



Airbus's perspective as an Aircraft Manufacturer and Data Provider

Information Session CS-FSTD(A) Issue 2

Eric Fuilla-Weishaupt
29 NOV 2018

AIRBUS

Why Stall Buffet Modelling Matters...

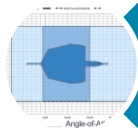
Airbus Stall Video, 2014 (extract)
Real Flight – A330-200
Experimental Test Pilots
Subject Matter Experts



<https://www.youtube.com/watch?v=4WuPoVjOXLY>



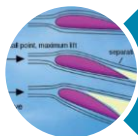
Airbus as a Data Provider (GO5)



UPRT



Icing



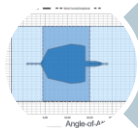
Stall



Role of Subject Matter Experts



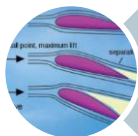
Airbus as a Data Provider (GO5)



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Stall



Role of Subject Matter Experts

Airbus Data Group: Groupe Opérationnel 5 (GO5)

- Focal Point between the Flight Simulation training Device (FSTD) industry and Airbus Commercial Aircraft Design Office
- Design, deliver and support aircraft data, software & cockpit aircraft hardware (the “SimPack”)
- Delivers “Simulation Standard” SimPacks (e.g. A320 standard 2.0.0)
- SimPack comes with a Service Bulletin available to customers and regulators on the GO5 portal: eGO5
- Technical queries (DIRs, DQ, DRs, Questions): TechRequest application

SimPack

ICAO 9625 ed4
Part 60 change 2
CS-FSTD(A) Issue 2

Aircraft Type Specific
Aircraft Modifications
New Systems

Malfunctions needs
Flight Crew Training
Operation Training Transmissions



Data Package (documents):

- Systems description
- Qualification Validation Source Data (QVSD)
- Validation Data Roadmap (VDR)
- Malfunctions Description Document

Simulation Software Package

Hardware

Simulation Product Operators
Transmissions

Simulation Product Operators Transmission (SPOT)

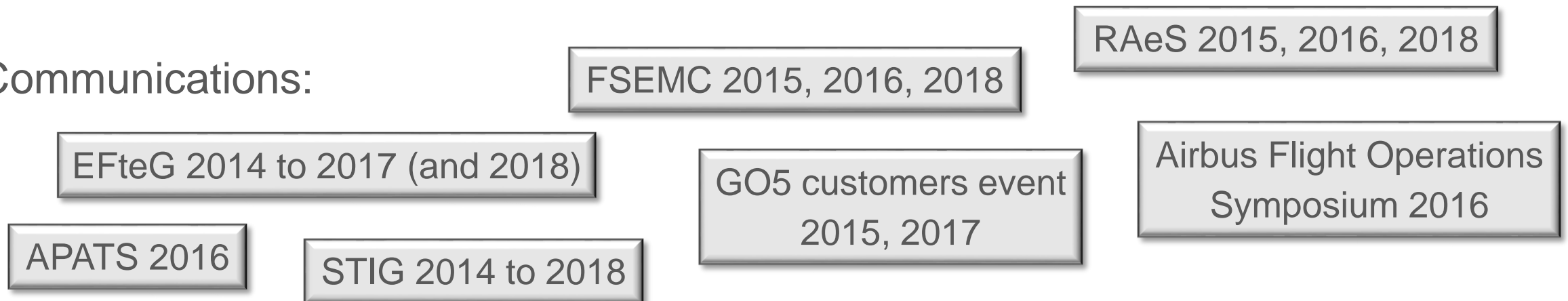
- Communication to all customers: Training Device Manufacturers (TDMs), airlines, training centers
- Available to regulators on request
- Information is “pushed” to the customers
- There is a dedicated SPOT focusing on “SimPack for UPRT and Stall Training” (new revision in progress)

SimPack for UPRT and Stall Training

- Started in 2012-2013 with “in-house” work on stall buffet modelling
- Update mainly driven by ICAO 9625 ed4 and 14 CFR Part 60 change 2

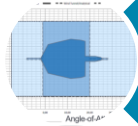
- CS-FSTD(A) Issue 2 requirements are a subset of FAA’s
- SimPack is in line with the most restrictive requirements
- No specific “CS-FSTD(A) Issue 2” SimPack

- Communications:





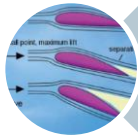
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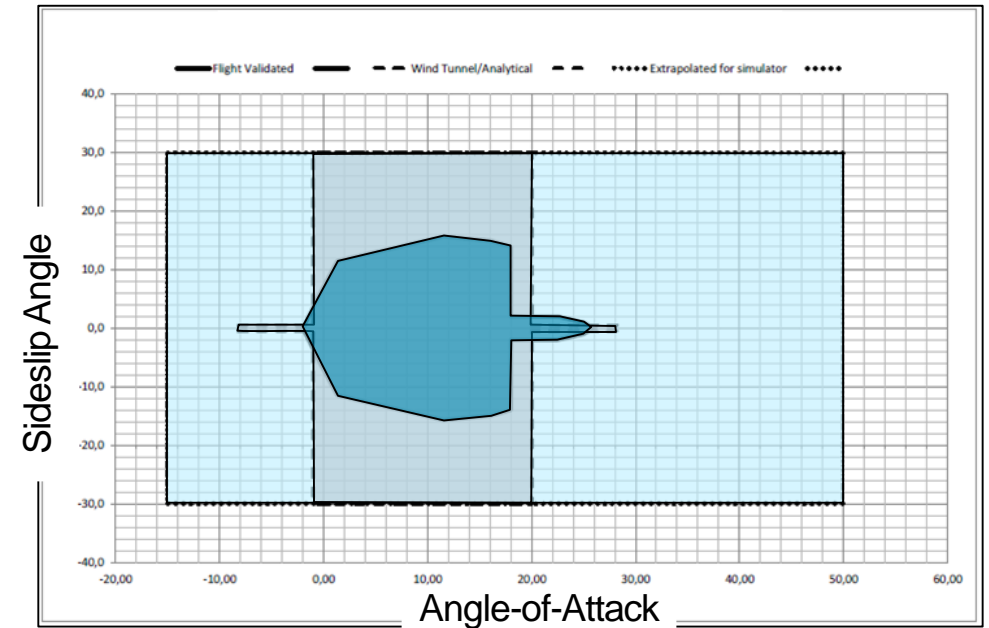
Stall



Role of Subject Matter Experts

UPRT

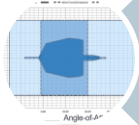
- “Simulator Validated Envelope” document
 - FSTD validation envelope
 - 3 regions:
 - Flight test validated
 - Wind tunnel / analytical
 - Extrapolated for simulator



- No additional document to support V-n diagram: information already available



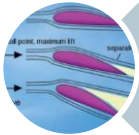
Airbus as a Data Provider (GO5)



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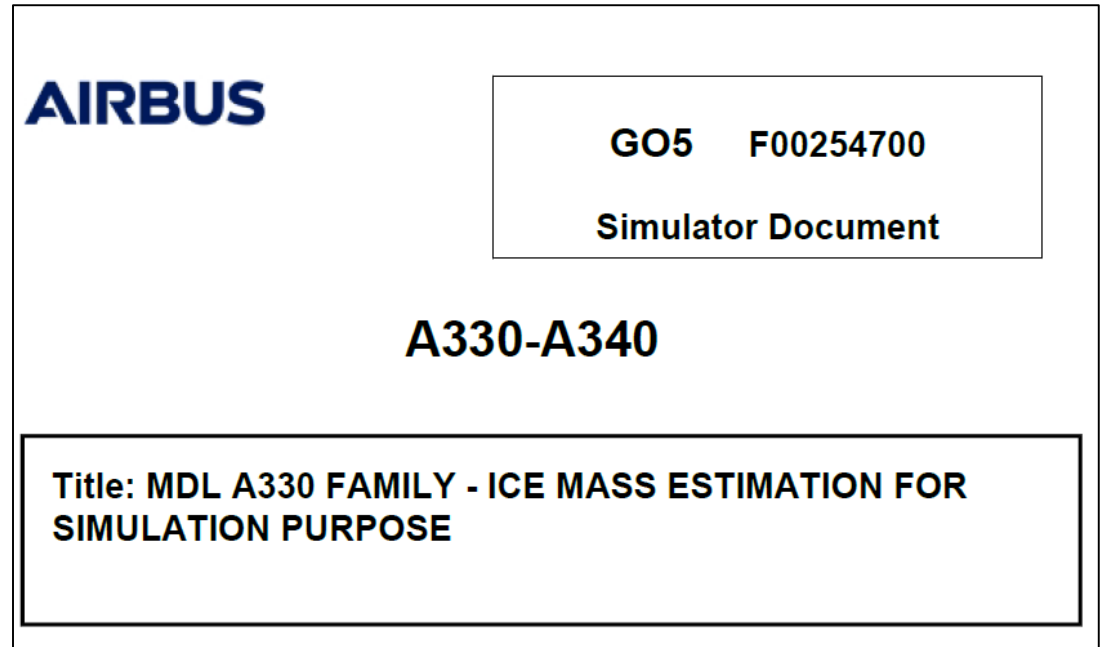
Stall



Role of Subject Matter Experts

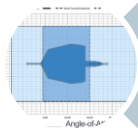
Icing

- Aerodynamics modeling (cf Stall)
- “Ice mass estimation” document
- No additional engine effect
- QVSD: 2.i “Engine and Airframe Icing Effects Demonstration” (High Angle of Attack)
 - Engineering data
 - Make implementation easier on FSTDs





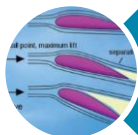
Airbus as a Data Provider (GO5)



UPRT



Icing



Stall

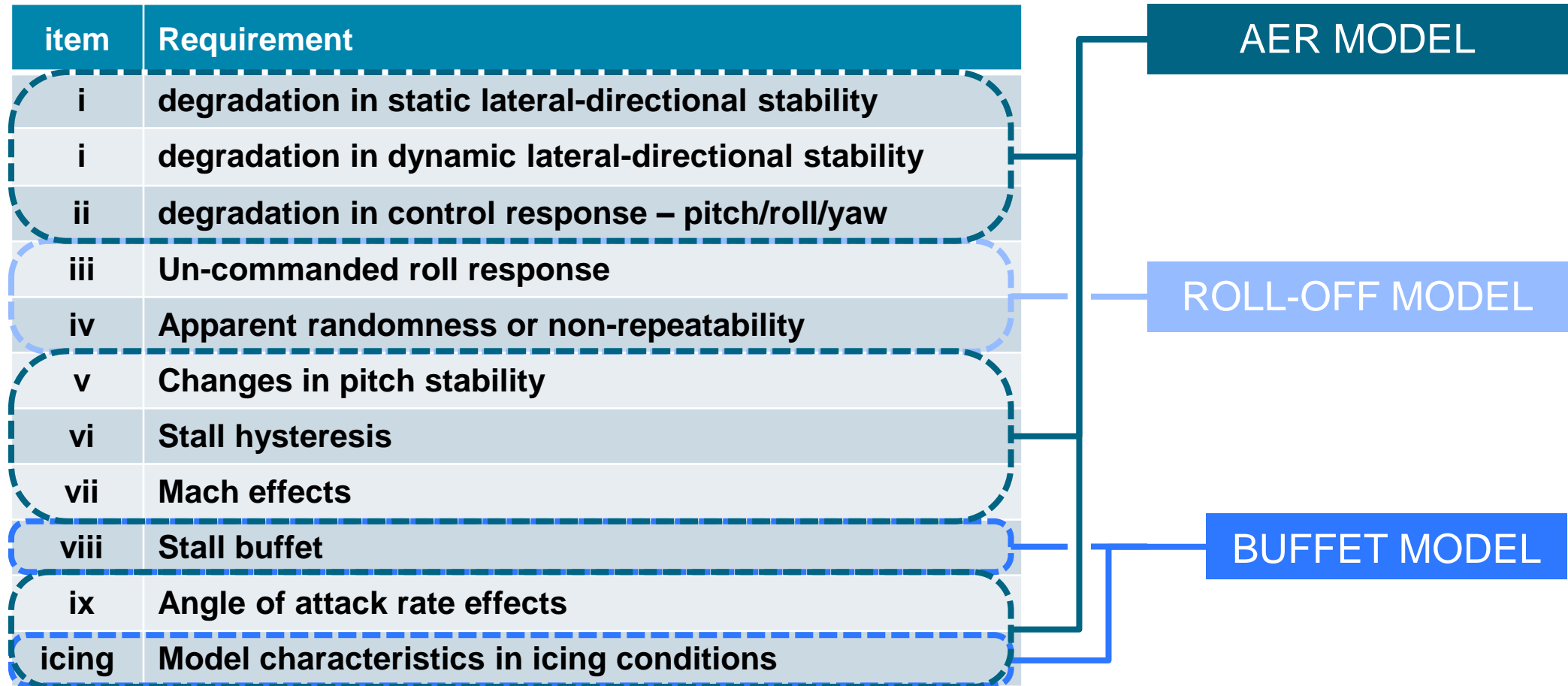


Role of Subject Matter Experts

Stall

- Models of the Natural Flight Loop (NFL):
 - Aerodynamics (AER) – Enhanced
 - Roll-off (ROF) – Created
 - Stall buffet (BUF) – Created (replaces a legacy technical paper)
- Documents (status of compliance, stall characteristics assessment...)
- QVSD for 2.c.8 and 3.g.5 QTG tests

Models (stall and icing)



Documents

- “Status of compliance”
 - Data, methods, maneuvers
 - Characteristics
- “Method to validate buffet model integration”

1.2.2 A320-200 – High Lift configuration maneuver list (High AoA)					Attachment 7 to Appendix A to Part 60		"Additional Simulator Qualification Requirements for Stall" at approach to stall or occurrence	Methodology to address the feature	Status of Compliance
					Chapter		Item		
Engines	CEO	NEO	CEC						
Stat/Flap	18/00								
ZP	FL100/FL200	FL1							
TYPE OF TEST	CG								
Stall	Forward Aft	CFM / IAE	PW / LEAP	CFM IAE	4-c (dry)	vi	Stall hysteresis	Clean configuration: $\Delta C_{m_{SEH}^{hys}}$: pitch-up hysteresis on A/C without Tail pitching moment. $\Delta \delta^{hys}$: downwash hysteresis Predicted data from Wind Tunnel tests and adjusted from Flight Tests analysis.	✓ Compliant
Angle of Attack protection	Forward Aft		PW / LEAP	CFM				High Lift configuration: $\Delta C_{z_{STALL}^{hys}}$: lift due to stall hysteresis. $\Delta C_{m_{STALL}^{hys}}$: pitching moment due to stall hysteresis. Data adjusted from Stall Flight Tests analysis	✓ Compliant
AoA protection in Turn	Forward Aft		PW / LEAP						
AoA protection with roll input	Forward Aft		PW / LEAP						
Powered Stall	Forward		PW / LEAP						
CFM: CFM56-5A1 or CFM56-5B4 engine flight tests. IAE: IAEV2500-A1 or IAEV2527-A5 engine flight tests. PW: PW1100G-JM engine flight tests. LEAP: LEAP-1A26 engine flight tests.					4-c (dry)	vii	Mach effects	Clean configuration: -A/C without Tail Pitch, Lift and Drag Non-Linearities dependant on AoA and Mach. Predicted data from Wind Tunnel tests and adjusted from Flight Tests analysis.	✓ Compliant

Title: MDL Method to validate Buffet Model Integration

Summary :

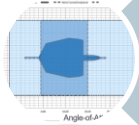
This document provides a method to validate the integration of the Buffet Model (included in the A350 Aerodynamic model). It explains how to compare the accelerations measured in a Full Flight Simulator to the Buffet Model outputs RSBBUFNZ (called RSABUFNZ in output of the A350 Aerodynamic model).

Qualification Validation Source Data (QVSD)

- 2.c.8a “Stall Characteristics”
 - High altitude cruise
 - Wind-up turn
 - Including in normal law (some commonalities with 2.h.6)
- 3.g.5 “Stall Buffet”
 - Several flight conditions, aligned (when possible) on the 2.c.8a
 - Dynamic flight manoeuvres



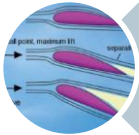
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Icing



Stall



Role of Subject Matter Experts

Principles

- We refer to AMC10 and AMC11: assessment on an engineering/development simulator (without motion system)

... the stall characteristics have been subjectively assessed by an SME pilot on the engineering/development simulator ...

- For stall buffet model, we need to use a simulator with motion system: level D FFS used “as an engineering simulator” (once for each aircraft type)
- A team of SMEs: Flight test engineer + Flight test pilot + Modelling experts

Documents


- “Stall characteristics assessment”:
 - Configurations
 - Maneuvers
- “Footprint tests”:
 - Record of the assessment (ASCII)
 - Flight + Vibration at the pilot’s seat
 - Valid for a given version of the models
 - Not additional QVSD (Reference: 2.c.8, 3.g.5)
 - A tool for integration (TDM)
 - A tool for consistency checks (operator)

3- Results and conclusion


In all tested cases with the last tuning of stall models,

- triggering of the buffeting, its amplitude, its frequency range, and its evolution while the Angle Of Attack was increasing up to the stall
- and
- the simulation of the roll-off phenomenon
- and
- the aerodynamic stall modelling


were judged representative of the real aircraft by the AIRBUS Subject Matter Expert pilots.



Stéphane VAUX
Flight Test Engineer
EVTD



Peter CHANDLER
Experimental Flight Test Pilot
EV



Xavier LESCEU
Flight Test Pilot
Head of Operational
& Training Policy
STLP

Test points:

Item	CONF	Roll-off	A320 CEO CFM		A320 CEO IAE		A320 NEO PW and CFM LEAP	
			α_{STALL}	THS	α_{STALL}	THS at VLS	α_{STALL}	THS at VLS
1	CLEAN/UP	OFF	13°	2.1°UP at VLS	13.5°	2.6°UP at VLS	13.5°	2.3°UP
2		ON						
3	2/UP	OFF	23°	6.2°UP at VLS-10	23°	6.0°UP at VLS-10	23°	4.0°UP
4		ON						
5	3/DN	OFF	22°	6.2°UP at VLS-10	21°	7.5°UP at VLS-10	21°	4.7°UP
6		ON						

Assessment Progress

Aircraft	Date	Status	Place	Operator / TDM
A300-600 PW	10 JUL 2018	Done	Louisville	UPS / TRU
A320 ceo/neo	29 JAN 2018	Done	Montréal	CAE / CAE
A320 ceo/neo (*)	05 SEP 2018	Done	Toulouse	Airbus / L3
A330-200 GE/RR	04 OCT 2018	Done	Atlanta	DAL / CAE
A330-300 PW	06 NOV 2018	Done	Charlotte	AAL / CAE
A350	20 JUN 2018	Done	Miami	Airbus / FSI
A380 RR/EA	20 NOV 2018	Done	Toulouse	Airbus / CAE

(*) Second A320 assessment: minor changes on buffet slope (visible on 2.c.8 tests)

Conclusion

Aircraft	Data	Qualified (part 60 ch 2 or directive 2)	Comments
A300-600 PW	Add-on to Aero rev5	Yes	
A320 ceo/neo	Standard 2.0.0	Yes	
A330-200 GE/RR	Standard 2.6.0	Yes	
A330-300 PW	Customized	Yes	
A350	Standard 1.1.0	Yes	
A380 RR/EA	Partial update to Standard 1.4.0	N/A	
<i>A330 neo</i>	<i>Standard 3.0.0</i>	<i>N/A</i>	<i>SimPack delivery: 2019</i>
<i>A340-300, A340-600, A300-600 GE, A310</i>	<i>On customer's request</i>	<i>N/A</i>	

Why Stall Buffet Modelling Matters...

JUL 2018

FFS session – A350-900

Experimental Test Pilots

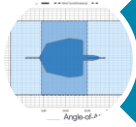
Subject Matter Experts



Not on Youtube



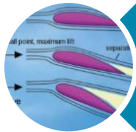
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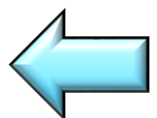
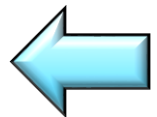
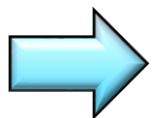
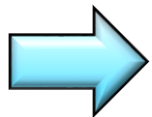
Role of Subject Matter Experts



Bounced Landings

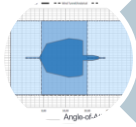


Gusting Crosswinds





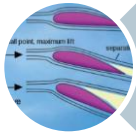
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Role of Subject Matter Experts



Bounced Landings



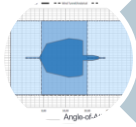
Gusting Crosswinds

Bounced Landings

- FAA specific (cf AC120-114, GB 17-01)
- No additional modelling required from the aircraft manufacturer
- Scenarios may be designed by Training Device Manufacturers



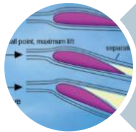
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Stall



Role of Subject Matter Experts



Bounced Landings



Gusting Crosswinds

Gusting Crosswinds

- FAA specific (cf GB 16-02)
- No additional modelling required from the aircraft manufacturer
- Wind profiles may be designed by Training Device Manufacturers

Thank you