Experience from Implementing Upset Prevention and Recovery Training

The Royal Aeronautical Society

Innovation in Technology, Training Practices and the Impact of Regulatory Change

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Main points

• Some key FAA and EASA upset training differences

• Initial hurdle: convincing experienced pilots that there may be something they still do not know

• A need for upset scenario development and sharing
Two “tipping points” in upset recoveries

Recovery difficulty

Roll < 90 degees, or stall warning
Two “tipping points” in upset recoveries

- Roll < 90 degs, or stall warning
- Roll > 90 degs, or fully stalled
Two “tipping points” in upset recoveries

Recovery difficulty

Upset severity

Roll < 90 degs, or stall warning

Roll > 90 degs, or fully stalled

Roll > 90
Pull tendency
No unload
AoA misunderstandings

Full stall
Poor recognition
Lulled to control roll
Full stall accidents

- China Air #006, 1985
- Airborne Express, 1996
- Pinnacle #3701, 2004
- West Caribbean #708, 2005
- XL Airways, 2008
- Colgan #3407, 2009
Full stall accidents

Air France #447, 2009

Air Algerie #5017, 2014

Air Asia #8501, 2014
# FAA and EASA key UPRT differences

<table>
<thead>
<tr>
<th></th>
<th>Simulator full stall training</th>
<th>On-airplane* UPRT</th>
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<tbody>
<tr>
<td>FAA</td>
<td>✓</td>
<td>X</td>
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<tr>
<td>EASA</td>
<td>X</td>
<td>✓</td>
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* - not in the jet transport
Accidents with roll > 90 degs

>180 deg roll

China Air #006, 1985

>180 deg roll

USAir #427, 1994

>180 deg roll

American Eagle #4184, 1994

113 deg roll

Airborne Express, 1996

111 deg roll

Flash Airlines #604, 2004

100 deg roll

Adam Air #574, 2007
Accidents with roll > 90 degs

115 deg roll
Kenya Airways #507, 2007

>180 deg roll
Aeroflot #821, 2008

>180 deg roll
XL Airways, 2008

140 deg roll
Air Algerie, 2014
Still seeing incidents with roll > 90 degs
Guidance removed training with roll > 90 degs

Recent industry guidance

FAA Upset Advisory Circular

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 requirements for full stall training, is contained in the current edition of AC 120-90, 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 UFR, 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 UFR maneuvers. Otherwise, negative transfer of training could occur.

John D. Dunne
Director, Flight Standards Service
Which reminds me…

“Even if all the experts agree, they may well be mistaken”

- Bertrand Russell
FAA UPRT course participants
Ground school vs simulator time

Learning

2 hr groundschool

Time
Ground school vs simulator time

Learning

Early attention getter

Time

2 hr groundschool

30 min simulator
Ground school vs simulator time

Learning

Early attention getter

Time

2 hr groundschool

30 min simulator
Ground school vs simulator time

Learning

Early attention getter

2 hr groundschool

30 min simulator

Time

Main Point #2
Thrust available **REALLY** goes down with altitude

- Few appreciate the **REALLY** part
- Exercise: 30 kt speed increase with thrust at 10000 ft, then at 39,000 ft
  - Most guess it will take 2x longer at 39,000 ft
    - It takes about 7x longer
- Afterwards, some pilots jam thrust forward on high altitude stall recoveries
  - Or, instructors say “get the power on, get the power on”
  - Or, trainees are worried of nose-up pitch with power
- Get a lot of “wow’s!” when the **REALLY** part is understood
Variations in recovery techniques

• For upsets
  – Several new airplane manuals have
    • “If the AP and/or A/THR are responding correctly to a flight path and/or energy divergence, it may not be appropriate to decrease the level of automation”
  – rather than
    • “AP: DISCONNECT”
    • “A/THR: OFF”
“Recognize/confirm” is forgotten first step

- There is a sweet spot between
  “Recognize/confirm”
  and
  “Troubleshooting”
- I don’t know how that sweet spot is defined
- 757 unreliable airspeed incident
  - pilot applies stall recovery technique and overcontrols
- FAA does not have “recognize/confirm” as the first
  step in stall recovery template
  - We do for non-stall upset recoveries
Startle and Surprise
Issues with the “push”

• First, the guidance is “push to relieve the excessive load” not “push”
  – Sometimes you don’t have to push
  – We don’t want robots that cause problems with an unnecessary push

• Second, seeing too many ham-fisted pushes (both in sim, and in operations)
  – like -0.5g’s in high-altitude stall recoveries
Issues with the “push”, cont’d

• Since $g \equiv (\text{pitch rate}) \times (\text{true airspeed})$, need to be gentle in pitch as speed increases

• Some are inappropriately using take-off rotation rate as a mantra for all upset recoveries
  – 3 deg/sec pitch rate for stall speed of 181 KCAS at FL370 (which is 329 kts TAS) buys you almost $\Delta 1g$…which is much more than you want

High-alt stall attitude $\sim +10$ degs

High-alt recovery attitude $\sim -15$ degs
Trying to do too much the first pass

• Admittedly, there is a lot in the rules and guidance
• Complete treatment of everything is not possible in one training session
  – Maybe do maneuver training now and add scenarios in the next passes
• After a session recently, one pilot stated that he didn’t want the takeaway to be “this airplane is going to kill me”
Flying to prevent the limit perceived
Flying to prevent the limit perceived
Flying to prevent the limit perceived
Pedal inputs

• Operationally, pilots getting on pedals, often cyclically, during wake recoveries
  – they know they shouldn’t, but they do
  – often complicates the recovery due to the unpredictable aircraft response (recent Russian incident)

• Good thing: We see it in the simulator too
  – Can correct it; something instructors should watch

• Academic training may still be weak on pedal usage
  – often talk structure and not about how pedal often adds to recovery difficulty
Strong buffet maintenance concerns

• Still need to wait and see
• If it becomes a problem, the benefit/cost will need assessed
• The importance of buffet was debated early
• During the FAA study in OKC, sim buffet was increased 2.5x
  – all 10 test pilots said the airplane buffet even stronger
• A common reaction when pilots experience the sim buffet is “Holy ***t!”
• Belief is AF447 misidentified stall buffet
• Had a 757 full stall incident where crew thought stall buffet was an engine problem
Motion

• An airplane manufacturer recommends
  – “…that the exercises are performed without the use of any motion system if there is a risk to go beyond the FSTD normal law flight envelope.”

• FAA will not approve the training program if this recommendation is followed
  – If you are hitting motion stops, etc., then you need to either
    • (1) Decide if you should be doing that maneuver, or
    • (2) Work with your sim manufacturer to adjust motion
Simulator upgrade status in U.S.

• As of June 1:
  – Have qualified 139 simulators to new simulation UPRT rules
  – Have 8 interim approvals
  – Have 67 qualifications in-work

• Note: New simulators worldwide will have full stall capability...all operators worldwide will pay for it...why not use it?
Conclusions

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