BOEING

737

BREAKOUT SESSION

Tail Strike Briefing

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Planned Tail Strike

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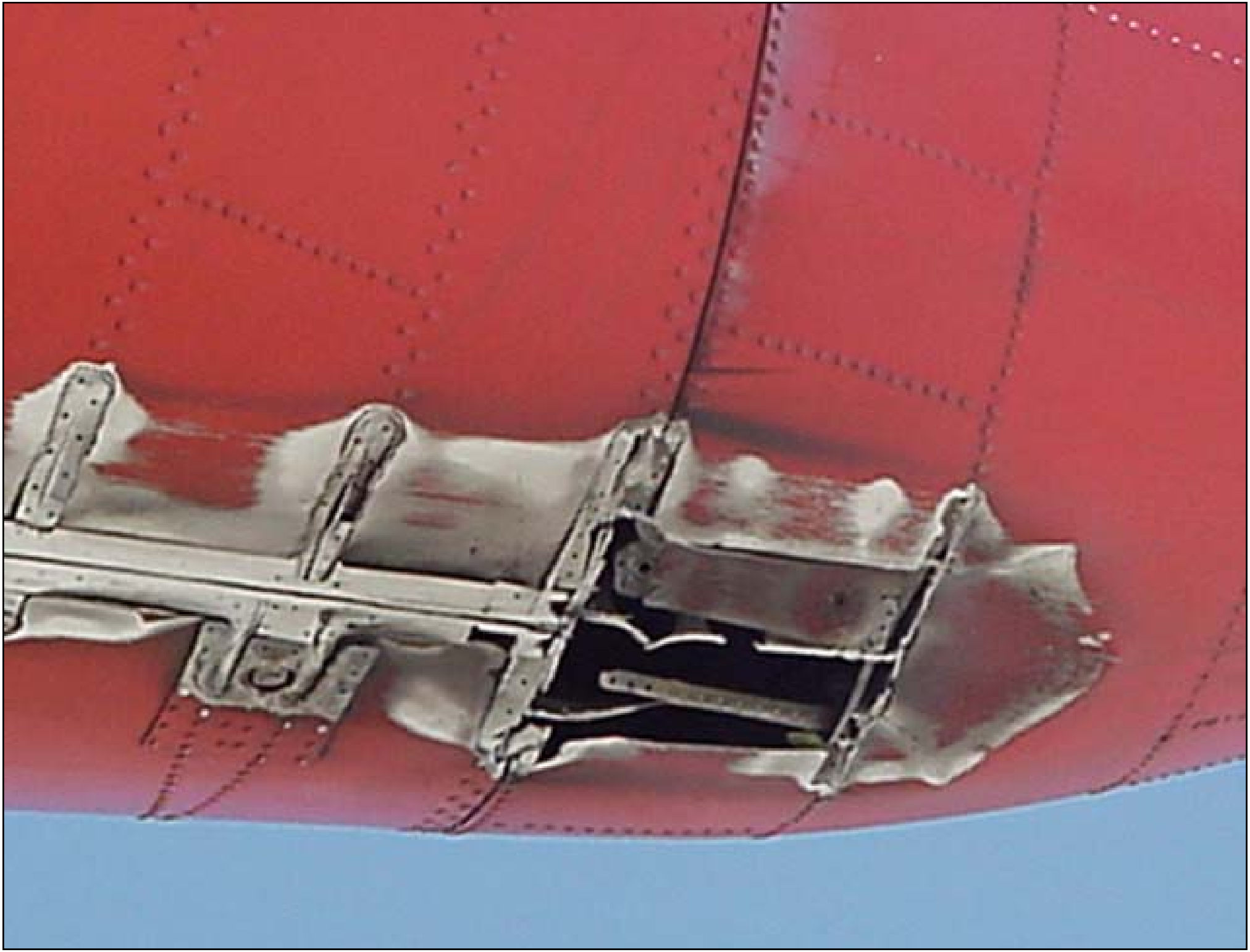


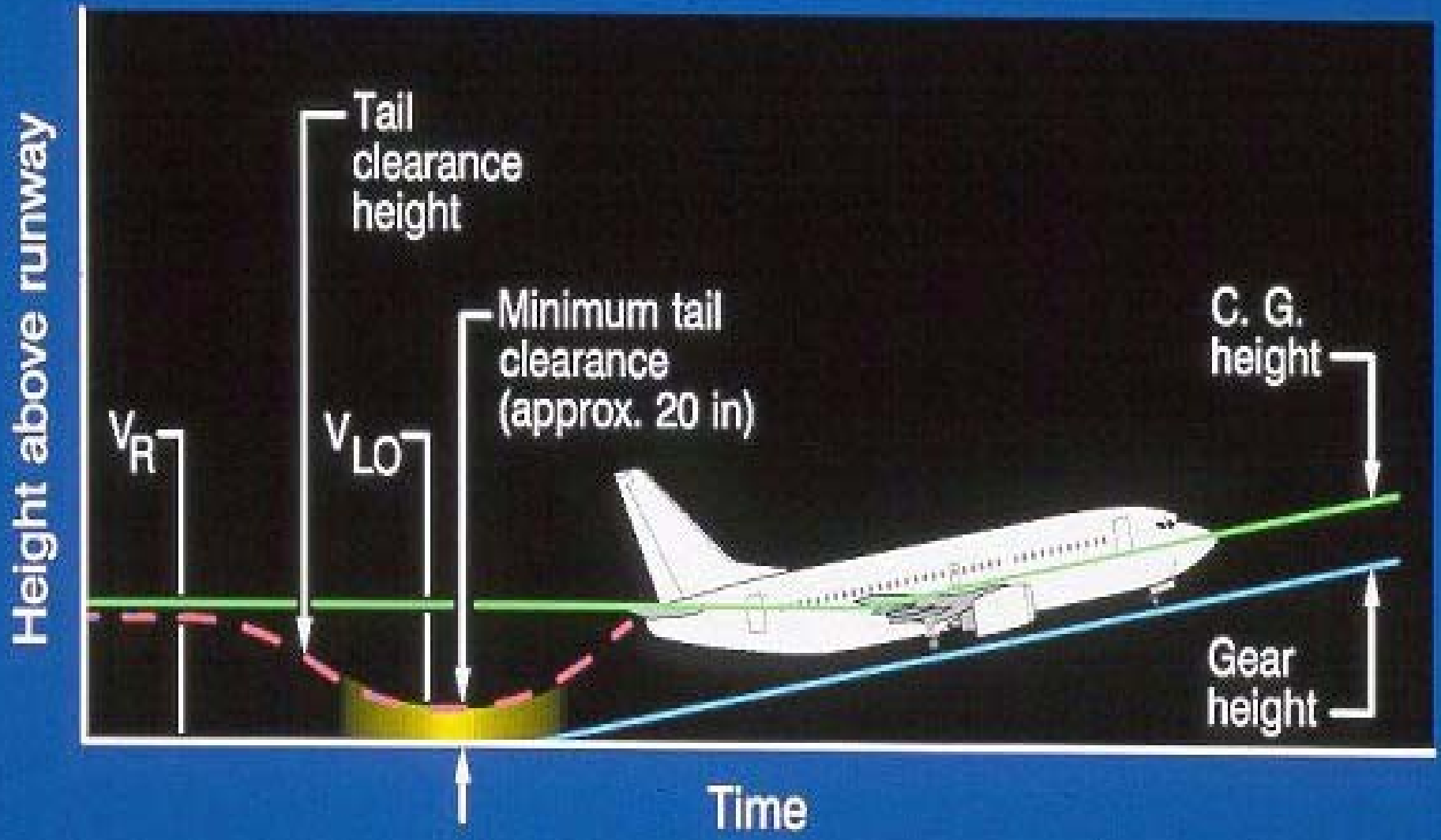
Presentation Overview

- General information
- Takeoff techniques
- Landing techniques
- Tail strike incidents on takeoff and landing
- Training recommendations

General Information

- More tail strikes occur on landing than on takeoff
- 82% of 737-*400* tail strikes occurred on landings
- 737-*400* does not have tail skid protection for landing therefore has higher damage
- 70% of 737-800 tail strikes occurred on landings
- 737-800/900 tail skid does not protect the aircraft body for landing. However, 737-800/900 have adequate aft body landing clearance
- 1994-1995 was another tail strike peak period with all Boeing models due to increased deliveries and/or new pilots

Typical Takeoff Tail Clearance Profile



Tail Strikes on 737-800

- 13 total tailstrikes to date
  - 3 without damage (not listed)
  - 10 with damage
  - 3 occurred during takeoff
  - 7 occurred during landing
  - limited damage occurred during takeoff tailstrikes
  - the 737-800/900 tailskid protects the aircraft on takeoff not on landing

Takeoff Risk Factors

- Mis-trimmed stabilizer
- Improper rotation techniques
- Improper use of the flight director
- Rotation prior to Vr
- Excessive initial pitch attitude
- Heavy derate/flight control abuse during gusty/crosswind conditions

Mis-trimmed Stablizer

- Usually results from using erroneous data
  - Wrong weights
  - Incorrect center of gravity (CG)
- Nose up mis-trim can present problems
  - Normal recommended rotation rate is 2 to 3 dps
  - Nose up mis-trim can rotate 5 dps or more
  - Aircraft may try to fly off runway without any pilot input

Improper Rotation Techniques

- Too early or too late rotation
- Too fast or too slow rotation
- Excessive rotation rate
- Excessive initial pitch attitude
- Rotation at incorrect Vr for the weight and flap setting

Effects of Improper Rotation

- Slow or late rotation uses additional runway - lower height at runway end
- Early, over or fast rotation - decreases initial climb performance
- Early and/or fast rotation increases chance of tail strike

Improper Use of the Flight Director

- *Cannot rotate on the flight director*
- Flight directors are designed to provide pitch guidance ***only after*** the aircraft is airborne, nominally passing 35 feet
- Proper rotation rate reaches 35 feet with about 15 degrees and a speed of V2 + 10 (V2 + 15 on some models)
- An aggressive rotation into the pitch bar may rotate the tail into the ground

Review of Proper Takeoff Techniques

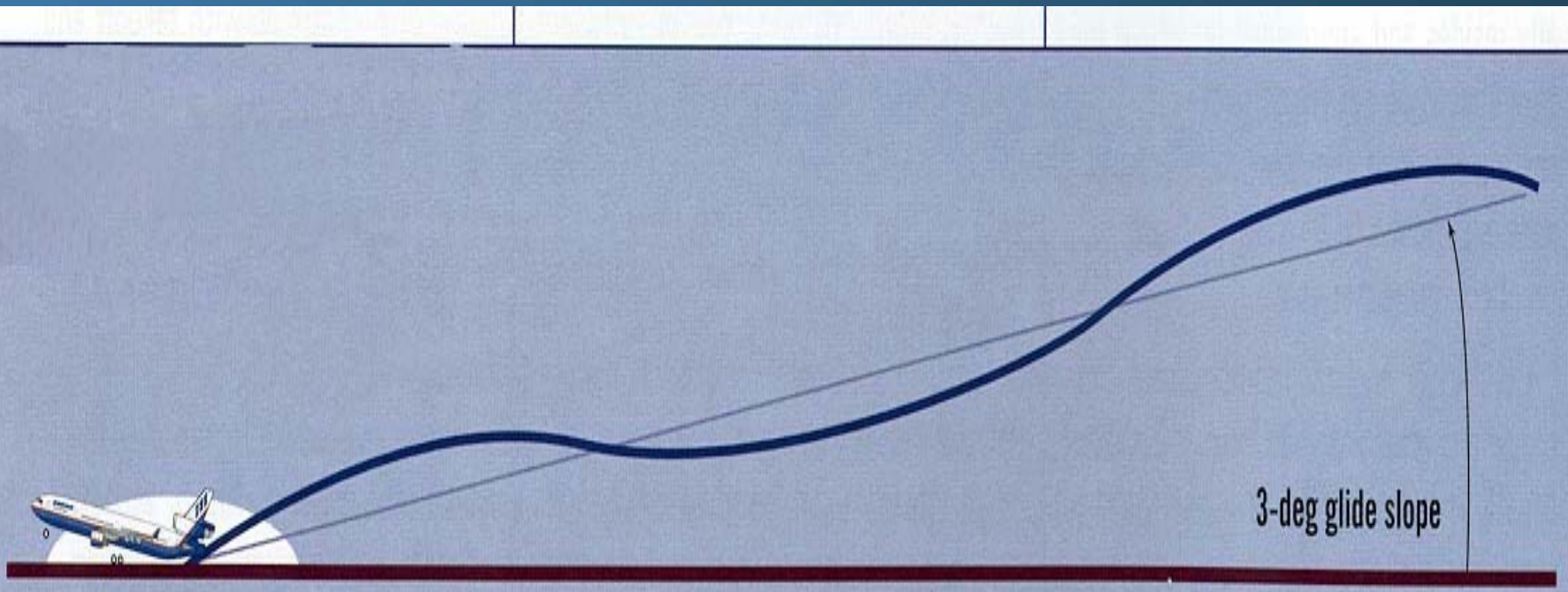
- Use normal takeoff rotation technique. Use same technique for -600 thru -900
- Do not rotate early
- Do not rotate at an excessive rate or to an excessive attitude
- Ensure takeoff V speeds are correct and adjusted for actual thrust used
- Consider use of greater flap setting to provide additional tail clearance
- Consider using Full Thrust during gusty/crosswind conditions

Landing Risk Factors

- Unstabilized approach
- Holding airplane off the runway in the flare
- Mis-handling of crosswinds
- Over-rotation during go-around

Note: Tail strikes on landing generally cause more damage. The tail may strike the runway before the main gear damaging the aft pressure bulkhead.

Unstablized Approach



An unstabilized approach is the biggest single cause of tail strike. Flight crews try to set all the approach variables — on centerline, on approach path, on speed, and in the final landing configuration — by the time the airplane descends through 1,000 ft (305 m) above ground level (AGL). This is not always possible. If by the time the airplane descends through 500 ft (152 m) AGL with these approach variables not stabilized, a go-around should be considered. For more information concerning go-arounds, see *Approach and Landing Accidents*, a report issued by the Approach and Landing Accident Reduction Task Force of the Flight Safety Foundation. It is available by calling the Jerry Lederer Aviation Safety Library at (703) 739-6700, ext. 103.

Unstablized Approach

- Usually appears in every landing tail strike
- Flight recorders show if not stabilized by 500 feet, will never get the approach stabilized
  - Excessive or insufficient airspeed in the flare
  - Long on runway touch down
- Increases tendency towards large pitch and power changes in the flare

Unstablized Approach … continued

- Spoilers add nose up pitching force when deployed
- Increases tendency toward vigorous nose up pull at touch down causing a tail strike
- If the airplane is slow, pulling the nose up in the flare does not reduce the sink rate, but may increase it
- Throttles above idle at touchdown add to instability.

Holding Airplane Off Runway in the Flare

- Allowing airspeed to decrease below Vref prior to landing flare resulting in high pitch attitude
- Trimming the stabilizer nose up just prior to or during landing flair
- Holding the airplane off with increasing pitch attitude in an attempt to make an extremely smooth touchdown
- Touchdown with an increasing pitch attitude
- Failure to *fly* nose gear onto runway immediately after main gear touchdown

Mis-handling of Crosswinds

- Crosswind landings may increase the tail strike risk, especially in gusty conditions
- To stay on glide path at high ground speeds, descent rates of 700 to 900 feet are required
- Cross controlling prior to touch down, reduces lift, increases drag, and may increase rate of descent
- Combined effects of high closure rate, shifting winds plus turbulence, can increase tail strikes

Over Rotation During Go-around

- Go-arounds initiated during flare and after a bounced landing, can cause tail strikes
- If a touchdown far down the runway is likely, consider a go-around
- Safe companies support go-arounds

Bounced Landing

FCTM Flare and Touchdown

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

Review of Proper Landing Techniques

- Maintain an airspeed of Vref + 5 kt minimum to start of flare
- Airplane should be in trim at start of flare; do not trim in the flare or after touchdown
- Do not “hold the airplane off” in an attempt to make an excessively smooth landing
- Immediately after main landing gear touchdown, release back pressure on control wheel and *fly* the nose wheel onto the runway
  - Do not allow pitch attitude to increase after touchdown
  - Do not attempt to use aero braking - ***it does not work*** !

Training Recommendations

- Include tail strike awareness and prevention briefings in all initial, transition and recurrent training

- Install and use simulator tail clearance page in all simulators. This has proven to be a very effective briefing tool during training

Continuous Training Awareness

- Emphasize DOs and DON'Ts of tail strike avoidance during training
- Include video as a basic item in all crew retraining sessions
- Include simulator software for tail strike awareness
- Display tail strike posters
- Distribute appropriate literature

Summary

- More tail strikes occur on landing than on takeoff
- Tail strikes are costly but can be prevented with proper training
- Tail strike awareness and training should be continuous
- Simulators can help
- Stabilize the approach by 500 feet AGL


Thank you for your attention !!