Upset Prevention and Recovery Training COSCAP-SA webinar – 13<sup>th</sup> of July 2022



To share Airbus experience regarding the **design** and **implementation** of Upset Prevention and Recovery Training.





#### Webinar Architecture





#### **UPRT Rule Making**







2012 (LOCART)

AURTA: 1998 / AURTA REV 1: 2004 / AURTA REV 2: 2008

2014

Doc 10011

Manual on

aeroplane upset

prevention and

recovery training

AIRBUS

2015 Advisory Circular 120-109A on Stall Prevention and Recovery Training

Advisory Circular 120-111 on Upset Prevention and Recovery Training





2015

Guidance Material and

Best Practices for the

Implementation of Upset

Prevention and Recovery

Training

2015 ED 2015-012-R amending the Acceptable Means of Compliance and Guidance Material to Part-Definitions and Part-ORO of Regulation (EU) No 965/2012

AIRBUS

2017 Revision 03 of the Anglane Upset Prevention and Recovery Training Aid



2018 14 CFR 121 423 Pilot: Extended Envelope Training.





2018 EU 2018/1974 (Arcrew) Amendment to Part FCL





# UPRT Concept



'Aeroplane upset' refers to an **undesired aircraft state** characterised by unintentional divergences from parameters normally experienced during operations. An aeroplane upset may involve pitch and/or bank angle divergences as well as inappropriate airspeeds for the conditions.





Aeroplane upset prevention and recovery training (UPRT) refers to training consisting of:

- Airplane upset prevention training: a combination of theoretical knowledge and flying training with the aim of providing flight crew with the required competencies to prevent aeroplane upsets
- Airplane upset recovery training: a combination of theoretical knowledge and flying training with the aim of providing flight crew with the required competencies to recover from aeroplane upsets.





#### **Training Toward Resilience**





# Pilot Training



#### **Guidance Material**





#### AMC1 ORO.FC.220&230 Operator conversion training and checking & recurrent training and checking

#### ICAO

11

A.	Aerodynamics
В.	Causes of and contributing factors to upsets
c.	Safety review of accidents and incidents relating to aeroplane upsets
D,	g-load awareness
E.	Energy management
F.	Flight path management
G.	Recognition
н	Upset prevention and recovery techniques
I.	System malfunction
J	Specialized training elements
K	Human Factors



#### EASA (Air Ops) Upset prevention training

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ſ	А,	Aerodynamics	
	Β.	Causes of and contributing factors to upsets	
	C.	Safety review of accidents and incidents relating to aeroplane upsets	
[	D.	g-load awareness and management	
	Ε.	Energy management	ŧ
	F.	Flight path management	1
	G.	Recognition	
	H,	System malfunction (including immediate handling and subsequent operational considerations, as applicable)	
1	Up	set recovery training	
l	Α.	Recovery from developed upsets	
	CF	RM training	
	Hu	man Factors	

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## EASA – Training Frequency



Pilot Recurrent Training Programme



#### Upset **PREVENTION** training

 Recurrent training programme should include upset prevention elements at least every 12 calendar months, such that all the elements are covered over a period not exceeding 3 years.

#### Upset RECOVERY training

- Be completed from each seat in which a pilot's duties require him/her to operate.
- Recurrent training programme should include the recovery elements for the, such that all the exercises are covered over a period not exceeding 3 years.

#### **Airbus Recommendations**

#### AIRBUS

A320

FLIGHT CREW TRAINING

STANDARDS





## **Airbus Recommendations**





FCTS Chapter 7.2: Undesired Aircraft States Prevention and Recovery Training:

Managing potential causes of flight path divergence.

- > 70 % Prevention and,
- ➢ 30 % Recognition and Recovery.



## **Airbus Recommendations – Theoretical Training**

- Elements of aerodynamics
- Causes and contributing factors of undesired aircraft states
- Examples of incidents related to undesired aircraft states
- G-load awareness and management
- Aircraft energy management including thrust settings
- Automated and manual flight path management
- Elements of active monitoring and associated observable behaviors
- Aircraft stall protection systems and stall cues
- Procedures and techniques for the recovery of undesired aircraft states.



#### As a minimum...

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## **Airbus Recommendation – Practical Training**



Undesired aircraft state **PREVENTION**:

- Understanding of the flight control laws principles and protections
- Exploration of the normal flight envelope (low and high speeds, low and high altitudes), with a specific emphasis on angle of attack awareness
- Energy management at low and high altitude
- Manual handling skills reinforcement in normal and reconfiguration flight control laws at low and high altitude
- Reminder of AP/FD and A/THR specificities (engagement and disengagement, operating limits, mode reversions, etc.).



## **Airbus Recommendation – Practical Training**



Undesired aircraft state RECOGNITION and RECOVERY:

- Recovery from unusual aircraft attitude at low and high altitude
- Approach to stall at low and high altitude
- Understanding of the Flight Path vector (FPV) and when to use or not to use it during recovery
- Full stall at low and high altitude (when mandated by the National Aviation Authority or decided so by the operator)
- Bounced landing (when mandated by the National Aviation Authority, part of the FAA 14 CFR 121.123 "extended envelope training").

- Recommended frequency for recurrent training: Unless otherwise mandated by National Aviation Authorities, all elements related to the training of undesired aircraft states should be performed over a period that does not exceed three years.
- **Credits between airbus A3XX FBW types:** Credits can be granted in accordance with the published Operational Suitability Data (OSD-FC).



Full credits for FSTD training



No credit at OEM level



## Airbus ATO – Initial Implementation





#### Airbus ATO – Theoretical Training

- Prevention Ground Training contents 8 Modules as follows:
  - o Module A: Aerodynamics
  - o Module B: Causes of and contributing factors to upsets
  - o Module C: Safety Review of accidents and incidents relating to aeroplane upsets
  - o Module D: G-Load awareness and management
  - o Module E: Energy management
  - o Module F: Flight Path Management
  - o Module G: Recognition
  - o Module H: System Malfunction
- Recovery Ground Training contents 1 Module as follows:
  - o Module A: Recovery from developed Upsets





## Airbus ATO – FTSD Training

- Prevention Training contents 8 Modules as follows:
  - Module A: Aerodynamics
  - Module B: Causes of and contributing factors to upsets
  - Module C: Safety Review of accidents and incidents relating to aeroplane upsets
  - Module D: G-Load awareness and management
  - Module E: Energy management
  - Module F: Flight Path Management
  - Module G: Recognition
  - Module H: System Malfunction
- Recovery Training contents 1 Module as follows:
  - Module A: Recovery from developed Upsets









## Training Device Requirements



- FSTD requirements for UPRT are included in the EASA CS-FSTD.
- Both EASA Part-FCL (Licensing) and Part ORO (AIR-OPS) refer to the CS-FSTD for UPRT training.
- As a rule, an FFS qualified according to the CS-FSTD is required for UPRT practical training.





FSTD validation envelope is defined by the CS-FSTD by the following three subdivisions :

- Flight-test-validated region: validated with flight test data,
- Wind tunnel and/or analytical region: wind tunnel testing or use of other reliable predictive methods,
- Extrapolated region: to ensure operational continuity.





## FSTD Training Envelope





FSTD Training Envelope or Valid Training Envelope (VTE): High and moderate confidence regions of the FSTD validation envelope.

## Effective FSTD Training



- Extended aerodynamic envelope
- Post stall aerodynamic model
- ➢ G-load
- > Appropriate high altitude performance, including stall
- > Appropriate buffet models.



## **FSTD** Requirements





- IOS feedback mechanism in real time: FSTD Training envelope - Controls input -Operational limit,
- > Aerodynamics model,
- > Motion system,
- Stall event limited to Approach-to-stall.



- Upset scenarios
- Post-stall training: Optional
  - only if Extended FSTD Training Envelope available

#### FAA: Post stall training is mandatory

OEM Recommendations for the use of FSTDs in UPRT are provided in the FCTS (7.2.5)

- Sompliance with CS-FSTD issue 2 (EASA) or FAA part 60 (Change 2)
- Respect of the valid training envelope (FSTD training envelope)
- Avoidance of negative training during unusual attitude training (use of In-seat instruction or specific IOS functions)
- >> Avoidance of negative training during approach to stall and/or full stall training.





#### **Airbus FSTD Specifications**



For AIRBUS A320/A330/A340/A350/A380

#### FSTD data package

- SimPack delivered by Airbus
- Integrated by the training device manufacturer:
  - Fully compliant with FAA Part 60 Change 2
  - Total free play capabilities (stall regime).
  - Enhanced aerodynamics model (full stall)
  - Stall Buffet
  - Roll Off.

#### **IOS Functions**

- Developed by the Training Device Manufacturer
- New IOS pages
  - UPRT and Stall scenarios
  - Provides feedbacks to instructor (plots on diagrams, flight controls positions, etc...).

#### Automatic Stall Entry



#### **IOS: Automatic Stall Entry**





#### **IOS: Upset Scenario**



## **IOS:** Composite Feed-Back



## Airbus ATO Policy



IOS feedback mechanism in real time Aerodynamics model Motion system	Mandatory
Stall event limited to Approach-to-stall	
Upset scenarios	If not available -> ISI
Post-stall training only if qualified accordingly.Required an Extended FSTD Training Envelope	Mandatory to conduct full stall





# Instructor Training



#### GM5 ORO.FC.220&230 Operator conversion training and checking & recurrent training and checking

#### PERSONNEL PROVIDING FSTD UPSET PREVENTION AND RECOVERY TRAINING (UPRT)

It is of paramount importance that personnel providing UPRT in FSTDs have the specific competence to deliver such training, which may not have been demonstrated during previous instructor qualification training. Operators should, therefore, have a comprehensive training and standardisation programme in place, and may need to provide FSTD instructors with additional training to ensure such instructors have and maintain complete knowledge and understanding of the UPRT operating environment, and skill sets.

## **UPRT - Instructor Training**

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UPR7 instructor training elements	UPRT	UPRT	TANK . N	
	instructor	instructor	_	
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Training platforms (aeroplanes and devices)				
1)initations of training platform				
2)operation of IDS and debriefing tools				0
Review of LOC-I accidents incidents	- -			
Energy management factors*	÷2		]	
Disorientation	12			
Workload management	25	2		1.000
Distraction	<b>3</b> 5	•		Instructor
OEM recommendations*	•	•		
UPRT recognition and recovery strategies*	20			FSTD
Recognition of trainee errors	•	÷		
Intervention strategies				
Astroplane type- specific characteristics*	<b>₩</b> 2	20		
Operating environment	<b>5</b> 8	37		
How to induce the startle factor		•		
Value and benefits of demonstration		•	Instructor	
How to assess plict performance using core competencies if conducting CBT (refer to the appendix)	101 1		]	
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<sup>1</sup> CEA may state part dwelp differing publicanegading procedure to abbrea these areas of baining which may assert the material povoled haven. In all cases, where the special CERT is being concluded, training organizations should provide procedural training which conforms to the appropriate perplanet light manual.

#### **Instructor Training - Objectives**



#### (vi) UPRT

Instructors should have the specific competence to provide UPRT during the type rating training course, including the ability to demonstrate knowledge and understanding of the type-specific upset recovery procedures and of the recommendations that are developed by the original equipment manufacturers (OEMs). Therefore, during the TRI training course, the student instructor should:

- (A) be able to apply the correct upset recovery techniques for the specific aeroplane type;
- (B) understand the importance of applying type-specific OEM procedures for recovery manoeuvres;
- be able to distinguish between the applicable SOPs and OEM recommendations (if available);
- (D) understand the capabilities and limitations of the FSTDs that are used for UPRT;
- (E) ensure that the training remains within the FSTD training envelope to avoid the risk of negative transfer of training;
- understand and be able to use the IOS of the FSTD in the context of providing effective UPRT;
- understand and be able to use the available FSTD instructor tools to provide accurate feedback on pilot performance;
- (H) understand the importance of adhering to the FSTD UPRT scenarios that are validated by the training programme developer; and
- understand the missing critical human factor aspects due to the limitations of the FSTD, and convey this to the student pilot(s) receiving the training.

>> The **principles** of flight applicable to UPRT:

- Influence of the Angle of Attack (AOA), critical AOA
- Lift/drag ratio, speed stability zone of the thrust curve
- Factors affecting the critical angle of attack that includes the Mach effect
- Static and dynamic stability, pilot-induced oscillations
- High speed flight, critical Mach number.
- >>> The capabilities and limitations of the FSTD
- The missing critical human factor aspects due to the limitations of the FSTD.



AJRBUS AJ25

### **UPRT - Airbus Stand-Alone Instructor Course**





Ground phase:

1 day ground training:

- ✓ ½ day e-training
- ✓ ½ day classroom training

The ground training is a combination of a self-study course, classroom lecture & facilitator-led discussions.



## **UPRT – Instructor Theoretical Training**







### **UPRT – Instructor Practical Training**

PREREQUISITE	DAY 1	DAY 2
Instructor Basic	Welcome	
Knowledge and Skill (e-Learning off-site)	Instructor Enhanced Knowledge & Skill	FFS 1

Simulator phase: customer UPRT training under supervision.

•	Se	ession 1 (for 2 candidates)
	-	Introduction by the UPRT tutor
	2	Session briefing by one instructor candidate
	-	FFS session (customer training under supervision)04.00
		Debriefing by one instructor candidate* using debriefing station
		General debriefing by the UPRT tutor, questions and answers

\* The instructor candidate that has not briefed the session.

# Implementation



## **EASA – UPRT Implementation Overview**



## Airbus ATO – UPRT Implementation





## Additional Documentation



#### AIRBUS

UPRT OVERVIEW

ICAO - EASA - AIRBUS ATO POLICY

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UPRT OVERVIEW

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Characteristics							x	N/A		CBT	/EL	x	N/A				FSTD	See below
2 Aeroplane certifica	tion and li	imitations					x	х		CBT	/EL	x	N/A				FSTD	See below
3 Aerodynamics (hig)	h and low	altitudes)						*		CRT	/FI	×	×				ESTD	See helow
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ICAO Training aloment	Description	Example of Airbus aconario elements
. Astrophysicka	There exists of the international exists all and injuration effects as both topic and local attallate. The effects the server exists and a set in the server exists and a set in the server exists of	A.1: Anisteur petal. AOA, flight pain. Annull flight servering responsible.     A.2: Annull measurempt properties to a safety of a servering responsible.     A.2: A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     Back A constraint coupled by a large and hypothesistics.     A: A constraint coupled by a large and hypothesistics.     Back and hypothesistics of A ABA hypothesistics.     Back and hypothesistics of ABA hypothesistics.     Back and
	en asset and a) nations doubt demonstrate honologie al the type space in systems that one ADA with emphases an exercise system and the institutions of these systems: for sources, surgraining an indication in the light data is a "continuum system" num larmed an others to a system being menually existent on	

ICAO Training element	Description	Example of Airbus scenario elements
A. Aerodynamics	Trainees should be knowledgeable about aerodynamic effects at both high and low altitudes. The FSTD training should be accomplished at both high altitude (within 1.500 m [5.000 ft] of the service celling of the aeroplane) and at low altitude (below 3.000 m [10.000 ft] above mean sea level) to reinforce the academic training described in 3.2. High-altitude training should be conducted at normal operational cruise altitudes. Trainees should also be trained with respect to the handling effects of operating at low speeds and high Mach, including: () demonstration of Mach tuck and Mach buffet (if applicable to the accoptane type); (ii) understanding of the change in aeroptane stability at high altitude; (iii) recognition of high speed/Mach buffet (as applicable to the aeroptane type) and low speed buffet; (iv) the altitude necessary to effectively recover from a stail event at high altitudes; and v) awareness of control surface effectiveness at low and high speeds.	A1: Relation pitch, ADA, flight path. Arcraft flight envelope exploration.     A2: PFD imitations reminder (speed, pitch, bank)     A3: Aircraft maneuvering capability at some calibrated airspeed at low and hi altitude     A4: Acceleration capability at low and high altitude, backside of power curve at recommended max altitude.     A5: Angle of Attack awareness at different calibrated airspeed     A5: Angle of Attack awareness at different calibrated airspeed     A6: Appendix to some any altitude, backside of power curve at recommended max altitude.     A6: Appendix to some any altitude, backside of power curve at recommended max altitude.     A6: Appendix to some any altitude, backside of power curve at recommended max altitude.     A6: Appendix to some any altitude     A7: Not applicable on Airbus types     A10: High-prede buffet (Mash effect) at high altitude following a sudden increase of ADA from craise AOA.     A9: Aircraft stability in pitch and roll in normal law. Static stability when out of normal envelope     A10: Disservation of turn coordination and yaw damping in normal law     A11: Disc of pitch time in direct law (circle law damping in normal law     A12: Effect of lacing on enginestatifname (limited effect of airframe ricing – FSTD effect to be checked)     A13: Not applicable.
	Trainees should apply their secodynamic knowledge by including the following in FSTD training () practice in manoeuvring the simulated secoplane at high attrude at various speeds and automation levels — the pilot will apply the secolynamic principles acquired in the academic training to prevent an upset; (i) trainees should be aware of the AOA from available data shown on the flight deck and demonstrate the use of these data to prevent an upset or recover from one: (ii) practice of speed controlled by elevator inputs or speed controlled by thrust, and undentanding of secoplane energy	Theoretical Content: At least the content from AUPRTA (AURTA REV 3) chapter 6.4
	To fully preferativel the concepts discussed in academic manage, halvass should be harved in the following: a analysis data in the background in a cademic manage in a cademic manage in a set of the management of the analysis of the set of th	Theoretical Covenant: All Innet The sources from AUTRITA (ALIBIA INTO 2) strengther 5.1, 6.2 and 6.5







#### Thank you

