Key Elements
of
Academic Training

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ICAO Regional Workshop on Loss of Control in-Flight and UPRT
November 17, 2020

Main Points

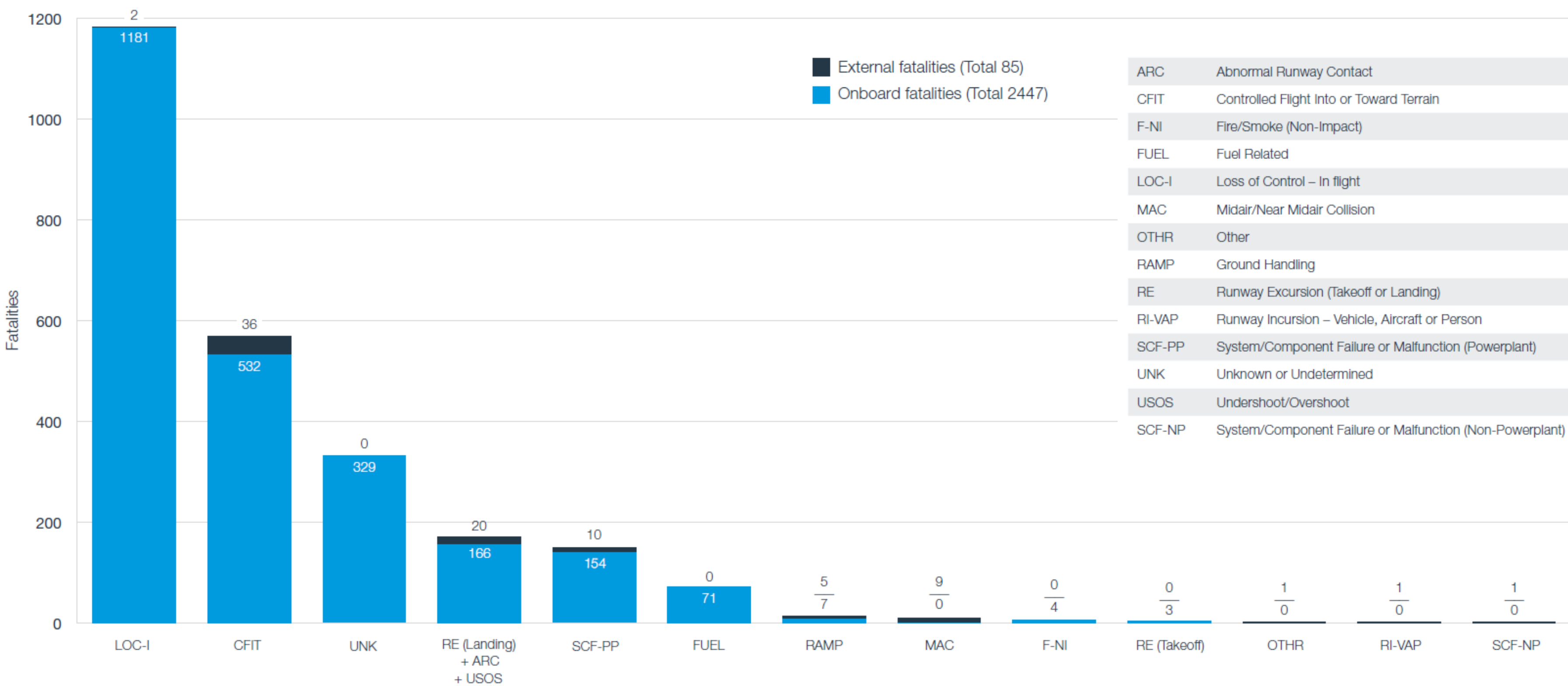
- COVID-19 is a UPRT learning opportunity!
- Read and understand the Airplane Upset Recovery Training Aid, **REVISION 2**
  - It's free
  - Reread until you can pass its test
- Don't oversimplify the past…it can happen to you

Groups Who Have Taken FAA Course

No one from Africa yet, but you are welcome – it's free

Upset Accidents and Incidents

Fatal Accidents | Worldwide Commercial Jet Fleet | 2009 through 2018



Where to find academic topics

AC 120-109A, Chapter 3

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Stall Prevention and Recovery Training

Date: 11/24/15

Initiated by: AFS-200

AC No: 120-109A

Change:

This advisory circular (AC) provides guidance for training, testing, and checking pilots to ensure correct responses to impending and full stalls. For air carriers, Title 14 of the Code of Federal Regulations (14 CFR) part 121 contains the applicable regulatory requirements. Although this AC is directed to part 121 air carriers, the Federal Aviation Administration (FAA) encourages all air carriers, airplane operators, pilot schools, and training centers to use this guidance for stall prevention training, testing, and checking. This guidance was created for operators of transport category airplanes; however, many of the principles apply to all airplanes. The content was developed based on a review of recommended practices developed by major airplane manufacturers, labor organizations, air carriers, training organizations, simulator manufacturers, and industry representative organizations.

This AC includes the following core principles:

- Reducing angle of attack (AOA) is the most important pilot action in recovering from an impending or full stall.
- Pilot training should emphasize teaching the same recovery technique for impending stalls and full stalls.
- Evaluation criteria for a recovery from an impending stall should not include a predetermined value for altitude loss. Instead, criteria should consider the multitude of external and internal variables that affect the recovery altitude.
- Once the stall recovery procedure is mastered by maneuver-based training, stall prevention training should include realistic scenarios that could be encountered in operational conditions, including impending stalls with the autopilot engaged at high altitudes.
- Full stall training is an instructor-guided, hands-on experience of applying the stall recovery procedure and will allow the pilot to experience the associated flight dynamics from stall onset through the recovery.

This revision of AC 120-109 reflects new part 121 regulatory terms and incorporates the full stall training requirement of Public Law 111-216. Considerable evaluation of the full flight simulator (FFS) must occur before conducting full stall training in simulation. Reference Appendix 5 for FFS evaluation considerations.

John S. Duncan
Director, Flight Standards Service

AC 120-111, Appendix 1

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Upset Prevention and Recovery Training

Date:

Initiated by: AFS-200

AC No: 120-UPRT

Change:

This advisory circular (AC) describes the philosophy and recommended training for airplane Upset Prevention and Recovery Training (UPRT). The goal of this AC is to provide recommended practices and guidance for academic and flight simulation training device (FSTD) training for pilots to prevent developing upset conditions and ensure correct and consistent recovery responses to upsets. The AC was created from recommended practices developed by major airplane manufacturers, labor organizations, air carriers, training organizations, simulator manufacturers, and industry representative organizations. This AC provides guidance to Title 14 of the Code of Federal Regulations (14 CFR) part 121 air carriers implementing the regulatory requirements of §§ 121.419, 121.423, 121.424, and 121.427. Although this AC is directed to air carriers to implement part 121 regulations, the FAA encourages all airplane operators, pilot schools, and training centers to implement UPRT and to use the guidance contained in this AC, as applicable to the type of airplane in which training is conducted.

Although a stall is categorized as an upset, this AC does not cover stall prevention and recovery training. This training, which includes the requirement for full stall training, is contained in the current edition of AC 120-109, Stall Prevention and Recovery Training.

Core principles of this AC include:

- Enhanced instructor training on the limitations of simulation.
- Comprehensive pilot academic training on aerodynamics.
- Early recognition of divergence from intended flight path.
- Upset prevention through improvements in manual handling skills.
- Progressive intervention strategies for the pilot monitoring.

CAUTION: Prior to commencing UPRT, air carriers should review and implement Guidance Bulletin 11-05, *FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers* to ensure FSTDs are specifically evaluated for UPRT maneuvers. Otherwise, negative transfer of training could occur.

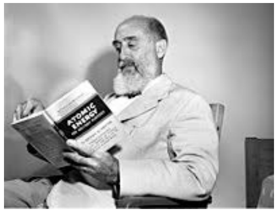
John S. Duncan
Director, Flight Standards Service

Big picture academic recommendations

Inputs

- Incidents
- Accidents
- ASAP data
- FOQA data
- ASRS data
- Airplane Upset Recovery Training Aid

Method



General to specific

Building result

- Situational awareness
- Insight
- Knowledge
- Skills

Knowledge areas from FAA guidance

- Airplane certification differences
- Factors leading to a stall event
- Normal and degraded modes for envelope protection
- System malfunctions
- Aerodynamics
- Energy management
- High altitude considerations
- Causes and contributing factors
- G awareness
- Specialized flight training elements
- Airplane-specific systems knowledge
- Flightpath management
- Recovery procedures
- Example events
- Review of accidents and incidents
- Recognition

Knowledge areas from FAA guidance

- Airplane certification differences
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- Example events
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Least important

↓

Most important

Note: This is MY unscientific ordering, not the FAA's

Knowledge areas

- Airplane certification differences
  - The rudder
- Factors leading to a stall event
  - Mach effects
- Normal and degraded modes for envelope protection
  - Effects of degraded protection modes
- System malfunctions
  - Partial automation effects
- Aerodynamics
  - Stability
- Energy management
  - Late awareness of an energy problem
- High altitude considerations
  - Effects of thrust
- Causes and contributing factors
  - Can’t control Mother Nature
- G awareness
  - Bridging the training gap to the airplane
- Specialized flight training elements
  - Loss of reliable airspeed
- Airplane-specific systems knowledge
  - Effective use of displays for prevention and recovery
- Flightpath management
  - Manual flight skill deficiencies
- Recovery procedures
  - Smooth, deliberate, positive inputs
- Example events
  - The thinking that they can’t happen to you
- Review of accidents and incidents
  - Oversimplifying
- Recognition
  - Crew inefficiency

Biggest issue for each knowledge area

- Airplane certification differences

3.8g symmetrical load limit

Asymmetrical (rolling while pulling) limit scales to that

2.5g symmetrical load limit

Asymmetrical (rolling while pulling) limit scales to that

Biggest issue for each knowledge area

- Factors leading to a stall event
  - Mach effects

<u>A330 example</u>

M=0.3, AOA_{stall} = 10 degs

M=0.82, AOA_{stall} = 4 degs

Knowledge areas

- Normal and degraded modes for envelope protection
  - Effects of degraded protection modes
    - Example: Stabilizer trimming in Alternate vs Direct

Knowledge areas

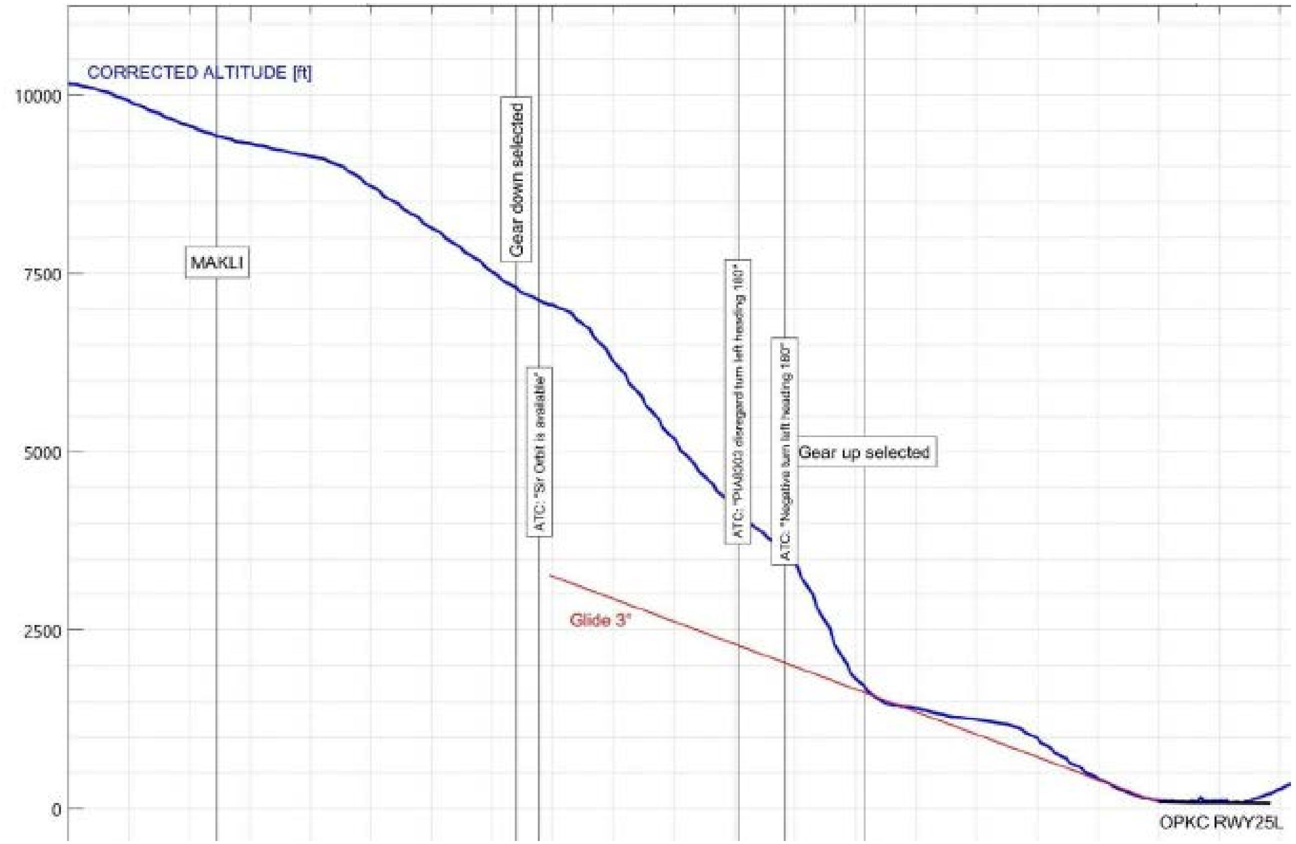
- System malfunctions
  - Partial automation effects
    - Example 2007 Thomsonfly B737-300 stall incident

Knowledge areas

- Aerodynamics
  - Stability
    - Examples – high-altitude CRJ stalls when on backside

Knowledge areas

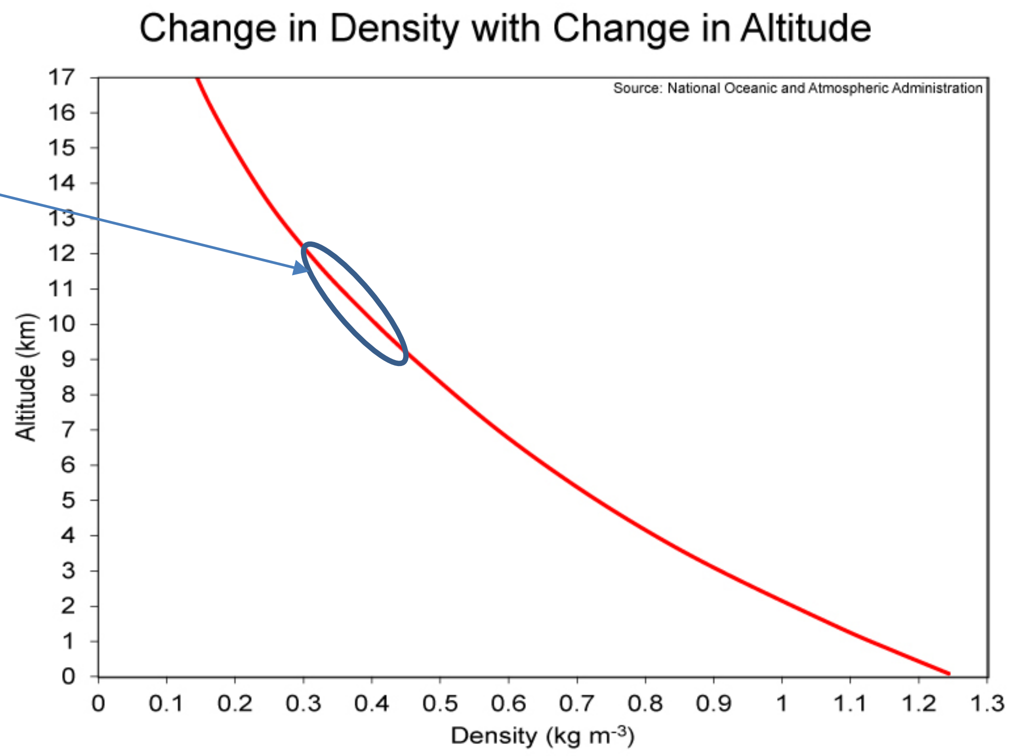
- Energy management
  - Late awareness of an energy problem
    - Example Pakistan International Flight 8303



Knowledge areas

- High altitude considerations
  - Effects of thrust
    - $Thrust_{altitude} \approx Thrust_{sea\ level} * (\text{density ratio})$

Slope steepens in FL300-400 region

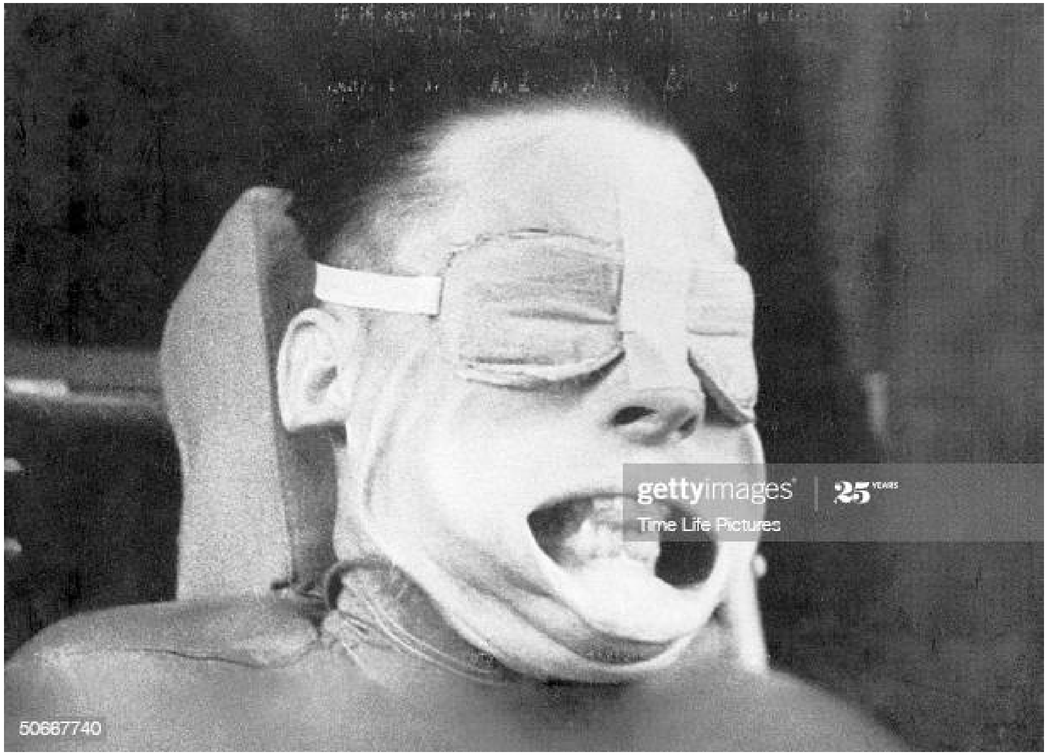


Knowledge areas

- Causes and contributing factors
  - Can't control Mother Nature
    - Still have instances of flying into known, poor conditions

Knowledge areas

- G awareness
  - Bridging the training gap to the airplane
    - Talked about in “lessons learned”
    - Instructors <u>must</u> bridge the gap between sim and flight



Knowledge areas

- Specialized flight training elements
  - Loss of reliable airspeed
    - Often too much time taken to recognize and correct
    - Get the most "fails" of all our simulator scenarios
    - Condition continues to occur across many aircraft

CAPT PFD

F/O PFD

Knowledge areas

- Airplane-specific systems knowledge
  - Effective use of displays for prevention and recovery
    - A lot of information that is not completely appreciated

Current mode
Mode transition
AOA and its limit
Speed trend and target
Pitch limit indicators (some)
Sideslip
Descent rate
Attitudes
Flightpath

GREAT for academics – Can set up “describe what’s wrong here” exercises

Knowledge areas

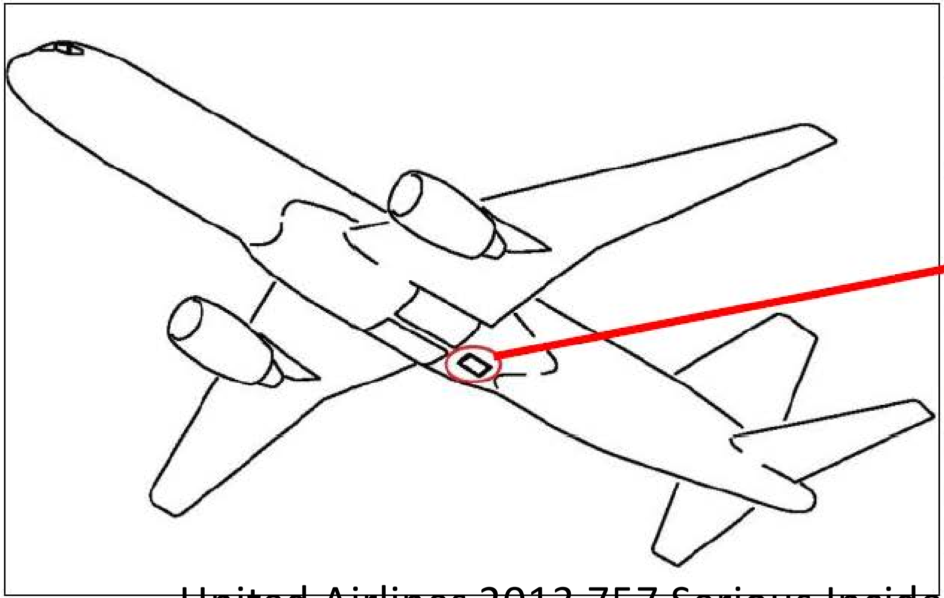
- Flightpath management
  - Manual flight skill deficiencies

The safety systems that the industry has developed and implemented
over the last twenty years are based on the assumption of
two fully trained, capable and experienced pilots in the cockpit,
with each pilot able to be the absolute master of the aircraft
in every possible situation at every moment.

Chesley B. Sullenberger III,

Knowledge areas

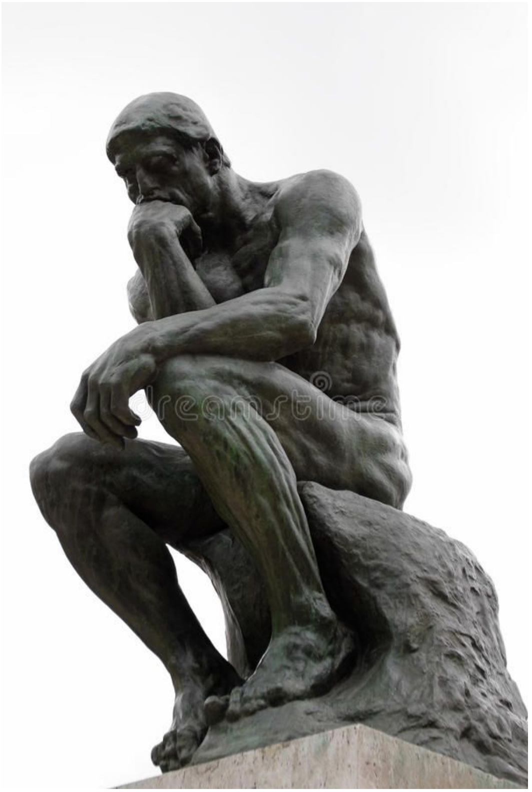
- Recovery procedures
  - Smooth, deliberate, positive inputs
    - Average airline pilot is smooth
    - Have instances of overcontrol



United Airlines 2013 757 Serious Incident, below 0g three times: -0.36g to 1.72g

Knowledge areas

- Example events
  - The thinking that they can’t happen to you
    - Reflection and introspection is hard for humans (and pilots)
    - Many accident reports now also cover similar instances!



Knowledge areas

- Review of accidents and incidents
  - Beware: human nature is to oversimplify
    - Oversimplifying is comforting
    - Oversimplifying requires less thought and effort
    - Oversimplifying allows you to easily rationalize
  - Example: Air France 447. Many oversimplify.
    - They should have went to reasonable pitch and power settings
    - They shouldn’t have had two F/Os flying in that situation
    - They shouldn’t have followed the flight director
    - They should have known they were stalled with that buffet
    - They should have lowered the nose with that stall warning
    - They should not both have been flying (at times)
    - They should have been trained for that situation
    - They should have known they were stalled with that ROD
    - They should have used the trim wheel to lower the nose
  - It wasn’t that simple…

Knowledge areas

- Recognition
  - Crew inefficiency
    - In my opinion, there are opportunities for working better as a crew for UPRT
  - Instruction aims almost exclusively at pilot flying
  - We give little guidance to the pilot monitoring
  - We know "two heads are better than one"
    - Yet, several eye tracking studies suggest both pilots have similar scans
  - One airline had arguments over the pilot flying saying "My airplane"…particularly when that was the F/O
    - That hints at the opportunity for improvement
  - I don't have the solution yet

Conclusions

- COVID-19 is a UPRT learning opportunity!
- Read and understand the Airplane Upset Recovery Training Aid, **REVISION 2**
  - It’s free
  - Reread until you can pass its test
- Don’t oversimplify the past…it can happen to you

Backups

Pitch damping at different altitudes, <u>with same IAS</u>

5,000 ft

FL350

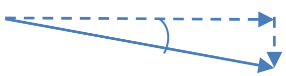
- Same pitch rate gives different tail lifts!
- This causes less pitch damping at higher altitudes

AoA difference at the tail

(IAS=200 kts, 5 deg/sec, 747 example)

5,000 ft

True airspeed = 215 kts



downflow
at tail, from pitch rate

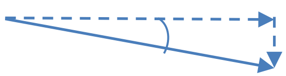
Tail AOA=1.4 degs

AoA difference at the tail

(IAS=200 kts, 5 deg/sec, 747 example)

5,000 ft

True airspeed = 215 kts



downflow
at tail, from pitch rate

Tail AOA=1.4 degs

FL350

Higher True airspeed = 347 kts

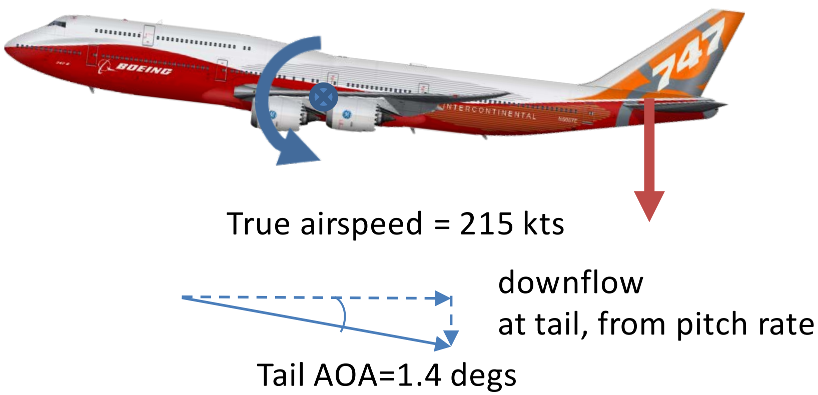
Same
downflow
at tail, as pitch
rate is the same

Tail AOA=0.88 degs

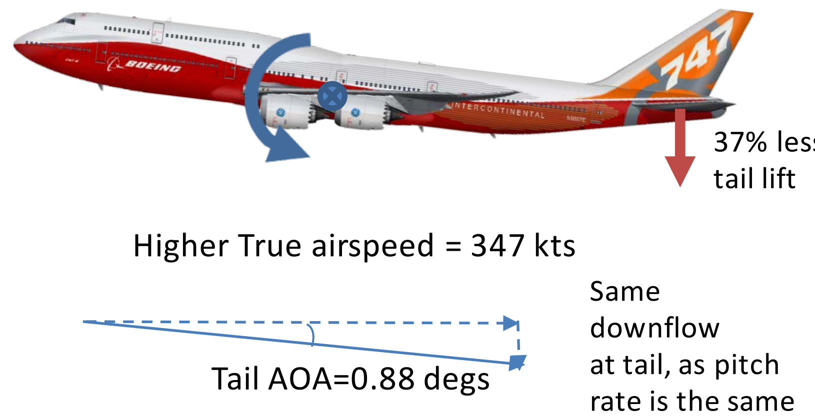
AoA difference at the tail

(IAS=200 kts, 5 deg/sec, 747 example)

5,000 ft



FL350



AoA difference at the tail

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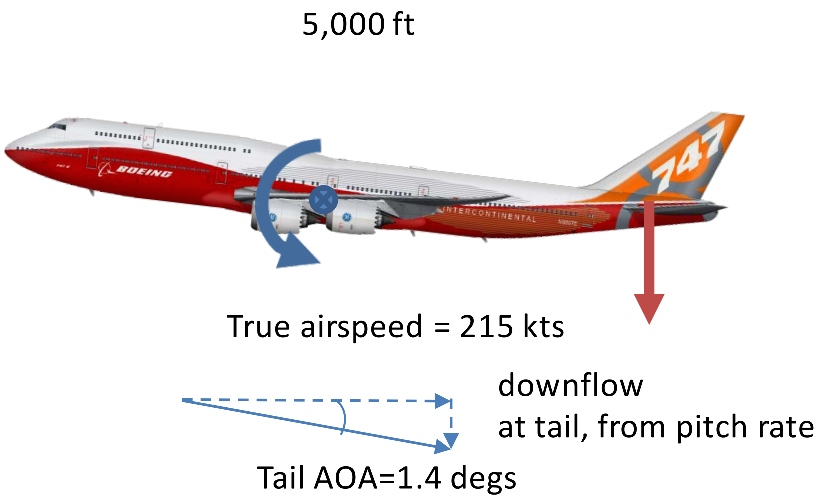

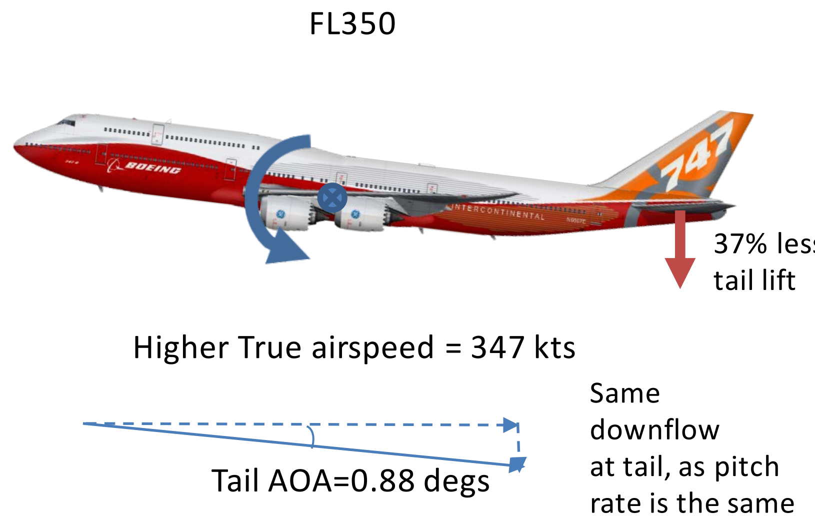

So, pitch damping is 37% less at the higher altitude, which makes it harder to control