OBJECTIVES

The objective of this chapter is to promote safety and achieve the best operational performance possible. This can be accomplished only if each crewmember is totally alert to his/her duties and responsibilities.

The material in this chapter is a guide to the procedures, maneuvers and methods involved in the various types of flight training and flight checks. All types of flight instruction and checking are covered. Where necessary, specific maneuvers and standards are indicated for particular types of flights, as dictated by either company policy or by Federal Aviation Regulations.

The description of procedures, maneuvers and recommended techniques apply to line operations and complement the material contained in the Normal Operating Procedures and Emergency sections of this manual. Pilots should be completely familiar, and operate in accordance with, material in each section.

Throughout the chapter "FP" means Flying Pilot, and "NFP" means Non Flying Pilot.

'CREW RESOURCE MANAGEMENT (CRM)

Statistics indicate that "Human Error" is the single largest factor in commercial aviation accidents, and CRM has been identified as the most effective way to address the problem.

Each member of the flight crew should contribute freely in areas of communication, decision making and problem solving. The Captain should create an environment that encourages participation and is free of intimidation. During times of increased workload / demands, the crew should perform in a coordinated manner based on I-priorities set by the Captain.

CHECKLIST PHILOSOPHY

One of the most important items in good cockpit management is the proper use of the checklist. The success attained by the flight crews in the execution of the various normal and emergency procedures is attributable to the reliability of the challenge and response and / or do-list checklist system. A high degree of standardization should result, which makes possible the interchange of crewmembers without jeopardizing safety. Evergreen employs both checklist methods, with the challenge-response method being dominant. The do-list will be employed for specific task checklists as necessary.

Refer to the Normal Procedures chapter of this manual for a more detailed discussion of checklist usage.

PROFICIENCY STANDARDS

The following proficiency standards will apply in all simulator or aircraft operations:

A. Altitude + or - 100'

B. Airspeed + or - 10 kts

C. Heading + or - 10°

D. Approaches

1. Proper configuration and airspeed for position on approach.

2. At DA or MDA, a normal landing may be made with little or no maneuvering.

E. Stalls

1. Early recognition.

2. Minimum loss of altitude.
3. Proper recovery technique.
F. Emergencies and Abnormals
1. Aircraft control at all times by either crewmember.
2. Safe flight path & altitude.
3. Proper organization of Emergency Procedures, crewmember duties, ATC and successful outcome of problem.
4. Knowledge of memory items and procedures.

STANDARD BRIEFINGS

—Standard briefing procedures are outlined in the Normal Procedures chapter of this manual.

THRUST MANAGEMENT

When setting power the following calls are to be used:
1. For takeoff, state "NORMAL (or MAX) POWER".
2. For Go-Around, state "MAX POWER".
3. If an encounter with windshear is experienced or any other emergency situations develops that requires the use of power to the mechanical thrust lever limits, state "EMERGENCY POWER". Use of this power setting will undoubtedly over- boost / over temp the engines. It will be the NFP / FE responsibility to note and record the engine parameters so that a logbook entry may be made with as much factual data as possible. The NFP / FE will not interfere with the setting of emergency power if the FP has commanded "EMERGENCY POWER". When emergency power is no longer necessary, the FP will call "MAX POWER", and the NFP / FE will set max power.
4.If a stall condition develops, advance the thrust levers to the mechanical limits and state "EMERGENCY POWER".

WING FLAP SELECTIONS

Use the following procedures whenever configuration changes are directed by the FP when airborne or the Captain when on the ground.

Flap Handle – When making wing flap selections, allow the flap handle to pause momentarily at all detents enroute to the commanded flap setting; i.e., when on the ground and the captain commands "FLAPS 10, TAXI CHECK", pause momentarily in the Flaps 1 position, and Flaps 5 setting before finally selecting Flaps 10.

NOTE: Exception – The above procedure is not required for flap retraction after landing or during a go-around.

Call Outs – The NFP will repeat the command given by the FP and after visually confirming flap handle selection will state "SELECTED"; i.e.,
FP – "FLAPS 5"; NFP – "FLAPS 5 SELECTED".

When the FP calls for FLAPS 5 on a Flaps 20 takeoff, the NFP will stop momentarily in the Flaps 10 detent, state "FLAPS 10", then immediately move the flap handle to the Flaps 5 detent and state FLAPS 5 SELECTED", after visually confirming flap handle position.

LANDING GEAR

The NFP will repeat all landing gear configuration calls made by the FP, i.e., FP – "GEAR UP", NFP – "GEAR UP".

ABNORMAL AND EMERGENCY PROCEDURES

The first priority during any abnormal or emergency procedure is to make clear who is to fly the aircraft and monitor flight path and position and who will carry out the abnormal / emergency procedure.
The procedures, including memory items, are described in the appropriate chapters. After the memory items on an emergency checklist are carried out, when time and circumstance allows, the checklist will be read and verified using the written checklist from the beginning. Most abnormals are carried out by direct reference to the written procedure; however, some require action by immediate recall.
All procedures that require the shutdown of an engine require the Captain or NFP to guard the throttle, start levers and fire handle on the good engine(s) as the procedure is carried out by the NFP or Flight Engineer. The NFP or Flight Engineer will call out the control or switch to be moved. The NFP will then call "VERIFIED" while guarding the operative control, switch or handle.

WINDSHEAR

The most important policy for the flight crew in coping with a windshear is to avoid areas of known windshear.

DEFINITION

Severe windshear may be defined as a rapid change in wind direction and / or velocity that results in airspeed changes greater than 15 knots or vertical speed changes greater than 500 feet per minute.

FLIGHT CREW ACTIONS

Flight crew actions preparatory to encountering possible windshear events are divided into five areas. They are:

1. Weather evaluation
2. Avoid known windshear
3. Consider precautions
4. Standard operating techniques
5. Recovery techniques

WEATHER EVALUATION

Detection of windshear is difficult with today's technology. Develop an awareness of the causes and danger signals of windshear to successfully avoid windshear.
The most dangerous form of windshear is a convective weather microburst of either the dry or wet type. As shown in the table below, convective weather conditions have produced the majority of known windshear accidents.

WEATHER EVALUATION

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CAUSE OF WINDSHEAR	APPROXIMATE PERCENTAGE OF WINDSHEAR ACCIDENTS
CONVECTIVE CONDITIONS	65 (Thunderstorms, rain, and snow showers)

FRONTAL SYSTEMS	15
LOW ALTITUDE JET STREAMS	5
STRONG OR GUSTY SURFACE	5 WINDS
ALL OTHER CAUSES waves, sea breeze circulations, unknown causes)	10 (Temperature inversions, mountain

DANGER SIGNALS OF DRY MICROBURSTS

PIREPS Caution — Due to the rapid intensification of microbursts, actual windshear may be up to twice as severe as the PIREP.

LLWAS Caution — LLWAS in its present state of development is not completely accurate in detecting microbursts and is prone to false alarms.

Virga Rain falling from high based convective clouds evaporating before it reaches the ground.

Temperature / Watch for a spread of 30 to 50°F (17 to 28°C). Dewpoint

Localized Blowing dust, rings of dust, dust devils, other tornado - like features Strong Winds and other evidence of strong local outflow near the surface.

Turbulence Moderate or greater turbulence may be associated with the outflow from a microburst.

Airborne Weather Radar Indications of weak (green) cells with bases from 5000 to 15,000 feet AGL which indicate weak precipitation, usually virga. In addition, in doppler mode, areas of red (doppler turbulence) surrounding weak precipitation may indicate microburst windshear conditions in their formative stages aloft.

Weather Forecast The potential for a microburst is indicated by mid-level moisture, very dry surface conditions and a 30 to 50°F (17 to 28°C) temperature / dewpoint spread.

DANGER SIGNALS OF WET THUNDERSTORM MICROBURSTS

PIREPS Caution — Due to the rapid intensification of microbursts actual windshear may be up to twice as severe as the PIREP.

LLWAS Caution — LLWAS in its present state of development is not completely accurate in detecting microbursts and is prone to false alarms.

Thunder-storms In addition to the well-known hazards of thunderstorms, an estimated 5% of thunderstorms accompanied by heavy rain and / or lighting contain embedded microbursts.

Localized Blowing dust, rings of dust, dust devils, other tornado - like features Strong Winds and other evidence of strong local oufflow (**Caution:** Visual clues may be obscured by low visibilities in wet thunderstorm microburst situations.)

Turbulence Moderate or greater turbulence may be associated with the outflow from a microburst.

Airborne Weather Search the area above and along the takeoff and approach paths for heavy precipitation. Radar

Weather Forecast Although no techniques currently exist to forecast wet microbursts, crews should consider the thunderstorm forecasts contained in the terminal forecasts and severe weather advisories as a possible indication of the presence of wet microbursts.

The following table, designed specifically for convective weather conditions, provides a subjective evaluation of various observational clues to aid in making appropriate real time avoidance decisions. Although encountering weather conditions described in the table above 1000 AGL may be less critical in terms of flight path, such encounters may present other significant weather related risks. Windshear clues should be considered cumulative. The probability of each single observation is given. However, if more than one windshear clue is observed, the probability rating may be increased to reflect the total set of observations. Use of the table should not replace sound judgement in making avoidance decisions. Crew members are urged to exercise caution when determining a course of action.

MICROBURST WINDSHEAR PROBABILITY GUIDELINES

OBSERVATION	PROBABILITY OF WINDSHEAR
PRESENCE OF CONVECTIVE WEATHER localized strong winds, tower reports or observed blowing dust, rings of dust, tornado-like features, etc.)	HIGH **NEAR INTENDED FLIGHT PATH:** With
With heavy precipitation, observed or radar shadow.	HIGH indications of contour, red or attenuation
With rain showers.	MEDIUM
With lightning.	MEDIUM
With virga.	MEDIUM
With moderate or greater turbulence, reported	MEDIUM or radar indications.
With temperature / dewpoint spread of 30 to	MEDIUM 50°F.
ONBOARD WINDSHEAR DETECTION	HIGH **SYSTEM ALERT:** Reported or observed.
PIREP OR AIRSPEED LOSS OR GAIN:	HIGH 20 KIAS or greater
Less than 20 KIAS	MEDIUM
FORECAST OF CONVECTIVE WEATHER	LOW

HIGH Critical attention needs to be given to this classification. A decision to avoid (e.g. divert or delay) is appropriate.

MEDIUM Consideration should be given to avoiding. Precautions are appropriate.

LOW Consideration should be given but a decision to avoid is not generally indicated.

NOTE: These guidelines apply to operations in the airport vicinity (within 3 miles of the point of takeoff or landing along the intended flight path and below 1000 feet AGL). The hazard increases with proximity to the convective weather. Weather assessment should be continuous.

CAUTION: CURRENTLY NO QUANTITATIVE MEANS EXISTS FOR DETERMINING THE PRESENCE OR INTENSITY OF MICROBURST WINDSHEAR. CREWMEMBERS ARE URGED TO EXERCISE CAUTION IN DETERMINING A COURSE OF ACTION.

CREW AWARENESS It is important for crews to remain alert for any change in conditions, remembering that windshear can be quick to form and to dissipate. The shears that prove most deadly are those which caught crews by surprise.

Crews should be aware of normal vertical flight path indications so that windshear induced deviations are more readily recognized. On takeoff, this would include attitude, climb rate, and airspeed buildup. On approach, airspeed, attitude, descent rate and throttle position provide valuable information. Awareness of these indications assures that flight path degradation is recognized as soon as possible. During takeoff and approach, be alert for airspeed fluctuations. Such fluctuations may be the first indication of windshear. Control column forces significantly different than those expected during a normal takeoff or go-around may result if airspeed is below target or airspeed buildup is low during rotation and liftoff. Vertical flight path displays should be used to crosscheck flight director commands, if the flight director is being used. During takeoff while at relatively low altitude (below 1000 feet), the techniques require awareness and use of normal climbout pitch attitude and less emphasis on strict airspeed control. Rotate at the normal rotation rate to the all-engine initial climb attitude, normally 15°, for all takeoffs. Minimize pitch attitude reductions in response to low airspeed until terrain and obstruction clearance is assured.

On approach, avoid large thrust reductions or trim changes in response to sudden airspeed increases as an airspeed decrease may follow. Closely monitor vertical flight path instruments, such as vertical speed, altimeters, and glideslope displacement. In addition, comparison of groundspeed and airspeed indications can provide additional information for timely windshear recognition. When potential for windshear exists, achieve a stabilized approach no later than 1000 feet AGL. High workload and distractions in the approach phase, particularly in marginal weather, may divert attention away from instruments that provide early recognition of flight path deterioration. Additionally, gradual application of thrust on approach may mask a decreasing airspeed trend. Crews should be prepared to execute the recommended recovery procedure immediately if deviations from target conditions in excess of the following occur:

Takeoff Approach:

1. + 15 knots indicated airspeed
2. + 500 fpm vertical speed
3. + 5° pitch attitude

Approach:

1. + / - 1 dot glideslope displacement
2. unusual throttle position for a significant period of time.

These values should be considered as guidelines only. Exact criteria cannot be established. In certain instances where significant rates of change occur, it may be necessary to initiate recovery before any of the above criteria are exceeded. Other situations may exist where brief excursions, particularly in airspeed, resulting from known or anticipated local wind effects may not be an indication of significant hazard. The flying pilot is responsible for assessing the situation and using sound judgment to determine the safest course of action.

CREW COORDINATION

The FP should focus attention on flying the airplane. In a windshear encounter, appropriate action should be taken in response to callouts. The NFP should focus attention on airspeed, vertical speed, altitude, pitch attitude, glidepath deviation, and thrust. If any significant deviations from normal indications are detected, the NFP should immediately call out the deviation. callouts in the cockpit are standardized as follows:

1. Vertical speed (1200) down (up)
2. Airspeed (150) decreasing (increasing)
3. Glideslope one dot low (high)

CONSIDER PRECAUTIONS

Precautions are recommended whenever probability of windshear exists but avoidance action is not considered necessary.

TAKEOFF PRECAUTIONS

Use maximum takeoff thrust instead of reduced thrust.

Use the longest suitable runway away from potential windshear.

Use normal Flaps 10° setting for the take-off.

Do not use any pitch mode of a speed referenced flight director for takeoff.

Turn off air conditioning pack(s). Add appropriate EPR corrections to takeoff EPR setting.

Consider using increased rotation (VR) speed, up to 20 kts. maximum increase. If this is to be used, the following applies:

1. Set the Airspeed Bugs to the actual take-off gross weight.

2. Make standard airspeed callouts based on the Airspeed Bugs.
3. The increased V. speed will be determined by using the maximum weight allowable for the intended runway; but not more than 20 lds. higher than the V. speed set for the actual gross weight.
(CONTINUED)
4. Although normal airspeed callouts are made, the aircraft will not be rotated until the higher VR speed is attained. IF THE AIRSPEED STAGNATES above V1, the aircraft may be rotated at the bugged VR speed, but no later than 2000' runway remaining.
If the aircraft is below V, when airspeed stagnation is recognized, the take-off must be rejected.

APPROACH PRECAUTIONS

Achieve a stabilized approach no later than 1000 feet AGL. Avoid large thrust reductions or trim changes in response to sudden airspeed increases as these may be followed by airspeed decreases. Use the longest suitable runway away from potential windshear.
-Consider using recommended flap setting of 25°. (Recommended landing flap setting is minimum flap setting authorized for normal landing configuration.) Consider using increased approach speed (correction applied in the same manner as gusts) up to a maximum of 20 knots. Use the autopilot and autothrottles for the approach to provide more monitoring and recognition time. If using the autothrottle, manually backup the throttles to prevent excessive power reduction during an increasing performance shear. Certain procedures and techniques can prevent a dangerous flight path situation from developing if windshear is inadvertently encountered. These procedures and techniques are of such importance that they should be incorporated into each crewmembers's personal standard operating techniques and practiced on every takeoff and landing whether or not windshear is anticipated. Develop a cockpit atmosphere which encourages awareness and effective crew coordination, particularly at night and during marginal weather conditions.

RECOVERY TECHNIQUES

The primary recovery technique objective is to keep the airplane flying as long as possible in hope of exiting the shear. The best technique to accomplish this, as determined by research, was to pitch toward an initial target attitude while using the necessary thrust. Several factors were considered in developing this technique. Studies show windshear encounters occur infrequently and that only a few seconds are available to initiate a successful recovery. Additionally, during high stress situations pilot instrument scan typically becomes very limited, and in extreme cases the focus extends to only one instrument. Recovery skills will not be used on an every-day basis. Therefore, the technique must be effective and simple, easily recalled in times of stress. The initial target pitch attitude for both takeoff and approach will be 15°, because it is easy to remember, is displayed on the attitude indicator, and has wide applicability.

ENCOUNTER DURING TAKEOFF — AFTER LIFTOFF; ON APPROACH

Windshear recognition is crucial to making a timely recovery decision. The recommended recovery procedure should be initiated any time the flight path is threatened below 1000 feet AGL on takeoff or approach. If windshear is inadvertently encountered after liftoff or on approach, immediately initiate the recovery. If on approach do not attempt to land. However, a normal go-around flap sequence may be used when an early precautionary go-around is initiated in an increasing performance shear or from a normal approach airspeed condition. The technique for recovery from a windshear encounter after liftoff or during approach is the same. This technique is described as follows:

THRUST

Apply necessary thrust to ensure adequate airplane performance. Disengage the autothrottles if used. Avoid engine overboost unless required to avoid ground contact. When airplane safety has been ensured, adjust thrust to maintain engine parameters within specified limits.

PITCH

At a normal rate (1 - 2 degrees per second) begin increasing or decreasing pitch attitude to an initial target attitude of 15°. The autopilot / flight director should be turned off unless it is specifically designed for operations in windshear. Use intermittent stick shaker as the upper pitch limit. In severe shear, stick shaker may occur below 15° pitch attitude.

If attitude has been limited to less than 15° to stop the stick shaker, increase attitude towards 15° as soon as the stick shaker stops. If vertical flight path or altitude loss is still unacceptable after reaching 15° and stick shaker is not encountered, further increase pitch attitude smoothly in small increments.

When making adjustments from the target attitude or stick shaker, control pitch in a smooth, steady manner to avoid excessive overshoot / undershoot of desired attitude. Once the airplane is climbing and ground contact is no longer an immediate concern, airspeed should be increased by cautious reductions in pitch attitude.

CONFIGURATION

Maintain flap and gear position until terrain clearance is assured. Although a small performance increase is available after landing gear retraction, initial performance degradation may occur when landing gear doors open for retraction. While extending flaps during a recovery after liftoff may result in a higher minimum altitude, it is not a recommended technique because:

1. Accidentally retracting flaps, the usual direction of movement, has a large impact on performance.
2. If landing gear retraction had been initiated prior to recognition of the encounter, extending flaps beyond takeoff flap setting might result in a continuous warning horn which distracts the crew.

ADDITIONAL CONSIDERATIONS

Avoid stabilizer trim changes in response to short term windshear-produced airspeed / stick force changes. However, stabilizer trim should be used to trim out stick force due to thrust application.

Throughout recovery, the NFP should call out vertical flight path deviations using the barometric altimeter, radio altimeter, or vertical speed indicator as appropriate. Rapidly changing winds may cause rapid excursions in pitch and roll with little or no pilot input as well as varying the attitude for stick shaker activation.

ENCOUNTER DURING TAKEOFF — ON RUNWAY

Recognition of windshear is difficult during takeoff roll since airspeed is changing rapidly. In addition to visual cues, unusual airspeed fluctuations, slow or erratic airspeed build-up may be indications of a windshear encounter.

The takeoff should be rejected if unacceptable airspeed variations occur below indicated V1 and the pilot decides that there is sufficient runway remaining to stop the airplane. The takeoff must be continued after V1 has been reached.

THRUST

Aggressively apply necessary thrust to ensure adequate airplane performance. Avoid engine overboost unless necessary to ensure airplane safety. When airplane safety has been ensured, adjust thrust to maintain engine parameters within specified limits. Overboost thrust alone, however, is not sufficient to offset the effects of an inadvertent windshear encounter. Proper pitch attitude control is the most important factor in recovery from windshear.

PITCH

When VF, is reached, rotate at a normal takeoff rotation rate to 15° pitch attitude. In severe encounters, however, V might not be reached and the option to reject the takeoff may not exist. If this is %te case, rotation must be initiated no later than 2000 feet from the end of the usable surface.

Pitch attitude and rotation rate should not be restricted to avoid aft body contact since all available pitch attitude may be required to lift off in the available runway. Once airborne, follow the after liftoff recovery technique if still experiencing a windshear.

FLIGHT DIRECTOR

Turn flight director off or disregard commands.

WARNING

A FLIGHT DIRECTOR AND / OR AUTOFLIGHT SYSTEM WHICH IS NOT SPECIFICALLY DESIGNED FOR OPERATIONS IN WINDSHEAR MAY COMMAND A PITCH ATTITUDE CHANGE TO FOLLOW TARGET AIRSPEEDS OR A FIXED PITCH ATTITUDE REGARDLESS OF FLIGHT PATH DEGRADATION. THIS GUIDANCE MAY BE IN CONFLICT WITH PROPER PROCEDURES FOR WINDSHEAR RECOVERY. SUCH SYSTEMS MUST NOT BE USED FOR WINDSHEAR RECOVERY. REPORT THE ENCOUNTER

Report the airspeed change, shear encounter location and altitude and airplane type to ATC as quickly as possible. Use the term PIREP in making the report in order to encourage rebroadcast to other airplanes. To deal with inadvertent windshear encounters, the pilot must be prepared to apply techniques which differ from those normally used, such as rotating before VR, rotation to normal or higher pitch attitudes on liftoff to keep from running out of runway, which may result in a tail strike. Also, pitch attitudes up to the stick shaker with associated low airspeeds to prevent altitude loss and ground contact may be required.

GPWS WARNING PROCEDURES

GENERAL

Under certain conditions of flight where immediate visual reference to the surrounding terrain is not available, prompt and decisive action is required for a GPWS warning. These conditions are primarily associated with arrivals and departures.

CAUTION: DO NOT IGNORE SHORT DURATION WARNINGS. TAKE IMMEDIATE AND AGGRESSIVE ACTION. ACTIVATION OF GPWS WARNING

The following sequence of actions should be memorized and utilized upon activation of an aural or visual GPWS warning. Thrust. Disengage the autothrottles (if installed) and aggressively apply necessary thrust to ensure adequate airplane performance. Avoid

engine overboost unless necessary to avoid ground contact. When airplane safety has been ensured adjust thrust to maintain engine parameters within normal limits.
Disengage the autopilot. Pitch For a GPWS warning after lift-off or on approach increase pitch attitude (at normal pitch rate) toward maximum climb attitude. The maximum climb pitch attitude may be maintained until either the warning has stopped or stick shaker is encountered. Always respect stick shaker. Use intermittent stick shaker as the upper limit pitch. If attitude has been limited to less than maximum climb pitch attitude to stop stick shaker, increase attitude toward maximum climb attitude as soon as stick shaker stops. Control pitch in a smooth, steady manner (in approximately 2 degree increments) to avoid excessive overshoot of the desired attitude. Once the airplane is climbing and ground contract is no longer an immediate concern, airspeed should be increased by cautious reduction in pitch altitude. Immediately retract the speedbrakes if extended. Retracting the speedbrakes is critical in maximizing the climb performance of the aircraft. Turn off flight director or disregard commands. At positive climb rate retract gear (if extended).

STANDARD CALL OUTS

The following tables outline the Evergreen standard call outs for each phase of flight. These call outs are to be memorized and used for each flight.

GENERAL

Many call outs require a response from the flying pilot. If the FP fails to respond, the NFP will challenge a second and final time, saying, "ARE YOU OK?" If no response is received, the NFP should assume that the FP has become incapacitated, and the NFP should take control of the aircraft.

DEVIATIONS

The NFP should call out the following deviations at the time they are noticed:

Altitude:	100 feet above or below assigned.
Heading:	10 degrees left or right of assigned.
Airspeed:	Any speed below maneuvering or reference speed, and 20 knots above reference speed.
Glide Slope:	One dot above or below center.
Localizes:	One dot left or right of center.

Vertical Speed: Sink rate exceeding 1,000 FPM on approach. On rare occasions, Glide Slope in excess of 3° may be utilized. In these situations, descent rates in excess of 1,000 ft. may be experienced.

TAKEOFF			
PHASE	**FP**	**NFP**	**ENGINEER**
On applying takeoff power	NORMAL POWER or MAX POWER	No response	No response
After trimming power	No response	No response	NORMAL (or MAX) POWER SET, N_1 CHECKS
80 knots	CHECKED, or the discrepancy	80 KNOTS	No response
100 knots	No response	100 KNOTS	No response
V_1	No response	V_1	No response
V_R	No response	ROTATE	No response
V_2	No response	V_2	No response
Upon observing a sustained positive rate of climb on both the IVSI and altimeter	GEAR UP	POSITIVE RATES GEAR UP	No response
Upon reaching 1500 AGL	No response	FIFTEEN HUNDRED	No response
Upon reaching Flaps 5 speed	FLAPS 5, SET CLIMB POWER or MAX CLIMB	FLAPS 5 SELECTED	ROGER
Upon reaching 3000 AGL	No response	THREE THOUSAND	No response
Upon reaching flap retract speed	FLAPS ____	FLAPS ____ SELECTED	No response
Upon reaching flaps up speed	FLAPS UP, AFTER TAKEOFF CHECKLIST	FLAPS UP SELECTED	AFTER TAKEOFF CHECKLIST
Passing transition altitude	Set altimeter	TRANSITION Set altimeter	Set altimeter
Passing FL 180	Complete Checklist Items	Complete Checklist Items	CHECKLIST COMPLETE

ABORTED TAKEOFF			
PHASE	**CAPTAIN**	**FIRSTOFFICER**	**ENGINEER**
Takeoff roll	ABORT SPOILERS	Slight forward pressure	Identify malfunction

CLIMB, CRUISE, DESCENT			
PHASE	**FP**	**NFP**	**ENGINEER**
New altitude assigned	ROGER, ___	CLEARED TO ___	No response
Within 1,000 ft. of clearance altitude	ROGER	THROUGH ___ FOR ___	No response
New heading assigned	ROGER, ___	HEADING ___	No response
Prior to or beginning Descent	DESCENT CHECKLIST	Perform checklist	DESCENT CHECKLIST

APPROACH			
PHASE	**FP**	**NFP**	**ENGINEER**
Passing 18,000 feet	APPROACH CHECKLIST TO THE LINE	Perform Checklist	APPROACH CHECKLIST TO THE LINE
When able to complete checklist	APPROACH CHECKLIST BELOW THE LINE	Perform Checklist	APPROACH CHECKLIST BELOW THE LINE
Flap extension	FLAPS___	FLAPS___ SELECTED	No response
First positive, inward motion of CDI	ROGER	COURSE or LOCALIZER ALIVE	No response
FD or AP capture of VOR or LOC course	ROGER	LOCALIZER CAPTURE	No response
First positive movement of glide slope needle	ROGER	GLIDESLOPE ALIVE	No response
FD or AP capture of glide slope	ROGER	GLIDESLOPE CAPTURE	No response
Final Approach fix	ROGER	FINAL APPROACH FIX, NO FLAGS, ALTITUDE CHECKS	No response
1,000 feet above DA or MDA	ROGER	1,000 ABOVE MINIMUMS, BUG ± ___, SINK___	No response
500 feet above DA or MDA	ROGER	500 ABOVE MINIMUMS, BUG ± ___, SINK___	No response
100 feet above DA or MDA	ROGER	100 ABOVE MINIMUMS	No response

PRECISION APPROACH			
PHASE	**FP**	**NFP**	**ENGINEER**
Reaching DH, no lights or runway in sight	MISSED APPROACH, MAX POWER, FLAPS 20	MINIMUMS, NO RUNWAY	ROGER, MAX POWER
Reaching DH, lights in sight	ROGER	MINIMUMS, LIGHTS IN SIGHT ___O'CLOCK	No response
Runway in sight	GOING VISUAL	RUNWAY IN SIGHT	No response

NON-PRECISION APPROACH			
PHASE	**FP**	**NFP**	**ENGINEER**
FAF	ROGER	FINAL APPROACH FIX, NO FLAGS, ALTITUDE CHECKS	No response
MDA	ROGER	MINIMUMS, TIME / DISTANCE TO GO	No response
MAP, no lights or runway in sight	MISSED APPROACH, MAX POWER, FLAPS 20	MISSED APPROACH POINT, NO RUNWAY	ROGER, MAX POWER
Runway or lights in sight	GOING VISUAL	LIGHTS / RUNWAY IN SIGHT, ___O'CLOCK	No response

NOTE: After any of the deviation calls listed above, the FP will respond "CORRECTING".

NOTE: For a PAR approach, no BUG + SINK or altitude calls are to be made after hand off to the final controller. Call outs for 100 feet above minimums; minimums, with runway in sight, or no runway; and uncorrected deviations from airspeed, assigned heading and descent rate must still be made.

NOTE: Should visual conditions be encountered prior to reaching DH or MDA, and FP calls "GOING VISUAL", altitude calls revert to height above touchdown; the "MINIMUMS" call is omitted.

NOTE If the NFP calls "MINIMUMS, APPROACH LIGHTS IN SIGH-17, this alerts the FP that sufficient visual cues are presently in view to continue the approach but NOT to make a visual transition. Therefore, the FP will continue the approach on instruments, waiting for the NFP to acquire the runway visually. The NFP MUST call "RUNWAY IN SIGHT" for the FP to make a visual transition and call "GOING VISUAL". The FP should include the approach lights in his instrument scan but not attempt visual transition until the runway is in sight.

VISUAL APPROACH, or after "GOING VISUAL" on an instrument approach			
PHASE	**FP**	**NFP**	**ENGINEER**
1,000 feet above touchdown	ROGER	1,000 FEET ABOVE TOUCHDOWN, BUG___, SINK___	No response
500 feet above touchdown	ROGER	500 FEET ABOVE TOUCHDOWN, BUG ___, SINK___	No response
100 feet above touchdown	ROGER	100 FEET ABOVE TOUCHDOWN	No response

NOTE: If the GPWS system is inoperative the NFP will make call outs shown above. The Flight Engineer will make the following call outs starting at 50 feet Radio Altitude: "50", "40", "30", "20", "10".

REJECTED LANDING / LANDING			
PHASE	**FP**	**NFP**	**ENGINEER**
Rejected landing	GOING AROUND, MAX POWER, FLAPS 20	FLAPS 20 SELECTED	ROGER, MAX POWER
Reverser lights illuminated	No response	No response	REVERSE AVAILABLE OR NO REVERSE #_______
Reversers operating	No response	No response	N1 _____ (read highest N1)
100 knots	No response	100 KNOTS	No response
80 knots	No response	80 KNOTS	No response
60 knots	No response	60 KNOTS	No response

TOWING / PUSHBACK

The nosewheel steering ground pin is installed before pushback or towing and is removed when the towbar is disconnected. Landing gear down lock pins need not be installed for pushback or towing, with or without hydraulic pressure.

TAXI

There is a large area near the airplane where personnel and obstacles on the ground cannot be seen, particularly in the oblique view across the cockpit. Special care must

be exercised in the parking area and while taxiing.
Before releasing the brakes for taxi: Clear the ground person off the headset and confirm their movement away from the aircraft, then complete the appropriate checklist confirming the door warning lights are out.
Do not operate any flight controls or surfaces during start or pushback until all ground personnel and equipment are clear of the airplane.

ICING CONDITIONS

If icing conditions are present the nacelle anti-ice switches should be turned on immediately after all engines are started. During prolonged ground operation, periodic engine run-up to as high a thrust setting as practical should be performed to minimize the possibility of ice build-up. These engine run-ups should be performed as defined in the Supplemental Procedures section of the Flight Operations Manual.

USE OF THRUST

Thrust use during ground operation demands sound judgment and technique. The air blast effects from the large, high bypass engines at relatively low thrust can be destructive and cause injury. Airplane response to thrust lever movement is slow, particularly at high gross weights. Idle thrust is adequate for taxiing under most conditions. A slightly higher thrust setting is required to start taxiing.
NOTE: Taxiing with two engines at high gross weight is not recommended.

BRAKES

Avoid "riding" the brakes to control taxi speed as brake heat build-up could become excessive. If taxi speed is too high, reduce speed with a steady brake application and then release the brakes to allow them to cool. Differential braking and braking while turning should be avoided under normal conditions. Allow for decreased braking effectiveness on slick surfaces.

ANTI-SKID / BODY GEAR STEERING

The anti-skid switch should not be turned off for any normal taxi operations. With anti-skid off, tire flat spotting or blow outs can occur if moderate to heavy braking is used. Body gear steering is installed to reduce thrust requirements for tight turns and to minimize tire scrubbing. It is not intended for speeds above 15 to 20 knots. The body gear steering switch should be in the ARM position prior to aircraft movement (push-back and / or taxi).

TILLER / RUDDER PEDAL STEERING

The tiller performs the same function as a conventional steering wheel. The steerable body landing gear facilitates short radius turns. Straight ahead steering and large radius turns may be accomplished with rudder pedal steering only (if installed). If nose wheel "scrubbing" occurs while turning, reduce steering angle and / or taxi speed. Avoid stopping the airplane in a turn as excessive thrust will be required to start taxing again. Differential thrust may be required for heavy airplanes during tight turns but should only be used as required to maintain the desired speed in the turn. Center the nose wheel and allow the airplane to roll straight ahead to relieve stresses in the main and nose gear structure prior to stopping after completing a turn.

TURN RADIUS

The "TURNING RADIUS" illustration in the Operations Manual shows the minimum turn radius capability. The HF antenna on the wing tip describes the largest arc while turning and determines the minimum obstruction clearance path.
CAUTION: DO NOT ATTEMPT TO MAKE A TURN AWAY FROM AN OBSTACLE WITHIN 12 FEET OF THE WING TIP OR WITHIN 50 FEET OF THE COCKPIT.

TAXISPEED

The airplane appears to the pilot to be moving slower than it actually is due to the cockpit height above the ground. Consequently, the tendency is to taxi faster than desired. This is especially true during runway turnoff after landing. The GPS GS mode may be used as an aid to determine actual taxi speed.
Nose wheel scrubbing indicates excessive steering angle and or taxi speed for surface condition.
When taxiing on a slick surface at reduced speeds, use of differential outboard engine thrust will assist in maintaining airplane momentum through the turn. Differential braking may be more effective than nose wheel steering on very slick surfaces.
Avoid following other aircraft too closely. Jet blast is a major cause of foreign object damage. Do not use reverse thrust while stopping or at low speeds, except in abnormal circumstances. High taxi speed combined with heavy gross weight can result in severe tire abuse due to tire sidewall heating.

CHECKLISTS

The BEFORE TAKEOFF checklist may be completed down to the line while taxing. Do not be diverted from the primary task of safely taxiing the airplane

REJECTED TAKEOFF

PHILOSOPHY AND CAUSES
A takeoff may be rejected for a variety of reasons, including engine failure, improper loading, takeoff warning horn, ATC, blown tires, etc. In contrast, the large number of takeoffs that are successfully continued with indications of airplane system problems, such as master caution lights or blown tires, are rarely ever reported outside the airline's own information system. These may result in diversions or delays, but the landings are usually uneventful. It is regrettable that in about 55% of the RTO accidents and serious incidents the result might have been an uneventful landing if the takeoff had been continued.
However, this should not be construed as saying 'go' no matter what. The goal of training is to eliminate RTO accidents by reducing the number of incorrect stop decisions, and to ensure that the correct procedures are accomplished when an RTO is necessary. Many of the situations that occur in line flying simply do not resemble the canned problems that one often sees in the simulator. The successful resolution of line situations, therefore, depends greatly upon the good judgment of the pilot.
Some of the lessons learned from studying RTO accidents and incidents are as follows:

1. Fifty-eight percent were initiated at speeds in excess of V,.
2. Approximately one third were reported as having occurred on runways that were wet or contaminated with snow or ice.
3. Experts examining these accidents estimated that in over 50% of them the airplane could have safely continued the takeoff and used the entire runway for stopping

in the subsequent landing.

4. Approximately 26% of the RTOs were engine related, which means that 74% were non-engine, such as tires, configuration, etc.

The crew must always be prepared to make the go / no-go decision prior to reaching V,. In order to eliminate unnecessary RTOs the crew must be able to differentiate between situations that are detrimental to a safe takeoff and those that are not. Finally, the crew must be prepared to act as a well-coordinated team. As speed approaches V, the successful completion of an RTO becomes increasingly more difficult.

CRITICAL ENGINE FAILURE

One common, yet misleading, way to think of V, is to say it is the decision speed. This is misleading because V, is not the point to begin making the operational go / no-go decision. The decision must have been made by the time the airplane reaches V, or the pilot will not have initiated the RTO procedure at V,. If the airplane is at field length limit weight, or if normal power has been used to balance the field, an overrun in the event of an abort is highly probable.

-The correct definition of V, in an operational field length limited context is the maximum speed at which the rejected takeoff maneuver can be initiated and the airplane stopped within the remaining field length under the conditions and procedures defined in the FARs. It is the latest point in the takeoff roll where a stop can be initiated. With respect to the go decision, it is also the earliest point from which an engine-out takeoff can be continued and the airplane attain a screen height of 35 feet at the end of the runway.

The go / no-go decision must be made before reaching V,. A no-go decision after passing V, will not leave sufficient runway remaining to stop if the takeoff weight is equal to the field length limit weight. Although data can be calculated to show the maximum speed above V, that a takeoff could be rejected if the weight is below field length limit, this is not done at Evergreen or most other carriers. In addition, we use normal power takeoffs whenever possible, which in effect balances the field, making most takeoffs essentially field length limited.

After an engine failure during the takeoff roll, the airplane must continue to accelerate on the remaining engine(s), liftoff, and reach V2 speed at 35 feet. The later in the takeoff roll that the engine fails, the heavier the airplane can be and still gain enough speed to meet this requirement. On the stop side of the V, / weight trade has the opposite trend. The lower V, or the earlier in the takeoff roll the stop is initiated, the heavier the airplane can be. If a graph were made of this data, the point at which the continued and rejected takeoff lines intersect is called a balanced field limit takeoff. The name balanced field refers to the fact that the accelerate-go performance required is exactly equal to (or balances) the accelerate-stop performance. The resulting unique value of V, is referred to as the balanced field limit V1, and is the speed normally given to the crews on the speed cards or in the performance manuals.

The question then becomes: how is V, calculated and how does this approach the real operational situations confronted by crews each day. The transition time is measured during certification flight tests. In these tests, the airplane is accelerated to the desired speed, one engine is failed, and the pilot flying rejects the takeoff. This may be termed a "simple" task because the test crew knows in advance to expect the RTO. Exact measurements of the time required for the pilot to apply brakes, retard the throttle(s) of the operating engine(s), and raise the speed brakes are made. The average of the times for the individual actions from at least six tests are used as the certification flight test

transition time parameters. The transition time is generally one second. It would be unrealistic, however, to expect the average line pilot to perform the in-service transition within one second. The line pilot's job is described as a complex task, since he does not know that he will be doing the PTO during a specific takeoff attempt, but must be prepared to do so if necessary. Recognition of this reality means that the AFM data presented to the pilot includes approximately 3 seconds for transition time from the published V, to the full stopping effort. This is not meant to imply that the stop can be delayed past V,; at V, the full effort to stop must have been started.
In the real world, studies have shown that the average line pilot, i.e. one who does not know when a rejection will take place, requires from 3 to 7 seconds to recognize a particular problem and start to react to it. Given the fact that 76% of the problems did not involve engine failures, the recognition problem becomes more acute. The aircraft, meanwhile, is accelerating at a rate of 3 to 6 knots per second. If recognition occurs at V, minus 6 knots, only 1 second is available to recognize and initiate an abort. And, when an abort occurs, simulator tests have shown that only 60% of the time does the pilot obtain maximum braking. Thus a real abort near V1 very likely will result in a stop initiated above V, . Since 76% of the time the problem is not engine-related, the airplane in most cases continues to accelerate at its full power.

REASONS TO REJECT

False or non critical cockpit warnings have activated at speeds near V1, and have led to high speed RTOs resulting in accidents and incidents. In response to the number of such warnings, the manufacturers recently have attempted to put the odds in the pilot's favor by inhibiting certain warnings. Above 80 knots, for example, the B-747-400, Airbus, and B-757 / 767 inhibit all nuisance type warnings, including engine fires (although a fire light will illuminate, no bell will sound) until 20 seconds after rotation or 400 feet AGL. The NTSB has looked very favorably on this development, but those of us flying older aircraft do not enjoy this new technology.
An additional consideration involves the training effort. The NTSB has observed that some carriers are using simulator scenarios that allow an aircraft to be stopped on the runway even though the piloting technique may not be optimal. They feel that the RTO scenario should simulate the most critical conditions and that the airplane should fail to stop on the runway unless the pilot responds as necessary. The scenario, therefore, should be runway limited, and at a high gross weight, approaching the maximum allowable structural weight.
The non-flying pilot (NFP) will call out 100 knots during the takeoff roll, and will indicate to the flying pilot (FP) that at that point an abort will normally be made only for two reasons, an engine failure or a significant malfunction such that, in the captain's judgment, the aircraft cannot fly.

DECISION SPEED

Although V1 will be obtained from the appropriate speed cards or performance manual, the airspeed bug will be set at this speed minus 8 knots. The call will be "Vi" at this new speed. At that point the Captain will remove his hands from the power levers and the takeoff will be continued.
NOTE: If an adjustment is required due to contamination, 8 knots will NOT be

subtracted from the calculated V1 for the speed bug. If V1 is reduced because of anti-skid inoperative, brakes deactivated, or a tailwind, 8 knots will be subtracted from that calculated V1.

SUMMARY

The previous discussion and description of procedures can be summarized as follows:

1. A rejected takeoff is an emergency procedure and should be treated as such.
2. After 100 knots, the takeoff should be rejected only for engine failure or other catastrophic failure.
3. In order for action to be initiated by VI~Vl -8 knots will be bugged, the hand will be removed from the power levers, and the decision to reject or continue will, therefore, have been made at that speed. If a contaminated runway is being used no 8-knot adjustment will be made.
4. The bugged speed, V1 -8 knots, will never be below VMCG•
5. Except for catastrophic failure, the "GO" decision will give the highest probability of success.

COMMAND AIRSPEED BUG USAGE — GENERAL

When an airspeed is assigned by ATC, or mandated by regulations or departure procedures, use the Command Bug to indicate that target speed. In setting these desired speeds, both pilots should check that the target speed is not below the minimum maneuvering speeds for the aircraft configuration.

If the assigned speed is below the maneuvering speed for the present configuration, the configuration should be changed to allow maneuvering at the assigned speed. If this is not desirable, for example on climbout, a higher speed may be requested from ATC.

Airspeed bug usage in other sections of this chapter describe procedures to be used for a particular phase of flight, notwithstanding the statements above.

NORMAL POWER TAKEOFF

Plan on using normal –7A power, performance permitting, for takeoff regardless of the engine installed, i.e. –7A, -7F, or –7J. Normal power takeoffs lower peak EGT and can extend engine life.

Normal Power – Assumed Temperature Method (ATM)

This method achieves a takeoff power less than the rated takeoff power by using an assumed temperature that is higher than the actual temperature. The maximum power reduction authorized by the FAA is 25% below any certified rating. It will not be more than .14 less than maximum power EPR. Set all EPR bugs on actual EPR to be used for takeoff.

NOTE: The B-747 AFM and its appendices as well as advisory circular #AC 25-13 dated May 04-88, allows for reduction of the –7J and –7F engines to –7A power takeoff. This applies to any of these engine combinations or to all four (4) of either –7J or –7F reduced to –7A performance. At no time does it allow for reduction of the –7A maximum EPR by more than .14 EPR, as stated elsewhere in the Performance Manual.

The power setting parameter (EPR) is not considered a limitation. If conditions are encountered during the takeoff where additional power is desired, such as windshear, or temperature inversions, the crew should not hesitate to advance thrust levers to emergency power.

CAUTION: DO NOT USE NORMAL POWER IF ANY CONDITIONS EXIST THAT WOULD REQUIRE MAXIMUM POWER. THESE CONDITIONS ARE LISTED IN THE TAKEOFF SECTION OF THE 747 PERFORMANCE MANUAL.

Adverse Runway Conditions

Slush, standing water, or deep snow can increase takeoff distance significantly due to increased rolling resistance, this resistance increases as speed is increased during the takeoff roll. Slush or standing water may cause impingement damage to the airplane. Ice and light coverings of powdery snow have little effect on accelerate-go distance but can have a significant effect on accelerate-stop distance.

Operation With Deicing / Anti-icing Fluids

Testing of undiluted deicing / anti-icing fluids has shown that some of the fluid remains on the wing during takeoff rotation and initial climb out. The residual fluid causes a temporary decrease in lift and increases in drag. These effects are more significant at lower ambient temperatures (approaching –20°C) where the fluid tends to stay on the wing longer.

AIRSPEED INDICATOR "BUG" SETTINGS FOR TAKEOFF

Command Airspeed Bug (CAB) Usage

Leave the command airspeed bug at V2 until initiating flap retraction, then position it to target maneuvering speed for flap retraction.

The recommended airspeed bug settings and their use during all phases of flight are as follows:

White Bug – one at V1 White Bug – one at flaps 5 maneuvering
White Bug – one at VR White Bug – one at flaps 1 maneuvering
Command Airspeed Bug – at V2 White Bug – one at flaps 0 (15 degree bank) maneuvering

FLAPS 10

NOTE: All bugs are set from speed cards (flip cards) or from the Performance manual. If some bugs are missing refer to the speed cards for the applicable speeds.

0 With 4 engines operating, V2 + 10 knots is maintained until reaching 1500 ft. AGL. The NFP states "FIFTEEN HUNDRED", and then rotates the command bug to Flaps 5 speed. The FP accelerates to flaps 5 speed and states "FLAPS 5, SET CLIMB POWER or MAX CLIMB POWER". The NFP selects flaps five and states "FLAPS 5 SELECTED", and the Engineer sets appropriate power. The FP continues the climb to 3000-ft. AGL, upon reaching 3000 AGL the NFP states "THREE THOUSAND", and rotates the command bug to flaps 1 speed. The FP will accelerate and command flap retractions on schedule. When the NFP retracts the flaps to each successive setting, he will state, "FLAPS____ SELECTED" and set the command bug to the next higher flap retract speed. Upon reaching Flaps Up speed, the FP will state "FLAPS UP, AFTER TAKEOFF CHECKLIST'.

During climbout with Takeoff flaps, at V2 + 10, bank angle is limited to 30 degrees. After retracting flaps to 5, bank angle is limited to 15 degrees at each flap setting until reaching V2 + 100. If maneuvering is necessary, accelerate to the next target speed

.,and hold flaps at current setting, this will allow 30-degree bank.

FLAPS 20

The Command Bug and Perimeter Bugs are set in the same manner as for Flaps 10.
NOTE: All bugs are set from speed cards (flip cards) or from the Flight Operations Manual.
The procedure is performed the same as Flaps 10 takeoff, with the following exception. At 1500 feet AGL, when the FP calls for flaps 5, the NFP will move the handle into the flaps 10 detent and state, "FLAPS 10", then immediately moves the flap handle into the flaps 5 detent. He then states, "FLAPS 5 SELECTED", after visually confirming the flap handle position. Flaps 10 retraction speed is never bugged.
With 3 engines operating, the FP climbs at V2 speed until reaching Obstacle Clearance Height. The NFP will state, "FLAP RETRACT ALTITUDE" and place the altitude hold switch ON, then rotate the command bug to flaps 5 speed. The FP will accelerate in level flight and command flap retractions until reaching the final flap setting. The FP will then state, "FLAPS ____, FINAL FLAP SETTING, SET MAX CLIMB POWER", followed by, "ACTION THE EMERGENCY or QUICK RETURN TO THE LINE", as appropriate. After final flap setting is made, the NFP will select ALTITUDE SELECT, and the FP will continue the climb. If flaps are fully retracted, the NFP will set the command bug to V2 + 100 knots, for full maneuvering capability.
NOTE: You may wish to leave flaps at 10 or 5° as an option for additional lateral control with 3 engines operating.

NORMAL ALL-ENGINE TAKEOFF

Setting Takeoff Thrust
NOTE: The entire Before Takeoff checklist must be completed prior to beginning the takeoff roll.
The First Officer will hold a light forward pressure on the control column and maintain wings level until 80 knots.
The Flying Pilot will maintain directional control with rudder pedal steering (if installed) until aerodynamic directional control is established.
The Non-Flying Pilot will call out "80 KNOTS", Flying Pilot will state "CHECKS".
The Captain should guard the tiller until 80 knots.
Prior to aligning the aircraft on the runway, review the takeoff data card. Extreme care should be used when setting takeoff EPR. Once aligned with the runway, the Flying Pilot will advance the thrust levers to approximately 1.10 EPR.
The Flying Pilot will then smoothly advance all thrust levers toward the computed takeoff EPR and state "Normal / Max Power'. The Flight Engineer will make the final precise adjustments to obtain takeoff EPR by 80 knots.
At that time, the Flight Engineer will state "NORMAL / MAX POWER SET, Ni CHECKS". The lowest Ni RPM should be within ±2% of the predetermined target value.
Since the Captain is responsible for rejecting a takeoff, he will maintain control of the throttles on all takeoffs once power has been set. In no instance will takeoff be considered assured below V1 speed.
If takeoff power is not set by 80 kts., the Flight Engineer will not advance the throttles beyond go-around EPR. The Flight Engineer will compute go-around EPR prior to

departure.
Due to RAM air effect on the JT9D engine, once takeoff power is set, the Flight Engineer will make no other power adjustments except those required to avoid exceeding Ni or EGT limits.
If the RAGS 3.5 bleed valve sticks open during the application of takeoff thrust, it will be necessary to move the related power lever forward of its normal position to obtain takeoff EPR. On a temperature-limited engine, takeoff EPR may not be attainable. If the valve should close during takeoff, EPR and EGT will rise very quickly, probably exceeding limits. Subsequent maintenance action will depend upon the amount and duration of the excess EGT. Vigilance and quick corrective action are critical as always.

TAKEOFF PROCEDURE

Takeoff roll
Smoothly advance thrust levers toward takeoff thrust. Final thrust adjustments should be made by eighty knots. Above eighty knots no change should be made except as required to maintain engine parameters within limits.
The Captain should guard the tiller until eighty knots and keep one hand on the thrust levers until V1 so that he can respond quickly to a rejected takeoff condition. Actual tiller inputs should be kept to an absolute minimum.
CAUTION OVER CONTROL OF THE TILLER, PARTICULARLY DURING SLIPPERY TAKEOFF CONDITIONS, CAN RESULT IN LOSS OF DIRECTIONAL CONTROL.
The Flying Pilot will maintain directional control and keep the airplane on the center line with rudder pedal steering (if installed) and rudder. The rudder becomes more effective than the rudder pedal steering at about fifty knots.
The First Officer will hold a light forward pressure on the control column and maintain wings level until approximately eighty knots, if he is the Non-Flying Pilot.
Fwd Center of Gravity Effects
At high gross weights and forward CG takeoff conditions, elevator pressure required for rotation is less than ten pounds pull force. It is important that pressure on the elevator during rotation be judiciously exercised to obtain the proper rotation rate and attitude.
Aft Center of Gravity Effects
At aft CG and light weights, nosewheel steering effectiveness is reduced, especially on slick surfaces. Application of takeoff thrust and a sudden brake release will lighten the nosewheel loading. With this condition, a rolling takeoff thrust is preferred with slow, steady thrust application to takeoff thrust during the initial roll. Hold the control column forward to improve nosewheel steering.

ROTATION

Takeoff and initial climb performance depend on rotating at the correct airspeed and proper rate, to the rotation target attitude. Early, rapid, or over-rotation may cause over-rotation warning (if installed) and aft fuselage contact with runway. Late, slow, or under-rotation increases takeoff ground roll. Any improper rotation decreases initial climb performance. For optimum takeoff and initial climb performance initiate a smooth continuous rotation between two to three degrees / second at VR to the rotation target attitude. The rate of rotation is related to the airplane acceleration. At light gross weights, the airplane accelerates rapidly and the rotation rate will be faster than at heavy gross weights. The total time to rotate from VR to the rotation target attitude will take approximately six seconds with all engines operating and nine seconds for three engines operating. Liftoff should occur at approximately ten degrees pitch attitude. If a stick shaker warning occurs during rotation smoothly re-establish a pitch angle of approximately ten degrees. The three-engine target attitude is recommended for all takeoffs. After liftoff continue the rotation to the rotation target attitude. Only slight adjustments are required to the rotation target attitude to maintain the desired initial climb airspeed.

Do not use large abrupt elevator inputs which result in large pitch rates, attitudes and possible tail strikes.

Aft fuselage contact will occur at 12.5 degrees pitch attitude with the wheels on the runway and the landing gear struts fully extended.

CAUTION: DO NOT PRESSURIZE AN AIRPLANE THAT HAS NOT BEEN INSPECTED BY MAINTENANCE FOR STRUCTURAL DAMAGE AFTER FUSELAGE RUNWAY CONTACT. A LANDING AT THE NEAREST SUITABLE AIRPORT IS RECOMMENDED.

Rotation Target Attitude

The airplane attitude required to achieve initial climb performance depends upon gross weight, flap position, ambient conditions and number of engines operating. It varies from approximately ten degrees to eleven degrees at heavy gross weights at high altitude and hot day conditions to approximate fifteen degrees to eighteen degrees for low gross weights, sea level, cool day conditions.

Calculating Rotation Target Attitude

The rotation attitudes are shown on the Takeoff Data (FLIP) Cards or in the Takeoff Speed chart in the Performance Manual. The three-engine rotation target attitude is used to simplify takeoff calculations and to eliminate the requirement for flight crews to recall a specific attitude in case of the loss of an engine after Vi.

Smoothly rotating to the three-engine rotation target attitude at VR will result in a speed, at thirty-five feet above field elevation, of approximately V2 if an engine failure occurs after V1 and approximately V2 + 10 with all engines operating.

NOTE: If normal power is used for takeoff, the rotation target attitude should be based on the assumed temperature that was used for the normal power calculation.

TYPICAL TAKEOFF ROTATION PROFILE — ALL ENGINES OPERATING
TIME - SECONDS
TAIL CLEARANCE TAKEOFF — ALL ENGINES
H
10.6
as
H = Approx 24"
TAIL CLEARANCE TAKEOFF — ONE ENGINE INOPERATIVE

NORMAL TAKEOFF

Noise abatement departure profile operations are authorized and procedures outlined in Operations Specification C068. Compliance is mandatory.

IAS hold is recommended for pitch control guidance. Maintaining initial climb airspeed of V2 + 10 is extremely important for both the turning profile and the climb out over the noise sensitive area. If the airspeed is allowed to increase above V2 + 10, the airplane will be closer to the noise sensitive area prior to obtaining the minimum altitude to commence a turn. Similarly if the airspeed is allowed to exceed V2 + 10 prior to thrust cutback on an overfly profile, the airplane will be lower and closer to the noise sensitive area before the thrust reduction. Care must be exercised to follow the departure track and where turns are required, a standard rate or 25° bank employed.

CROSSWIND TAKEOFF

Adverse Runway Conditions With Crosswinds

The 747 has good crosswind control capability during takeoff. Crosswind values of 15 knots can be controlled on icy runways with adverse combinations of light gross weight and aft c.g. using normal pilot techniques. This 15 knot value is conservative for heavy gross weight and forward c.g.. Initial runway alignment and smooth symmetrical thrust application are quite important.

Forward pressure on the control column during the initial phase of takeoff roll (below approximately 80 knots) will increase nose wheel steering effectiveness. Directional control from nose wheel steering and aerodynamic rudder forces should be optimized at the initiation of the takeoff roll on very slippery runways by limiting the rudder pedal input to approximately 1/2 of full rudder pedal travel for airplanes with rudder pedal steering. Full rudder will provide more directional control than optimum nose wheel steering on a slippery runway at about 40 to 50 knots. As the airplane reaches about 80 knots, increased rudder effectiveness makes control easier.

ENGINE FAILURE AT OR AFTER V,

Takeoff Roll

If an engine fails between V, and liftoff, maintain directional control by smoothly applying rudder commensurate with thrust decay.

Rotation

Do not rotate early or rapidly. At VR, smoothly rotate to the rotation target attitude. The rate of rotation should be somewhat slower than with all engines operating. With an engine inoperative, the rotation target attitude will result in a speed very near V2 during initial climb after gear retraction. As soon as the rotation target attitude is established, check the airspeed and make smooth pitch changes on the attitude indicator, as required, to maintain V2.

Initial Climb

Maintain V2 and the takeoff flap setting to flap retraction altitude. Retract the landing gear after a positive rate of climb is indicated.

NOTE: The airplane drag will increase during gear retraction while the geardoors are open. If the engine failure occurs at or after liftoff, apply rudder and aileron to control heading and stop the roll. In flight, the correct rudder input will approximately center the control wheel.

This approximates a minimum drag configuration. If an engine fails at an airspeed above V2, climb at the airspeed at which the failure occurs. Do not exceed V2 + 10 until clear of obstacles.

For reduced thrust takeoffs, resetting operating engines to full thrust will provide additional performance margin. This additional performance margin is not a requirement of the reduced thrust takeoff certification and its use is at the discretion of the flight crew.

Immediate Turn After Takeoff

Obstacle clearance or departure clearance may require a turn shortly after takeoff. Climb performance is slightly reduced while turning but is accounted for in the airport analysis. Maintain V2 and takeoff flap setting while maneuvering. Limit bank angle to 15 degrees when below V2 + 10 with takeoff flaps.

If the runway to be used has a special turn procedure for an engine failure, it will be noted with TURN under the runway number in the performance manual. The procedure will be published on pink paper in the Jeppesen route manual. This procedure must be followed in the event of an engine failure, and may not follow the ATC clearance. ATC is not aware of any special turn procedures. If a special turn procedure is used, it is used under the captain's emergency authority. ATC should be notified as to what is happening as soon as it is safe to do so.

Flap Retraction Altitude

When the height selected for flap retraction is based on clearing a distant obstacle, maintain level flight during flap retraction to flaps 1 and until reaching flaps 0 (15° bank) speed. Re-establish climb at this speed while retracting flaps from flaps 1 to flaps up and limit bank angle to 15°. Observe flap placard speeds for flaps 5 (LE flap sets 1 and 3) and flaps 1 (LE flap sets 2 and 4).

After flap retraction, set maximum climb power appropriate for bleed configuration and continue climb at 0 flap (15° bank) speed to obstacle clearance altitude. Ensure that adequate terrain clearance can be obtained along the departure track, and if not possible, take an alternate course of action such as climbing in a holding pattern. Limit bank angle to 15 degrees until established at 0 flap 30° bank speed.

ENGINE OUT CHARACTERISTICS

The takeoff speeds are generally substantially higher than VMCA except for takeoff at very light weights, and control required to maintain a straight track is reduced significantly with increase in speed. Adequate thrust is available for climb with one engine inoperative at maximum takeoff weights with the result that for light weight takeoffs with lift-off near VMCA, a large amount of excess thrust is available for climb and speed increase.

At heavier weight takeoff conditions, smaller control deflections are required for engine-out control and very little bank angle is required to maintain heading.

Discussions thus far have had to do with the static characteristics with an engine inoperative. The ability to control the airplane dynamic responses has been demonstrated in flight at the VMCA speeds determined for static trim. These tests demonstrated recovery with normal piloting technique and showed that the heading change following the engine cut was less than the 20 degrees allowed by the FAA rule.

Regarding the pilots references and technique for minimizing sideslip with an engine-out, since there is no sideslip instrumentation in operational aircraft, rudder control, up to the maximum available, should be used as necessary to minimize the wheel input required for roll control. This is the technique taught in flight training and will result in minimizing the sideslip angle and, consequently, aircraft drag. Also, at speeds near VMCA, if the pilot does not apply rudder to reduce sideslip, much larger wheel control is required to control bank angle.

Engine Out Familiarization

The objective of this maneuver is to train the pilot in the recognition of engine failure and the recommended procedures and techniques for control.

Airplane Response

If an engine failure occurs on the ground during takeoff, yaw is the first noticeable response. In flight, yaw and roll toward the failed engine occur almost simultaneously. In instrument flight conditions, roll (resulting from yaw) is usually the first noticeable airplane response.

Flight Instrument Indications Inflight

Until corrective action is initiated, the attitude indicator will show a roll toward the failed engine, the ball of the turn and bank instrument will be deflected opposite to the failed engine and the needle will be deflected toward the failed engine. The HSI and RMI will indicate a turn toward the failed engine.

Pilot Reaction

Any engine failure should trigger the same sequence of thought and action. Apply rudder (and aileron if required) to counter thrust asymmetry, control flight path and airspeed, then accomplish the appropriate engine failure procedure after the airplane is stabilized and at a safe altitude.

Yaw and Roll Control

During visual flight conditions on the runway, or in flight, stop the yaw by smoothly applying rudder at the same rate that thrust decays. When the rudder input is correct, very little control wheel displacement or lateral trim is necessary. Refine the rudder input as required and trim the rudder so the control wheel remains approximately level.

To hold the wings level, a small wheel input away from the failed engine is required due to the rolling movement generated by the larger rudder deflections associated with engine out trim. The rudder required to trim the airplane with a failed outboard engine and the other three engines at MCT is within the rudder trim authority.

The rudder ratio changer system limits the amount of rudder available from rudder pedal or trim input as a function of airspeed. The amount of rudder pedal or trim required to maintain directional control does not vary appreciably with airspeed. In the event full rudder trim is not sufficient to maintain heading with wings level, a very small amount of bank will be required. For the extreme case of two engines out on one side and the remaining two engines operating at MCT, bank angles up to approximately three degrees are used to maintain heading. Under this maximum engine out trim requirement, up to 1 1/2 units of aileron trim may be required to trim the slight bank.

The necessity of applying a slight bank angle in trimming two engines out on one side under some flight condition should not be regarded as a marginal or unacceptable condition in that adequate excess rudder is available for coordinated maneuvering. Also since the spoilers do not pick up within + 1.8 lateral trim units, the trim drag associated with a small bank angle is minimal. If the airplane is trimmed with too much control wheel displacement , full lateral control is not available and spoilers on one wing may be raised, increasing drag.

During instrument flight conditions, the first noticeable indication of an asymmetric problem will probably be a bank into the failed engine.

Apply aileron to level the wings, then smoothly apply rudder in same direction that the control wheel is displaced. Refine the rudder input and trim as previously described. The correct control input for an asymmetric condition can best be determined by exterior visual cues when VFR, or the attitude indicator, when on instruments. The turn and bank indicator and HSI are more difficult to interpret and the use of these instruments to correct an asymmetric condition may cause a wrong control input. These instruments are best used to refine control inputs.

Thrust and Airspeed

If not thrust limited, apply additional thrust, if required, to control the airspeed. The total four engine fuel flow existing at the time of engine failure may be used initially to establish a three engine thrust setting at low altitude. If performance limited (high altitude), adjust airplane attitude to maintain airspeed while setting max climb power.

LOSS OF TWO ENGINES ON TAKEOFF

A loss of two engines on takeoff in the B-747 is not covered in any aircraft manual issued by Boeing. This emergency maneuver was not required for certification of the aircraft and it is therefore up to each operator to cover possible techniques for successful completion.

The loss of two engines has happened with enough frequency to warrant discussion of possible scenarios and how to return safely to the airport. What has happened in the past varies, but essentially an inboard engine suffers a catastrophic failure at or near rotation, with subsequent FOD damage and failure of an outboard engine. At high gross weights and -7A engines, the successful outcome will be in doubt unless the crew has the room to clean up the aircraft. Some suggested techniques follow.

1. For a two-engine failure with flaps 10, the aircraft should be cleaned up to flaps 5 as soon as possible. This may require a level-off at a low altitude for acceleration. Flaps should be left at 5° and thrust at the maximum available, considering controllability of the aircraft, until flaps to speed is attained.

When a second engine fails with flaps 20, the pilot must quickly retract flaps to at least 5 degrees to assure adequate performance. At any given weight, V2 for a 20 flap takeoff is approximately equal to Vref. On a normal 20 flap takeoff, we retract flaps directly to 5° at the flaps 5 retract speed. Similarly, when a second engine fails on a go-around (flaps 20) we may safely retract the flaps to 5° at the appropriate speed.

2. Flaps should not be retracted below 5 unless the aircraft will not fly at 5 and acceleration is not possible. Consider the use of emergency power on the inboard engine to assist in acceleration.

3. If the second engine fails suddenly, the flying pilot should:

a. Increase thrust as necessary on operative engines.

b. Level off or descend slightly (altitude permitting) to accelerate to command airspeed bug plus 10 knots.

c. Call for flaps 5. Non-flying pilot will retract flaps to 5 degrees. Accelerate to minimum maneuvering speed for flaps 5 and resume climb.

d. Reduce thrust to go-around EPR or as required.

If the second failing/failed engine is producing power, use thrust as required on the malfunctioning engine, clean up, and shut down the engine after achieving maneuvering speed.

In the event of a fire warning from a second engine, retard the throttle to check for a false warning/bleed air leak.

NOTE: If thrust is increased beyond takeoff power on two engines on the

same side of the airplane, Vmca may be higher than the speeds published in the flight manual.
NOTE: It is not recommended that flaps be retracted to a position between flaps 5 and flaps 1. There are flap detente only for flaps 5 and flaps 1, and the leading edge flaps will retract during the travel from flaps 5 to flaps 1, reducing the airplane's ability to maintain level flight or acceleration.
Refer to the Two Engine Landing procedure for more information.

AREA DEPARTURE AND CLIMB

Area Departure
A major factor in area departure is an airspeed selection that will allow a turn radius suitable for the assigned departure. The selection of the climb speed becomes an item of pilot judgment based on departure requirements. It may require a minimum radius turn, a maximum rate of climb or a penetration of turbulence.
Initial Climb
With all engines operating, maintain V2 + 10 and takeoff flaps until reaching 1500 feet 0 AGL. Retract the landing gear after a positive rate of climb is established. V2 + 10 is approximately the best angle climb speed with takeoff flaps. It results in the maximum altitude in the shortest horizontal distance. If airspeed exceeds V2 + 10 during the initial climb, stop the acceleration but do not attempt to reduce airspeed to V2 + 10. Continue to climb at the higher speed.
Maneuvering After Takeoff
Obstruction clearance, noise abatement or departure procedures may require an immediate turn after takeoff. When a turn is required immediately after takeoff, initiate the turn at a safe altitude, maintaining takeoff flaps and V2 + 10. Climb performance is slightly reduced while turning but is accounted for in the airport analysis. A maximum bank angle of 30° is permitted at V2 + 10 with takeoff flaps. At flap retraction altitude, continue in a reduced climb while accelerating and retracting flaps.
If a turn is required before or while retracting flaps, it is often better to delay or stop flap retraction rather than accelerate and retract flaps while turning. After flap retraction, maintain best angle climb speed for obstruction clearance or until attaining minimum crossing altitude. The autopilot may be engaged during the climb to minimize the workload and enhance safety by allowing the FP to broaden his scan and watch for other traffic. When the autopilot is used during initial climb, it may be used in heading, GPS or VOR / LOC mode with altitude select set for clearance altitude and the speed mode set for IAS or V/S. The pilot may select V/S and set the vertical speed control to a reduced rate of climb for airplane cleanup. The FE will set climb power when the flaps have retracted to flaps 5, as called for by the Flying Pilot.
s Flap Retraction Altitude
The altitude selector for acceleration and flap retraction is usually specified for each airport. Safety, obstruction clearance, airplane performance or noise abatement requirements are usually the determining factors.
Command Airspeed Bug (CAB) Usage – After Takeoff
Leave the command airspeed bug at V2 until initiating flap retraction, then position it to target maneuvering speed for flap retraction.
Climb, Cruise and Descent / Approach

Position the command airspeed bug to desired target airspeed, maneuvering + 10 knots while maneuvering in the pattern.
NOTE: During cruise, one white bug should be positioned to the 1.3 buffet onset IAS. All other white bugs may be positioned together at the bottom of the indicator.

Enroute Climb

Maintain V2 + 100 (for full maneuvering) until clear of obstacles or above minimum crossing altitude.
The requirements for a flaps up maneuvering speed of V2 + 100 stemmed from the certification of higher takeoff gross weights and the use of higher thrust engines. As airplane gross weight increases, the flaps up initial buffet speed increases at a faster rate than the V2 plus additive increases, which decreases the maneuver margin. The increase in maximum gross weight has resulted in a small reduction in the available bank angle capability at the flaps up maneuver speed.
If there are no altitude or airspeed restrictions, accelerate in level flight or a slight rate of climb to the desired climb speed schedule and select IAS, if desired. If airspeed restrictions exist, the flight crew should not be hesitant to coordinate with ATC and request the desired departure speed.

Best Rate Climb

Best rate climb results in the greatest altitude gain in a given time. The airspeed for best rate climb varies with gross weight and thrust available and increases with increased gross weight. It is approximately VREF + 130 to VREF + 150 / M.82 -.83 for four engines and V2 + 100 for three engines.
Normal Climb / Best Economy
The normal or best economy climb speed schedule minimizes trip fuel. It varies with gross weight and is referenced to VREF instead of V2 because V2 may be influenced at medium to low gross weight by ground minimum control speed, while VREF is directly related to actual gross weight.

Altitude Selection

The altitude selected for cruise should normally be as close to optimum as possible. Optimum altitude is the altitude that gives the best fuel mileage for a given configuration and gross weight. It normally provides at least a 1.50 "g" (approximately 47° bank to buffet onset) or better buffet margin. If altitude changes enroute are difficult to obtain, some thought should be given to selecting an initial cruise altitude based on maximum cruise thrust. 2,000 feet above optimum altitude will normally allow approximately 45° bank prior to buffet onset. The higher the airplane flies above optimum altitude, the more the buffet margin is reduced.

Approaching Top of Climb

A smooth transition from the constant IAS climb to the constant Mach can be made on auto-flight systems without MACH HOLD by switching the speed mode switch from IAS to WS at the climb IAS / Mach crossover point. It will be necessary to increase the rate of climb slightly to maintain the desired constant Mach number. As the climb progresses, gradually reduce the rate of climb to maintain the desired constant Mach climb.