DataPackage update

for CS-FSTD(A) issue 2

BOSSUOT Cyril, Flight Dynamics Simulation support (GO5)
05 June 2019

AIRBUS

Context

2016
FAA Part 60 Change 2

New FSTD requirements
- Full Stall
- Engine and Airframe Icing
- UPRT
- Others

2018
EASA CS-FSTD(A) Issue 2

New FSTD requirements
- Full Stall
- Engine and Airframe Icing
- UPRT

AIRBUS GO5 DataPackage update

1. Stall Modelling : new General Requirements (1.s.3 + AMC 9 + AMC10)

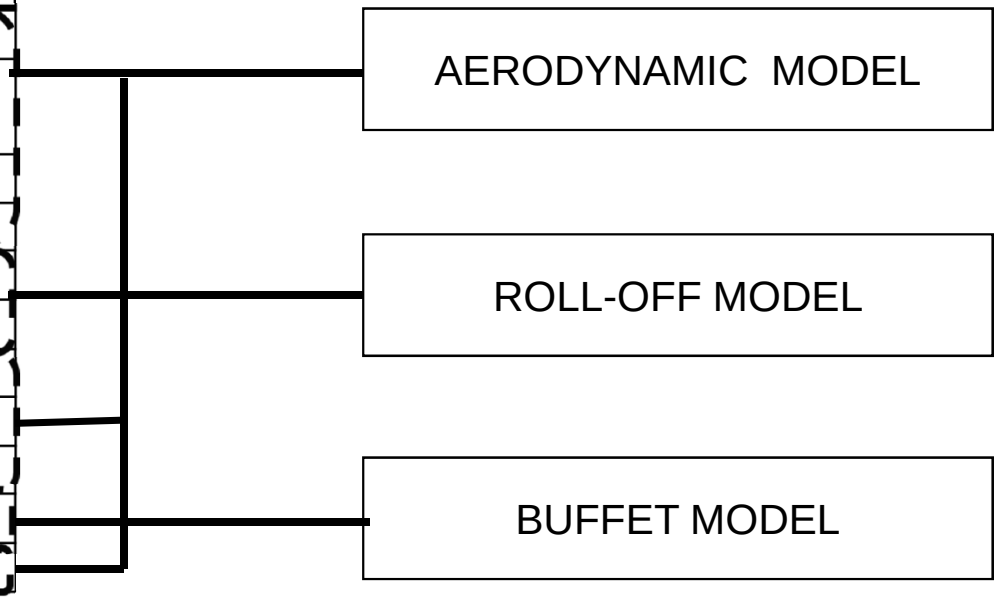
item	Requirement
i	degradation in static lateral-directional stability
i	degradation in dynamic lateral-directional stability
ii	degradation in control response – pitch
ii	degradation in control response – roll
iii	Un-commanded roll response
iv	Apparent randomness or non-repeatability
v	Changes in pitch stability
vi	Stall hysteresis
vii	Mach effects
viii	Stall buffet
ix	Angle of attack rate effects

A Statement of Compliance (SOC) is required which describes the aerodynamic modeling methods, validation, and checkout of the stall characteristics of the FSTD.

Subject Matter Expert Pilot Evaluation
Where an FSTD shares common aerodynamic and flight control models with that of an engineering or development simulator, the authority will accept a SOC from the data provider that confirms the stall characteristics have been subjectively assessed by a SME pilot on the engineering simulator

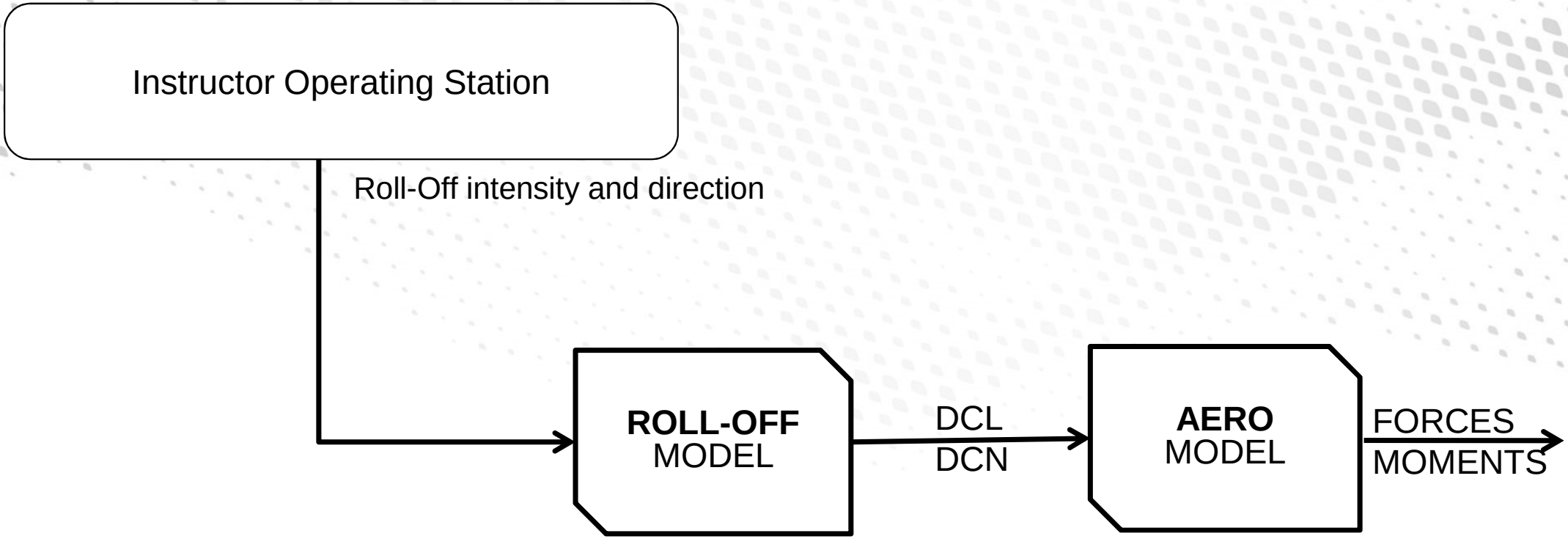
1.1 Stall modelling in the DataPackage : Aerodynamic models

item	Requirement
i	degradation in static lateral-directional stability
i	degradation in dynamic lateral-directional stability
ii	degradation in control response – pitch
ii	degradation in control response – roll
iii	Un-commanded roll response
iv	Apparent randomness or non-repeatability
v	Changes in pitch stability
vi	Stall hysteresis
vii	Mach effects
viii	Stall buffet
ix	Angle of attack rate effects



AIRBUS

1.2 Stall Modelling in the DataPackage : Roll-Off model

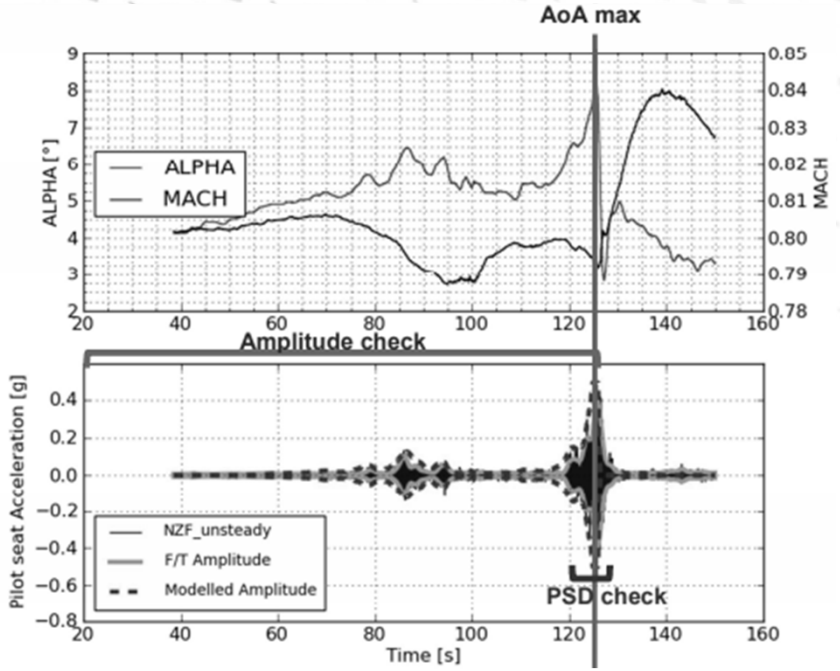


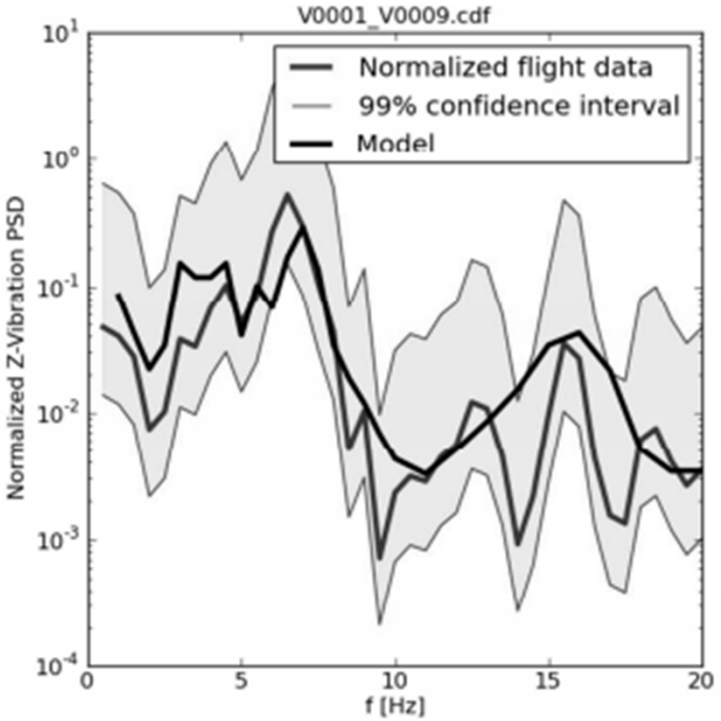
AIRBUS

1.3 Stall Modelling in the DataPackage : Buffet model

BUFFET
MODEL

Amplitude of the load factor vibration at pilot's seat (g)
Normalized Power Spectral Density content [0,1,…,20] Hz





AIRBUS

1.4 Stall Modelling in the DataPackage : Aerodynamic SOC

A Statement of Compliance (SOC) is required which describes the aerodynamic modeling methods, validation, and checkout of the stall characteristics of the FSTD.

Aerodynamic Model Status Of Compliance

AIRBUS

A350-900 STATUS OF COMPLIANCE
Flight Dynamics Simulation Technical Report

ORIGIN EGYA
REFERENCE RP1633402
ISSUE 3.0
DATE 26 Jun 2015

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			
4-c	i (2)	degradation in **dynamic** lateral-directional stability	**Cnr derivative**: non linearities at high AoA/Beta modeled from analytical vertical tail ΔCnβ gradient. **Clp derivative**: degradation with high AoA modeled from analytical ΔCzα gradient. **Cnp derivative**: degradation with high AoA modeled from analytical ΔCzα gradient pre-computation **Clr derivative**: no degradation with high AoA modeled: effect is neglected. Predicted data adjusted with Flight Test analysis.	✓ Compliant
4-c	ii (1)	degradation in control response - **pitch**	**Pitch rate derivative** degradation modeled with : - **Cmq derivative** loss of dynamic pressure at high AoA. - **ΔCmH** loss of Horizontal Tail plane lift and pitch effect with Tail AoA including pitch rate local incidence contribution. - **ΔCmδq** loss of elevator lift and pitch effect with Tail AoA including pitch rate local incidence contribution and elevator deflection in Non Linear domain. Data from Wind Tunnel test and/or CFD and adjusted from Flight Tests analysis.	✓ Compliant

Page 11 of 17

AIRBUS

1.5 Stall Modelling in the DataPackage : SME assessment

Subject Matter Expert Pilot Evaluation
Where an FSTD shares common aerodynamic and flight control models with that of an engineering or development simulator, the authority will accept a SOC from the data provider that confirms the stall characteristics have been subjectively assessed by a SME pilot on the engineering simulator

SME assessment report + Tests results

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

2. Icing effect : Updated General Requirements (1.t.1 + AMC 13)

Modelling that includes the effects of icing, where appropriate, on the airframe, aerodynamics and the engine(s).

Icing models must simulate the aerodynamic degradation effects of ice accretion on the airplane lifting surfaces

A Statement of Compliance (SOC) is required.

- ✓ Icing is covered by the modelling (AER, BUF, ROF models)
- ✓ Icing SOC is covered by the Aerodynamic Status Of Compliance Document
- ✓ Ice Weight estimation is provided in a dedicated document

SUBJECT: HOLD ICE MASS ESTIMATION

This memo defines the ice mass accreted on the wing, HTP and VTP during a 45 minute Hold, based on the flight test artificial ice shape volume, assuming an ice density of 917kg/m3:

Wing (anti-icing on)	226kg
Wing (anti-icing off)	314kg
HTP	76kg
VTP	63kg
Total (anti-icing on)	365kg
Total (anti-icing off)	453kg

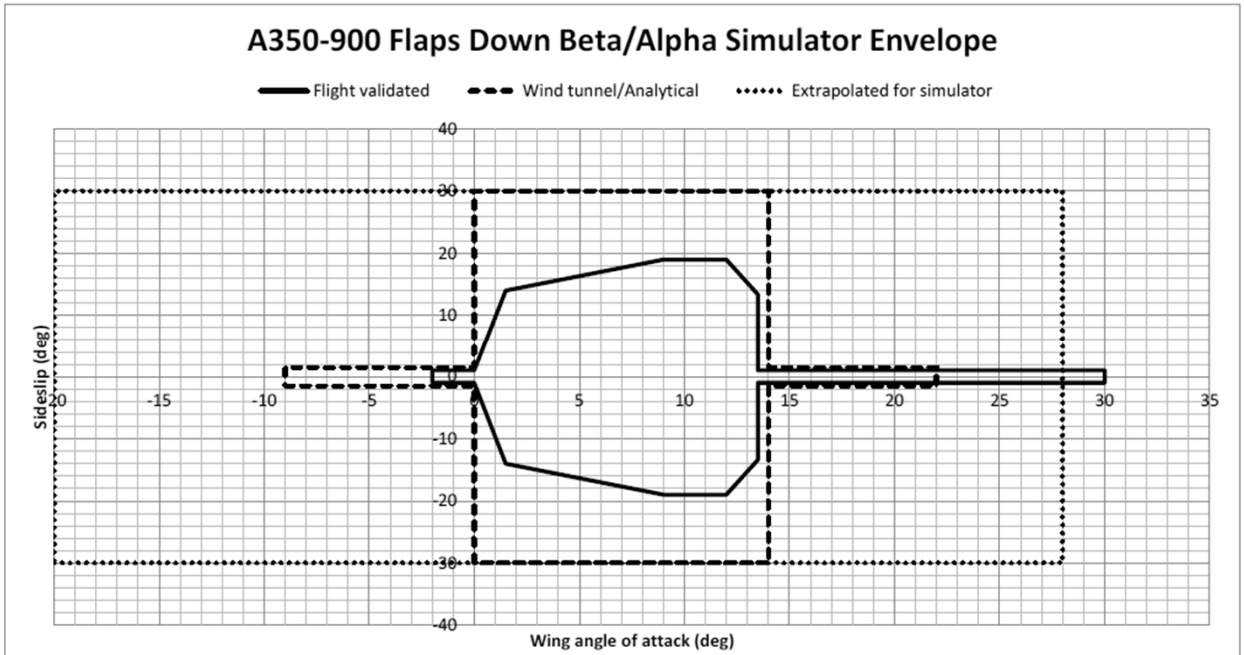
3. FSTD Validation Envelope: New Requirements (1.h.2 + AMC 12)

Instructor Operating System (IOS): FSTD validation envelope

a. Flight test validated region
b. Wind tunnel and/or analytical region
c. Extrapolated

A Statement of Compliance (SOC) is required.

Simulator Validated Envelopes



AIRBUS

4. Objective Tests : New Tests (2.c.8, 2.i, 3.f.5)

- 2.c.8a Stall Characteristics: High Altitude Cruise, Second Segment Climb, and Approach or Landing

Test in normal and non-normal control states

→

- 2.c.8a ➔ 6 reference tests (2 previously)

1 new stall test in direct Law in Cruise conditions
3 new tests in normal law

- 2.i Engine and Airframe Icing Effects Demonstration (High Angle of Attack)

→

- 2.i ➔ 1 new demonstration test

1 test 2c8 as baseline test w/o ice
Same test in icing condition

- 3.f.5 Stall buffet: Cruise (High Altitude), Second Segment Climb, and Approach or Landing.

Tests must be conducted for an angle of attack range between the buffet threshold of perception to the pilot and the stall angle of attack
PSD analysis should be conducted for a time span between initial buffet and the stall angle of attack

→

- 3.f.5 ➔ 3 new reference tests (1 previously)

3 dynamic stall manoeuvers instead of 1 static approach-to-stall manoeuver

AIRBUS

Conclusion

Regulation Change

ICAO 9625 Ed 4

14 CFR Part 60 Change 2

CS-FSTD(A) issue 2

GO5 Data Package

Enhanced Simulation Models			New Reference Tests (plus POM)			New Documents			
Aerodynamic	Buffet	Roll-Off	2c8	2i	3f5	Stall Characteristics assessment	Aerodynamic SOC	Ice Weight Estimation	Simulator Validated Envelope

Conclusion - AIRBUS Standard Compliant with CS-FSTD(A) issue 2

Available

	A300-600	A320	A330	A350	A380
Native		Standard 2.0.0	Standard 3.0.0 Standard 2.6.0	Standard 1.2.0 Standard 1.1.0	
Partial Update	Aero Rev 6 (PW)	Standard 1.9.1 Standard 1.9.0 Standard 1.8.1 Standard 1.8.0 Standard 1.7.0	Standard 2.5.0 Standard 2.4.0		Standard 1.4.0
In progress	Aero Rev 6 (GE) End 2019				

Not available. Developed upon customer request

- A310
- A340

AIRBUS

Thank you

AIRBUS