Aviation Safety

"Can the Universities make a difference?"

Report to the JUP for ATR

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December 27, 2001

Recent Safety Challenges-1/5

9/14/99

- Olympic Airways Falcon 900,
  - Romanian airspace
  - Over a period of 24 seconds, experienced 10 pitch oscillations with up to +4.7 and -3.26 g
  - 7 fatalities
  - http://www.bea-fr.org/docs/sx-h990914/pdf/sx-h990914.pdf

Olympic Airways Falcon 900

ROMANIA
MINISTRY OF TRANSPORT
CIVIL AVIATION INSPECTORATE

Nr. 711 / 01.08.2000

SYNOPSIS

Aircraft Accident Report:	Nr.711/01 .08.2000(File:1999091401)
Registered Owner:	Hellenic Air Defence
Operator:	Olympic Airways
Aircraft Type:	Mystère Falcon 900B

Between FL 150 and FL 140, for approximately 24 seconds, the aircraft experienced 10 oscillations in pitch axis which exceeded the limit manoeuvring load factor. Maximum recorded values of the vertical accelerations recorded by an accelerometer located in the landing gear bay were: +4.7 g and -3.26 g.

the ACCIDENT of the FALCON 900B

registered SX-ECH,

- 14 September 1999 -

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FINAL REPORT on THE ACCIDENT - FALCON 900B / SX-ECH
14 September 1999 / in Bucharest FIR Area – ROMANIA
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inspectorate by Romanian ATC. The investigation began immediately and was carried out in accordance with Romanian Ordinance nr. 51/1999 regarding Investigation of Air Accidents and Incidents.

The aircraft performed the flight OAL3838, from Athens to Bucharest as a government flight.

During climb after flap and slats were retracted, the flight crew noticed, on the warning panel, the "PITCH FEEL" light came on. The "PITCH FEEL" warning light, remained continuously ON, during cruise and descent until SLATS were extended.

During descent the Indicated Air Speed (IAS) increased from 240 Kts to 332 Kts.

Approaching FL 150, the F/O had a request for a further descent. Just before FL 150 the ATC re-cleared OAL3838 to continue descent to FL 50, while PIC briefed F/A about ETA. One second later, A/P disengaged and for the next 1 minute and 36 seconds the aircraft was manually flown by the PIC.

Between FL 150 and FL 140, for approximately 24 seconds, the aircraft experienced 10 oscillations in pitch axis which exceeded the limit manoeuvring load factor. Maximum recorded values of the vertical accelerations recorded by an accelerometer located in the landing gear bay were: +4.7 g and -3.26 g.

FINAL REPORT on THE ACCIDENT - FALCON 900B / SX-ECH
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Olympic Airways Falcon 900

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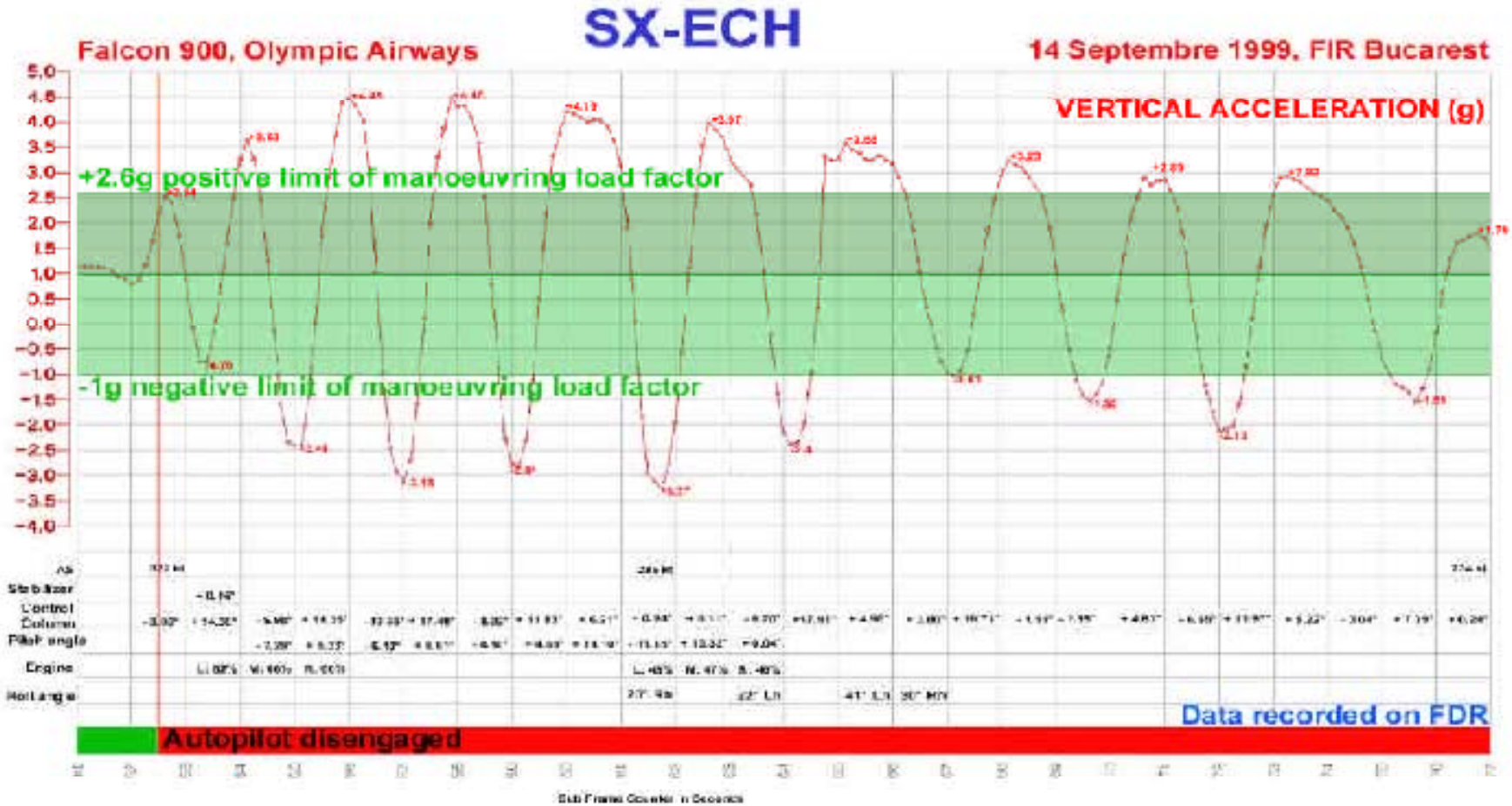
The impact of the unfasten passengers with cabin ceiling and aircraft furniture, due to accelerations occurring during the pitch oscillations caused fatal injuries to 7 passengers, serious injuries to 1 crew member and 1 passenger and minor injuries to 2 passengers.

The investigation identified following causal factors:

1. Inadequate risk assessments of the PITCH FEEL malfunctions.
2. Overriding of the A/P on the pitch channel by the crew.
3. Inappropriate inputs on the control column at high speed and with Arthur unit failed in "low-speed" position leading to Pilot Induced Oscillations.
4. Seat-belts not fastened during descent flight phase.

Twelve Safety Recommendations have been made as a result of this investigation

VERTICAL ACCELERATION



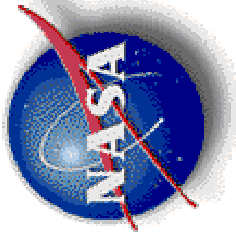
Created: June 28, 2000

Laboratoires du Bureau Enquêtes-Accidents

Recent Safety Challenges-2/5

3/18/01

- NWA A-320 flight 985
  - Aborted take-off from Detroit Metropolitan Airport
  - Time Histories on next slide
  - Investigation ongoing
  - http://www.ntsb.gov/ntsb/brief.asp?ev_id=20010319X00608&key=1
  - http://www.cnn.com/2001/US/03/17/plane.off.runway/



Recent Safety Challenges-3/5

7/31/97

- FedEx, McDonnell Douglas MD-11
  - Newark International Airport
  - Crashed During Landing
  - NTSB Recommended FAA Sponsor NASA Lg. A/C FQ Study
  - http://www.ntsb.gov/Publictn/2000/aar0002.htm

PB2000-910402
NTSB/AAR-00/02
DCA97MA055

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

CRASH DURING LANDING
FEDERAL EXPRESS, INC.
MCDONNELL DOUGLAS MD-11, N611FE
NEWARK INTERNATIONAL AIRPORT
NEWARK, NEW JERSERY
JULY 31, 1997

7047B

3. Conclusions

3.1 Findings

1. There was no preexisting damage or degradation to the airplane structure, systems, or components that contributed to this accident.

2. The airplane's approach before the landing flare was stabilized.

3. The captain's execution of the beginning of the flare maneuver was normal and not a factor in the accident.

4. The accident airplane performed normally in response to the captain's flight control inputs until after the second touchdown.

5. The captain was concerned about the airplane's touchdown location on runway 22R and intended to take measures during the landing to achieve an early touchdown and minimize the length of the rollout on the runway after touchdown.

6. The captain's nose-down elevator input beginning at 17 feet radio altitude was not consistent with Federal Express guidance for landing the MD-11.

7. The captain's nose-down elevator input at 17 feet radio altitude (2 seconds before the first touchdown) was consistent with an attempt to control the point of touchdown given his concerns about the runway length.

8. The captain made a nearly full nose-up elevator input and a large throttle increase to compensate for the increased sink rate caused by his previous nose-down input.

9. The captain's full nose-down elevator control input at the time of the first touchdown was consistent with his continued concerns to avoid a long landing and his desire to avoid a tailstrike.

10. The captain's overcontrol of the elevator during the landing and his failure to execute a go-around from a destabilized flare were causal to the accident.

11. The captain's control inputs during the flare and bounce were not consistent with landing procedures and techniques outlined in the Federal Express MD-11 pilot training procedures, McDonnell Douglas flight crew operating manual, or with Federal Express' MD-11 tailstrike awareness and high sink rate and bounce recovery training.

12. The captain had no previously documented skill deficiencies that contributed to this accident.

…

Sponsor a National Aeronautics and Space Administration (NASA) study of the stability and control characteristics of widely used, large transport-category airplanes to

Sponsor a National Aeronautics and Space Administration (NASA) study of the stability and control characteristics of widely used, large transport airplanes …

Compare overall qualitative and quantitative stability and control characteristics on an objective basis.

The study should include analyses of DC-10 and MD-11 landing accidents and any other landing incidents and accidents deemed pertinent by NASA. (A-00-100)

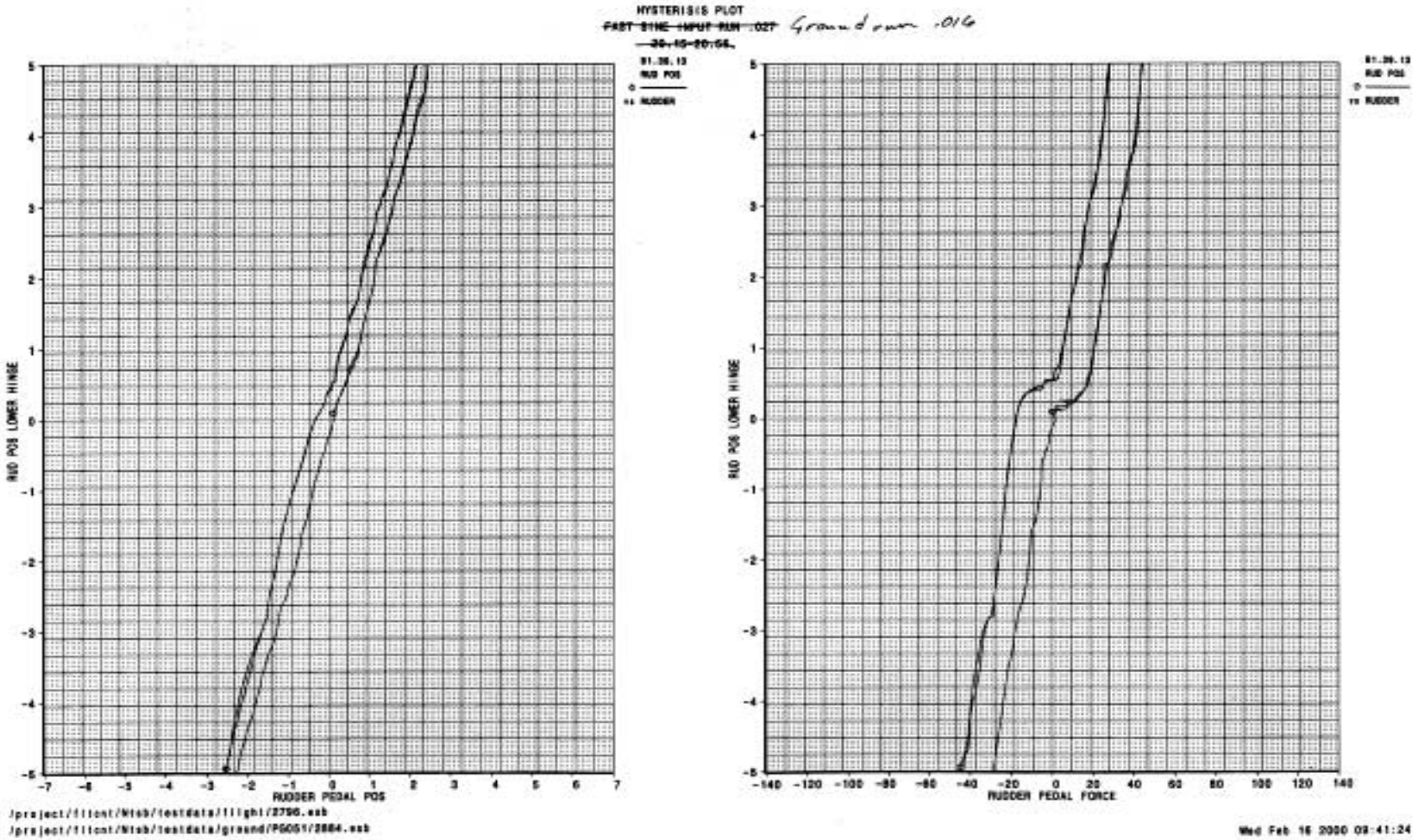
…

Recent Safety Challenges-4/5

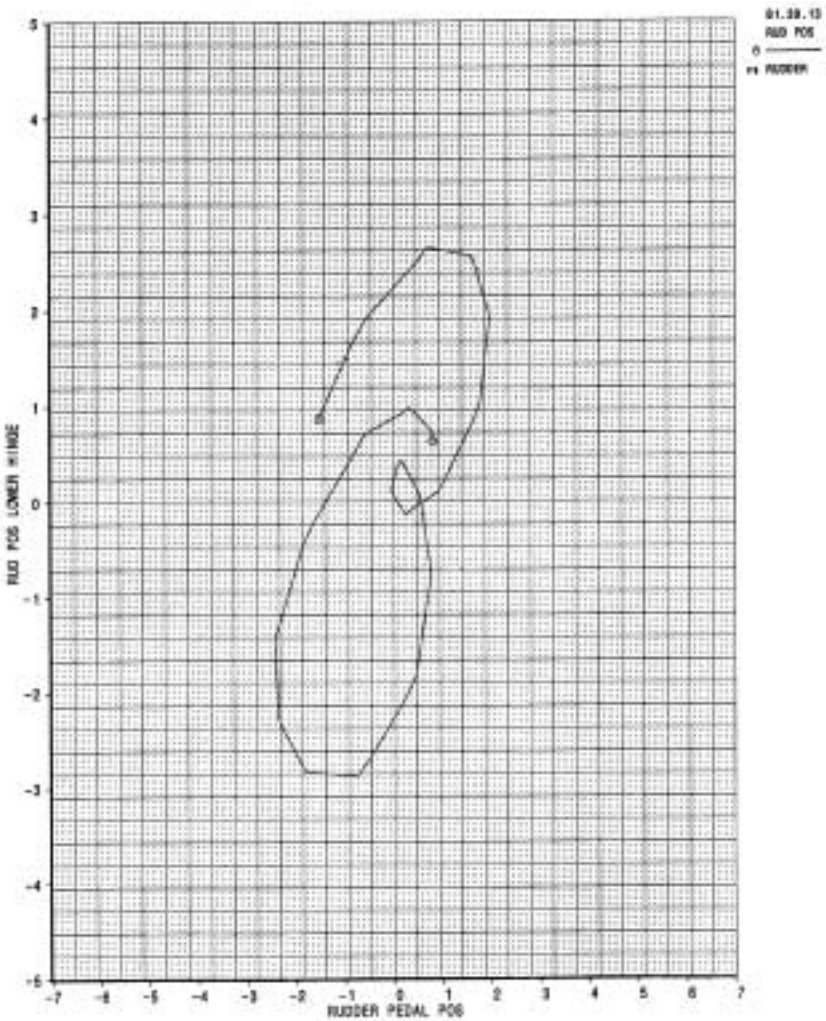
11/12/01

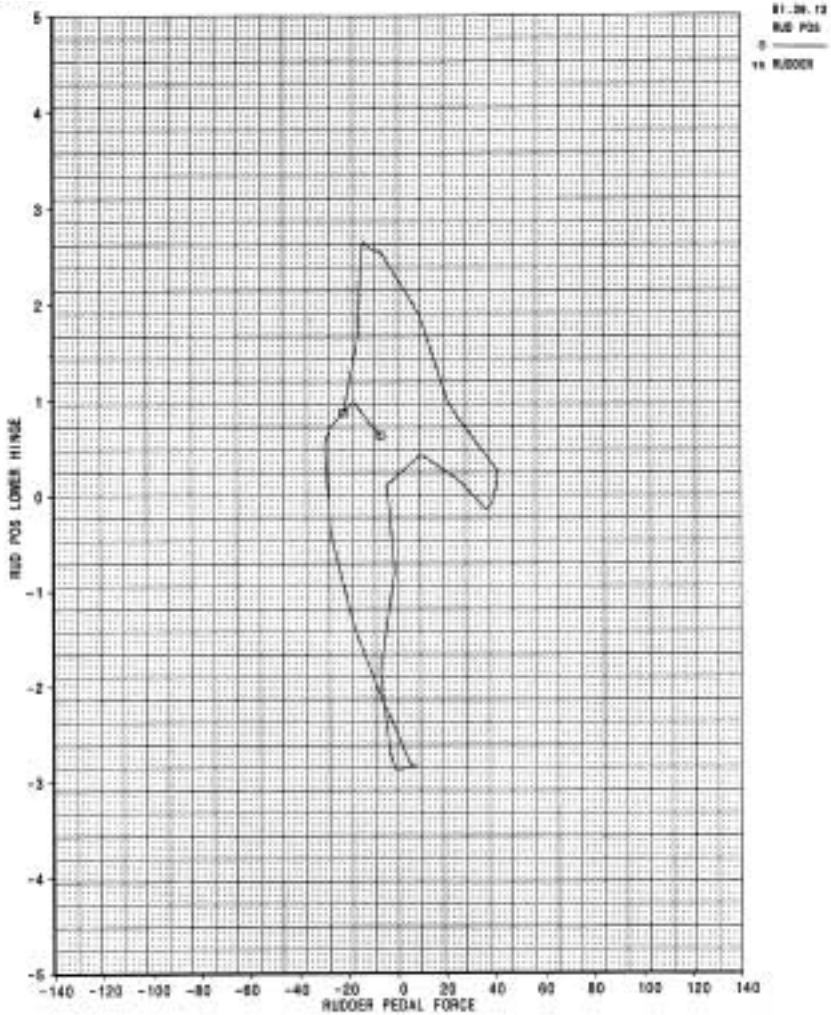
- American Airlines 587, A300-600
  - Belle Harbor, New York
  - 260 fatalities
  - Wake vortex triggered aggressive rudder inputs; vertical tail failed
  - Investigation ongoing
  - http://www.ntsb.gov/events/2001/aa587/

Rudder Deflection vs. Pedal Position & Force
Ground Run, .016 Hz

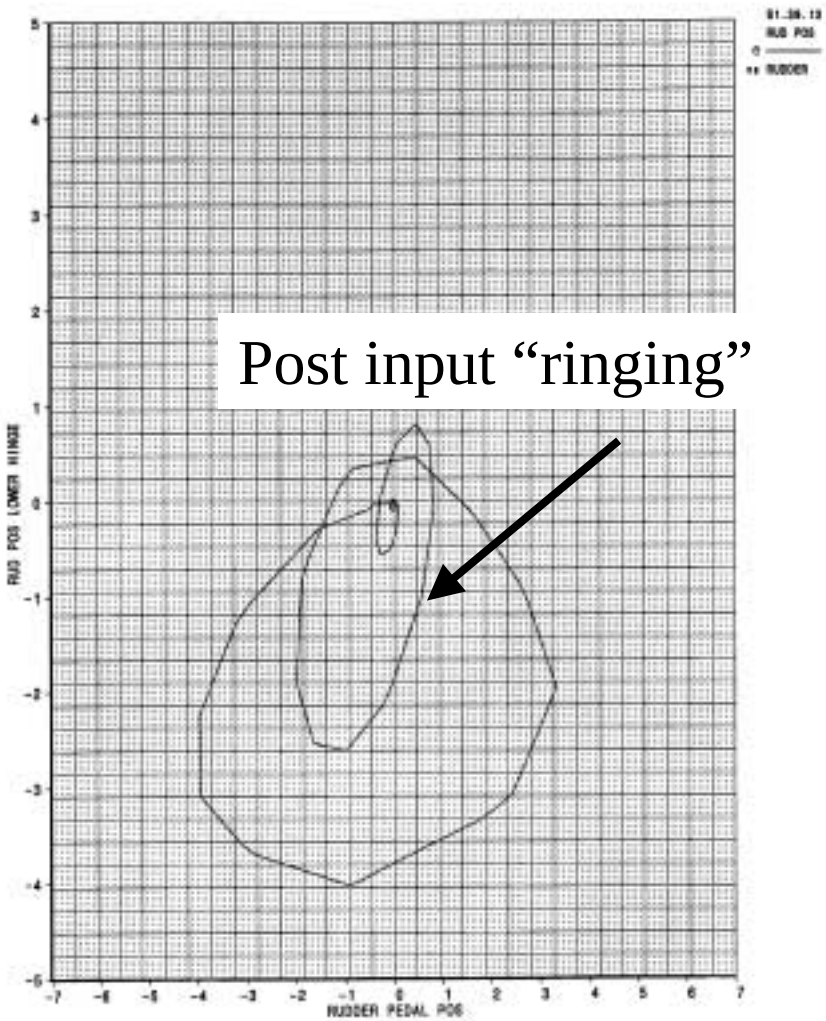


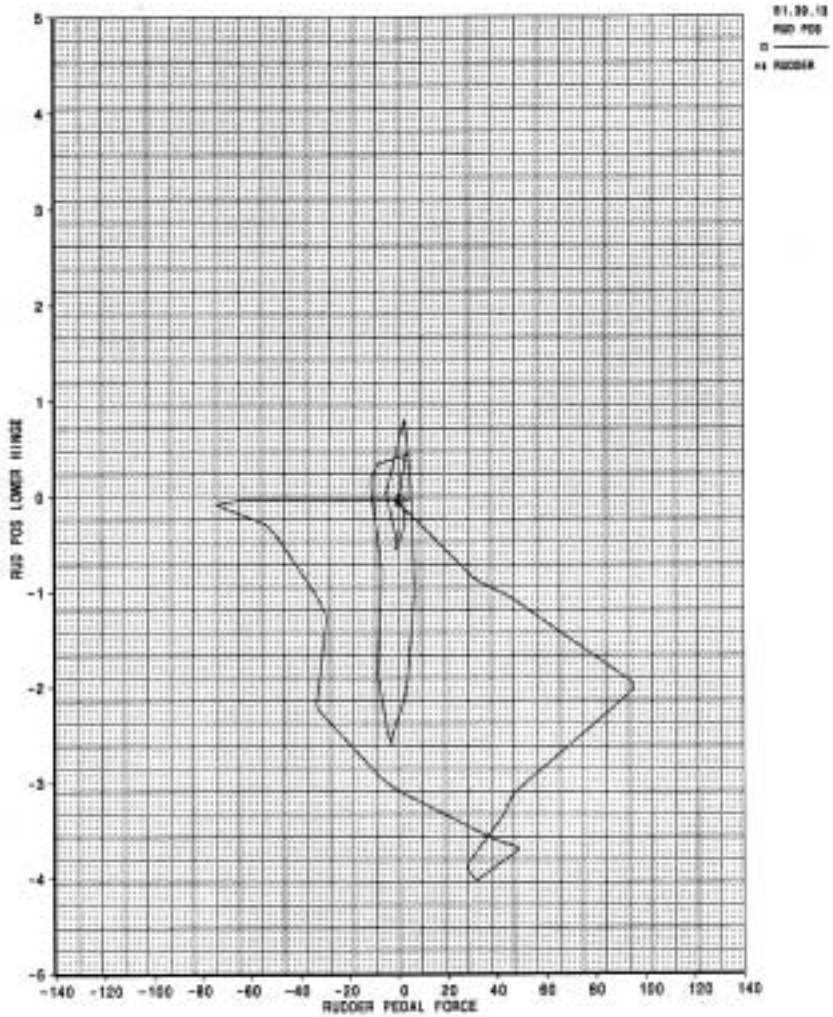
Rudder Deflection vs. Pedal Position & Force
Run 027, 2.50 Hz





Rudder Deflection vs. Pedal Position & Force
Run 027, Left/Right Doublet





Recent Safety Challenges-5/5

- Airbus 319 aileron flutter
  - ASRS AB 2001:63/3-39, 9/4/01
  - Reported two cases of damaging aileron flutter undetected by the pilot because there is no feedback with current FBW implementation

ALERT BULLETIN

AB 2001-63/3-34
9/4/01
511315

SUBJ: A319 Aileron Panel Flutter

… During two incidents, the A319 sustained damage to the aileron and the panel. … the flight crews were unaware of the flutter and vibration because of the FBW system …

Recent References

- Aviation Safety and Pilot Control: Understanding and Preventing Unfavorable Pilot-Vehicle Interactions -1997

  NRC Report, http://www.nap.edu/catalog/5469.html, http://books.nap.edu/html/aspc/#summary
- Flight Control Design - Best Practices, RTO-TR-029, 2000 NATO/RTO Report, http://www.rta.nato.int/Rdp.asp?RDP=RTO-TR-029
- AGARD-AR-335 Workshop on Pilot Induced Oscillations

  http://www.rta.nato.int/Rdp.asp?RDP=AGARD-AR-335

Examples of Aircraft-Pilot Discord

- http://www.aero-space.nasa.gov/library/interest_ai.htm#
- Boeing corrects several 777 PIOs, Dornheim, M 1995 AvWk

What is Needed?

- Some fresh views on flight control system design
  - Under normal conditions the pilot's expectations of the aircraft response to his inputs are currently satisfied
  - but when stuff happens, we could/should be doing a better job of keeping the pilot out of trouble, and communicating the symptoms of the problem

What is Needed? — example 1

- Active feel systems with “smart” feedback to the pilot
  - Physically prohibits control overdriving
  - maintains latency of control rate reversal to surface rate reversal to less than 100 msec.
- OK, with current control law implementation

What is Needed? — example 2

- Alternate control scheme when the pilot is “overdriving” the controls
  - assure latency of control rate reversal to surface rate reversal of less than 100 msec.
- OK, with current passive feel systems

What is Needed? — example 3

- FBW with “feel by wire” to the cockpit controls to provide intuitive communications to the pilot, e.g.,
  - Surface position limiting
  - Surface rate limiting
  - Surface flutter
  - Icing
  - Trim run away
  - Envelop limiting
  - Control inputs by other pilot
  - Loading anomaly (cargo shift, mal-distribution of fuel, …)

FAA Flight Certification

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2/02

http://www.aero-space.nasa.gov/goals/safety.htm