



# 757 Pilot Induced Oscillations (PIO)

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# PIO

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*Why are we talking about this?*

- Continue to get infrequent reports of oscillatory events in the roll axis
  - Usually on landing (“high gain” pilot task)
  - Usually in light crosswinds
- Review Some Actions Already Taken
- Preview More Actions to Come



# Agenda

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- What is a Pilot Induced Oscillation (PIO)
- What causes a PIO
- What we have done already
- What we will be doing



# What is a Pilot Induced Oscillation?

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- National Research Council Definition:
  - An inadvertent, sustained aircraft oscillation resulting from a closed-loop interaction between the aircraft dynamics and the pilot's flight control inputs in which the aircraft response becomes substantially out-of-phase with the pilot input.



# PIO – A Pilot's Comments

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- Pilot must be in the loop – trying to control the airplane
  - Open-loop control wiggling is not a PIO
- Pilot must be out-of-phase with the airplane response
  - Typically reported as “airplane going the wrong way” or that something in the control system had broken
- Event is usually precipitated by a “Trigger” event
  - External Disturbance
  - Inadvertent large pilot input
  - Unanticipated airplane response to an input



# Actions:

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- Immediately stop control wheel input
- Go-around, if safe landing cannot be made



# What We Have Done to Date

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## *Flight Crew Awareness*

- 09/28/00 Fleet Team Digest Article
- 07/05/02 Operations Manual Bulletin
- 08/02/02 Flight Operations Technical Bulletin
- 11/05/02 Non-Normal Maneuver added to QRH
- 11/09/02 Fleet Team Conference
- 11/29/02 Flight Operations Symposium
- 05/10/04 Flight Operations Symposium



# What We Have Done to Date

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## *Airplane Changes*

- Vortex Generators on Flaps
  - Service Bulletin on existing -200
  - Production on -300
- Serve to smooth the rapid separation of airflow on the flaps at small spoiler deflections
- Makes the roll response more linear, eliminating an “unanticipated response” PIO trigger associated with some crosswind landing conditions





# Upcoming Actions

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## *Wheel Damper*

- Wheel Damper Installation
  - Designed to increase the pilot force required to make very large, very rapid wheel inputs
  - Provides a tactile cue to the pilot that inputs are becoming unnecessarily large and/or fast
  - Consistent with the Boeing cueing philosophy
  - Designed to not interfere with “normal” flying



# Upcoming Changes

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## *Wheel Detent Force*

- Revised Wheel Force Rigging Procedure
  - Boeing airplanes use artificial force-feel systems to generate wheel forces
  - Wheel feel systems include a center “detent” force
    - Helps hold the wheel in neutral position during unattended operation
    - Provides a tactile cue to identify neutral wheel



# Wheel Force Rigging

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- Some airplanes have higher detent forces than others
- Excessive detent forces are potential PIO triggers
  - Contributes to imprecision in rapid wheel inputs
  - Potentially generating unanticipated airplane response
- Revised rigging procedure will provide adequate wheel centering and minimize the adverse trigger effects
  - Wheel centering on some airplanes may not be as “crisp” as previously



# Summary

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- PIO's are caused by an adverse interaction between the pilot and the airplane dynamics
  - Transport airplane dynamics are slow enough that pilots can get out-of-phase
  - The cycle can be broken by freezing the control inputs
  - Published Info: Fleet Team Digest, Technical Bulletin, OMB, SB, symposiums
- PIO's are often precipitated by “trigger” events
  - Boeing has been aggressively eliminating potential triggers
    - Vortilon installation
    - Wheel damper installation
    - Revised rigging procedures