Collaborating to address
LOSS OF CONTROL IN-FLIGHT

Upset Prevention and Recovery Training Workshop

Yann RENIER, IATA
Presented by Henry Defalque, ICAO

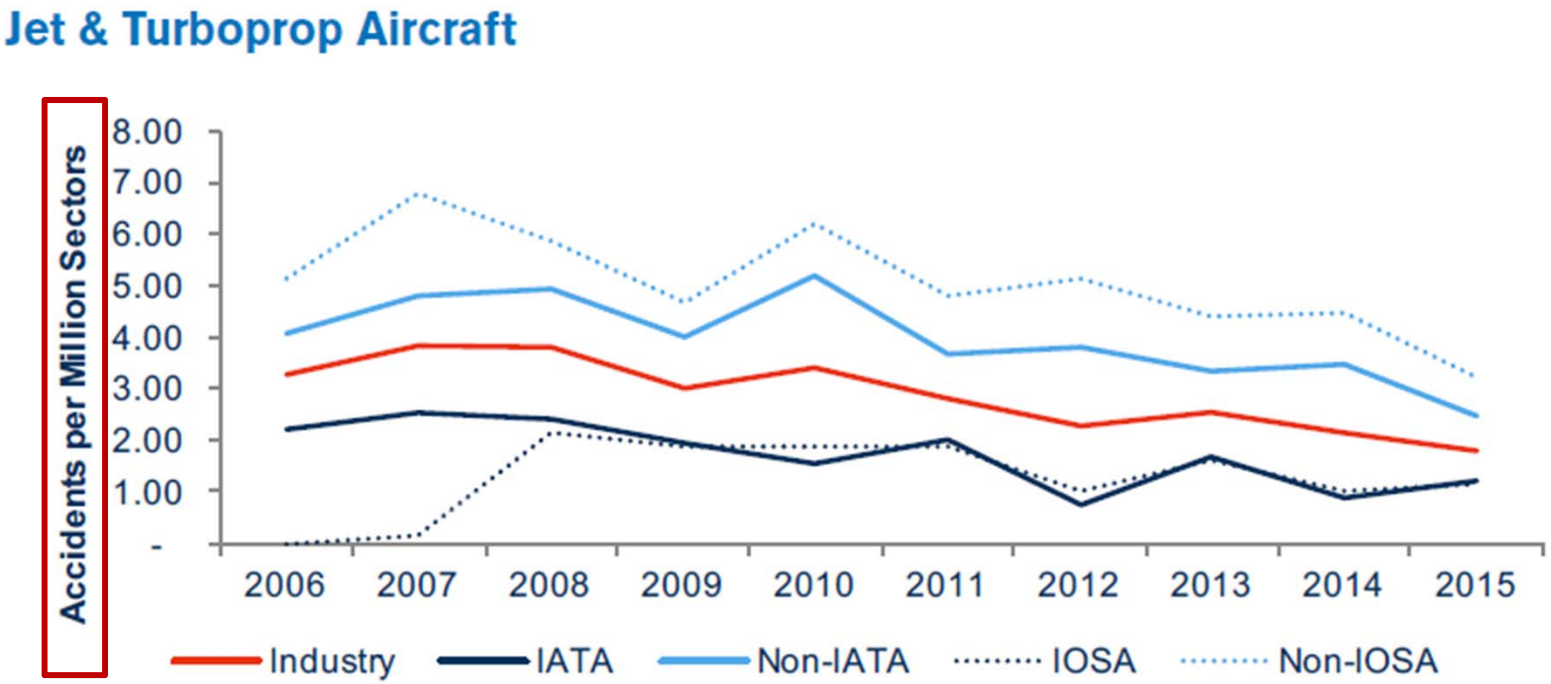
Module 3 – Day 1

Implementing UPRT in an airline

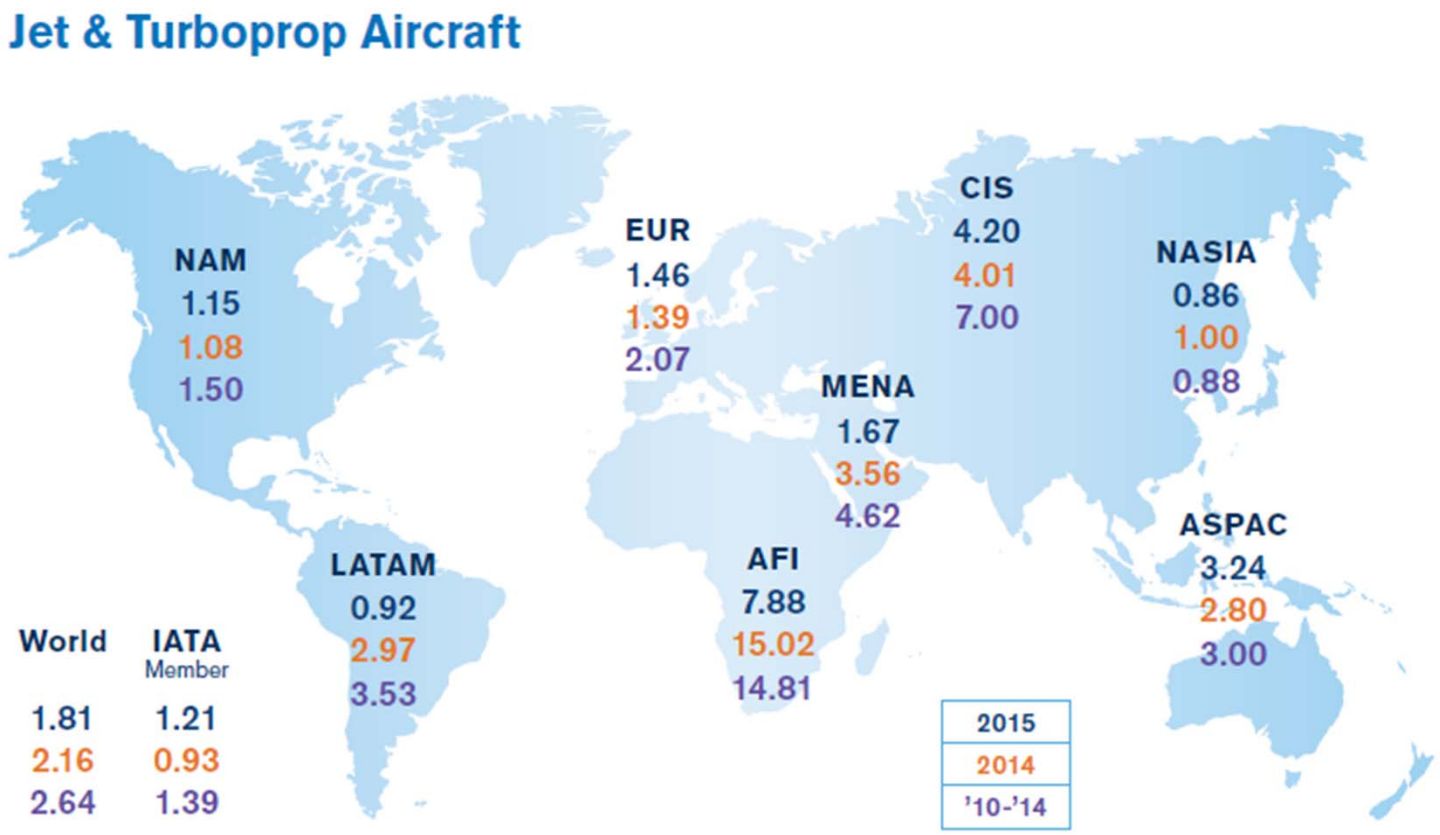
Flight Plan

- *Safety Data*
- Regulatory matters
- Training content
- Instructor qualification
- FSTD requirements
- Evaluation

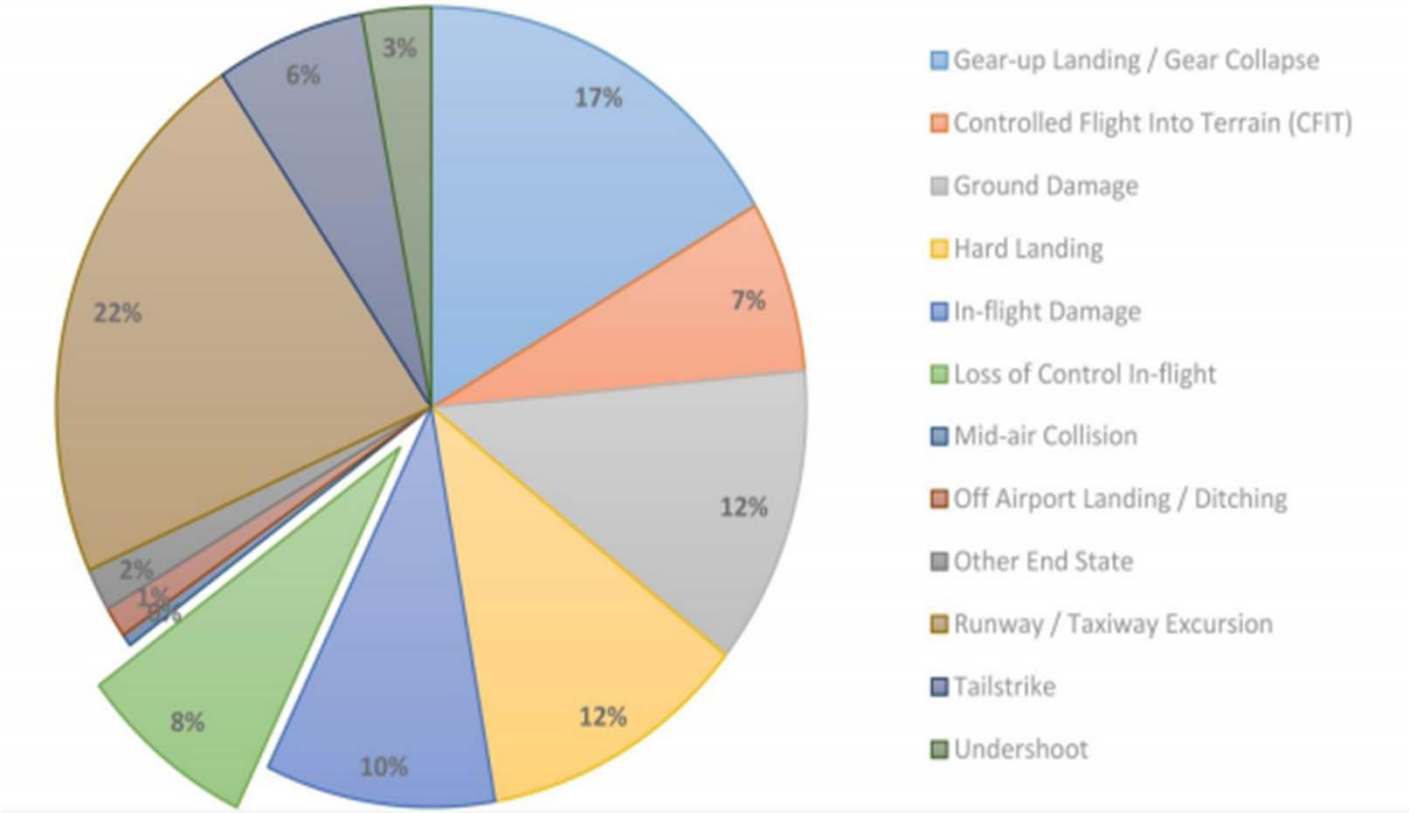
Safety data: big picture



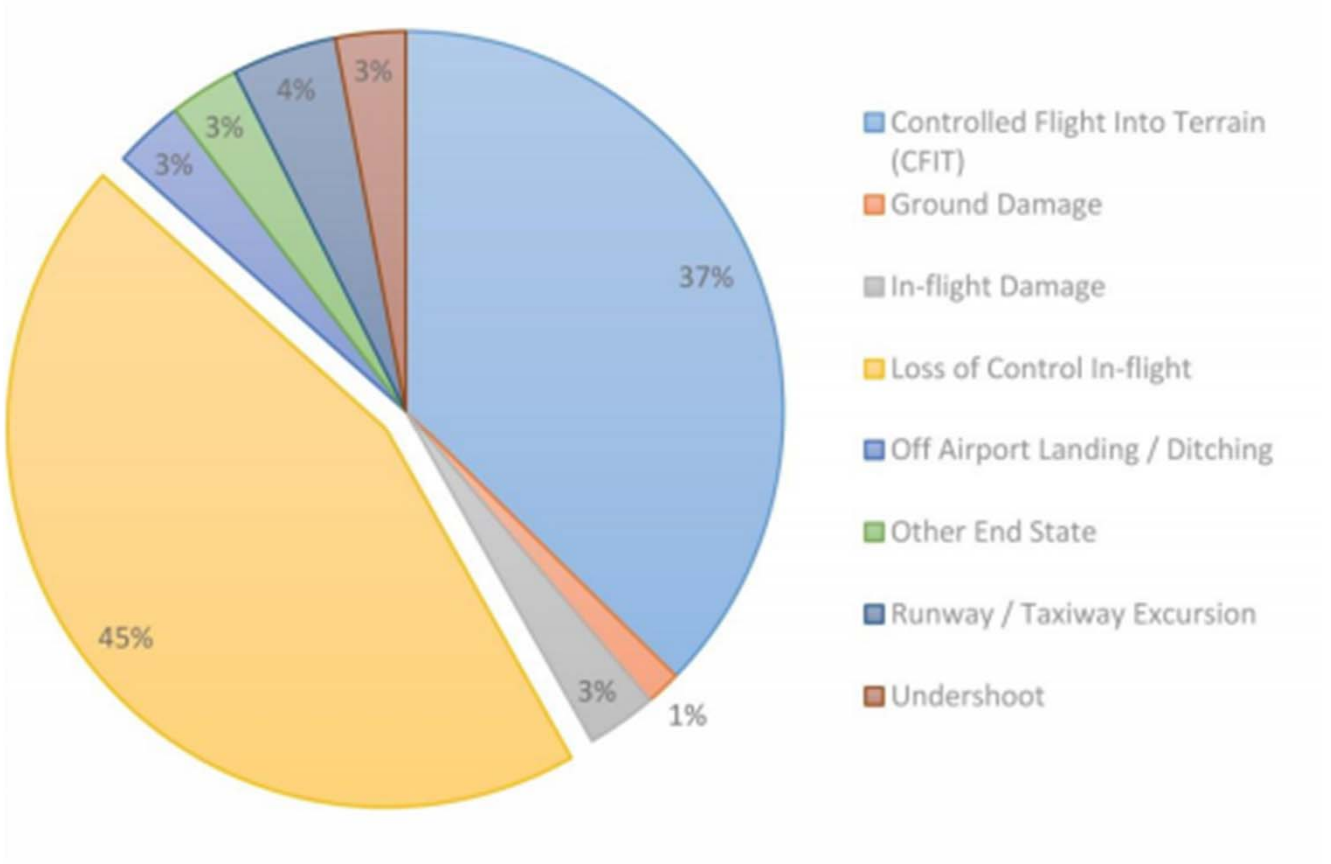
Accident per million sectors per region of operator APR 2016



Global Accidents (2011-2014)



Global Fatal Accidents (2011-2014)



Accident count

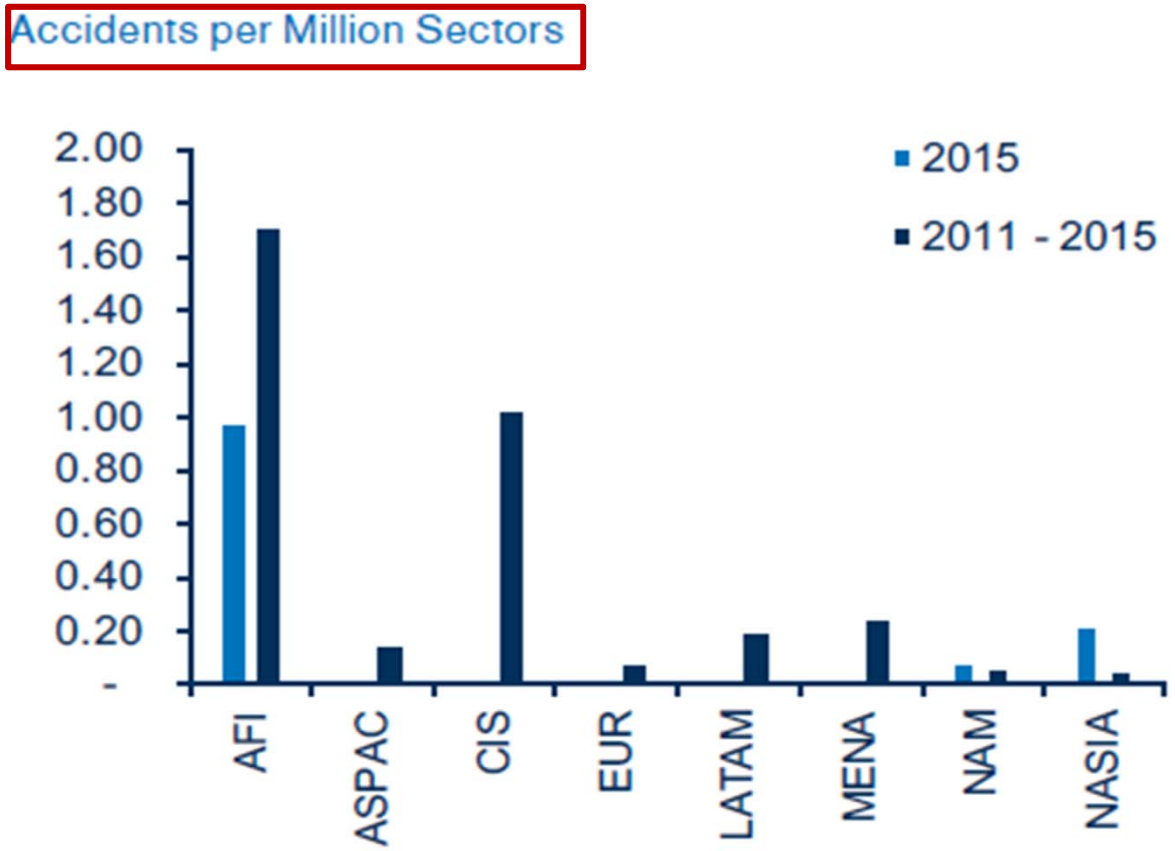
2015	Number of accidents: 3	Number of fatalities: 82
2011-2015	Number of accidents: 31	Number of fatalities: 1083

Accident Count % from total	2015	'11-'15
IATA Member	33%	16%
Full-Loss Equivalents	91%	81%
Fatal	100%	97%
Hull Losses	100%	97%

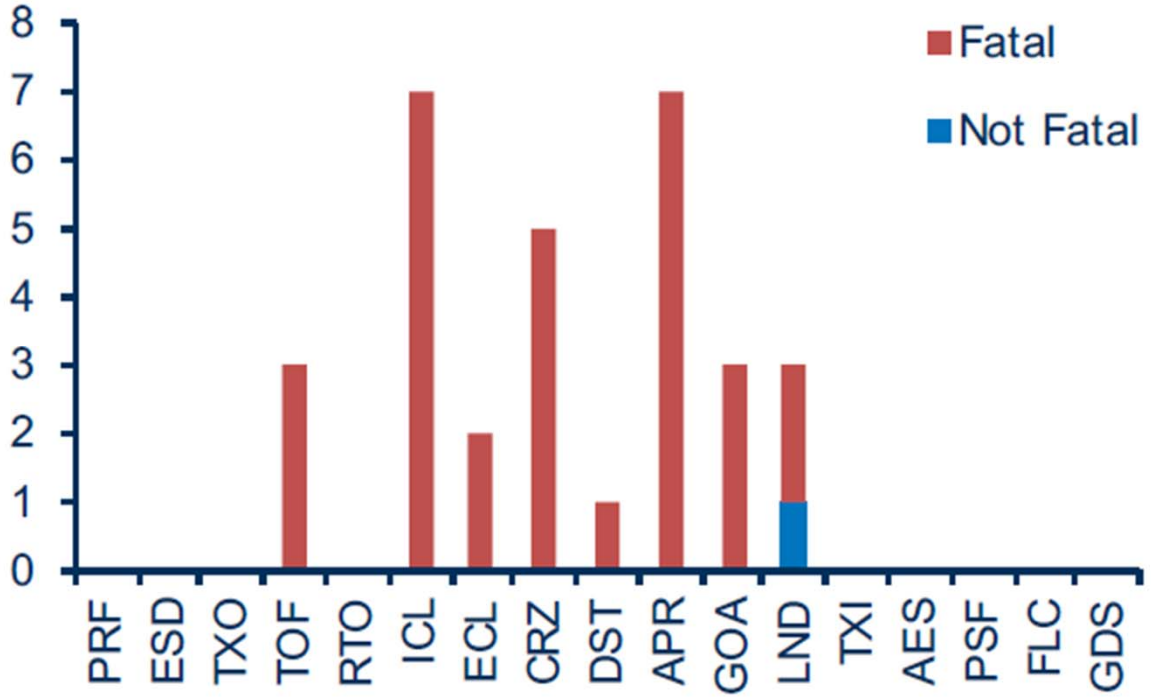
	Passenger	Cargo	Ferry	Jet	Turboprop
2015	33%	67%	0%	0%	100%
2011-2015	68%	32%	0%	32%	68%

LOC-I Accidents by Region (2011-2015)

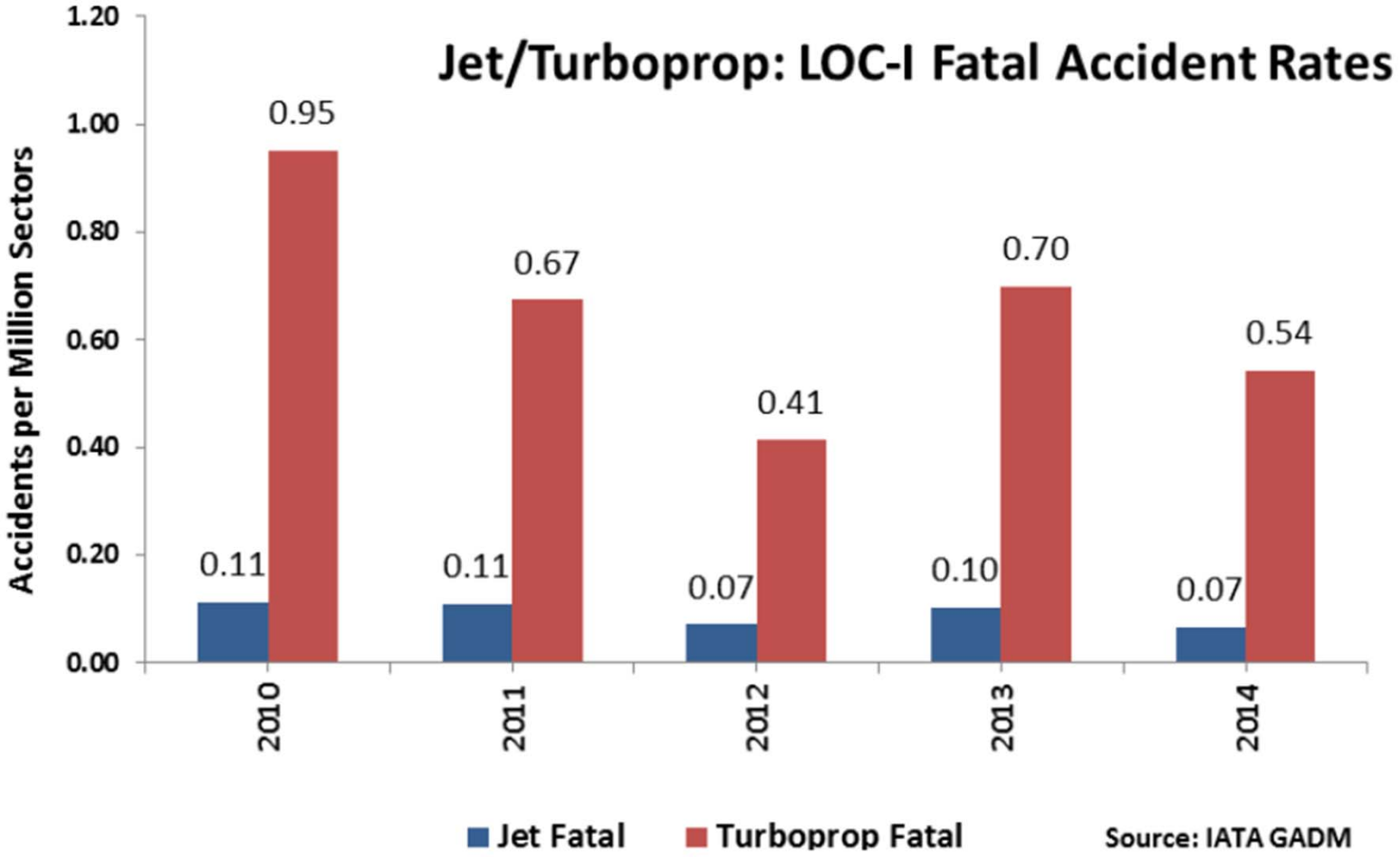
LOC-I Accidents by Region (2011-2015)



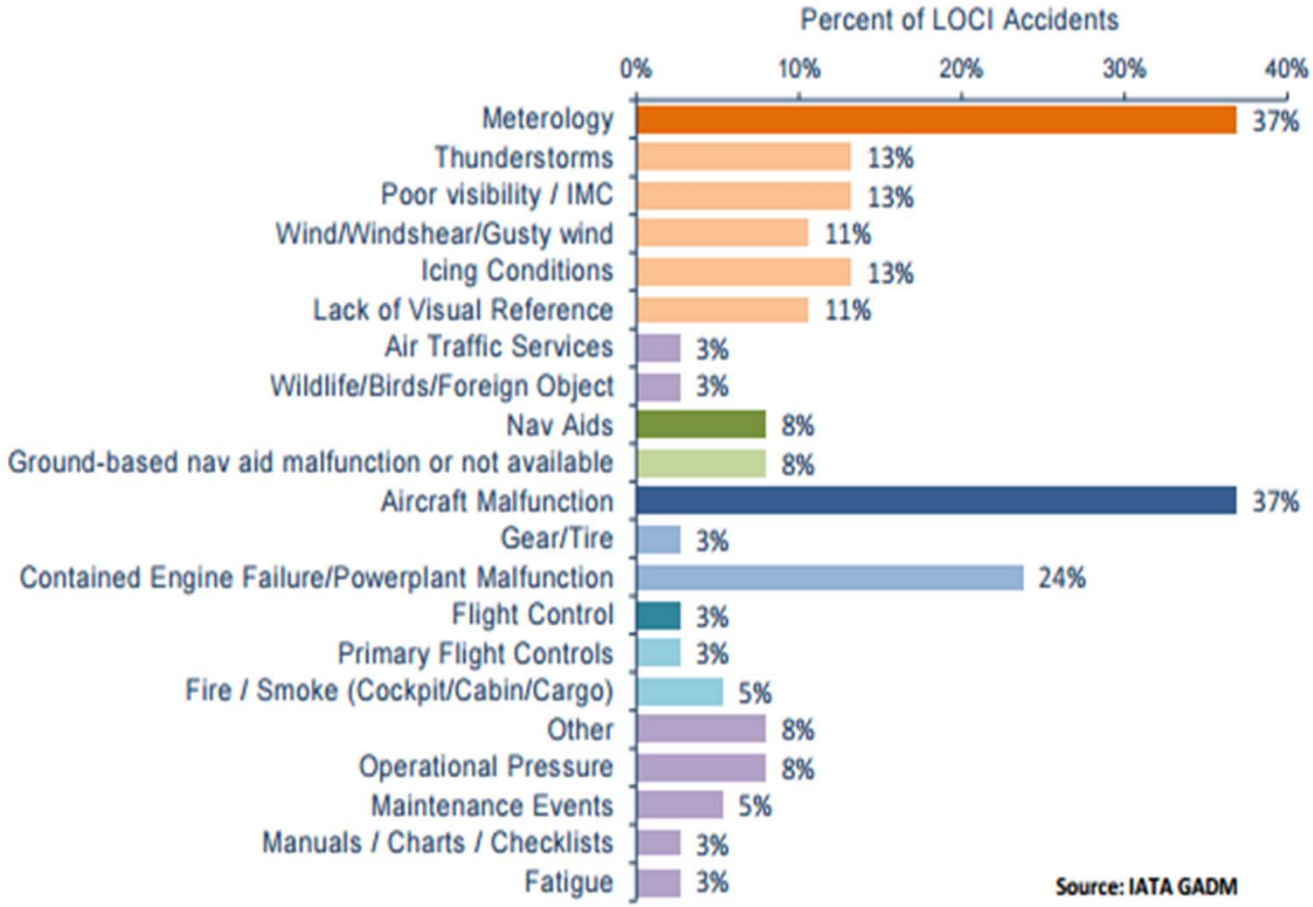
LOC-I Accidents by Phase (2011-2015)



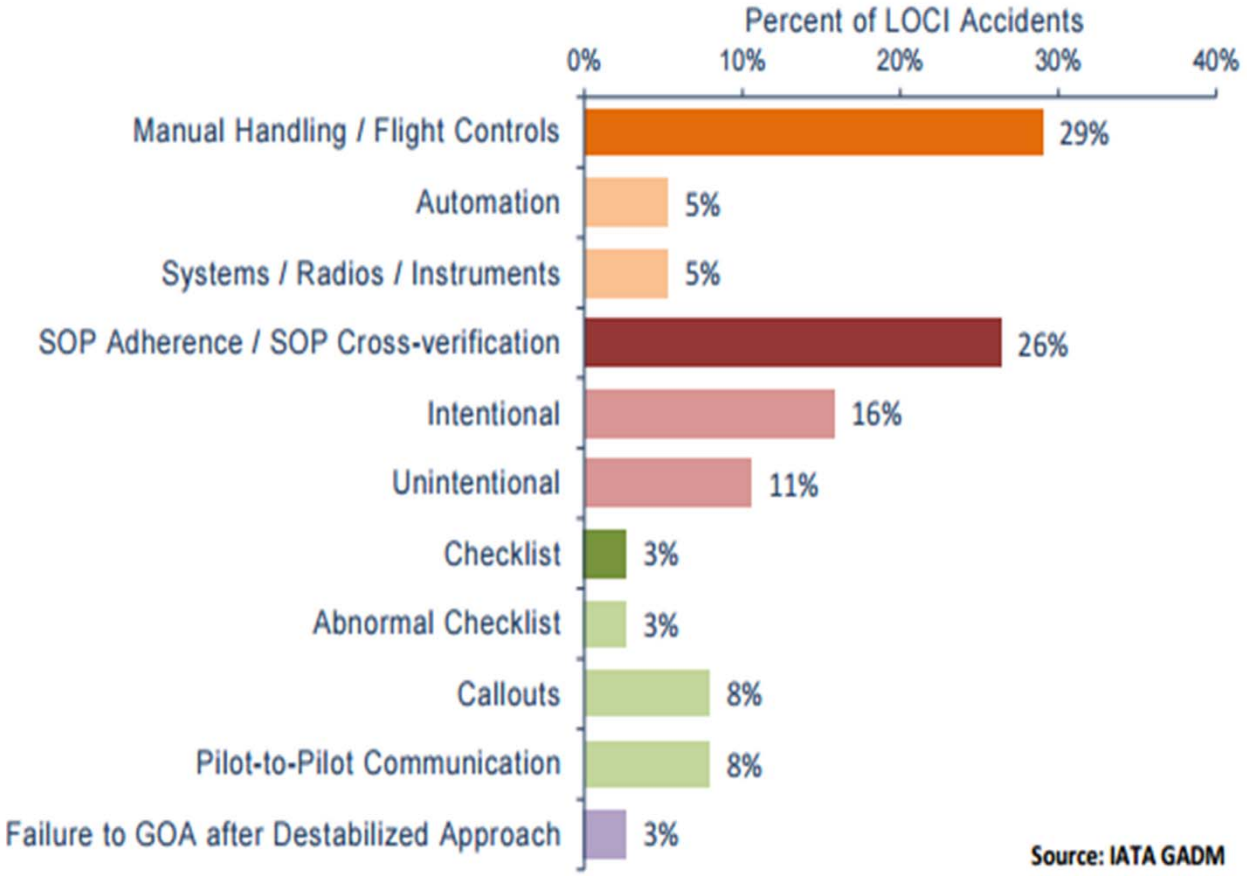
LOC-I Accidents by Propulsion Type



Environmental & Airline Threats



Flight Crew Errors



http://www.iata.org/whatwedo/safety/Pages/loss-of-control-inflight.aspx

Available studies & reports on IATA website

- SAFETY REPORT 2015 Issued April 2016
- Loss of Control In-Flight Accident Analysis Report
- Environmental Factors Affecting Loss of Control In-Flight: Best Practice for Threat Recognition & Management
- Loss of Control In-flight (LOC-I) Prevention: Beyond the Control of Pilots

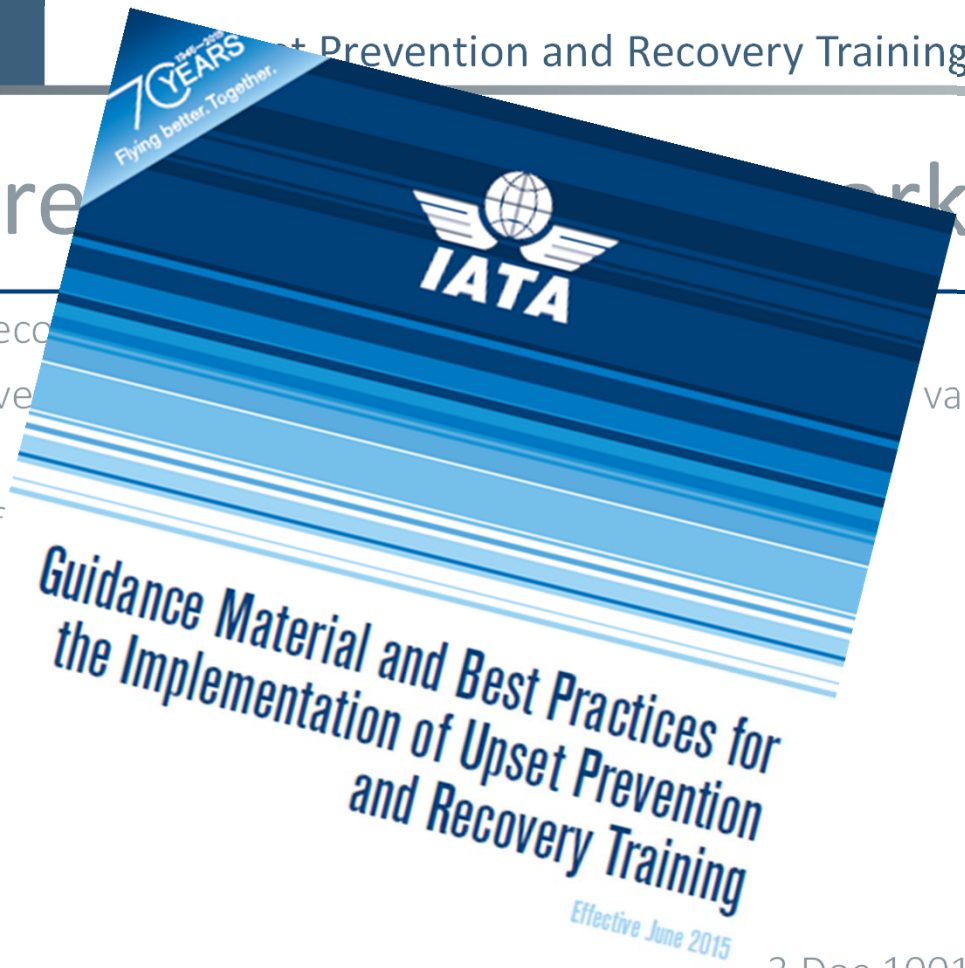
Flight Plan

- Safety Data
- ***Regulatory matters***
- Training content
- Instructor qualification
- FSTD requirements
- Evaluation

References & regulatory frame work

- 2008/2017 Airplane Upset Recovery Training Aid (AURTA) Revision 2/3
- 2010 FAA SAFO 10012 (Recovery from stall does not mandate a predetermined value for altitude loss)
- 2012 FAA AC No: 120-109 Stall and Stick Pusher Training
- 2013 FAA SAFO 13002 (encourage manual flying)
- 2013 EASA SIB No.: 2013-02 Stall and Stick Pusher training
- 2013 EASA SIB No.: 2013-05 Manual Flight Training and Operations
- 2013 TCAA AC 700-031
- 2013 FAA NOTICE N 8900.241
- 2013 ICATEE Research and Technology Report (FSTD)
- 2014 ICAO Annex 1 – Amdt.172; Annex 6 – Amdt.38; PANS-TRG – Amdt. 3; Doc 10011
- 2015 FAA AC No: 120-111
- 2015 EASA SIB No.: 2015-07 (low speed high altitude)
- 2015 EASA ED Decision 2015/012/R Amendment to Acceptable Means of Compliance and Guidance Material to Part-Definitions and Part-ORO of Regulation (EU) No 965/2012

References & re rk



- 2008/2017 Airplane Upset Reco
- 2010 FAA SAFO 10012 (Recove value for altitude loss)
- 2012 FAA AC No: 120-109 Sta
- 2013 FAA SAFO 13002 (encc
- 2013 EASA SIB No.: 2013-0
- 2013 EASA SIB No.: 2013-0
- 2013 TCAA AC 700-031
- 2013 FAA NOTICE N 890
- 2013 ICATEE Research a
- 2014 ICAO Annex 1 – A 3 Doc 10011
- 2015 FAA AC No: 120-
- 2015 EASA SIB No.: 2
- 2015 EASA ED Decision 2015/012/R ns of Compliance and Guidance Material to Part-Definitions and ... on (EU) No 965/2012

Regulatory

❑ FAA:

All part 121 Carriers / until **12 March** 2019

Initial, transition, upgrade, recurrent

(FAA notice N 8900.241 of 11/4/13)

❑EASA:

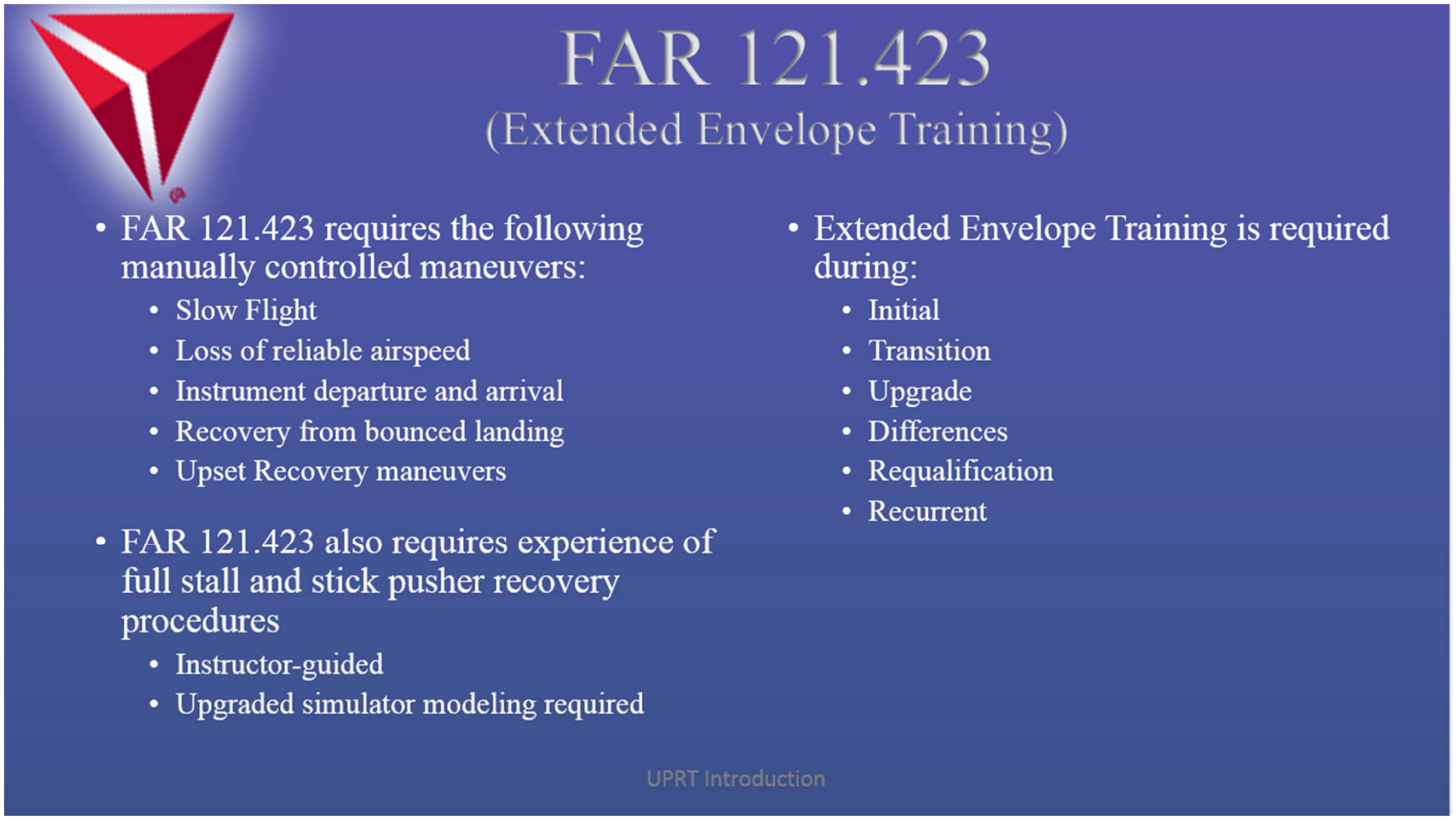
EASA ED 2015/012/R (Air Operations)

CAT Operators / since **04 May 2016**

Conversion course, recurrent

Licensing (Aircrew expected **08 April 2018**)

Regulatory, FAA example



Flight Plan

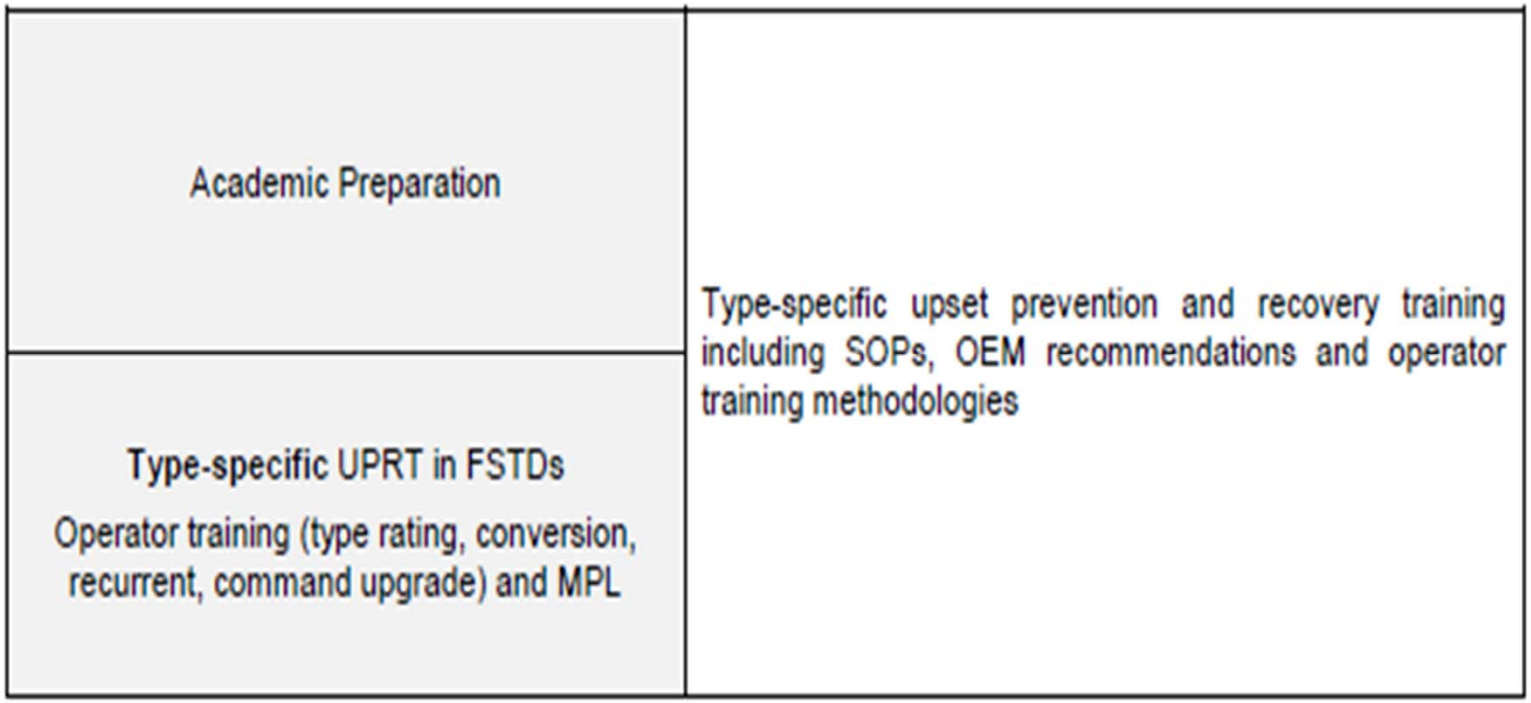
- Safety Data
- Regulatory matters
- *Training content*
- Instructor qualification
- FSTD requirements
- Evaluation

Initial training

ref IATA guide

The ideal complete UPRT program	
Academic Preparation	Exposure to flight within the full range of the FAA25/CS25 certification g-envelope, all attitude exposure, essential human factor training. • Adapting to all attitudes • Adapting to g-exposure (-1g to 2,5g) • Overcoming surprise and startle • Developing counter-intuitive recovery skills • Developing AOA awareness • Recovery from aerodynamic stall • Recovery from all attitude aeroplane upsets
On-aeroplane UPRT MPL, CPL	
Academic Preparation	Non type-specific upset prevention and recovery training, consolidation of OEM recommendations
Non-type-specific UPRT in FSTDs MPL, CPL	

Conversion & Recurrent training *ref IATA guide*



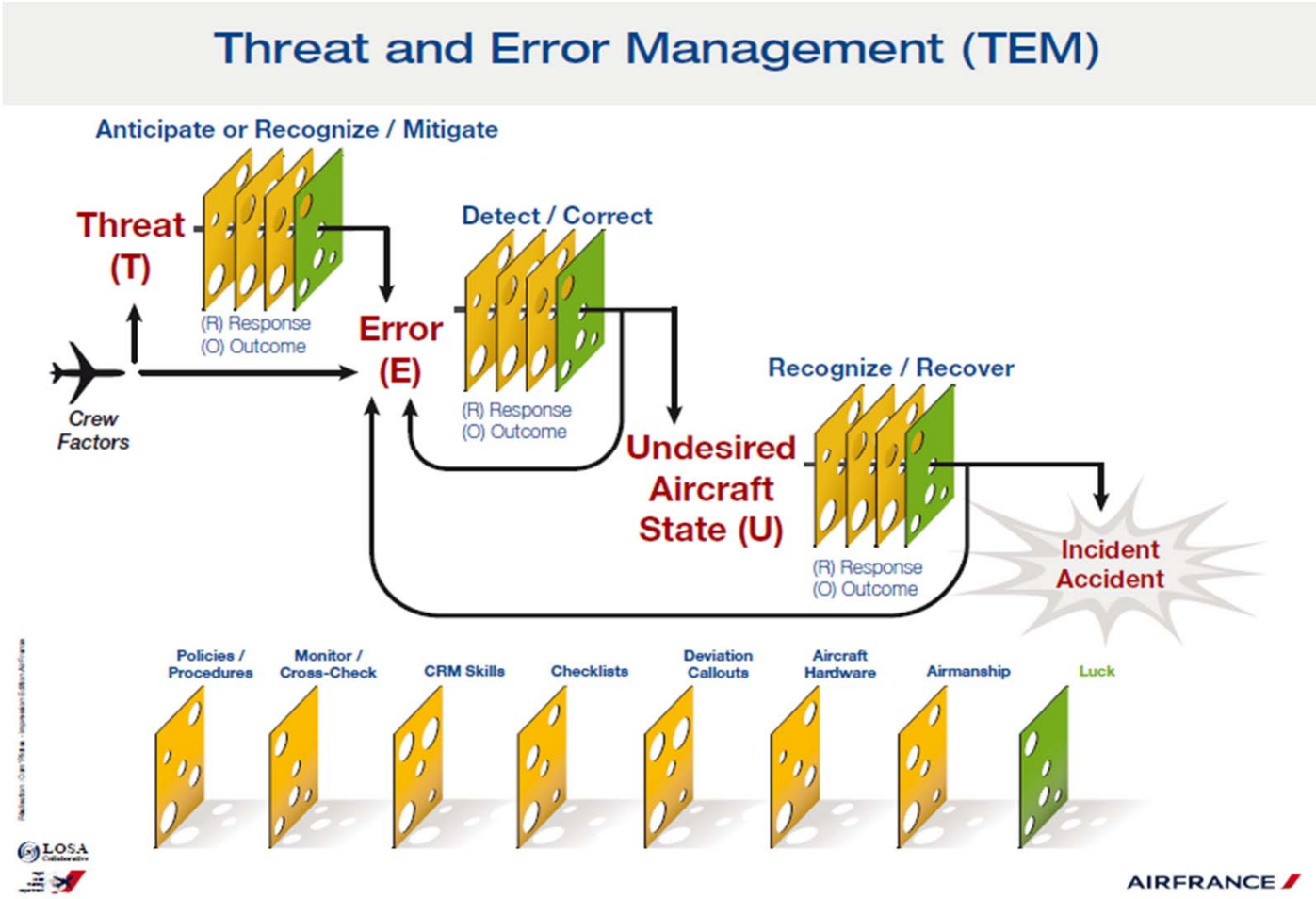
ICAO Doc 10011

A. *Aerodynamics*
B. *Causes and contributing factors of upsets*
C. *Safety review of accidents and incidents relating to upsets*
D. *G-awareness*
E. *Energy management*
F. *Flight path management (manual handling skills included)*
G. ***Recognition (importance of monitoring)***
H. *Upset prevention and recovery techniques*
I. *System malfunction (fbw)*
J. *Specialized training elements*
K. ***Human Factors (importance of TEM)***

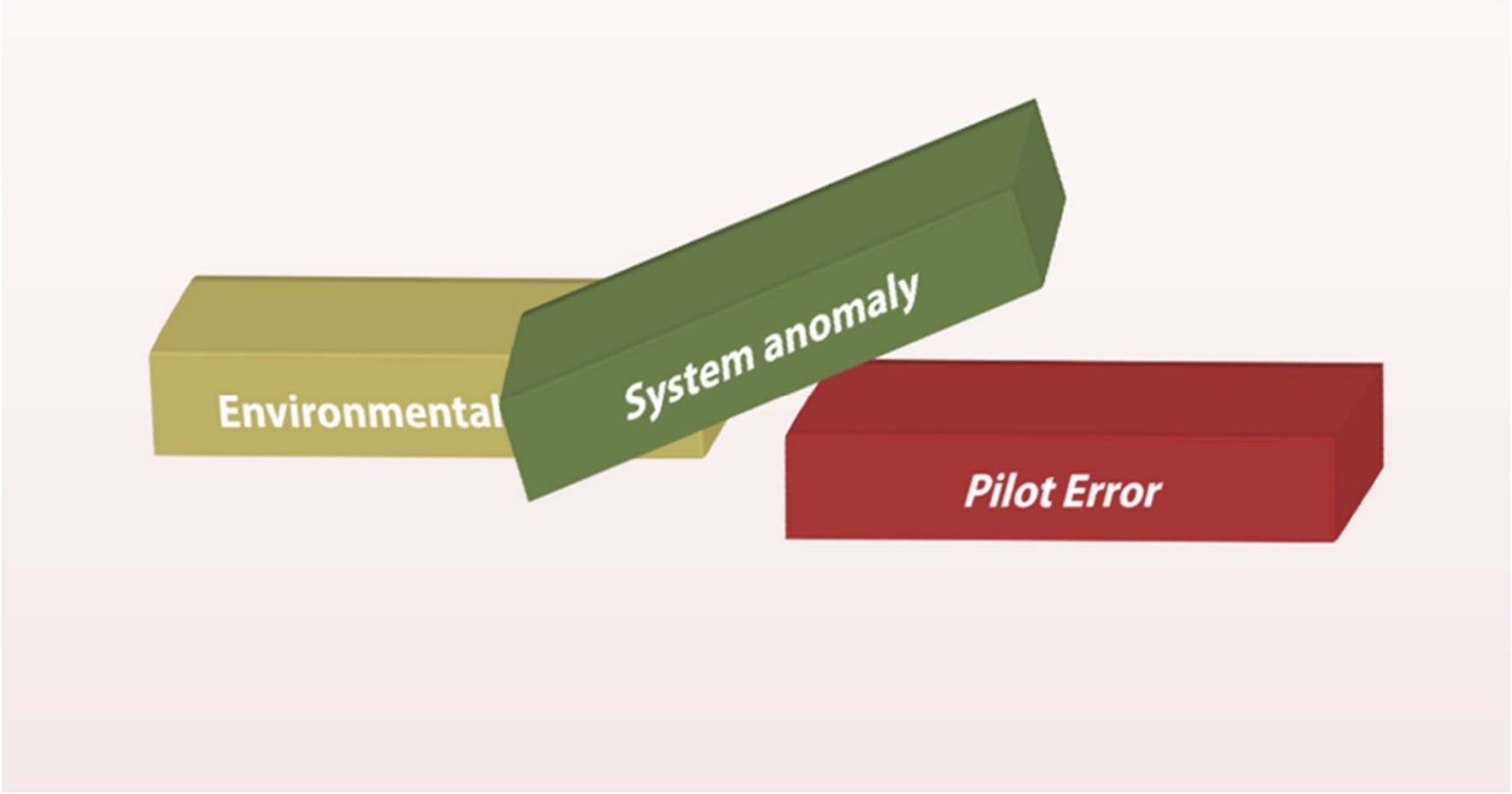
*K. Human Factors importance of **TEM***

Subjects and training elements	*Academic training*	*On-aeroplane training — CPL(A)/MPL*	*Non-type-specific FSTD training — (CPL(A)/MPL)*	*Type-specific FSTD training*	*AURTA, Revision 2, references*
ii) inattention, fixation, distraction	•	•	•	•	
iii) perceptual illusions (visual or physiological) and spatial disorientation	•	•	•	•	
iv) instrument interpretation	•	•	•	•	
2) startle and stress response					
i) physiological, psychological, and cognitive effects	•	•	•	•	
ii) management strategies	•	•	•	•	
3) threat and error management (TEM)					
i) TEM framework	•	•	•	•	
ii) active monitoring, checking	•	•	•	•	
iii) fatigue management	•	•	•	•	
iv) workload management	•	•	•	•	
v) crew resource management (CRM)	•	•	•	•	

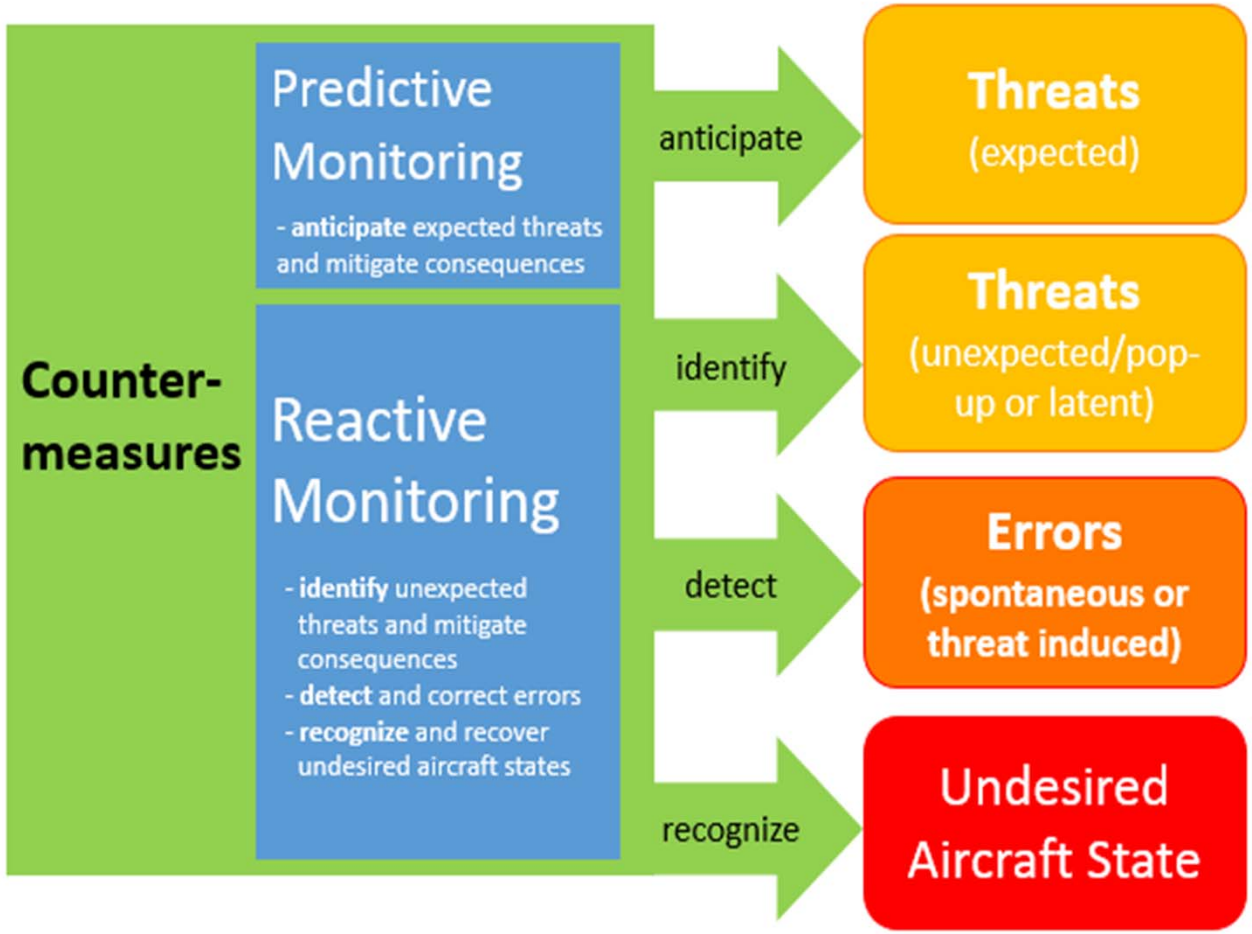
*K. Human Factors importance of **TEM***



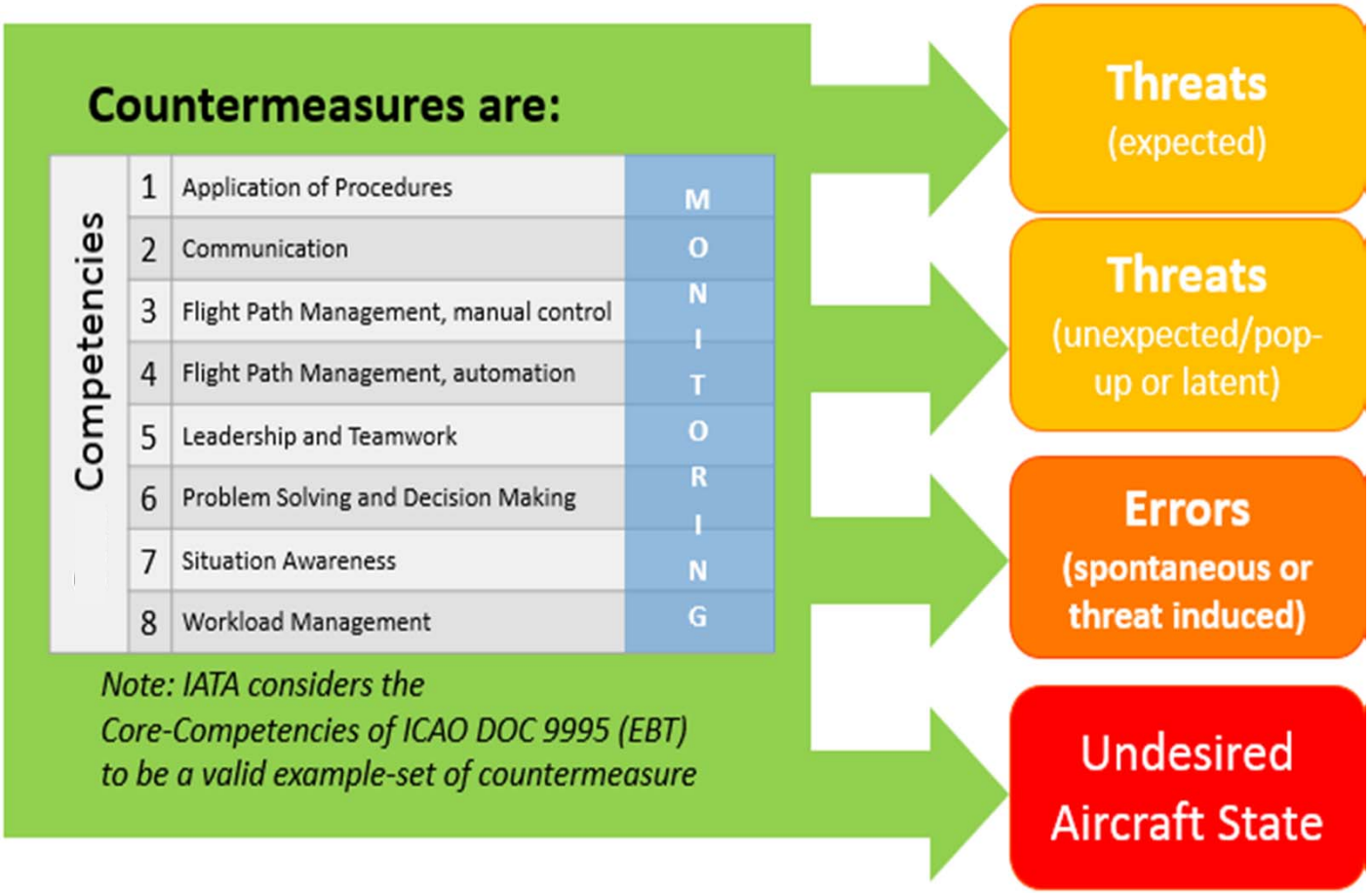
Cascading effect



*G. Recognition: importance of **monitoring***



Monitoring & Competencies



https://m.youtube.com/watch?v=QVaQYhd_Qy0

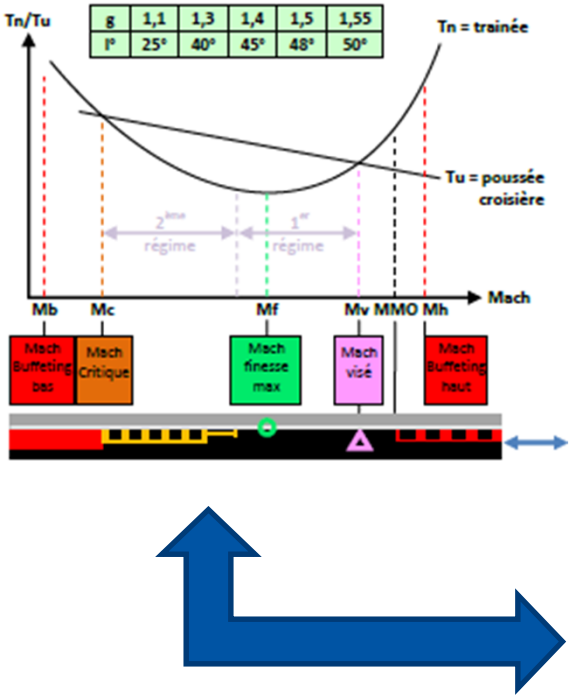
ICAO Doc 10011

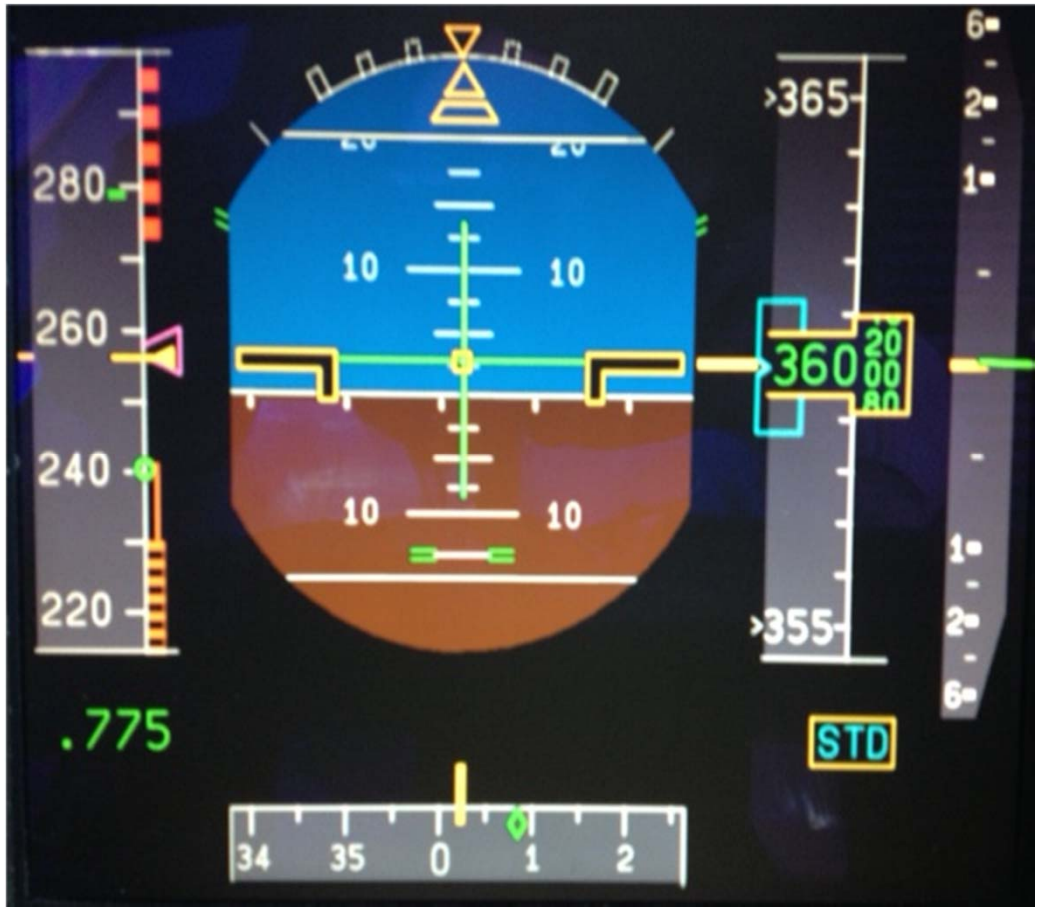
A. *Aerodynamics*
B. *Causes and contributing factors of upsets*
C. *Safety review of accidents and incidents relating to upsets*
D. *G-awareness*
E. *Energy management*
F. *Flight path management (manual handling skills included)*
G. *Recognition (importance of monitoring)*
H. *Upset prevention and recovery techniques*
I. *System malfunction (fbw)*
J. *Specialized training elements*
K. *Human Factors (importance of TEM)*

ICAO Doc 10011

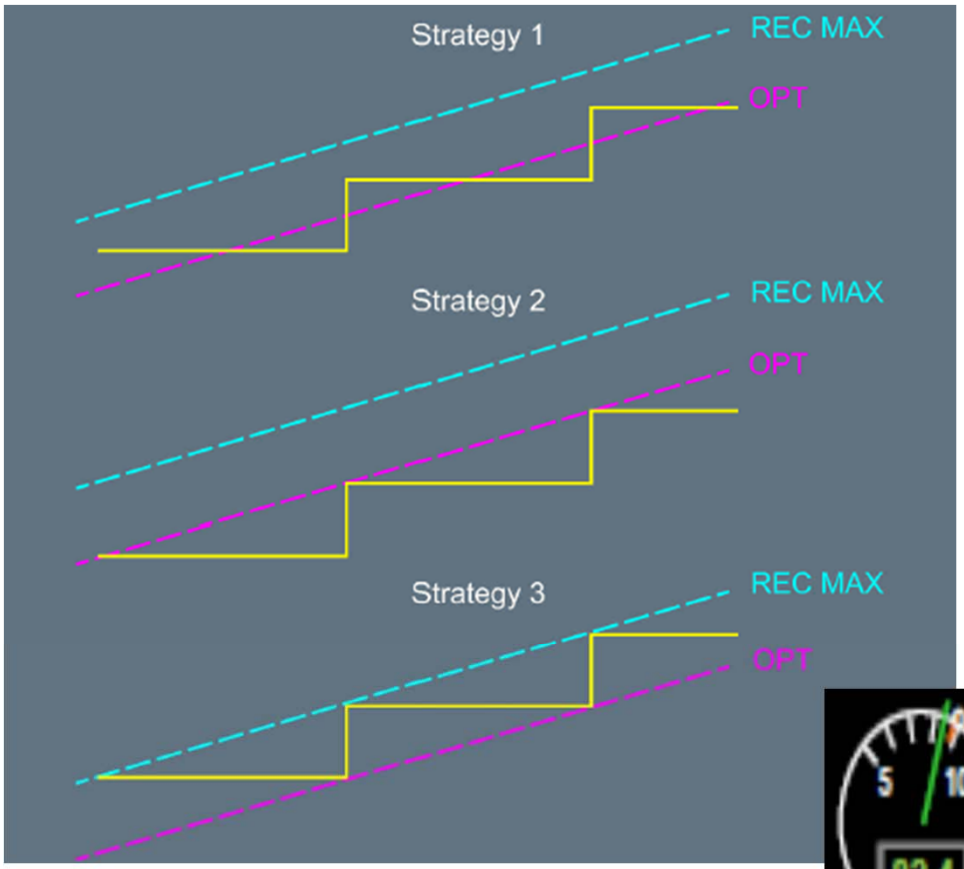
Subjects and training elements	*Academic training*	*On-aeroplane training — CPL(A)/MPL*	*Non-type-specific FSTD training — (CPL(A)/MPL)*	*Type-specific FSTD training*	*AURTA, Revision 2, references*
A. *Aerodynamics*					section 2.5
1) general aerodynamic characteristics	•	•	•		
2) advanced aerodynamics	•	•	•	•	
3) aeroplane certification and limitations	•	•		•	
4) aerodynamics (high and low altitudes)	•	•	•	•	
5) aeroplane performance (high and low altitudes)	•	•	•	•	
6) angle of attack (AOA) and stall awareness	•	•	•	•	

Academics & Practical application

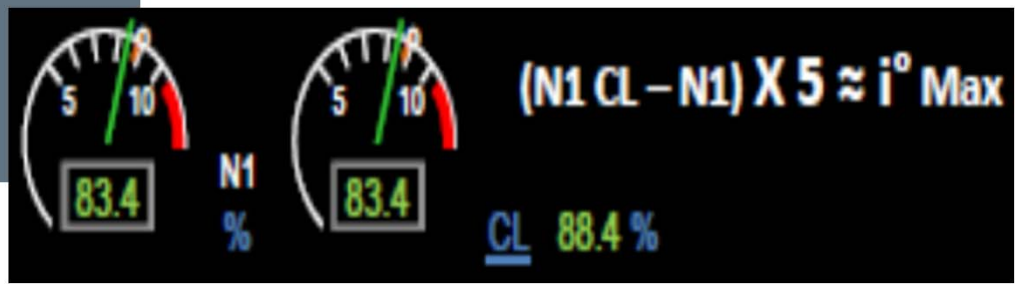




Academics & Practical application



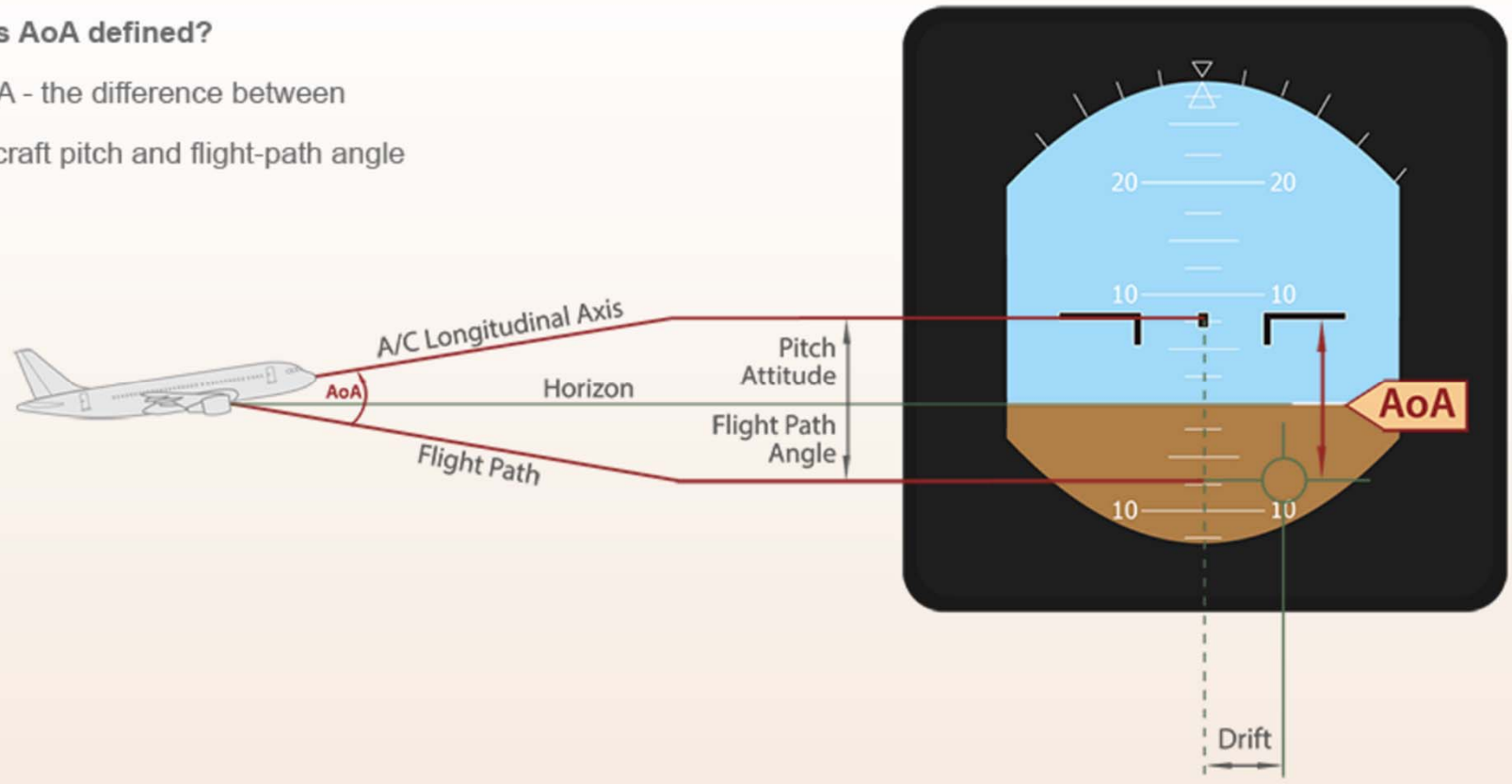
I Max = Max Bank angle



Academics & Practical application

How is AoA defined?

- AoA - the difference between aircraft pitch and flight-path angle



Academics & Practical application

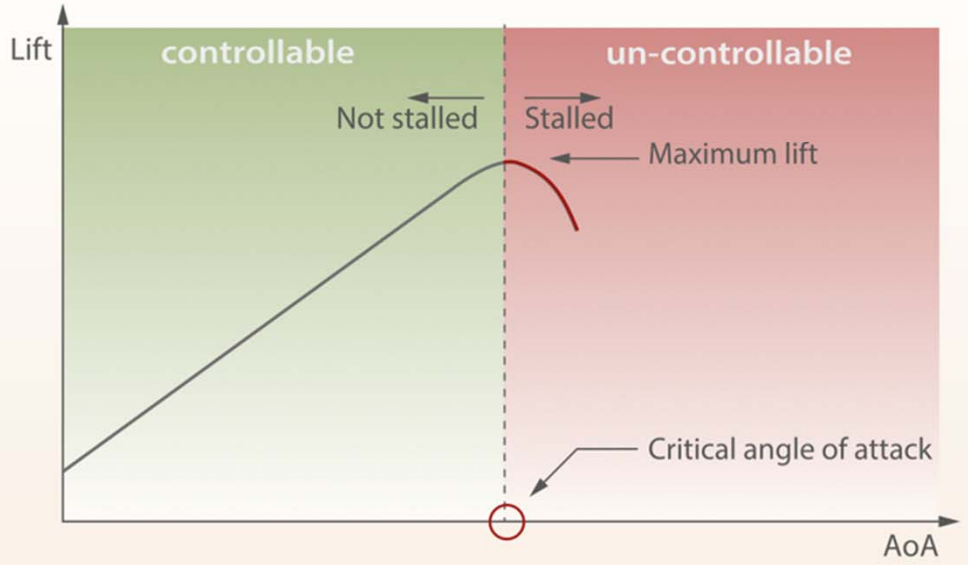
3 Airplane at Work

UPRT

3.2 The Critical AoA 1/2

26/124

- How is the critical AoA defined?



Academics & Practical application

Academics & Practical application

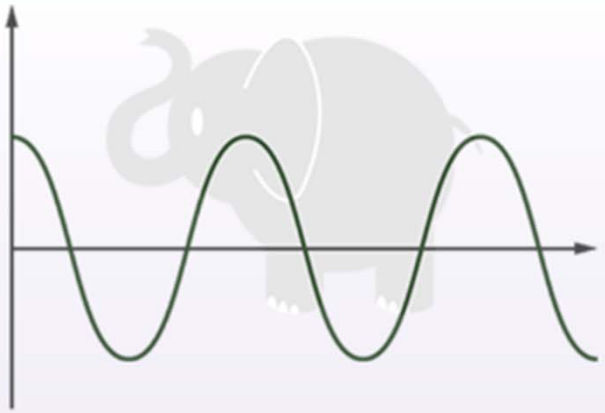
4 How the airplane talks to you

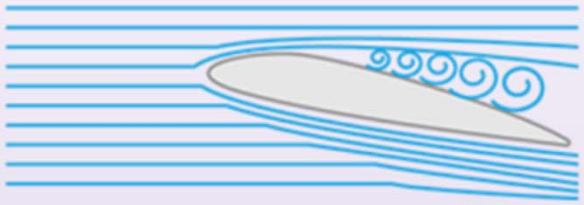
4.1 High AoA / Stall Warning

UPRT

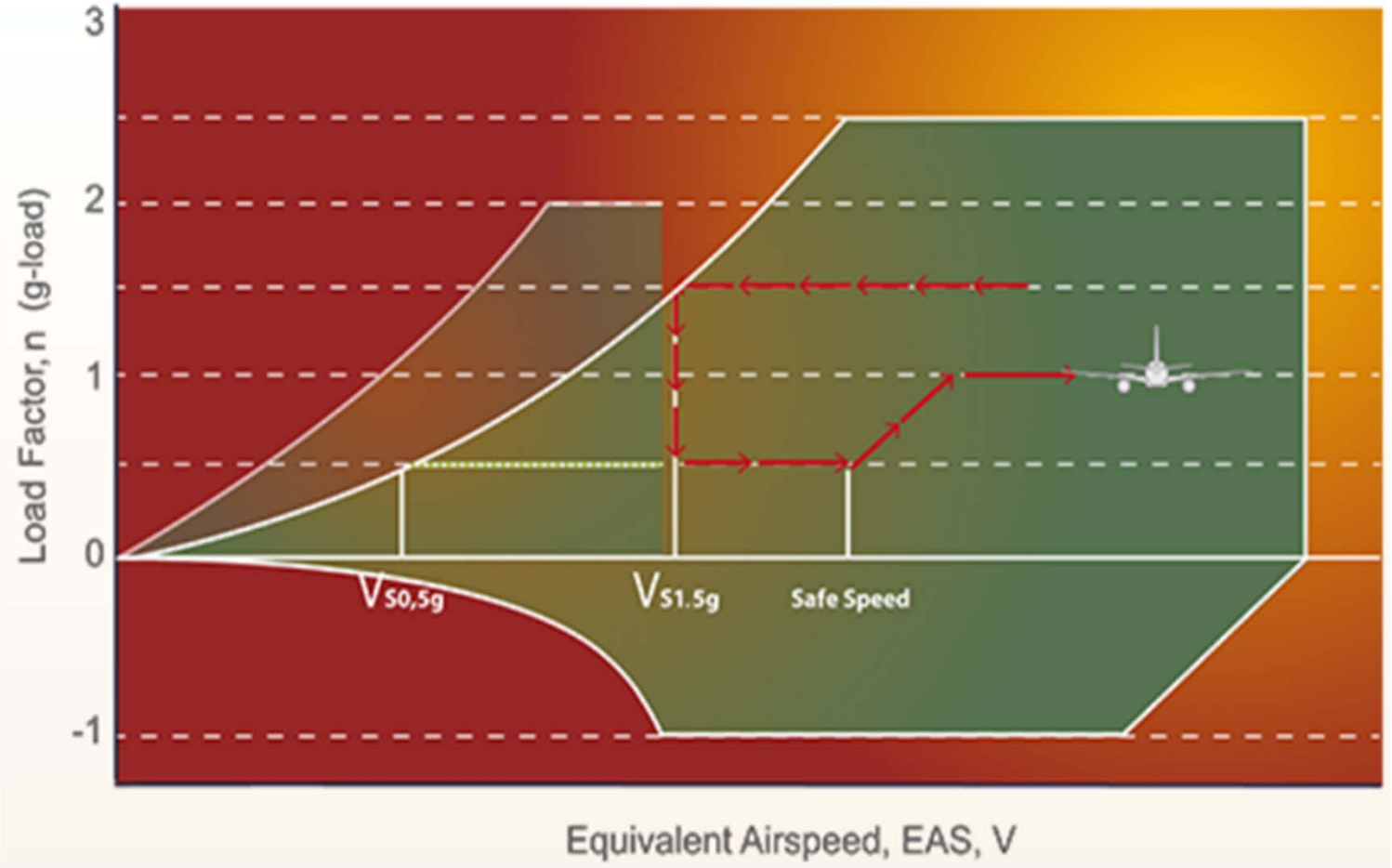
Natural Indications

- Aerodynamic buffeting
- Reduced roll stability and aileron effectiveness
- Reduced elevator authority
- Inability to maintain altitude or arrest rate of descent





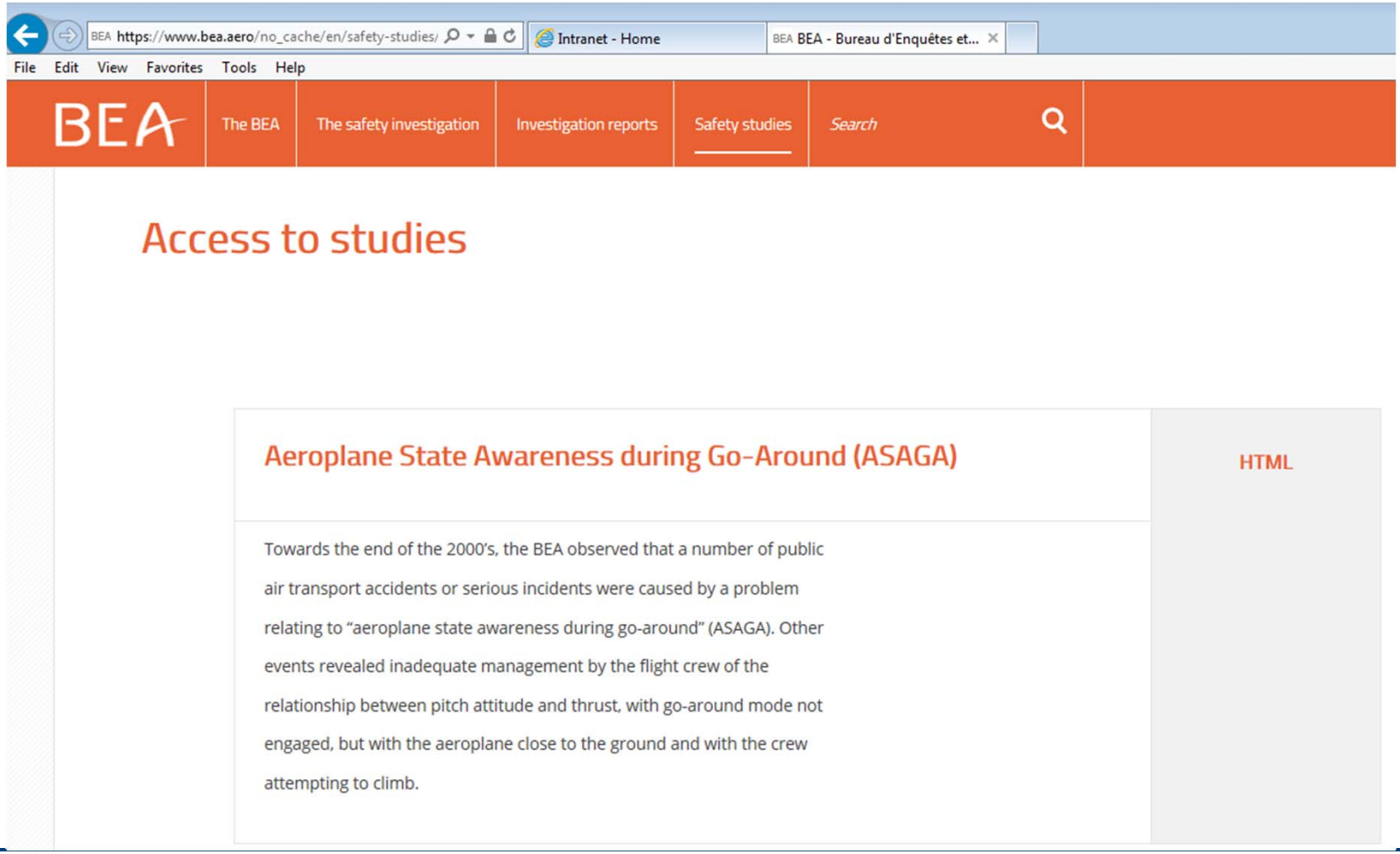
Academics & Practical application : Stall speed



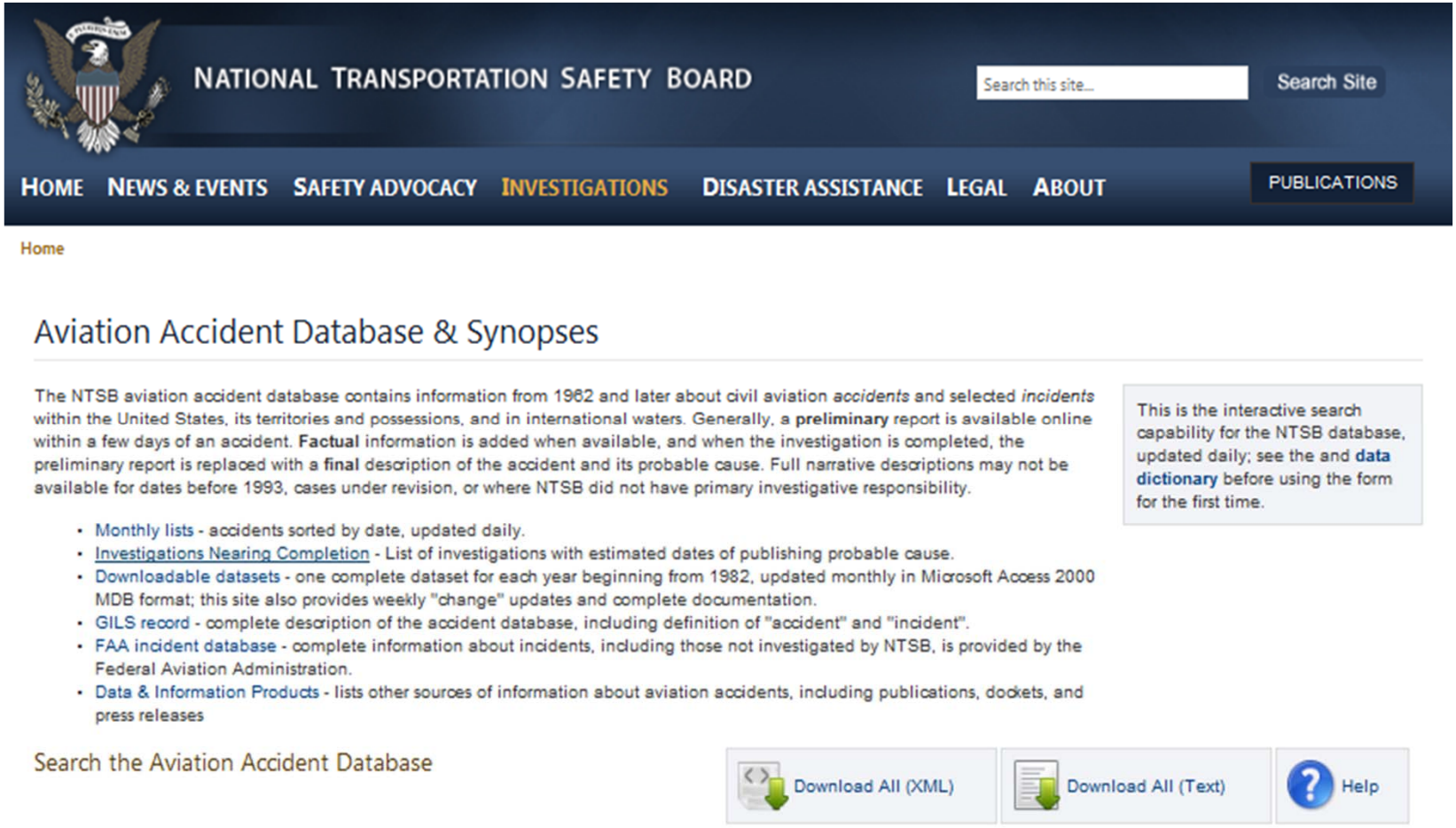
ICAO Doc 10011

A. *Aerodynamics*
B. *Causes and contributing factors of upsets*
C. ***Safety review of accidents and incidents relating to upsets***
D. *G-awareness*
E. *Energy management*
F. *Flight path management (manual handling skills included)*
G. *Recognition (importance of monitoring)*
H. *Upset prevention and recovery techniques*
I. *System malfunction (fbw)*
J. *Specialized training elements*
K. *Human Factors (importance of TEM)*

C. Safety review of accidents and incidents relating to upset



C. Safety review of accidents and incidents relating to upset



ICAO Doc 10011

A. *Aerodynamics*
B. *Causes and contributing factors of upsets*
C. *Safety review of accidents and incidents relating to upsets*
D. *G-awareness*
E. ***Energy management***
F. ***Flight path management (manual handling skills included)***
G. *Recognition (importance of monitoring)*
H. ***Upset prevention and recovery techniques***
I. *System malfunction (fbw)*
J. *Specialized training elements*
K. *Human Factors (importance of TEM)*

IATA recommends to combine UPRT with manual flying skills training

- Continuous use of auto flight systems could lead to degradation of the pilot‘s manual handling skills and ability to recover the aircraft from an upset
- Manual handling errors have been increasing. Operators and authorities have recognized that operators need to enhance the manual flying skills of flight crews.
- This includes new guidance by regulators, OEMs, and the review of the operator‘s policy to promote manual flying and manual throttle/thrust operation where appropriate in line operations, and the respective adaptation of recurrent training programs in FSTDs.

Scenario-Based Training and Upset Prevention

- Training scenarios should be designed in a way that crews can develop the competencies to recognize and manage threats, errors and undesired aircraft states successfully and to achieve a safe outcome.

- The ultimate training objective of scenario-based training is to avoid or arrest a divergence from the intended flight path as early as possible and secure the intended flight path.

- Scenarios leading to upsets, despite correct intervention by the crew, are not recommended.

Maneuver-Based Training and Upset Recovery

- The instructor, not the crew, takes responsibility for the creation of the upset condition. Training starts after the upset condition has been established.

- Reasons/causes for upset conditions may be taken from case studies but should not be the responsibility of the crew under training.

- The ultimate training objective is to effectively apply recovery actions and to return the aircraft to a stabilized flight path.

"OEM recommendation"

6 Recovering from Upsets

6.2 Nose-High Recovery 1/3

UPRT

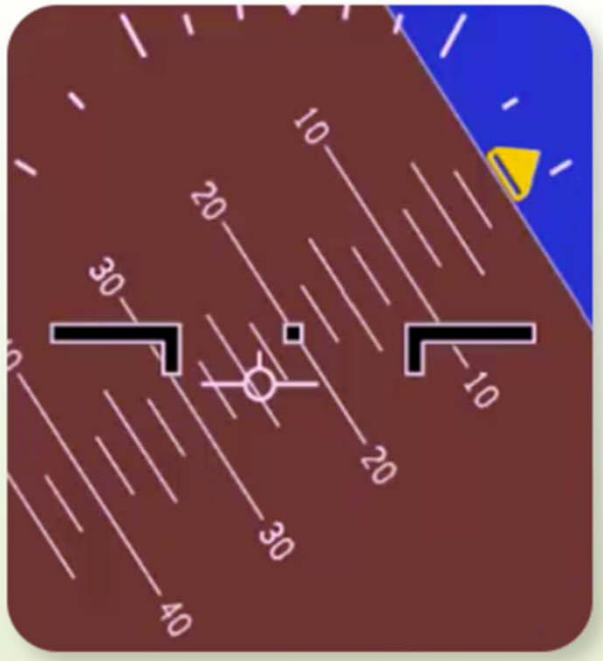
Nose HIGH Recovery		
„NOSE HIGH" (or callout by operator)		MONITOR airspeed and attitude throughout the recovery and ANNOUNCE any continued divergence
1	Autopilot.....disconnect	
2	Autothrust/Autothrottle.....OFF	
3	APPLY as much nose-down control input as required to obtain a nose-down pitch rate	
4	THRUST.....adjust (if required)	
5	ROLL.....adjust (if required)	
6	When airspeed is sufficiently increasing .....RECOVER to level flight	

"OEM recommendation"

6 Recovering from Upsets

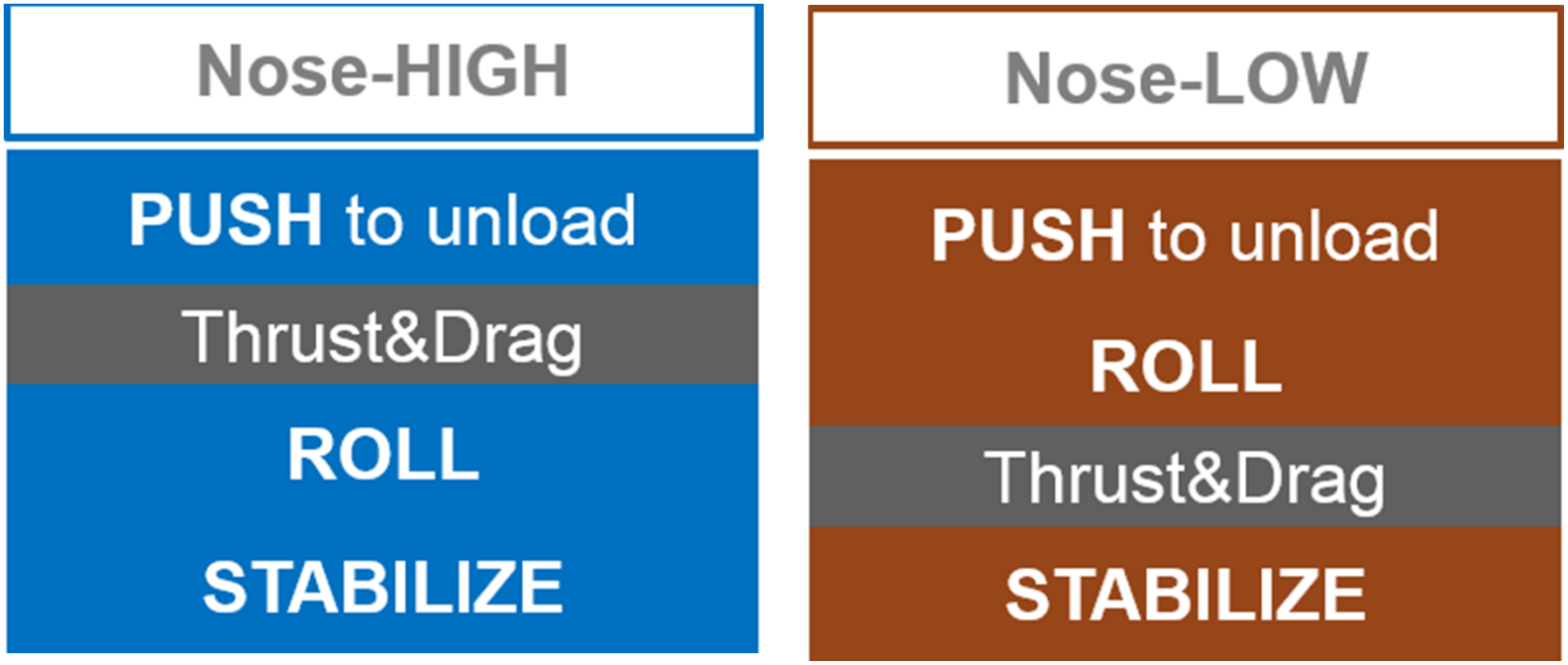
UPRT

6.3 Nose-Low Recovery 78/124

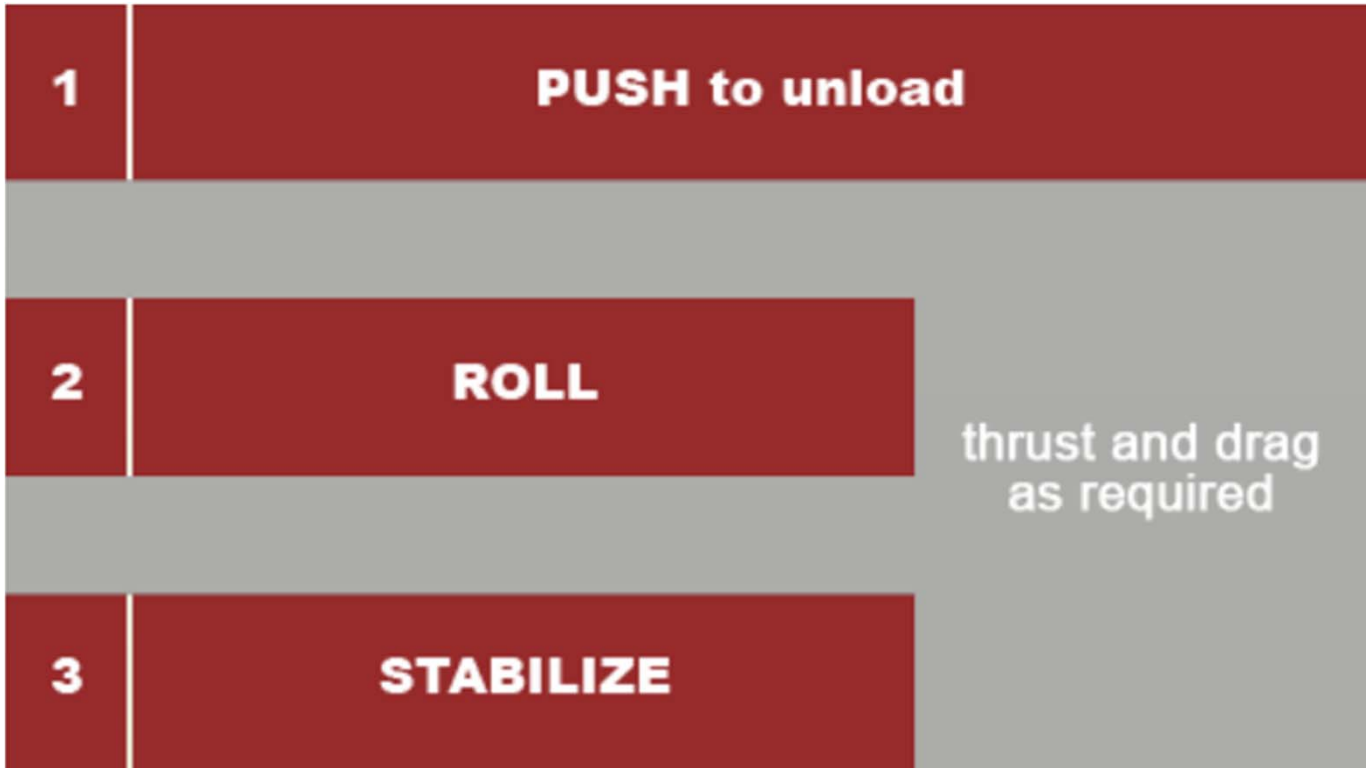


Nose LOW Recovery		
"NOSE LOW" (or callout by operator)		MONITOR airspeed and attitude throughout the recovery and ANNOUNCE any continued divergence
1	Autopilot.....disconnect	
2	Autothrust/Autothrottle.....OFF	
3	RECOVERY from stall if required	
4	ROLL in the shortest direction to wings level	
5	THRUST and DRAG.....adjust (if required)	
6	RECOVER to level flight	

LH Learning methodology



LH learning methodology



Stall event

STALL RECOVERY

Ident.: PRO-ABN-10-00013768.0001001 / 02 MAY 13
Applicable to: ALL

As soon as any stall indication (could be aural warning, buffet...) is recognized, apply the immediate actions:

NOSE DOWN PITCH CONTROL.....APPLY

This will reduce angle of attack

Note: In case of lack of pitch down authority, reducing thrust may be necessary.

BANK.....WINGS LEVEL

- **When out of stall (no longer stall indications) :**

  THRUST.....INCREASE SMOOTHLY AS NEEDED

  Note: In case of one engine inoperative, progressively compensate the thrust asymmetry with rudder.

  SPEEDBRAKES.....CHECK RETRACTED

  FLIGHT PATH.....RECOVER SMOOTHLY

  - **If in clean configuration and below 20 000 ft :**

    FLAP1.....SELECT

    Note: If a risk of ground contact exists, once clearly out of stall (no longer stall indications), establish smoothly a positive climb gradient.

Unload

Type specific

Example of training syllabi

Module	Content	Terminal training objectives
1	Advanced Manual Flying Skills	- Handling characteristics - airplane response to specific primary and secondary flight control inputs - Gain confidence for appropriate application of manual flight control inputs required during upset prevention and recovery conditions - Energy awareness
2	AOA awareness	- Vn diagram in practical application, loading and unloading - Stall is independent from attitude and speed - Stall recovery is based on AOA-reduction only - must be separated from the application of thrust - High Altitude ops
3	**Recoveries**	- Apply the OEM-recommendations - Separate “push/unload” from “roll”, control thrust at the correct time during recovery - Apply the airplane specific STALL-RECOVERY SOP correctly - Increase resilience by managing surprise and startle, and develop counterintuitive actions

Flight Plan

- Safety Data
- Regulatory matters
- Training content
- *Instructor qualification*
- FSTD requirements
- Evaluation

PERSONNEL PROVIDING FSTD UPSET PREVENTION AND RECOVERY TRAINING (UPRT)

ref GM5 ORO.FC.220&230

Standardisation and training should ensure that personnel providing FSTD UPRT:

(1) are **able to demonstrate** the correct upset recovery techniques for the specific aeroplane type;

(2) understand the importance of applying type-specific Original Equipment Manufacturers (OEMs) procedures for recovery manoeuvres;

(3) are able to distinguish between the applicable **SOPs and the OEMs recommendations** (if available);

(4) understand the **capabilities and limitations of the FSTD** used for UPRT;

(5) are aware of the potential of negative transfer of training that may exist when training **outside the capabilities of the FSTD**;

PERSONNEL PROVIDING FSTD UPSET PREVENTION AND RECOVERY TRAINING (UPRT)

ref GM5 ORO.FC.220&230

Standardisation and training should ensure that personnel providing FSTD UPRT:

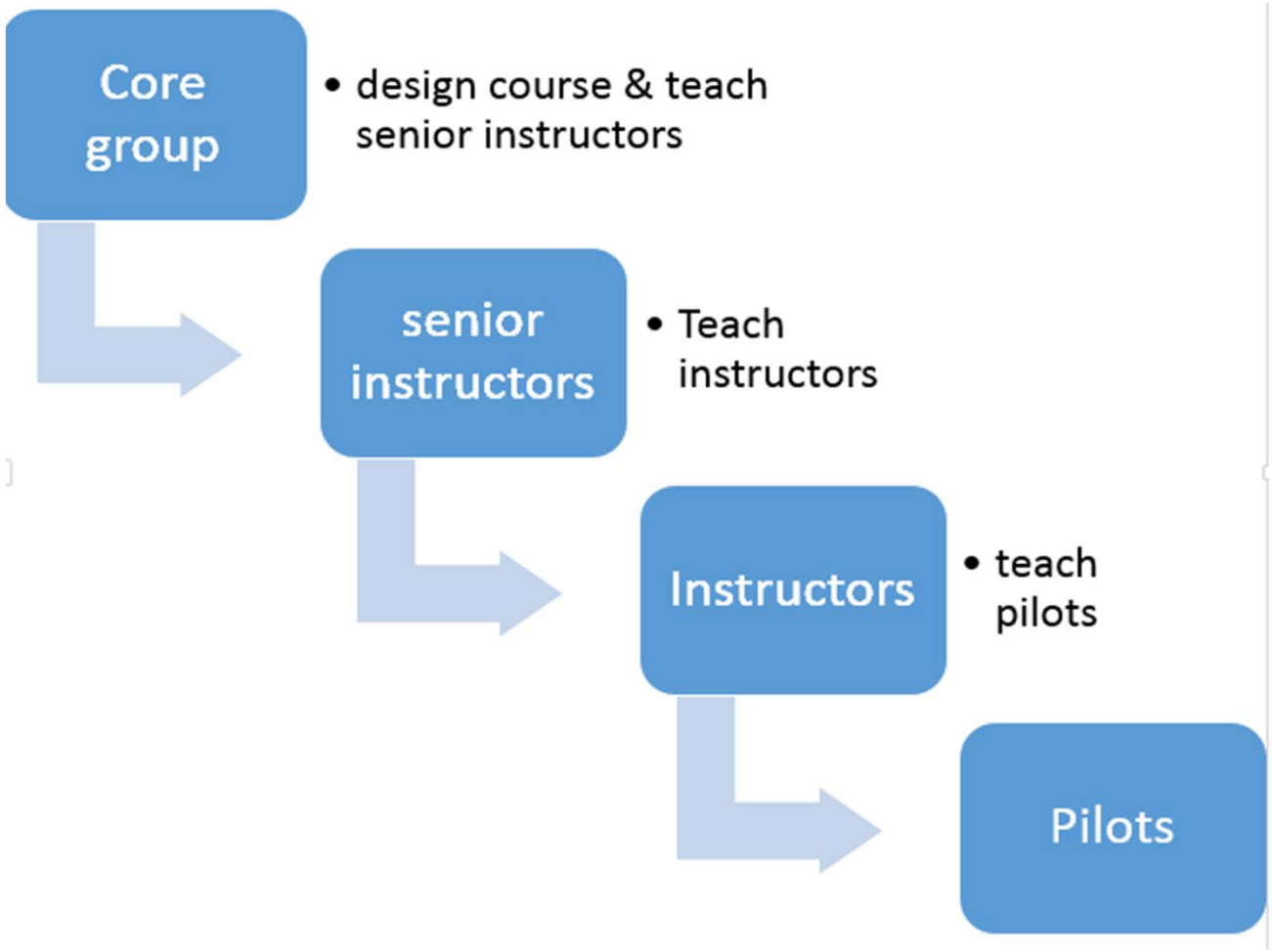
(6) understand and **are able to use the IOS** of the FSTD in the context of effective UPRT delivery;

(7) understand and are able to use the **FSTD instructor tools available for providing accurate feedback** on flight crew performance;

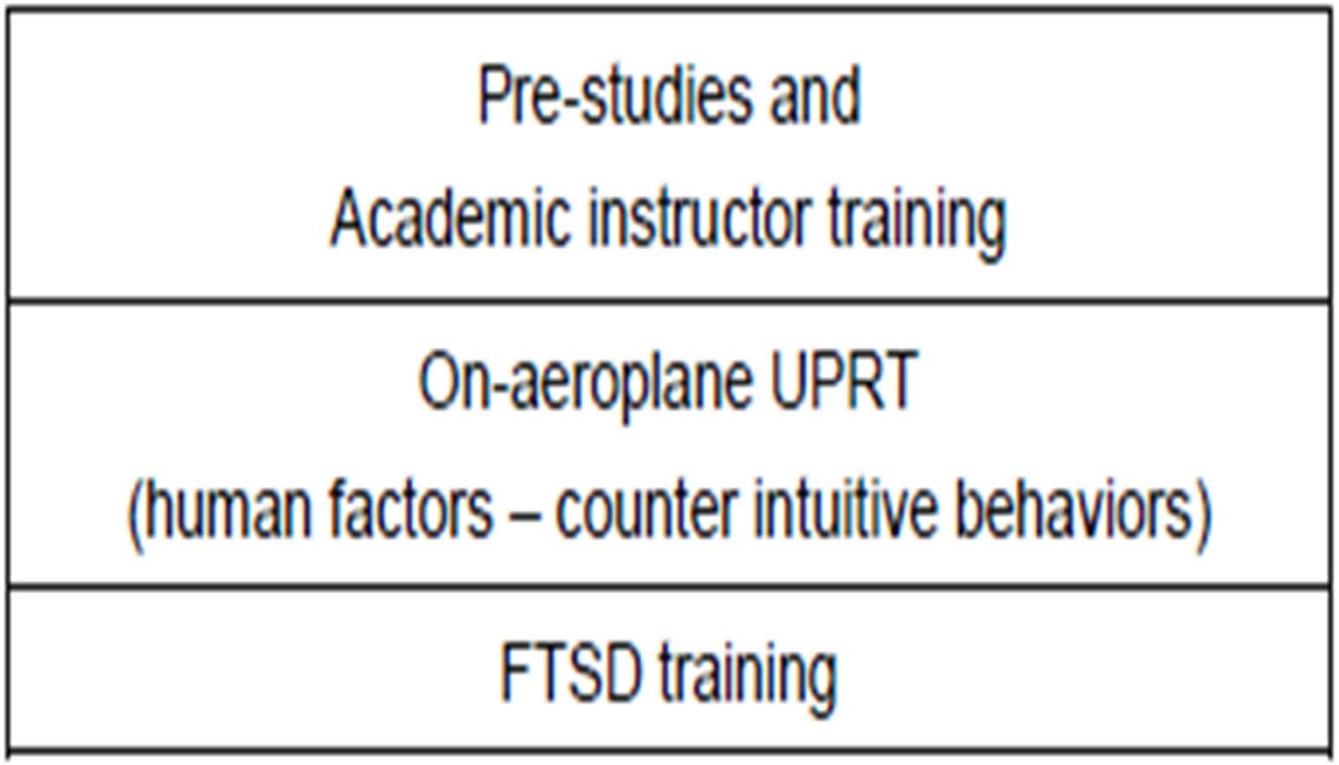
(8) understand the importance of **adhering to the FSTD UPRT scenarios** that have been validated by the training programme developer; and

(9) understand the **missing critical human factor aspects** due to the limitations of the FSTD and convey this to the flight crew receiving the training.

Instructors UPRT qualification process



IATA recommends for the "core group"



Core group & On-Aeroplane UPRT

- Ab initio ATO (example LH)
- Flight test school (example AF)
- Specialized ATO (example Delta Airline)

All Instructors: initial training

- Academics ½ day up to 1 day
- Practical FFS instruction 4H00
- Examples of exercises:
  - ✓ Uncommanded FLAPS retraction during climb
  - ✓ High pitch attitude protection and Steep Turns at FL 100
  - ✓ Steep Turns at high altitude
  - ✓ STALL RECOVERY (at high altitude)
  - ✓ Uncommanded flight controls inputs
  - ✓ Demo low speed protections
  - ✓ STALL RECOVERY (at low altitude)

Flight Plan

- Safety Data
- Regulatory matters
- Training content
- Instructor qualification
- *FSTD requirements*
- Evaluation

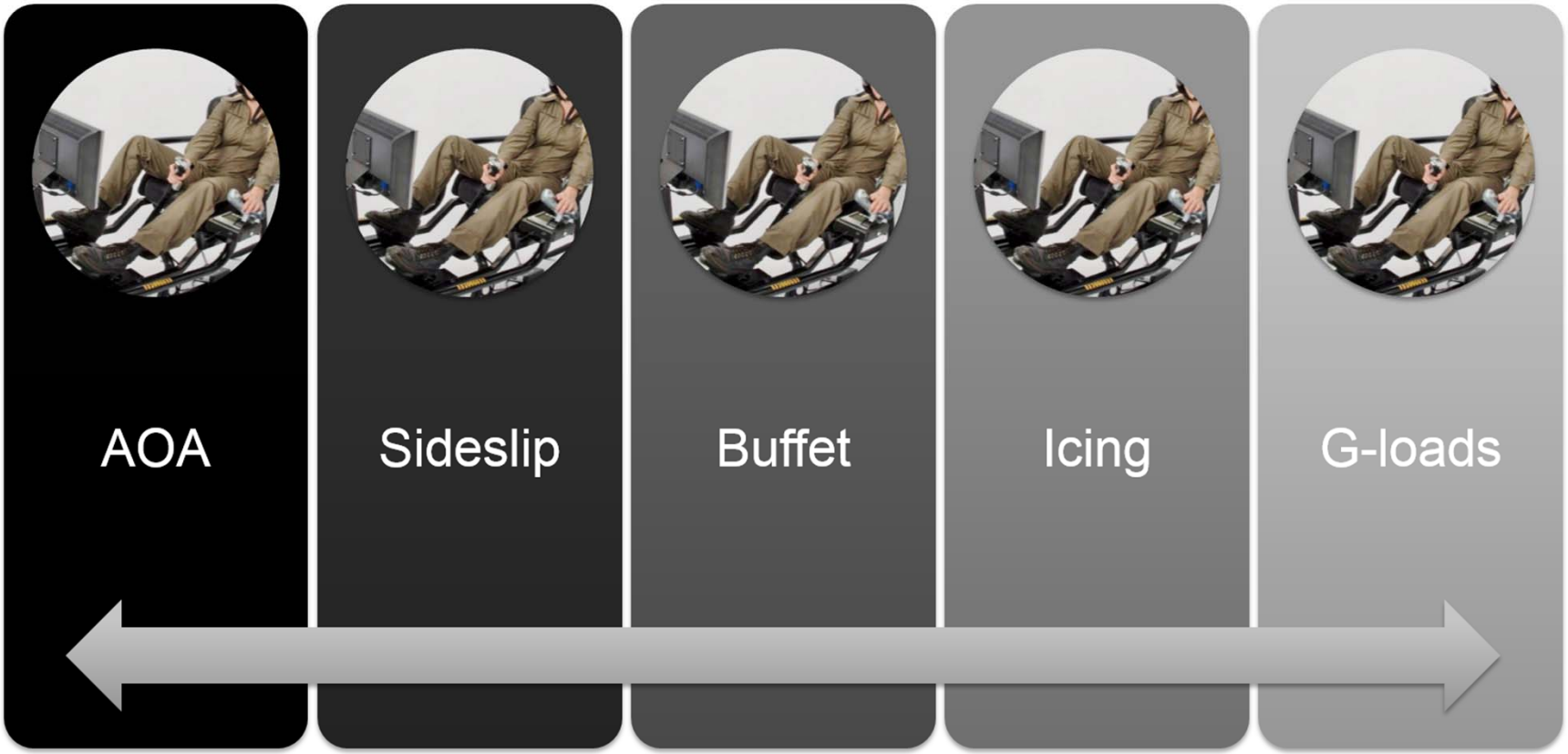
FSTD Requirements

See Doc 9625, 4th edition

- The FFS level C and D if maintained in the VTE (Validated Training Envelope) are suitable for UPRT initial and recurrent training sessions. For the time being, EASA does not require full stall exercises.
- FSTD Enhancements (Stall modelling)

  To be evaluated by a competent authority
- Recognition of FSTD motion limitations
- Additional IOS displays or tools

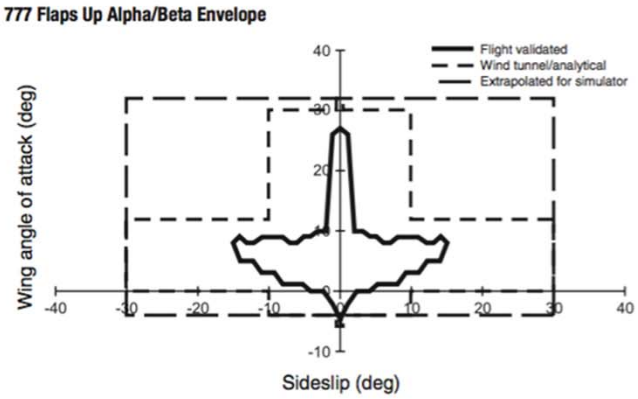
FSTD limitations

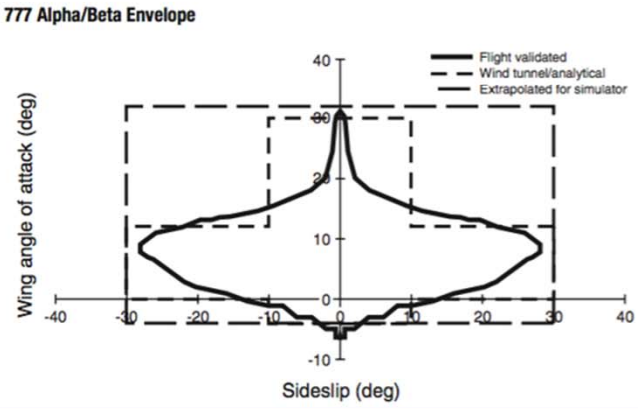


FSTD limitations

VTE

- No pitch limit
- No roll limit
- At high AOA (alpha) very narrow sideslip limits (beta)





FSTD Limitations

- G-loads below 1g
- G-loads above 1g
- FSTD motion limitations

FSTD motion limitations

Motion systems of modern full flight simulators are only capable of delivering **less than 10% of the real g-loads**.
When training upset recovery the simulation environment, they cannot deliver the real sensations.

These human factors play a key role in UPRT.
To compensate for the shortcomings of FSTD motion this CBT and your instructor will emphasize on human factors, especially during counterintuitive actions.

Flight Plan

- Safety Data
- Training content
- Instructor qualification
- Training delivery
- FSTD requirements
- *Evaluation*

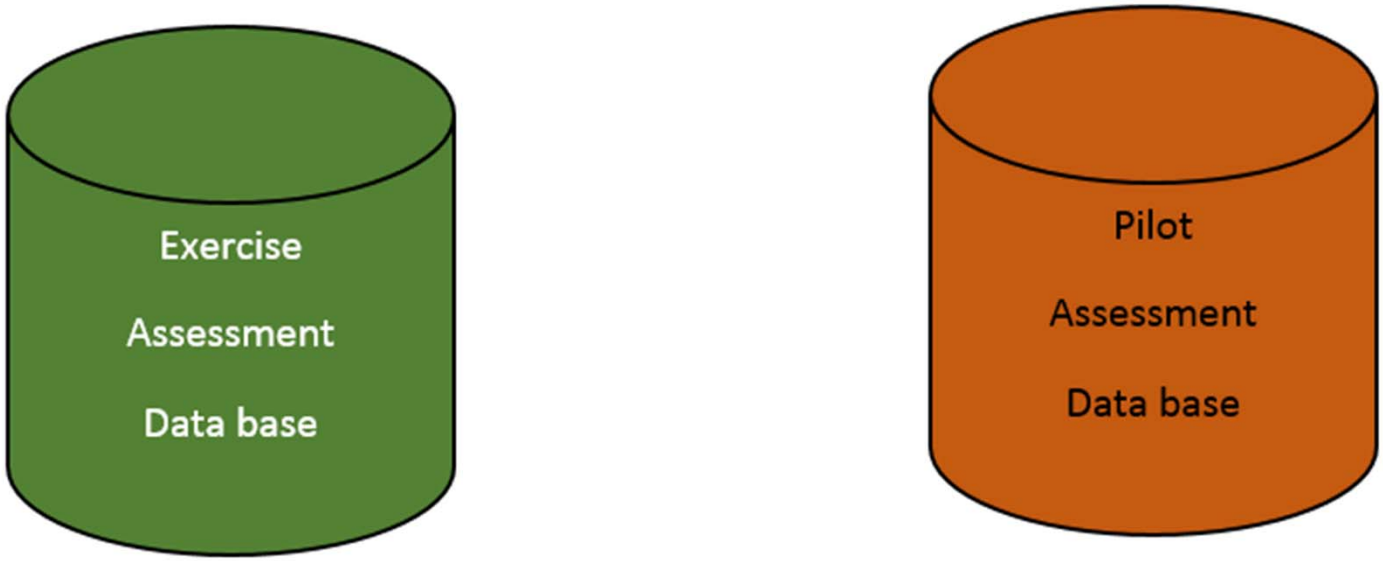
Evaluation of training course effectiveness

- Assessment of exercises
- Pilot proficiency assessment
- Pilots' feedback
- Instructors' Observations

Not discussed here

- Line Check/observation
- FDM (FOQA) improvements

Exercise / Pilot Assessment



Pilot Proficiency: Competencies

(Doc 9995 – Manual of Evidence-Based Training)

- Aircraft Flight Path Management, manual control
- Aircraft Flight Path Management, automation
- Application of Procedures

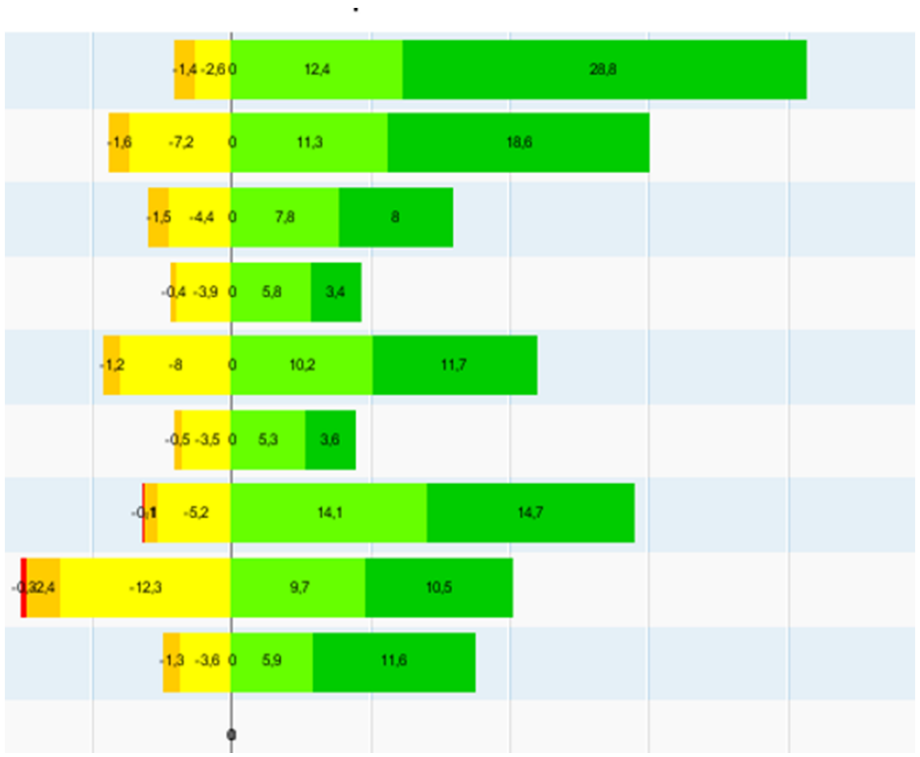
Technical

- Communication
- Situation Awareness
- Workload Management
- Leadership and Teamwork
- Problem Solving and Decision Making

Human Performance

	Assessment and training topic	*Frequency*	*Flight phase for activation*	*Description (include type of topic, being threat, error or focus)*	*Desired outcome (includes performance criteria OR training outcome)*	*Example scenario elements*	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem solving and decision making*	*Situation awareness*	*Workload management*
Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Upset recovery	C	ALL	An airplane upset is defined as an airplane in flight unintentionally exceeding the parameters normally experienced in line operations or training. 1. Pitch attitude greater than 25° nose up. 2. Pitch attitude greater than 10° nose down. 3. Bank angle greater than 45°. 4. Within pitch and bank angle normal parameters, but flying at airspeeds inappropriate for the conditions.	Recognize upset condition Take appropriate action Assure aircraft control Maintain or restore a safe flight path Assess consequential issues Manage outcomes	Upset recognition: Demonstration of the defined normal flight envelope and any associated changes in flight instruments, flight director systems, and protection systems. This should take the form of an instructor-led exercise to show the crew the points beyond which an upset condition could exist			x	x			x	x
			TO APP			Upset recognition and recovery — Severe wind shear or wake turbulence during take-off or approach			x	x		x	x	
			CLB DES			Upset recognition and recovery — as applicable and relevant to aircraft type, demonstration at a suitable intermediate level, with turbulence as appropriate; practice steep turns and note the relationship between bank angle, pitch and stalling speed				x			x	
			CRZ			Upset recognition and recovery — at the maximum cruise flight level for current aircraft weight, turbulence to trigger overspeed conditions (if FSTD capability exists, consider use of vertical wind component to add realism)			x	x		x	x	
			CRZ			Upset recognition and recovery — at the maximum cruise flight level for current aircraft weight, turbulence and significant temperature rise to trigger low speed conditions (if FSTD capability exists, consider use of vertical wind component to add realism)	x			x			x	
			CRZ			Upset recognition and recovery — demonstration at a normal cruising altitude, set conditions and disable aircraft systems as necessary to enable trainee to complete stall recovery according to OEM instructions	x			x			x	
			APP			Upset recognition and recovery — demonstration at an intermediate altitude during early stages of the approach, set conditions and disable aircraft systems as necessary to enable trainee to complete stall recovery according to OEM instructions	x			x			x	

Pilot Proficiency: competencies

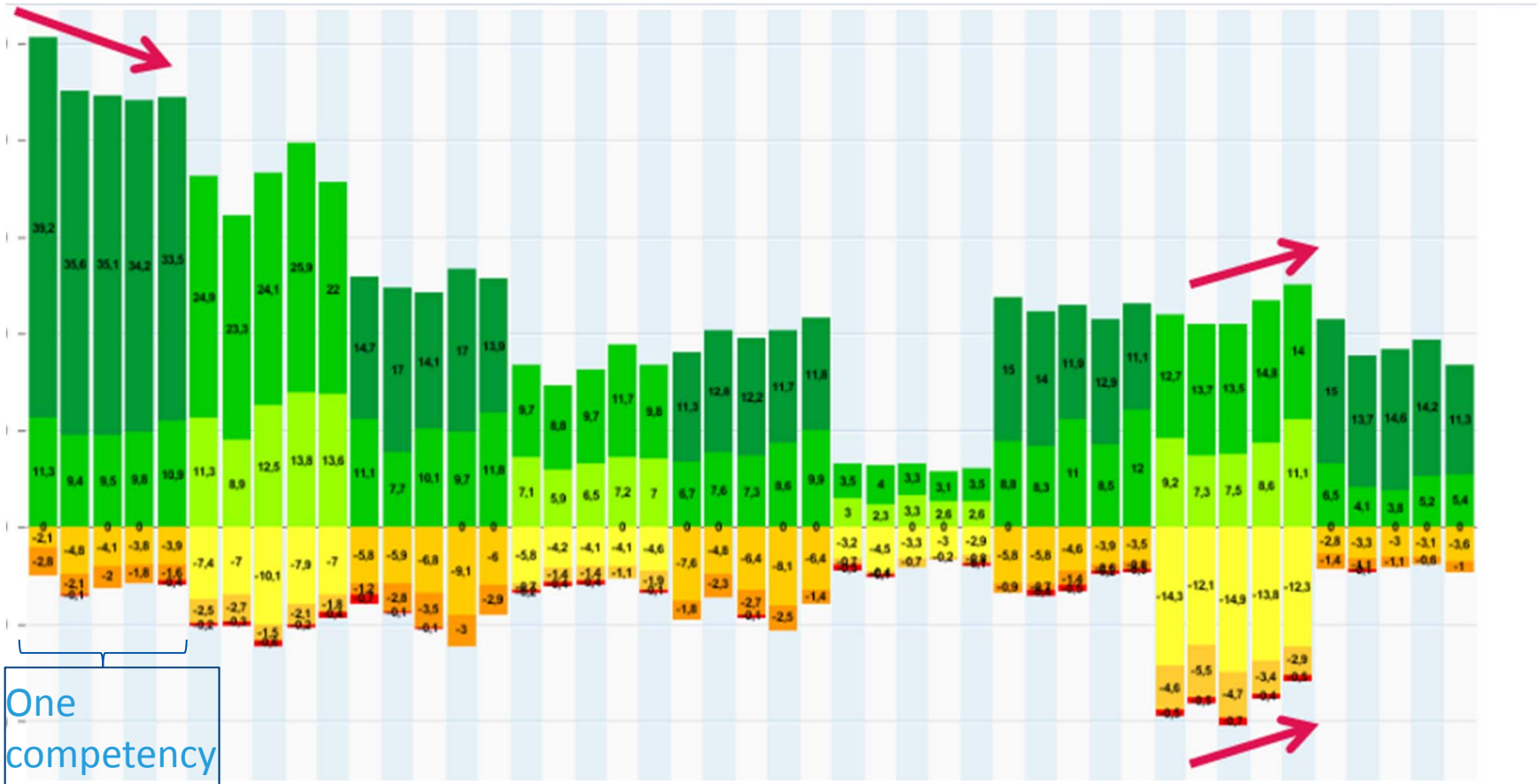


- ✓ MAN
- ✓ AUTO
- ✓ PRO
- ✓ COM
- ✓ SA
- ✓ WOR
- ✓ LEA
- ✓ DEC

Pilot Proficiency: Core competencies

- Aircraft Flight Path Management, manual control
- Aircraft Flight Path Management, automation
- Application of Procedures
- Communication
- Situation Awareness
- Workload Management
- Leadership and Teamwork
- Problem Solving and Decision Making

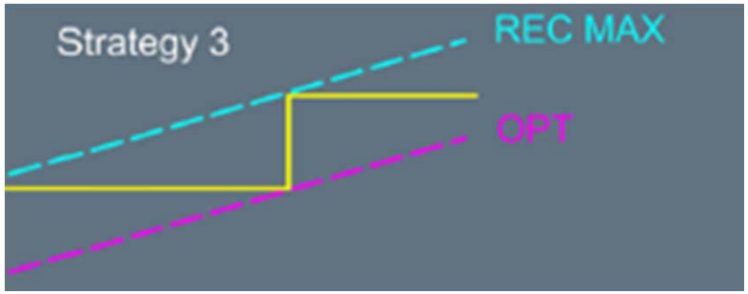
Competencies trends



Line ops checks / observations

Area of special emphasis, example:

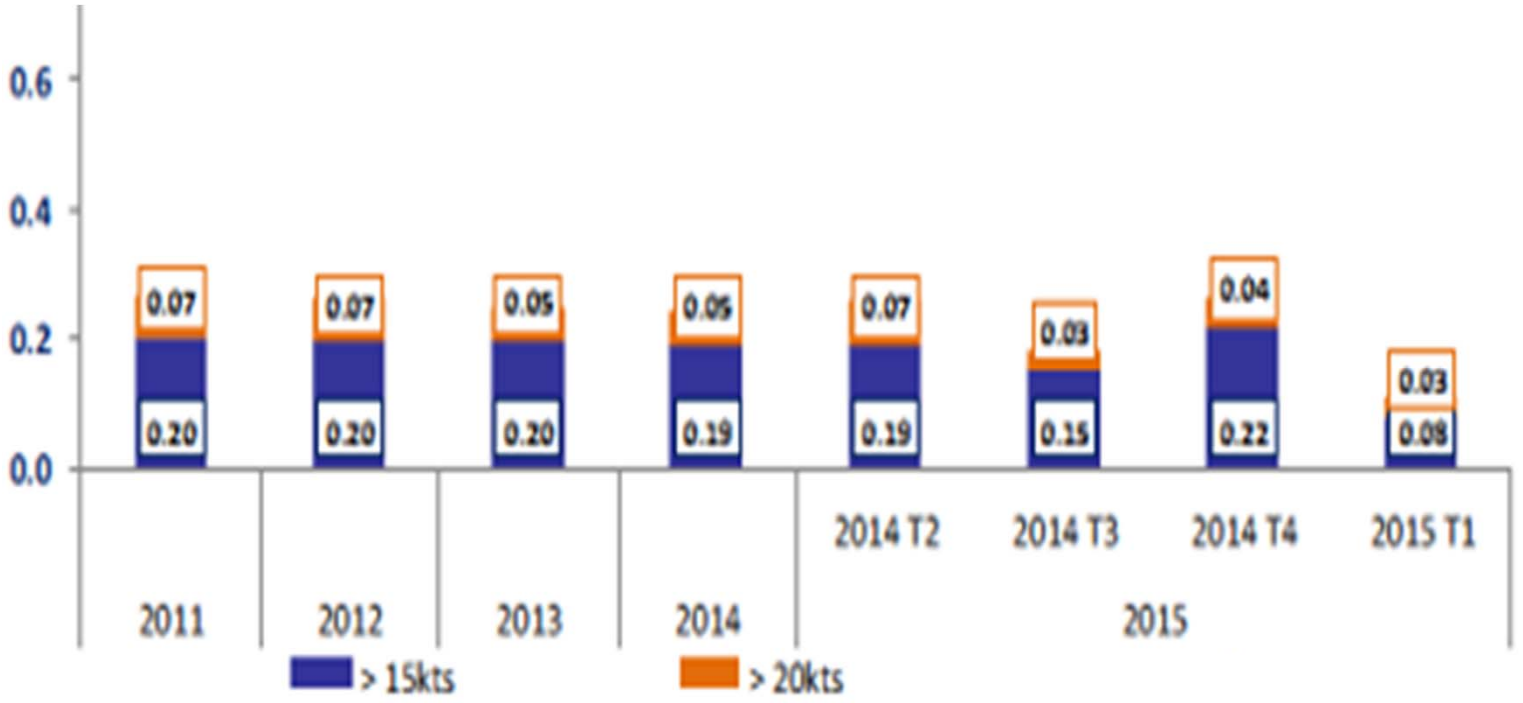
- Flight level choice



- Radar tilt selection
- Weather avoidance (icing, …)

Flight data monitoring

Speed below design maneuvering speed



Flight Safety and UPRT

- Global approach
- Safety culture promotion
- Crew debriefing promotion
- ASR customization
- Weather event trends (precursor)

Crew debriefing Example

An Operator's Debriefing Example
TEM: Did we anticipate/identify all threats? Did we develop the proper mitigation strategies? Did we detect and correct our errors? Did we recognize and recover undesired aircraft states? Which countermeasures worked effectively?
Procedures: As a crew, did we make any procedural error? How did we detect and correct the error?
Pending questions: Are there any phases of flight to clarify (CRM...)? Any report to be completed? (Air Safety Report, Technical Log...)
Improvements: What could we have done better?

Take away UPRT

- Program development: Time and Resources
- Instructor ADD-ON training: Essential
- Content: Practical and Basic knowledge
- FSTD: Remain in VTE

Train to Proficiency

Yann RENIER
IATA Flight Operations, SFO
Head of Training & Licensing
Email: reniery@iata.org