BOEING

757

BREAKOUT SESSION

Autothrottle Use with Autopilot Off

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Autothrottle Use W/Autopilot Off

What Is Pitch Coupling

- The thrust vector for engines mounted under the wing will cause the airplane to pitch up with increasing thrust and pitch down with a reduction in thrust. When an autothrottle makes changes in gusty conditions it causes unwanted pitch changes.
- Example: Imagine you are in level flight with autothrottle on, autopilot off, and a brief wind change causes a reduction in airspeed. The autothrottle will slightly advance the throttles to maintain commanded speed. This in turn will cause a slight aircraft pitch change upwards. The autothrottle will respond to the subsequent speed loss by increasing thrust further, resulting in further pitch up. The pilot will then correct by decreasing pitch attitude to descend back to the assigned altitude. As airspeed increases, thrust will decrease causing a further pitch down resulting in a descent through the desired altitude. The end result is a pitch “PIO” above and below the desired altitude.

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Some Advantages

- Stabilized speed during approach
- Speed floor protection
- Allows pilot focus on visual maneuvering
- Reduces necessity of wind additives (assumes autoland) for shorter landing distances

Note: With a headwind additive, the actual landing distance would still be less than a planned 0 wind distance.

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Some Disadvantages

- Excessive airspeed landing in gusts and turbulence
- Potential pitch coupling close to the ground
- Additional MCP coordination
- Excessive unexpected throttle movement
- Less thrust awareness (out of loop)
- Airspeed crosscheck skills not exercised

Flight Crew Training Manual

- **Landing (Previous Words)**
- When using autothrottle, position command speed to VREF + 5 knots. Sufficient wind and gust protection is available with autothrottle engaged because the autothrottle adjusts the approach speed upward to account for the wind gusts actually encountered during the approach.

Flight Crew Training Manual

Landing (New words)

- When using autothrottle, position command speed to VREF + 5 knots. Sufficient wind and gust protection is available with autothrottle engaged because the autothrottle adjusts thrust **rapidly when the airspeed drops below command speed while reducing thrust slowly when the airspeed exceeds command speed. In turbulence, the result is that average thrust is higher than necessary to maintain command speed. This results in an average speed exceeding command speed.**

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Incidents

- Boeing training pilots have repeatedly observed pitch coupling cause destabilized manual approaches on short final.
- While infrequent, it is particularly hazardous when it occurs in unstable air, close to the ground.
- Several hard landing incidents have been reported over the years.

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737 NG Incident

- The gusts, turbulence and autothrottle engagement contributed to an unstabilized manual final approach.
- At 0.6 miles and 14.4 seconds to touchdown, the “glideslope” warning sounded.
- Over control of pitch attitude started after a high rate of descent occurred at 100 ft at 0.25 miles and 5.4 seconds from touchdown, causing a “sink rate” warning.
- Over control continued throughout the flare. Nose landing gear collapsed.

737 Nosegear Collapsed on Landing

Flight Operations Safety

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737 NG Incident

cont'd

- 3.1.8 The autothrottle remained engaged after manual control was initiated on the approach, and remained engaged until after the touchdown, when it disconnected.
- The gusts and turbulence contributed to over control of the pitch attitude during the flare resulting in a hard touchdown. The aircraft pitched down. This caused the aircraft to contact the ground nose gear first, with a longitudinal deceleration of 0.4 G. Shortly thereafter, the main gear contacted the ground coincident with a vertical load factor of 3.8 G.

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747 Incident (Canada)

- Hard landing. Lost all the primary flight displays plus significant other damage.
- Cause: 15kt HW gust just prior to flare, throttles went to idle with consequent pitch down.

[Plus other incidents]

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Recommendation

- Use manual thrust control when in manual flight due to potential “pitch coupling”
- Unable to provide NTOs due to accident & incident history

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Risk Mitigation

- Autothrottle disconnect altitude no lower than (300?) feet
- Not with gusty winds or turbulence
- Establish a procedure in case of sudden thrust increases and the landing becomes unstabilized
- Provide training on pitch coupling
- Establish Clear policy

Questions

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Boeing Flight Crew Training Manual

- If the autothrottle is disengaged, or is planned to be disengaged prior to landing, the recommended method for approach speed correction is to add one half of the reported steady headwind component plus the full gust increment above the steady wind to the reference speed. One half of the reported headwind component can be estimated by using 50% for a direct headwind, 35% for a 45° crosswind, zero for a direct crosswind and interpolation in between.

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737 NG Accident

- **3.1.7** An ILS approach was flown to Rwy XX. DFDR data show that pitch attitude averaged near 0º during the initial coupled approach, which was appropriate for the airspeed, gross weight and flap setting. The glide slope and localizer were tracked to within tolerances until the final approach segment. At 3.5 miles from touchdown the autopilot was disengaged. Pitch excursions from –3.3º to 3.5º were present throughout the final approach. A crosswind heading correction of approximately 5ºnose left was maintained at touchdown.
- **3.1.8 The autothrottle remained engaged after manual control was initiated on the approach, and remained engaged until after the touchdown, when it disconnected.**
- **3.1.9** The 737 Flight Crew Training Manual (FCTM), Reference C, page 2.8, states: *"when in manual flight, manual thrust control is recommended".* The approach was flown using autothrottle while in manual flight, contrary to the FCTM recommendation.
- **3.1.10** The gusts, turbulence and autothrottle engagement contributed to an unstabilized final approach under manual control. At 0.6 miles and 14.4 seconds to go to touchdown the "*glideslope"* warning sounded. **Overcontrol of the pitch attitude started after a high rate of descent occurred at 100 ft at 0.25 miles and 5.4 seconds from touchdown, causing a "*sink rate"* warning. Overcontrol continued throughout the flare.**
- **3.1.11** This led to a hard first ground contact and rebound, followed by a large forward pilot control input to a negative pitch angle of – 3.5º. A go-around was apparently attempted but this was quickly discontinued.