aircraft and reduce negative "g" forces while bringing the nose down.

This technique is especially effective when the nose up attitude is caused by an improper stabilizer trim position.

RECOVERY PROCEDURE

- Verify Indications

Crosscheck other ADIs to confirm an actual unusual attitude exists.

- Disengage the Autopilot

Attempting to overpower the autopilot will slow the recovery.

- Recover

Smoothly execute the appropriate recovery technique while avoiding excessive "g" forces.

RECOVERY TECHNIQUE

Nose Up

- Roll the aircraft until approaching 90° bank.
- Allow nose to fall toward horizon while maintaining positive "g" forces.
- Roll wings level as nose approaches the horizon.
- Make smooth power applications based on airspeed.

Nose Down

- Roll rapidly to the nearest horizon.
- Pull nose to horizon while avoiding excessive "g" forces.
- Use power and speedbrakes as required.

RUDDER AND ROLL EXERCISE

Begin the maneuver at about 10000 feet AGL, in a clean configuration.
Roll the aircraft to a 60° bank and return to level using full throw of the aileron only.
To introduce rudder authority, smoothly apply full rudder to roll the aircraft a nominal amount and return to wings level using rudder only.
Rapidly roll (not necessarily with full throw) the aircraft to 90° bank and return to wings level using aileron only. Observe the amount that the nose drops.
Again roll to and return from a 90° bank using aileron only to roll in and aileron with rudder to roll out. Observe the improved roll rate and the reduced amount that the nose drops.
Do rolls and returns to higher bank angles using aileron to roll in and add rudder with aileron when rolling out. Each time, practice glancing across at other ADIs to confirm the attitude and immediately rolling wings upright.
Observe the position of the bank index or "sky pointer" during the recovery to level flight. Be sure the wings are in a near upright and level position before pulling the nose up toward the horizon.

UNUSUAL ATTITUDE RECOVERY EXERCISE

Recoveries should be practiced at nose high and nose low attitudes, at various airspeeds and at extreme bank angles. Simulator software may be used to induce the unusual attitude or the instructor/pilot may fly the aircraft to the desired attitude. 'Recoveries may be practiced at high and low altitude and in various configurations.

APPROACHES

Terminal instrument operations; approach procedures types and limitations; and straight-in Category I Approach Procedure minimums are authorized and procedures outlined in Operations Specification 0051, CO52, 0053, CO54, and C074

DESCENT

Enroute Descent

The cockpit workload increases gradually as the airplane descends into the terminal area. Good judgment dictates that distractions be minimized and administrative and non-essential duties be completed before descent or held until after landing. The earlier that essential duties can be performed, the more time will be available in the more critical approach and landing phases.
Other factors permitting, maintain cruise altitude until reaching the proper distance for the planned descent. Deviations from the descent schedule can result in arriving too high at destination requiring a circling descent, or too low and far out requiring extra time and fuel and unnecessary exposure to possible low altitude weather penetration in icing or turbulence.
The descent schedule in the Performance Manual accounts for a speed restriction of 250 knots below 10,000 feet. Adjust top of descent (TOD) for altitude and airspeed restrictions and allow about ten miles for level flight prior to approach fix of airport.

The GPS can be used for descent planning by monitoring the time to go to destination, present rate of descent, and altitude change required. For example, time to go to clearance limit, ten minutes; present rate of descent, 1,500 feet per minute; altitude change from present altitude to clearance limit, 20,000 feet; flight profile change required; increase rate of descent to 2,000 feet per minute.

The crew, having maintained an awareness of the destination weather and traffic situation and having considered the requirements of a potential diversion, 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 TOD, so the crew may give full attention to airplane control.

The descent profile and speed schedule are sometimes varied by ATC or weather conditions. The pilot should select a descent schedule to provide passenger comfort, schedule compliance and economy. Before descent, check terminal information. Review approach charts and procedures. In marginal weather, review routing to alternate. Use DME, GPS, ground radar and any other means to accurately fix distance out before commencing descent.

Close-in, low-speed, descents may be accomplished with landing gear and flaps extended. Use the Altitude Alert System for warning approaching assigned altitudes and standard Call Outs.

Descent Schedule

Several descent schedules are shown in the Operations Manual to allow flight crews to select the most appropriate one for the existing conditions. These schedules are based on an idle thrust descent in a clean configuration for a straight in approach. Any anticipated additional time or fuel requirements should be added to these figures. Flaps down maneuvering fuel is 500 lbs. per minute. The descent profile may be varied slightly by changing airspeed. When too low on profile, reduce airspeed. When too high on profile, increase airspeed within limits.

Use of Radio Altimeter Procedures

To enhance the flight crew's terrain awareness, the RA DH will be set at 200 feet. The radio-altimeter indication should be included in the instrument scan for approach. Flight crews should call radio-altimeter indications that are below obstacle-clearance requirements during the approach. The radio altimeter indications should not be below the following minimum heights:

- 1,000 feet during arrival until past the Initial Approach Fix (IAF), except when being radar-vectored;
- 500 feet when being radar-vectored by ATC or until past the Final Approach Fix (FAF); and,
- 250 feet from the FAF to a point on final approach where the aircraft is in visual conditions and in position for a normal landing, or within 1 mile from the landing threshold.

Flight Engineer Descent Procedures

In planning the descent, crew coordination is most important. The FE must know the type of descent planned, i.e., low speed or high speed. When these factors are known, the FE can set his pressurization for the proper rate, as well as determine the landing weight of the airplane. He will also be able to provide the Captain with the landing data.

Minimum thrust settings for pressurization are not required during descent. When the engines are at idle thrust the high stage bleed system provides adequate pressure to hold an acceptable cabin rate of pressure change.
The FE will, in addition to his normal monitoring of the engine instruments on the forward center panel, monitor communications and flight instruments, especially altitude and airspeed. He should watch for visual cues approaching DH / MDA during an instrument approach and be alert for a missed approach. He should assist in maintaining a watch for traffic and other factors that could adversely affect safety.
The flight crew should cross check radio and pressure altimeters from time to time during the approach and maintain an altitude awareness.

ICING

Engine and Nacelle Icing
The timely use of recommended nacelle anti-icing procedures cannot be over-emphasized for the high bypass engines used on the 747. Several incidents, ranging from partial loss of thrust on one or more engines to one or more engine flameouts, have occurred. These incidents occurred during flight through icing conditions with nacelle anti-icing either not activated or activated but with insufficient N1. Engine icing often forms when not expected and may occur when there is no evidence of other icing on the windshield or other parts of the airplane. Once ice commences to form, an appreciable accumulation can build up with surprising rapidity. Engine and nacelle icing conditions should be anticipated when the TAT is plus 10°C or less and visible moisture (fog, rain, snow, sleet, ice crystals, etc.) is present.
When using engine anti-ice during the descent, monitor and maintain sufficient N1 to keep the flashing LOW N1 annunciator light extinguished (At least 50% N1 at or above 10,000 feet and 45% N1 below 10,000 feet). This will ensure adequate heat is being supplied for engine nacelle anti-icing. In addition, the pneumatic duct pressure should be maintained at or above 15 PSI.
When holding in icing conditions, monitor pneumatic duct pressure to ensure adequate nacelle and wing anti-icing. Thrust requirements for holding at light gross weight may be in the region of the bleed air switching point (high stage bleed switching to low stage bleed). The resulting drop in duct pressure to less than 15 PSI will result in low nacelle and wing anti-icing performance. Increased duct pressure can be obtained by:

- Reducing thrust to switch to high stage bleed air.
- Increasing thrust to obtain higher pressure from the low stage bleed.
- Reducing air conditioning bleed to two-pack operation.
- Setting two engines at minimum thrust (45% or 50% N1) and the other two as required. This will provide adequate pressure with two engines bleeding high stage and two engines bleeding low stage air.

Wing Icing
Normally, wing TAI operation is not required. Do not use wing anti-icing with the leading edge flaps extended. Use wing anti-icing system after an appreciable amount of ice has formed or after leaving the icing zone and prior to extending the leading edge flaps. It should not normally be used as an anti-ice system, i.e., turned on continuously in icing conditions, due to performance penalties and runback ice formations. Ensure that the wing TAI is off when the wing flaps are extended to prevent heat damage

to the forward wing section aft of the LED.
Flap extension
Flap extension is programmed to decrease airspeed without large thrust or trim changes. Extend flaps to the next lower position as airspeed approaches the minimum for full banking capability at present flap position; i.e., select flaps 1 when airspeed approaches Bug + 80 etc..
These speeds are well below flap placard speeds. Flap service life is reduced if flaps are continually extended at or very near flap placard speeds and passenger comfort is reduced. Airspeed reduction in the flaps-up configuration is best obtained by thrust reduction and speed brakes. In the flaps-down configuration, it is best obtained by thrust reduction and landing gear. "Nose-up" trim is required when flaps are extended from zero to position 5, primarily because of the decrease in airspeed. A very small trim change is required when flaps 20 is selected. A small amount of "nose-up" trim is required when selecting flaps 25. When flaps 30 is selected a noticeable pitch down occurs requiring further "nose-up" trim.
Maneuvering Speeds
Airspeeds shown on flight profiles are recommended speeds at approximate maximum fuel economy, provide a high degree of speed stability and allow full maneuvering capability.
One Engine Inoperative
An approach with one engine inoperative is the same as a normal approach. Zero rudder trim prior to landing.
Final Approach
The main objective is to position the airplane so that a stabilized final approach may be flown to landing. The desired visual final approach condition is airspeed at Bug plus wind correction and a 2.5 to 3 degree glide path that will result in main landing gear touchdown at least 1,000 feet beyond the runway threshold. When the desired conditions are established, maintain them to flare height. Do not "duck under" an established glide path near the runway threshold to achieve an early touchdown.

EMERGENCY DESCENT

This maneuver is designed to bring the airplane down smoothly to a safe cabin altitude in the minimum time with the least possible passenger discomfort. It is intended as a specialized case to cover an uncontrollable loss of cabin pressurization. When it is used for other than pressurization problems or contamination of cabin atmosphere, the oxygen procedures may be omitted.
Rapid Depressurization Causes
An uncontrollable loss of cabin pressurization is a rare occurrence in line operations. It may be caused by a malfunctioning pressurization system or structural damage. In either case, initiate the RAPID DEPRESSURIZATION checklist and ascertain that the cabin pressure is uncontrollable before initiating the rapid descent. When structural integrity is in doubt, limit configuration change and speed as much as possible, preferably at or below the existing speed at the time of the problem. Attempt to determine the extent of damage from cabin crewmembers. Use a reduced rate of descent if necessary and avoid high maneuvering loads.

RAPID DESCENT CONFIGURATION

Rapid descents are made at idle thrust with the speedbrake extended. The use of

extended landing gear for aiding the descent depends on the amount of passenger oxygen time available, the requirement to level off at intermediate altitudes over very high terrain, and the possibility that the aircraft has sustained structural damage.
Descents with landing gear extended are made at the gear limit speed (320 knots / M.82), while descents with landing gear up should be made at MMO / VMO.
The following chart shows typical descent profiles from a cruise altitude of FL 450 and a cruise speed of M.84 using both configurations. Note that descent times from FL 450 to FL 250 are approximately the same for both configurations. A gear up descent requires about 1 1/2 minutes longer to descend to 10,000 feet.
Some advantages and disadvantages of the two configurations are shown in the table above.

CONFIGURATION: GEAR UP GEAR EXTENDED

- Shallower descent attitude • Minimum time to 10,000
- Higher level off speed feet

ADVANTAGES • good performance for • Lower speed for structural intermediated level off damage

- Better fuel mileage
- Longer time to 10,000 feet • Steeper attitude
- Higher speed for structural • Major configuration change

damage - Deceleration required to
DISADVANTAGES lower gear prior to descent

- potential requirement for

speeds below minimum
maneuvering
Entry and Level Off
The entry may be accomplished on heading or a turn may be used to facilitate entry, establish descent attitude, or to clear the airway or controlled track. Maintain altitude until reaching landing gear operating speed. Avoid abrupt control inputs and negative "g" forces.
At high gross weights, landing gear extension speed may be less than the minimum maneuvering speed. Under these conditions make a smooth, wings level entry. To minimize exposure to initial buffet, carefully monitor the entry speed until the landing gear doors are closed.
If the landing gear is used, expect a slight nose up pitch as gear extends. As landing gear extends, smoothly lower the nose to approximately 10 to 15 degrees below the horizon and accelerate to target speed. Do not exceed gear extension speed until the gear indicate down and the gear doors indicate closed. When a turn entry is used, roll wings level as pitch attitude is established and at least 10 knots before target speed.
Adjust pitch attitude to maintain target speed and keep in trim at all times.
The NFP should call out every 5000 feet, 2,000 feet above and 1,000 feet above level off altitude.
When turbulent air is encountered, reduce to turbulent air penetration speed.
If the descent will enter icing conditions, use engine anti-ice and thrust as required. If structural integrity is in doubt, limit speed as much as possible, preferably at or below the existing speed at the time of the problem and avoid high maneuvering loads.
Approaching level off altitude, smoothly adjust pitch attitude to reduce rate of descent.
The speed brake lever should be returned to the down decent when

approaching the desired level off altitude. Retract the landing gear below gear retraction speed limit. After reaching level flight, add thrust to maintain desired speed, and determine new course of action.

Use of the Autopilot

At the Captain's discretion, the autopilot may be disengaged and the emergency descent flown manually, or left engaged and used to accomplish the descent. If the autopilot is used for descent, the heading select may be used if desired to effect a turn while waiting for deceleration to landing gear operating speed. A turn is not required but may be accomplished to clear present airway or controlled track.

After the landing gear lever is placed down, place the Altitude Mode Switch to OFF and use the autopilot Manual Pitch or Control Wheel Steering (CWS) to lower the nose to approximately 10° nose down pitch. Due to automatic stabilizer trim lag, the pitch attitude should be stopped at about 5° nose down and then slowly stabilized at about 10° nose down. Do not exceed the gear placard speed until all gear doors are closed. Adjust the pitch attitude to maintain 320 IAS /.82 Mach. This will initially require 10 to 20 degrees nose down.

Do not use IAS or MACH HOLD until stabilized in descent. During descent set the desired level off altitude on the Altitude Selector and set the Altitude Mode Switch to Altitude Select (Do not use ALT SEL until rate of descent is less than 5,000 fpm). Set the A/T Speed Selector on the desired level off airspeed. Approaching 2,000 feet above level off altitude, select WS and select 500 fpm descent. Monitor the altitude capture and advance power as the landing gear is retracting.

NOTE: If the rate of descent is not reduced approaching the level off altitude the autopilot may allow the airplane to descend through it. The altitude detector may not "see" the selected altitude and therefore would not capture it.

APPROACHES AND LANDINGS

LANDING BUGS

All normal landings (4 or 3—engine) will be performed using Flaps 25. Flaps 25 landings are required to comply with Stage III noise provisions. Icy runways, emergencies, landing runway performance and Captain's discretion may require landing with Flaps 30.

FLAPS 25

The Command Bug is utilized as a target speed as flaps are extended on schedule. Since any target speed for a particular flap setting does not provide full maneuvering capability except for VREF + 100, a buffer of 10 knots is to be used while maneuvering prior to final approach. After established on final approach, the Command Bug is lowered to the actual target maneuvering speed fora given flap setting, since banks in excess of 15° are not likely. Full maneuvering capability would also be provided for a given flap setting by using the next higher flap setting speed.

Perimeter Bugs are set to:

VREF 25,

VREF + 20,

VREF + 40,

VREF + 60,

and VREF + 80 knots.

As flaps are progressively lowered and the aircraft slowed, the NFP will change the Command Bug to constantly reflect the target speed to be flown. After flaps are selected to 25°, the Command Bug will be selected to VREF 25 plus 1/2 steady wind plus gust factor, to a maximum of 20 knots. In all wind conditions, add a minimum of 5 knots to VREF. Advisory airspeed calls by the NFP will be relative to the command bug. If a subsequent missed approach is necessary, the Command Bug is then utilized as targets for progressive flap retraction as in normal takeoff.

FLAPS 30

The Command Bug is utilized in the same manner as for the Flaps 25 landing.
Perimeter Bugs are set to:
VREF 30,
VREF + 20,
VREF + 40,
VREF + 60,
and VREF + 80 knots.
Abnormal Landing

JAMMED STABILIZER

ONE OR MORE LED INOPERATIVE
TWO HYDRAULIC SYSTEMS INOPERATIVE
Since less than normal flaps and/or controllability with the primary flight control surfaces is a factor, all maneuvering speeds are increased as well as VREF. The factor of 20 knots is added to all normal speeds, and the final flap setting is 25°, although all additives are made to VREF 30.
The airspeed indicator will have the identical appearance as for the normal Flaps 30 landing - all speeds are simply increased. It should be noted that the highest airspeed bug which would ordinarily represent clean maneuvering speed with 15° bank capability only, could now be utilized as clean maneuvering speed with 30° bank capability due to the added speed. However, all other bugs represent speed / flap combinations that are limited to 15° bank only. The Command Bug is utilized during flap extension / retraction as in normal landings or missed approaches.
With the increased airspeed required for controllability, care must be taken to adhere to the maximum limitations for flap operating speeds.
NOTE: It is reasonable to assume that stall speeds would be increased for landings with less than all Leading Edge Devices or Trailing Edge Flaps, and to a lesser extent, a jammed Stabilizer. Therefore, for One or More LED inoperative, Jammed Stabilizer, or Asymmetric/Split Trailing Edge Flaps approaches, 20 knots will be added to the Flaps 25 stall speed and noted on the Landing Data Card.

Asymmetric/Split Trailing Edge Flaps
This maneuver is performed with a final flap setting of 25° and airspeed additives are applied to VREF 30. The new VREF is VBEF 30 + 25 knots, with all other target perimeter bugs in 20 knot increments. . The remainder of the procedures are identical to Jammed Stabilizer, One or More LED inoperative, and Two Hydraulic Systems inoperative. The Command Bug is utilized in the normal manner.
Zero Flap
Although the inability to extend flaps to some setting other than zero is remote, and

crews are not checked to proficiency on this maneuver, the following material is provided for standardization.
Only two perimeter bugs are utilized - VREF 30 plus 80 knots, corresponding to clean maneuvering with 15° bank maximum, anW:VREF 30 plus 70 knots, which becomes VgEF' All remaining perimeter bugs are stacked at the top of the airspeed indicator.
Tie Command Bug is utilized in the normal manner.

ILS / ILS DME

ILS APPROACH PREPARATIONS

Thorough planning and briefing are the key to a safe, unhurried, professional, approach. All pertinent factors such as minimums, missed approach, and instrument failure procedures, etc. should be reviewed and alternate courses of action considered prior to beginning an approach.
Part of the approach briefing should include delegation of duties regarding use of windshield wiper and rain repellent systems. Often it is difficult to anticipate the need for these systems so planning is desirable. Landing, wing, and logo lights make the airplane more conspicuous at night and during twilight; for this reason, they are normally used throughout the final approach. Complete the approach preparations before arrival in the terminal area.

Localizes Intercept

The H.S.I. course deviation indicator (CDI) will remain at a full-scale deflection until the airplane is approximately 2Y2 degrees off course. The magnetic bearing information on the RMI should be used to supplement the CDI during initial course interception.
Begin the turn to the inbound localizer heading at the first movement of the CDI.
After course interception, maintain the published heading plus or minus the GPS drift; i.e., rollout on the inbound course plus or minus the drift correction. When tracking inbound, large bank angles will rarely by required.
While maneuvering to hold the localizer, 5 degrees to 10 degrees bank angle will normally be sufficient.

Final Approach

Adjust to final approach configuration and airspeed as the glide slope is intercepted. Check altitude and time crossing the outer marker to check on glide slope accuracy and to know when to start a missed approach if the glide slope information is lost during the approach. Make instrument cross checks and check for flags. When stabilized on the glide path, note the rate of descent, body attitude and thrust required. Use the values noted as references and maintain them until flight path or airplane performance dictates a need for corrections. Apply corrections at approximately the same rate and amount as the flight path deviations. Avoid tendency to chase the course deviation and glide slope indicators.

Decision Attitude (DA)

The NFP should expand his instrument scan pattern to include outside visual cues when approaching DH. Do not continue the approach below decision height unless the airplane is in a position from which a normal approach to the runway of intended landing can be made and adequate visual reference can be maintained.
If upon arrival at decision height, or any time thereafter, any of the above requirements

are not met, immediately execute the missed approach procedure. Do not "duck under" the glide path to achieve touchdown short of ground point of intercept.
The FE, in addition to his regular duties, should cross check flight instruments, be aware of altitude, be alert for missed approach and watch for visual cues approaching

DA.

NOTE: DH is normally indicated on a radio altimeter for Category II operations, unless not authorized due to approach terrain irregularities. DA for Category I operations is indicated on the pressure altimeter.
Flight Instrument / ILS Component Failure
Immediately execute a missed approach if less than 500 feet above field elevation in instrument conditions and a failure is noted in a flight instrument or an ILS component, or a significant deviation from the ILS flight path exists, or the Captain's and FO's flight instruments disagree. A new course of action can be determined after corrective action has been taken for the failure.

ILS One Engine Inoperative

An ILS approach with one engine inoperative is the same as a normal ILS. Zero rudder trim prior to touchdown. Realize performance margin is reduced and maintain stable airspeeds.
Glide slope in excess of 3°
Some ILS approaches have glide slope angles in excess of 3°, primarily due to terrain in the approach area. If such an approach is being used, the following items apply:

1. No tail wind is allowed.
2. Land at the lightest weight possible.
3. Do not try to capture the glide slope from above.
4. Sink rate may be more than 1,000 fpm.
5. A very low power setting will be required.
6. Fly the aircraft on speed.

NOTE: Flaps 30° landing should be considered, if in the Captain's discretion operational necessity dictates its use.
30 VREF (+) speeds are minimum speeds. The command airspeed bug should be set at 10 knots above these speeds until on final approach when bank angles will not normally exceed 15 degrees.
Approx. 1 min. past LOM (depending on wind) start procedure turn.

ILS TWO ENGINES INOPERATIVE

This procedure does not imply that an ILS approach must be flown W two engines are inoperative. It simply provides the pilot with an alternate approach procedure if good weather conditions do not prevail and indicates where configuration changes take place in the ILS pattern.
NOTE: See Two ENGINE INOPERATIVE LANDING in this section for procedural discussion.
Approach Preparations:

- Initiate two-engine inop checklist
- Check weather
- Reduce weight to minimum

- Standard call outs

ILS FINAL APPROACH AND LANDING GEOMETRY (ANTENNA 52 FT)

Antenna Location Versus Main Landing Gear Path
The ILS glide slope tracking antennas are located in the nose gear doors approximately 20 feet above the main landing gear (normal approach attitude, oleo struts extended and landing gear tilted). The illustration shows the main landing gear crossing the threshold at a height of 32 feet with a glide path angle of 3.0 degrees and a ground point of intercept of 1,000 feet beyond the threshold. Marginal threshold clearance may exist when the glide path angle is less than 2.5 degrees and / or the glide slope ground point of intercept is less than 1,000 feet beyond the runway threshold. The situation becomes more critical if the airplane is below the glide path near the runway threshold.

ILS FINAL APPROACH AND LANDING GEOMETRY

Threshold Height
During an ILS approach, main landing gear height at the runway threshold is a function of glide slope angle, glide slope ground point of intercept, and glide slope receiver antenna location on the airplane. In first-generation jet transports it was assumed that any approved ILS would provide a safe threshold clearance for the landing gear and a touchdown in the normal touchdown zone. This assumption was not necessarily true if the glide path was followed to main gear touchdown with no flare.

ILS Geometry

A typical ILS may have a 2.75 degree glide path, a glide path threshold height of about 50 feet and a ground point of intercept of 1,000 - 2,000 feet beyond the runway threshold. Assuming an "on the glide path" condition, the main landing gear would cross the runway threshold at a height of 28 feet.
An approved ILS may have a glide path as low as 2 degrees and a ground point of intercept of only 750 feet beyond the runway threshold. Under these conditions, threshold clearance and landing gear touchdown zone safety margins would not be adequate. The main landing gear height at the threshold would be about 7 feet and gear touchdown could occur about 200 feet beyond the runway threshold (no flare).
ILS installations approved for Category II operations must have a glide path threshold clearance of 47 to 60 feet. Glide path threshold clearance for other than Category II ILS installations must be determined by reference to approach plates and / or contact with airport authorities.

ILS PRM SYSTEM

An approach system permitting simultaneous ILS / PRM approaches to dual runways with centerlines separated by less than 4,300 feet, and equipped with final monitor controllers. To qualify for reduced lateral runway separation, final monitor controllers must be equipped with high update radar and high resolution ATC radar displays, collectively called a PRM system. The PRM system displays almost instantaneous radar information. Automated tracking software provides monitor controllers with aircraft identification, position, a ten-second projected position, as well as visual and aural controller alerts. Simultaneous close parallel ILS / PRM approaches are identified by a separate Approach Procedure Chart named ILS / PRM (Simultaneous Close Parallel). The name ILS / PRM is derived from the Precision Runway Monitor System which provides a means for simplifying the name of the simultaneous close parallel ILS approach.

REQUIREMENTS

The following requirements must be met in order to fly an ILS / PRM approach:

- Pilots must have completed ILS / PRM training, which includes viewing the ILS / PRM training video.
- All ATC directed "breakouts," a vector off the ILS prior to the decision altitude (DA), must be hand-flown.
- If the airport has two tower frequencies operating for each runway, the aircraft flying the ILS / PRM approach must have the capability of enabling the pilot to listen to two frequencies simultaneously. Pilots shall advise air traffic control within 200 miles of the airport of intended landing if the pilot(s) are not qualified and/or the aircraft is not equipped to fly the approach.

RADAR MONITORING

Simultaneous close parallel ILS / PRM approaches require final monitor controllers utilize the Precision Runway Monitor system to ensure prescribed separation standards are met. To ensure separation is maintained, and in order to avoid an imminent situation during simultaneous close parallel ILS / PRM approaches, pilots must immediately comply with final monitor controller instructions to avoid an imminent situation. A minimum of 3 miles radar separation or 1,000 feet vertical separation will be provided during the turn on to close parallel final approach courses. In the event of a missed approach, radar monitoring is provided to one-half mile beyond the departure end of the runway. Final monitor controllers will not notify pilots when radar monitoring is terminated.

DIFFERENCES BETWEEN ILS AND ILS PRM APPROACHES OF IMPORTANCE TO THE PILOT

Runway Spacing

Prior to ILS / PRM approaches, most ATC directed breakouts were the result of two aircraft in trail getting too close together. Two aircraft going in the same direction did not mandate quick reaction times, but two aircraft along side each other separated by less than 4,300 feet and closing at 135 feet per second, does constitute the need for quick action. A blunder has to be recognized by one controller, the information passed on to another controller and breakout instructions issued to the endangered aircraft. The pilot will not have any warning that a breakout is imminent because the blundering aircraft will probably be on another frequency. To conduct PRM approaches pilots must keep an increased sense of awareness, to immediately act and respond to an ATC instruction (breakout) or TCAS alert, and breakout away from a blundering aircraft.

A "blunder" is an unexpected turn by an aircraft already established on the localizes toward another aircraft on an adjacent approach course. A "breakout" is a technique used to direct aircraft out of the approach stream. For close parallel operations, a breakout is used to direct an aircraft away from a blundering aircraft while simultaneous operations are being conducted.

Because of the traffic operating closer in IMC conditions it is urgent that crews conduct careful briefings using the approach plate and "attention all users page". The information is to raise pilot awareness, and help crews in being prepared to respond immediately to the controller's breakout instruction, or a TCAS alert.

Communications

To help in avoiding communication problems caused by stuck mikes and two parties talking at the same time, two tower frequencies for each runway will be in use during ILS / PRM approach operations. The tower controller and the monitor controller will be broadcasting on both of the assigned frequencies. The monitor controller has the capability of overriding the tower controller. The pilots flying the approach will listen to both frequencies and only broadcast on the primary tower frequency. If a breakout is initiated by the monitor and the primary frequency is blocked by another transmission, the breakout instruction will be able to be heard on the second frequency.

Hand-flown Breakouts

The use of the autopilot is encouraged while flying an ILS / PRM approach, but the autopilot must be disengaged in the rare event that a breakout is issued. Simulation studies of breakouts have shown that a hand flown breakout is initiated consistently faster than a breakout performed using the autopilot.

Descending Breakouts

In the past, breakout descents were rarely given to pilots when flying on the ILS localizes and glideslope. A greater chance exists for the controller to issue a descending breakout when there is a blundering aircraft from an adjacent approach course crossing an aircraft's path. Pilots must be aware that a descending breakout is a possibility. In no case will the controller descend an aircraft below the Minimum Vectoring Altitude (MVA) which will provide at least 1,000 feet clearance above obstacles. The pilot is not expected to exceed 1,000 feet per minute rate of descent in the event a descending breakout is issued.

TCAS

The ATC breakout instruction is the primary means of conflict resolution. TCAS, if installed, provides another form of conflict resolution in the unlikely event other separation standards would fail.

The TCAS provides only vertical resolution of aircraft conflicts, while the ATC breakout instruction provides both vertical and horizontal guidance for conflict resolutions. Should a TCAS Resolution Advisory (RA) be received, the pilot should immediately respond to the RA. If following a RA requires deviating from an ATC clearance, the pilot shall advise ATC as soon as practical. While following a RA, comply with the turn portion of the ATC breakout instruction unless the pilot determines safety to be a factor. Adhering to these procedures assures the pilot that acceptable "breakout" separation margins will always be provided, even in the face of a normal procedural or system failure.

PROCEDURES

During turn on to parallel final approach, aircraft will be provided 3 miles radar separation or a minimum of 1,000 feet vertical separation. Aircraft will not be vectored to intercept the final approach course at an angle greater than thirty degrees.

The final monitor controller will have the capability to override the tower controller on the tower frequency.

Pilots will be instructed to monitor the tower frequency to receive advisories and instructions.

Aircraft observed to overshoot the turn-on or to continue on a track which will penetrate the NTZ will be instructed to return to the correct final approach course immediately. The final monitor controller may also issue missed approach or breakout instructions to the deviating aircraft.

PHRASEOLOGY-

"(Aircraft call sign) YOU HAVE CROSSED THE FINAL APPROACH COURSE. TURN (left/right) IMMEDIATELYAND RETURN TO THE LOCALIZER 1AZIMUTH COURSE,-

or

(aircraft call sign) TURN (left / right) AND RETURN TO THE LOCALIZER / AZIMUTH COURSE."

If a deviating aircraft fails to respond to such instructions or is observed penetrating the NTZ, the aircraft on the adjacent final approach course may be instructed to alter course.

PHRASEOLOGY-

'TRAFFIC ALERT" OR "BREAKOUT ALERT" (aircraft call sign) TURN (left lright) IMMEDIATELY HEADING (degrees), (climb / descend) AND MAINTAIN (altitude).

Radar monitoring will automatically be terminated when visual separation is applied, the aircraft reports the approach lights or runway in sight, or the aircraft is .5 NM beyond the runway departure end. Final monitor controllers will not advise pilots when radar monitoring is terminated.

FLIGHT DIRECTOR SYSTEM

All modes to the autopilot, except turbulence (TURB), are also provided for the flight director. Simultaneous or selective operation of the flight director and autopilot is possible. BACK BEAM mode is a flight director mode only. Flight director modes of operation discussed in the airplane Operations Manual must be thoroughly understood for effective flight director use.

Flight Director Use

Flight director commands should be followed smoothly and precisely. Do not concentrate excessively on the flight director commands, but scan and respond appropriately to the entire flight instrument and flight mode annunciator (FMA) display. Realize that the flight director commands only the appropriate action and does not show airplane altitude or position in relation to the desired flight path.

NOTE: If the Captain is flying the 'A' autopilot / flight director computer and the "B" computer captures the glide slope, the altitude hold function for both computers will be tripped and the Captain's flight director will command a pitch altitude with reference to the manual pitch setting last set on his flight director. If the last manual pitch setting was a nose-down command, the Captain could start a descent away from the glide slope if he failed to cross check the raw data and the FMA.

CAUTION: WHENEVER THE F/D PITCH COMMAND BAR IS NOT BEING USED, STOW IT IN THE FULL-UP POSITION TO AVOID INADVERTENTLY FOLLOWING A PITCH-DOWN COMMAND.

During area arrival for ILS approach, both flight directors should be ON and the Navigation Mode Selector switch placed to HDG. When established on Localizes intercept heading and cleared for the approach, or when established procedure turn inbound, check that Navigation mode is selected to ILS and that NAV and GS annunciators are armed indicating intercept circuits are armed. With NAV armed, the heading bug is still usable to set vector headings. When the FMA indicates NAV capture, indicating automatic capture has started, the intercept angle will be commanded by the flight director. (Heading settings will no longer control heading command.) Set heading bugs to runway heading for use in HDG mode in case of a missed approach. Prior to glide slope capture, all pitch modes are available. When the glide slope indicator centers, the FMA will indicate glide slope capture and the flight director will command glide slope tracking. Set the altitude Selector to the missed approach altitude.

Go Around Mode

Be careful not to inadvertently actuate the go-around switches during the approach. If they are inadvertently actuated, cycle the Navigation Mode Switch to VOR-LOC and back to ILS. The flight director should return to the capture mode. The NFP and the F/E should be briefed to back-up the FP on actuating the go-around mode and disengaging the autothrottles (if required) in case of a missed approach.

If the go-around is initiated prior to localizer capture (1,500 feet for later airplanes) the flight director will command a nose up pitch and wings level. When the go-around is initiated after localizer capture, the flight director commands a set rate of climb for early airplanes and attempts to maintain ground track.

For later airplanes, the flight director commands a longitudinal acceleration-programmed rate of climb. This provides an initial rate of climb of approximately 500 feet per minute which is augmented by using excess thrust for additional climb rate. Switch the Navigation Mode Selector to HDG. Set the Speed Mode switch to IAS or V/S as desired. Check that the ALT SEL is set to the desired altitude and the Altitude Mode switch to ALT SEL.

Distortion Of Localizes / Glide Slope Beam

The performance of the flight director system will vary, depending on the quality of the facility in use. Extra caution should be exercised during an approach to an unfamiliar facility. Airplane or ground vehicles moving or parked near the ILS runway may cause distortions of the localizer and / or glide slope beam. A preceding airplane on the approach may cause oscillations of the beams. A departing airplane on the ILS runway may also cause localizer beam distortion. The pilot is the master monitor, and approach progress should be continually assessed.

Flight Director Switching

For all ILS approaches Course Selectors 1 and 2 should be set on the inbound course and both VHF navigation radios tuned and identified for the ILS facility. This arrangement provides an independent crosscheck of approach progress and precludes inappropriate flight director commands, if instrument switching is required. If a flight director or flight instrument fault is indicated by the central instrument warning system or warning flags, control the flight path of the airplane by reference to the basic flight instruments (raw data) or allow the other pilot to control the airplane. Evaluate the instrument / warning display and determine the source of the fault. If a heading, altitude, or radio fault is indicated, correct it by using the appropriate instrument transfer switch. If a flight director computer fault is indicated, select an alternate computer not in use, using the computer selector switch. If a flight instrument failure occurs at an altitude less than 500 feet above field elevation, while in instrument conditions, execute a missed approach.

AUTOPILOT APPROACH

Autopilot

Automatic approach functions are provided only in the command mode. Hydraulic pressure must be available from hydraulic systems 2 or 3 for single channel operation.

COUPLED APPROACH – FALSE COURSE CAPTURE

The localizer capture criterion designed to minimize localizer overshoot may initiate false captures in areas located well off course where receivers cannot properly process the localizer modulation levels. These false captures are short-lived deviations, as they are not followed by the appropriate localizer guidance.

False course captures may occur when the pilot selects Approach mode from either HDG or LNAV mode. Some ILS receivers produce lower than expected course deviation outputs in the presence of high modulation levels of the localizer radiated signal. The reduced course deviation can, in turn, trigger a false course capture in the ARCS. False course captures are most likely to occur in the vicinity of 8 to 12 degrees azimuth from the published localizer course. This equates to approximately 1.3 NM when intercepting the localizer at 10 NM from the threshold.

The following procedures will be used to minimize the possibility of a false course capture:

1. Approach mode will not be selected until the aircraft is within the ILS service volume, approximately 18 NM from the threshold.
2. The ADF bearing associated with an appropriate NDB site will be monitored for correct runway orientation, if available.
3. Raw data will be monitored along with the flight director and ILS indications, to determine that the aircraft is on the correct path.

If a false capture occurs, it may be necessary to deselect and rearm the Approach mode in order to achieve a successful coupled approach on the correct course.

Autopilot / Flight Director Computer Tolerances

Later autopilot / flight director computers have reduced roll rate and bank angle gains for most modes of operation when the TAS exceeds 296 + 20 knots. Slight differences may be noted between flight director roll commands and / or autopilot operation when the airplane is operating in the 276 to 316 knot TAS range; i.e., the "A" autopilot may bank the airplane to 27-1/2 degrees for a turn and the Captain's flight director may command less bank while the F/O's flight director may agree with the Captain's or with the autopilot. This TAS range normally occurs above 10,000 feet while the airplane is accelerating to the climb schedule and should be of short duration.

When Established on Localizer Intercept

Heading:

- NAV mode switch – ILS
- Second autopilot – command
- FMA:
- NAV – armed
- GS – armed
- Dual – armed Radar Vector

After Localizer

Capture:

- Runway heading

GS Capture:

- FMA
- GS – capture
- Go-around – armed
- ALT SEL
- Missed Approach

altitude

Approaching Localizer or Outer Marker

- Radio / INS switches – radio / VOR ILS
- NAV mode switch – HDG
- Heading selector – select localizes intercept or

desired heading

- Course selectors – select ILS inbound course
- Both VHF navigation radios – select ILS

frequency

- F/D switches – ON
- A/T speed selector – as required
- A/T Engage SW – optional
- F/D computers – Capt. and FO on different

computers

Missed Approach:

- Go-around switches – press
- FMA:
- NAV and GS – blank
- Go-around – engaged

When established in go-around:

- NAV mode switch – HDG
- Speed mode switch – as desired

Autopilot Hardovers

During airplane certification the autopilot system was demonstrated with hard-over signals and open feed-back faults. These demonstrations have shown to be completely safe under the more stringent criteria required by the Aeronautical Review Board (allowing 5 seconds prior to corrective action when the fault was introduced in straight and level flight). The test hardover resulted in easily identifiable airplane response conditions which were well within the capability of flight crew recognition and control. Simultaneous roll and yaw hardovers were also demonstrated.

One open feed-back test resulted in a slowly developing oscillatory airplane response (3 second period in pitch and 4 second period in roll). These conditions were readily detectable and were easily controlled even if allowed to develop for many cycles.

Autopilot / attitude malfunctions during dual or triple autopilot operation are annunciated and flight path deviations are negligible due to the dual / triple system logic.

Single channel autopilot coupled approach pitch hardovers have been demonstrated with the following results:

- Maximum glide slope deviation above 100 feet altitude was 25 feet below the

glide slope (corrective action was not initiated until one second after recognition).

- Maximum glide slope deviation below 100 feet (recovery initiated without delay after recognition) was negligible.
- Flight crews should realize that these failures are possible in all type airplanes and should be detectable by unexpected attitude, altitude or CIWS annunciation. Corrective action should be taken as soon as the problem is recognized. The flight crew should crosscheck all ADI's to determine which instruments are correct and take immediate appropriate action such as disengaging the autopilot and / or transferring airplane control to the pilot with good flight instruments.

PAR APPROACH

A PAR approach is a precision instrument approach wherein the air traffic controller issues guidance instructions, for pilot compliance, based on the aircraft's position in relation to the final approach course (azimuth), the glide slope (elevation), and the distance (range) from the touchdown point on the runway as displayed on the controller's radar scope.

The only airborne radio equipment required for radar-controlled approaches is a functioning radio receiver and transmitter. By means of radar, the controller closely follows the flight path of the aircraft and issues instructions to align it with the centerline of the runway and keep it on course until the pilot can complete his approach and landing by visual reference to the surface.

PAR approach should not be flown using the autopilot.

Approach Preparations

Precision approach (PAR) is one in which the controller provides azimuth and elevation navigational guidance to the pilot. The aircraft follows the same flight path to the instrument runway as with the ILS approach.

Final Approach

Pilots are told when to anticipate glide slope interception, at which point they should begin a normal 700-800 fpm rate of descent. The flight director heading mode may be used for course guidance, and vertical speed mode for descent path guidance. If the aircraft deviates above or below the glideslope or to left or right of the runway extension line, the pilot is given the amount of deviation and asked to adjust descent or heading to correct. Range from touchdown is given at least each mile. If the aircraft deviates outside of specified safety limits in azimuth or elevation, and the pilot does not have ground reference, missed approach instructions are given.

Navigational guidance during an approach is given until the aircraft passes over the approach end of the runway, at which time he is directed to take over visually and complete the landing.

NON-PRECISION APPROACHES

VOR / VOR-DME / NDB / NDB-DME / LOC / LOC-DME / LIDA / LDA-DME / ASR

Approach Preparations

Complete approach preparations before arrival in the terminal area. Accomplish the procedural steps as illustrated. Flight director system use is recommended, except during NDB final approach.

Inbound Course Intercept

Inbound localizes only course intercept is handled in the same manner as in the "ILS" discussion. Final approach course intercept and track is directed by the controller during an ASR. The VOR final approach capture depends on intercept angle and rate of closure to the final course. Normally the capture will occur at slightly less than 5 degrees (one dot). Realize the 2 dots displacement on the HSI represents 10 degrees when a VOR frequency is selected on the NAV radio. Closely monitor the RMI and HSI during the approach. The RMI and the HSI will continue to show the actual position of the airplane with reference to the desired track. If the intercept angle is large and the airplane is close to the VOR, the flight director will not have time to satisfy the "on course" conditions that are required to reduce the bank angle and roll rate gains for course tracking and to arm the over station sensor (OSS). The conditions necessary to satisfy the "on course" are bank angle less than 3 degrees and airplane heading within 15 degrees of the selected course for approximately one second. The OSS will arm approximately eight seconds after the above conditions are met on late roll computers or at the same time the "on course" conditions are met for early roll computers. The OSS prevents the flight director from trying to follow the rapidly changing course signal as the airplane approaches the VOR. Allowing sufficient time and distance from the VOR for final course intercept will ensure "on course" conditions. Cross check ground speed and drift angle during the intercept angle accordingly. If the COI indicates a fast closure rate to the final approach course, reduce the intercept angle by a 15 to 20 degrees heading bug change prior to NAV capture.

Final Approach

Approaching final approach fix (FAF) landing gear should be extended. At the FAF, start timing, extend flaps to landing configuration, maintain airspeed to bug plus wind correction, and initiate descent to MDA. Descend to MDA at approximately 1,200 feet per minute to ensure reaching MDA before the missed approach point. Decrease vertical speed approaching MDA, to avoid premature descent below MDA.

GPS

The GPS furnishes GS and Drift Angle read-outs, and can be used to determine actual wind component on final approach to aid in assessing the potential for windshear and fix to field timing, plus proper drift correction throughout the approach.

NOTE: Head or tail wind components may be read directly on the GPS by selecting Nav page 3.

If missed approach or go-around is necessary, apply and call for Max Power. Retract the flaps to 20 and retract the gear at a positive rate of climb. At 1500'AGL, retract the flaps on schedule.

NOTE: The FE should include flight instruments in his scan until touchdown and call out warning flags or deviations from target airspeed or excessive vertical speed not identified by the NFP.

Landing

When the runway is in sight, maintain altitude until intercepting a normal visual descent glide path.

One Engine Inoperative

An approach with one engine inoperative is the same as a normal approach. Zero rudder trim prior to landing.

LOC / BACK COURSE

ILS back course approaches are non-precision approaches and glide path information is not provided. To maintain the proper airplane heading / localizes course relationship, set the published front course in the course selector. Back course approaches are flown using techniques applicable to other non-precision approaches, such as VOR. When a BB (Back Beam) Switch is installed, the flight director may be used in the VOR / LOC mode. Place back beam switch on VOR / LOC. Complete the approach the same as other non-precision approaches.

ASR APPROACHES

An ASR approach is an instrument approach wherein the air traffic controller issues instruction for pilot compliance base on aircraft position in relation to the final approach course (azimuth), and the distance (range) from the end of the runway as displayed on the controller's radar scope. The controller will provide recommended altitudes on final approach is requested by the pilot. The only airborne radio equipment required for radar-controlled approaches is a functioning radio receiver and transmitter. The controller closely follows the flight path of the aircraft and issues instructions to align it with the centerline of the runway and keep it on course until the pilot can complete his approach and landing by visual reference to the surface.

Approach Preparations

Surveillance approach (ASR) is one in which the controller provides guidance to the pilot in azimuth only. Since the radar information used for a surveillance approach is less precise than that for a precision approach, the accuracy of the approach will not be as great and weather minima will be higher. The aircraft follows the same flight path to the instrument runway as with the non-precision approach.

Final Approach

The pilot is furnished headings to fly to align his aircraft with the extended centerline of the landing runway. The pilot will be given a point at which to start his descent based on a desirable glide angle and the approach speed of the aircraft. He will be advised of distance from the end of the runway each mile on final and recommended altitudes can be furnished at each mile. Navigational guidance is provided until the aircraft is one mile from the approach end of the runway. At this point, he is given his distance from the runway and directed to execute a missed approach if he does not have the runway in sight at landing minimums.

MISSED APPROACHES

Do not operate below DH or MDA unless the airplane is in a position from which a normal approach to the runway of intended landing can be made and the approach threshold, approach lights, or other markings identifiable with the approach end of the runway are clearly visible. If upon arrival at the missed approach point or at any time thereafter, if any of the above requirements are not met, immediately execute the missed approach.

As the missed approach is initiated, the FP should advance the thrust levers and rotate to the go around-around attitude (approximately 12 degrees), simultaneously calling for "MAX POWER and FLAPS 20".

With all engines operating, climb to 1500' AGL at BUG + 10, then accelerate to flaps 10 speed, retract flaps to 10 and set climb power. Continue to retract flaps on

schedule until the final flap setting is selected. Performance is improved and body attitude is less at "Bug" plus 10 knots.
With an engine inoperative, follow the engine inoperative takeoff profile until the final flap setting is selected. Unless otherwise specified, use a generic OCH of 800" AGL.
Initial climb speed for all engine out missed approaches is on BUG.
If a turning missed approach is required, accomplish the missed approach procedure through gear up before initiating the turn. Delay further flap retraction until initial maneuvering is complete and a safe altitude and appropriate speed are attained.
NOTE: Evergreen International Airlines shall not conduct circling maneuvers when the ceiling is less than 1,000 feet or the visibility is less than 3 statue miles.

VOR – NDB

Radio facility on airport
NOTE: 30 VREF (+) speeds are minimum speeds. The Command Airspeed Bug should be set at 10 knots above these speeds until on final approach when bank angles will not normally exceed 15 degrees.
Approach Preparations

- Review approach chart
- Initiate descent – approach checklist
- Standard call-outs

Missed Approach Flap Retraction Schedule

At	Select Flaps
30 VREF + 20	10
30 VREF + 40	5
30 VREF + 60	1
30 VREF + 80	Up

- Flaps 10

30 VREF +20

- Flaps 1

30 VREF +60

- Approximately 2 min past radio

fix (depending on wind) start
procedure turn
Missed Approach:

- Go-around thrust
- Minimum descent • Rotate to go-around altitude

altitude on pressure Flaps 20
altimeter Positive rate of climb
Touchdown target 1000 ft. minimum

CIRCLING APPROACHES

Circling requirements and weather minimums are outlined in the GOM and operations specification C075. Compliance is mandatory.
1. Approach
A circling approach is a visual flight maneuver. It is used after an instrument approach is completed to visually acquire the landing runway. Each landing situation is different because of the variables of ceiling, visibility, wind direction and velocity, obstructions, and final approach course.

Since these variables may exist in many combinations, there is no set procedure for accomplishing a circling approach. The illustrated procedure shows a typical circling approach. If specific circling instructions are not provided, the pilot must select the maneuver required to accomplish a safe landing.

The appropriate minimum altitude should be maintained until on base turning final with runway environment in sight. A satisfactory approach includes proper altitude, airspeed and directional control.

2. Missed Approach

If a missed approach is required at any time while circling, turn toward the runway to the missed approach heading, even if the turn is more than 180 degrees (not the shortest direction). This procedure ensures proper clearance of obstructions in the vicinity of the airport. Maintain missed approach flap setting until close-in maneuvering is completed.

Different patterns will be required to become established on the prescribed missed approach course depending on the airplane position at the time the missed approach is commenced.

VISUAL APPROACH

Terminal visual flight rules, limitations, and provisions operations are authorized and procedures outlined in Operations Specification C077. Compliance is mandatory.

Exterior Visual Cues

Final approach and landing practice will develop the pilot's ability to discern a 2.5 to 3 degree glide path. Realize, however, that terrain, runway characteristics, prevailing visibility, runway and area lighting and deviations from the desired visual glide path can affect the pilots judgment. An up slope on either the runway or approach zone creates an "above glide path" illusion. Actual height is lower than it appears to be. A down slope on either the approach zone or runway creates a "below the glide path" illusion and actual height is greater than it appears. Under conditions of haze, smoke, dust, glare or darkness, expect to appear higher than you actually are. Bright runway lights appear closer while dim runway lights appear farther away. The flight path will appear to be higher than actual when approaching a wide runway and closer than actual when approaching a narrow runway. Be alert for depth perception problems on snow-covered runways or when runway color approximates that of the surrounding terrain.

Cockpit Instrument Cues

Airplane body attitude, rate of descent and thrust required can be used along with exterior visual cues to establish or verify a correct final approach visual glide path. Body attitudes vs. visual glide path angles are shown on the Visual Final Approach and Landing Geometry table. A typical rate of descent for a 3 degree visual glide path is about 700 feet per minute. Realize however, that rate of descent is a function of ground speed and glide path angle. Dividing the ground speed by two and adding a zero will result in the approximate rate of descent for a 2.75 degree glide path. Ground speed may be determined from the GPS. A flat approach (below 2.5 degree visual glide path angle) is indicated by an increase in thrust required lower rate of descent than normal and a higher body attitude. A steep approach (above 3.5 degree visual glide path) is indicated by a low thrust setting, higher-than-normal rate of descent and a lower body attitude. These cues are only true for stable conditions

(thrust, body attitude, and airspeed).
The normal body attitude on final approach with flaps 30 and VREF + 5 is about 1.5 to 2.0 degrees. Body Attitude for flaps 25 is approximately 3.0 to 3.5 degrees.

APPROACH AND LANDING GEOMETRY

The long wheel base and cockpit height of the 747 result in the landing gear being well below and aft of the pilot's eyes during the approach and landing. The main gear touchdown target should be a minimum of 1000 feet down the runway. If ILS is used, do not "duck under" the glide path. On visual approaches, the "eye level aim point" should be approximately 1500 feet from the runway threshold.
If the airplane ILS glide slope antenna is traveling on a 2-1/2 degree glide slope toward an antenna site which is 1000 feet from the threshold of the runway (an ICAO standard installation), the pilot travels towards a point 1500 feet from the threshold, because the glide slope antenna is located approximately 21 feet below the pilot on the nose wheel door.
On a no flare touchdown, the main wheels will contact the runway about 1000 feet closer to the threshold than the visual aim point.
If the airplane is on the glide slope crossing the threshold, the main landing gear will be about 22 feet lower than the threshold crossing height (TCH) or (GS height above threshold) shown on the profile portion of the approach plate page.
Recommended approach and landing technique:
Use the 1500 foot runway markings as a visual aim point. Flying the center of the glide slope of a reasonably standard ILS installation provides the same visual aim point.
A moderate flare initiated after passing the runway threshold should extend the flight path of the main wheels about 500 to 1000 feet horizontally resulting in a main gear touchdown between 1000 and 1500 feet from the threshold.