CS-FSTD(A) ISSUE 2 — CHANGE INFORMATION

EASA publishes issues to certification specifications as consolidated documents. These documents are used for establishing the certification basis for applications made after the date of entry into force of the amendment.

Consequently, except for a note '[Issue: CS-FSTD(A)/2]' under the amended paragraph, the consolidated text of CS-FSTD(A) does not allow readers to see the detailed changes introduced by the new issue. To allow readers to also see these detailed changes, this document has been created. The same format as for the publication of notices of proposed amendments (NPAs) has been used to show the amendments:

— deleted text is ~~struck through~~;

— new or amended text is highlighted in grey;

— an ellipsis '[…]' indicates that the rest of the text is unchanged.

A 'Preamble' is inserted in CS-FSTD(A).

1. CS-FSTD(A) — Book 1

1.1. Appendix 1 to CS FSTD(A).300 is amended as follows:

APPENDICES

Appendix 1 to CS FSTD(A).300 Flight Simulation Training Device Standards

[…]

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
	1. General											
a.1	A fully enclosed flight deck.	✓	✓	✓	✓							
a.2	A cockpit/flight deck sufficiently enclosed to exclude distraction, which will replicate that of the aeroplane or class of aeroplane simulated.						✓	✓	✓	✓	✓	
a.3	Flight deck, a full-scale replica of the aeroplane simulated. Equipment for operation of the cockpit windows shall be included in the FSTD, but the actual windows need not be operable. The flight deck, for FSTD purposes, consists of all that space forward of a cross section of the fuselage at the most extreme aft setting of the pilot~~s'~~ seats. Additional required flight crew member duty stations and those required bulkheads aft of the pilot seats are also considered part of the flight deck and shall replicate the aeroplane.	✓	✓	✓	✓							Flight deck observer seats are not considered to be additional flight crew member duty stations and may be omitted. Bulkheads containing items such as switches, circuit breakers, supplementary radio panels, etc., to which the flight crew may require access during any event after preflight cockpit preparation is complete are considered essential and may not be omitted. Bulkheads containing only items such as landing gear pin storage compartments, fire axes or extinguishers, spare light bulbs, ~~aircraft~~aeroplane document pouches, etc., are not considered essential and may be omitted. Such items, or reasonable facsimile, shall still be available in the FSTD but may be relocated to a suitable location as near as practical to the original position. Fire axes and any similar purpose instruments need only be represented in silhouette.
a.4	Direction of movement of controls and switches identical to that in the aeroplane.	✓	✓	✓	✓							

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
a.5	A full-size panel of replicated system(s) which will have actuation of controls and switches that replicate those of the aeroplane simulated.					✓	✓					The use of electronically displayed images with physical overlay incorporating operable switches, knobs, buttons replicating aeroplane instrument~~s~~ panels may be acceptable to the competent authority.
a.6	Cockpit/flight deck switches, instruments, equipment, panels, systems, primary and secondary flight controls sufficient for the training events to be accomplished shall be located in a spatially correct flight deck area and will operate as, and represent those in, that aeroplane or class of aeroplane.							✓	✓	✓	✓	For Multi-Crew Cooperation (MCC) qualification, additional instrumentation and indicators may be required. See table at start of this Appendix. For BITDs, the switches’ and controls’ size and shape and their location in the cockpit shall be representative.
a.7	Crew member~~s’~~ seats shall be provided with sufficient adjustment to allow the occupant to achieve the design eye reference position appropriate to the aeroplane or class of aeroplane and for the visual system to be installed to align with that eye position.						✓		✓	✓		
b.1	Circuit breakers that affect procedures and/or result in observable cockpit indications properly located and functionally accurate.	✓	✓	✓	✓	✓	✓		✓	✓		

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
c.1	Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight corresponding to actual flight conditions, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location, and configuration.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	For FTD levels 1 and 2 aerodynamic modelling sufficient to permit accurate systems operation and indication is acceptable. For FNPTs and BITDs, class-specific modelling is acceptable.
d.1	All relevant instrument indications involved in the simulation of the applicable aeroplane shall automatically respond to control movement by a flight crew member or induced disturbance to the simulated aeroplane,~~;~~ e.g.~~,~~ turbulence or wind shear.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	For FNPTs, instrument indications sufficient for the training events to be accomplished. Reference: AMC3 FSTD(A).300. For BITDs, instrument indications sufficient for the training events to be accomplished. Reference: AMC4 FSTD(A).300.
d.2	Lighting environment for panels and instruments shall be sufficient for the operation being conducted.					✓	✓	✓	✓	✓	✓	For FTD level 2 lighting environment shall be as per aeroplane.
d.3	Instrument indications respond appropriately to icing effects.			✓	✓				✓	✓		

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
e.1	Communications, navigation, and caution and warning equipment corresponding to that installed in the applicant's aeroplane with operation within the tolerances prescribed for the applicable airborne equipment.	✓	✓	✓	✓	✓	✓					For FTD level 1 applies where the appropriate systems are replicated.
e.2	Navigation equipment corresponding to that of the replicated aeroplane or class of aeroplanes, with operation within the tolerances prescribed for the actual airborne equipment. This shall include communication equipment (interphone and air~~/~~–ground communication~~s~~ systems).							✓	✓	✓	✓	
e.3	Navigational data with the corresponding approach facilities. Navigation aids should be usable within range without restriction.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	For FTD level 1 applies where navigation equipment is replicated. For all FFSs and FTDs level 2 where used for area or airfield competence training or checking, navigation data should be updated within 28 days. For FNPTs and BITDs, complete navigational data for at least five different European airports with corresponding precision and non-precision approach procedures including current updating within a period of three months.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
f.1	In addition to the flight crew member duty stations, three suitable seats for the instructor, delegated examiner and competent authority inspector. The competent authority shall consider options to this standard based on unique cockpit configurations. These seats shall provide adequate vision to the pilot’s panel and forward windows. Observer seats need not represent those found in the aeroplane but in the case of FSTDs fitted with a motion system, the seats shall be adequately secured to the floor of the FSTD, fitted with positive restraint devices and be of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	For FTDs and FNPT’s, suitable seating arrangements for the instructor and examiner or competent authority’s inspector should be provided. For BITDs, suitable viewing arrangements for the instructor shall be provided.
g.1	FSTD systems shall simulate applicable aeroplane system operation, both on the ground and in flight. Systems shall be operative to the extent that all normal, abnormal, and emergency operating procedures can be accomplished.	✓	✓	✓	✓	✓	✓		✓	✓		For FTD level 1, applies where system is simulated. For FNPTs systems shall be operative to the extent that it shall be possible to perform all normal, abnormal and emergency operations as may be appropriate to the aeroplane or class of aeroplanes being simulated and as required for the training.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
g.2	For aeroplanes equipped with stick pusher system (e.g. longitudinal control feel system, or equivalent) control forces, displacement, and surface position of the aeroplane correspond to those of the aeroplane being simulated.			✓	✓							A statement of compliance (SOC) is required verifying that the stick pusher system has been modelled, programmed, and validated using the aeroplane manufacturer's design data or other acceptable data source. The SOC must address, at a minimum, the stick pusher activation and cancellation logic as well as system dynamics, control displacement and forces as a result of the stick pusher activation. This requirement applies only to FSTDs that are to be qualified to conduct full stall training tasks. Test required.
h.1	Instructor controls shall enable the operator to control all required system variables and insert abnormal or emergency conditions into the aeroplane systems.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Where applicable, and as required for training, the following shall be available: — position and flight freeze; — a facility to enable the dynamic plotting of the flight path on approaches, commencing at the final approach fix, including the vertical profile; — hard copy of map and approach plot.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
h.2	The FSTD must have a real-time feedback tool that provides the instructor/evaluator with visibility of whenever the FSTD training envelope or aeroplane operating limits have been exceeded. Additionally, and optionally, a recording mechanism may be utilised.			✓	✓							This feedback tool must include the following: (a) FSTD validation envelope: This must be in form of an alpha/beta envelope (or equivalent method) depicting the 'confidence level' of the aerodynamic model. This 'confidence level' depends on the degree of flight validation or on the source of predictive methods. There must be a minimum of a flaps-up and flaps-down envelope available. (b) Flight control inputs: These must enable the instructor/evaluator to assess the pilot's flight control displacements and forces (including fly-by-wire, as appropriate). (c) Aeroplane operational limits: This must display the aeroplane's operational limits during the manoeuvre as applicable for the configuration of the aeroplane. An SOC is required that defines the source data used to construct the FSTD validation envelope. Please refer to AMC12 FSTD(A).300.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
h.3	Upset scenarios: When equipped with instructor operating station (IOS) selectable dynamic aeroplane upsets, the IOS is to provide guidance on the method used to drive the FSTD into an upset condition, including any malfunction or degradation of the FSTD's functionality, required to initiate the upset. The unrealistic degradation of simulator functionality (such as degrading flight control effectiveness) to drive an aeroplane upset is generally not acceptable unless used purely as a tool for repositioning the FSTD with the pilot out of the loop.			✓	✓							An SOC is required to confirm that each upset prevention and recovery feature programmed at the IOS and the associated training manoeuvre have been evaluated by a suitably qualified pilot. Please refer to AMC9 FSTD(A).300(a)(1).

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
i.1	Control forces and control travel shall correspond to that of the replicated aeroplane. Control forces shall react in the same manner as in the aeroplane under the same flight conditions.	✓	✓	✓	✓		✓	✓	✓	✓	✓	For FTD level 2, control forces and control travel should correspond to that of the replicated aeroplane with CT&M. It is not intended that the device should be flown manually other than for short periods when the autopilot is temporarily disengaged. For FNPT level I and BITDs, control forces and control travel shall broadly correspond to that of the replicated aeroplane or class of aeroplane. Control force changes due to an increase/decrease in ~~aircraft~~aeroplane speed are not necessary. In addition, for FNPT level II and MCC control forces and control travels shall respond in the same manner under the same flight conditions as in the aeroplane or class of aeroplane being simulated.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
j.1	Ground handling and aerodynamic programming shall include: (1) Ground ~~E~~effect. For example: round-out, flare, and touchdown. This requires data on lift, drag, pitching moment, trim, and power ground effect. (2) Ground reaction —– reaction of the aeroplane upon contact with the runway during landing to include strut deflections, tyre friction, side forces, and other appropriate data, such as weight and speed, necessary to identify the flight condition and configuration. (3) Ground handling characteristics —– steering inputs to include crosswind, braking, thrust reversing, deceleration and turning radius.	✓	✓	✓	✓				✓	✓		Statement of compliance required. Tests required. For level ~~'~~A~~'~~ FFSs, generic ground handling to the extent that allows turns within the confines of the runway, adequate control on flare, touchdown and roll-out (including from a crosswind landing) only is acceptable. For FNPTs, a generic ground handling model need only be provided to enable representative flare and touchdown effects.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL		FNPT LEVEL			BITD	COMPLIANCE
		A	B	C	D	1	2	I	II	MCC		
k.1	Wind shear models shall provide training in the specific skills required for recognition of wind shear phenomena and execution of recovery manoeuvres. Such models shall be representative of measured or accident derived winds, but may include simplifications which ensure repeatable encounters. For example, models may consist of independent variable winds in multiple simultaneous components. Wind models shall be available for the following critical phases of flight: (1) Prior to take-off rotation, (2) At lift-off, (3) During initial climb, (4) Short final approach.			✓	✓							Tests required. ~~See~~Please refer to AMC1 FSTD(A).300, (b)(3) 2.g.

[…]

s.1	Aerodynamic modelling ~~shall be provided. This shall~~ includes, for aeroplanes issued an original type certificate after June 1980, low altitude level flight ground effect, Mach effect at high altitude, normal and reverse dynamic thrust effect on control surfaces, aeroelastic representations, and representations of non-linearities due to sideslip based on aeroplane flight test data provided by the manufacturer.			✓	✓							Statement of compliance required~~,~~ to include: — Mach effect, aeroelastic representations, ground effect and non-linearities due to sideslip;~~ are normally included in the FSTD aerodynamic model. The statement of Compliance shall address each of these items.~~ — ~~S~~separate tests for thrust effects~~ and a statement of compliance are required~~. Please refer to AMC9 FSTD(A).300(a)(2).
s.2	The aerodynamic model has to incorporate data representing the aeroplane's characteristics covering an angle of attack and sideslip range to support the training tasks.			✓	✓							An SOC is required. Please refer to AMC9 FSTD(A).300(a)(3).
s.3	Applicable only for those FSTDs that are to be qualified for full stall training tasks. The aerodynamic modelling has to support stall-recovery training tasks in the following flight conditions: (a) stall entry at wing level (1g); (b) stall entry into turning flight of at least 25° bank angle (accelerated stall); (c) stall entry into a power-on condition (required only for propeller-driven aeroplanes);			✓	✓							An SOC is required which describes the aerodynamic-modelling methods, validation, as well and check of the stall characteristics of the FSTD. An additional SOC has also to include a verification that the FSTD has been evaluated by a subject-matter expert pilot acceptable to the competent authority. Please refer to AMC10 FSTD(A).300(e) for clarification on the definition of a 'subject-matter expert pilot'. Please refer to AMC9 FSTD(A).300(a)(4) for clarification on the stall modelling. Please refer to AMC1 FSTD(A).200 for clarification of the 'near performance limited condition'.

	and (d) aeroplane configurations of second-segment climb, high-altitude cruise (‘near performance limited condition’), and approach or landing.											
t.1	Modelling that includes the effects of ~~airframe and engine~~ icing, where appropriate, on the airframe, aerodynamics and the engine(s). Icing-effects simulation models are only required for aeroplanes authorised for operations in icing conditions.			✓	✓				~~✓~~	~~✓~~		~~Statement of compliance required.~~ Icing models simulate the aerodynamic degradation effects of ice accretion on the aeroplane lifting surfaces, including (if present on the simulated aeroplane) loss of lift, decrease in stall angle of attack, change in pitching moment, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag. Aeroplane systems (such as the stall protection system and auto flight system) must respond properly to ice accretion, consistent with the simulated aeroplane. Aeroplane original equipment manufacturer (OEM) data or other acceptable analytical methods must be used to develop ice accretion models. Acceptable analytical methods may include wind tunnel analysis and/or engineering analysis of the aerodynamic effects of icing on the aeroplane lifting surfaces coupled with tuning and supplemental subjective assessment by a subject-matter expert pilot knowledgeable of the effect of ice accretion on the handling qualities of the simulated aeroplane. An SOC is required ~~shall~~ describing the effects that provide training in the specific skills ~~required~~ for recognition of icing phenomena and execution of recovery. The SOC must describe the source data and any analytical methods used to develop ice accretion models, including a verification that these effects have been tested. Please refer to AMC13 FSTD(A).300.

t.2	Modelling that includes the effects of icing, where appropriate, on the airframe, aerodynamics and the engine(s). Icing-effects simulation models are only required for those aeroplanes authorised for operations in icing conditions.								✓	✓		An SOC is required describing the effects that provide training in the specific skills for recognition of icing phenomena and execution of recovery.

[…]

	2. Motion system											
a.1	Motion cues as perceived by the pilot shall be representative of the aeroplane, e.g. touchdown cues shall be a function of the simulated rate of descent.	✓	✓	✓	✓							For FSTDs where motion systems are not specifically required, but have been added, they will be assessed to ensure that they do not adversely affect the qualification of the FSTD. For level C or level D devices, special consideration is given to the motion system response during upset prevention and recovery manoeuvres. Notwithstanding the limitations of simulator motion, the operator should place specific emphasis on tuning out objectionable motion system responses, where possible.
b.1	A motion system shall: (1) provide sufficient cueing, which may be of a generic nature to accomplish the required tasks;	✓										Statement of compliance required. Tests required.
	(2) have a minimum of 3 degrees of freedom (pitch, roll & heave); and		✓									
	(3) produce cues at least equivalent to those of a six-degrees-of-freedom synergistic platform motion system.			✓	✓							

c.1	A means of recording the motion response time as required.	✓	✓	✓	✓							
d.1	Motion effects programming shall include: (1) effects of runway rumble, oleo deflections, ground speed, uneven runway, centre line lights and taxiway characteristics; (2) buffets on the ground due to spoiler/speed brake extension and thrust reversal; (3) bumps associated with the landing gear; (4) buffet during extension and retraction of landing gear; (5) buffet in the air due to flap and spoiler/speed brake extension; (6) approach-to-stall buffet and stall buffet (where applicable); (7) touchdown cues for main and nose gear; (8) nose-wheel scuffing; (9) thrust effect with brakes set; (10) Mach and manoeuvre buffet; (11) tyre failure dynamics; (12) engine malfunction and engine damage; and (13) tail and pod strike.	✓	✓	✓	✓							For level ~~'~~A~~'~~ FFSs: effects may be of a generic nature sufficient to accomplish the required tasks. For level B, C and D FFSs: if there are known flight conditions where buffet is the first indication of the stall, or where no stall buffet occurs, this characteristic should be included in the model.

[…]

	4. Sound System											
a.1	Significant flight deck sounds which result from pilot actions corresponding to those of the aeroplane or class of aeroplane.	✓	✓	✓	✓		✓	✓	✓	✓	✓	For FNPTs level I and BITDs, engine sounds only need to be available.
b.1	Sound of precipitation, rain removal equipment and other significant aeroplane noises perceptible to the pilot during normal and abnormal operations and the sound of a crash when the FSTD is landed in excess of limitations.			✓	✓							A ~~S~~statement of compliance is required. Sounds have to be directionally representative. For FSTDs that are to be qualified for full stall training tasks, sounds associated with stall buffet have to be replicated, if significant in the aeroplane.
c.1	Comparable amplitude and frequency of flight deck noises, including engine and airframe sounds. The sounds shall be coordinated with the required weather.				✓							Tests required.
d.1	The volume control shall have an indication of sound level setting which meets all qualification requirements.	✓	✓	✓	✓							

2. CS-FSTD(A) — Book 2

2.1. AMC1 FSTD(A).200 is amended as follows:

SUBPART B — TERMINOLOGY

AMC1 FSTD(A).200 Terminology and abbreviations

(a) Terminology

In addition to the principal terms defined in the requirement itself, additional terms used in the context of CS-FSTD(A) and CS-FSTD(H) have the following meanings:

[…]

— ‘FSTD training envelope’ means high- and moderate-confidence regions of the FSTD validation envelope.

[…]

— ‘High angle of attack’ means flying at an angle of attack higher than in normal operation beyond the first indication of stall or stall protection systems, whichever occurs first.

[…]

— ‘Near performance limited condition’ (when related to approach to stall or stall) means a stall event occurring close to the lowest limit of the following:

- maximum certified altitude (structural);
- thrust-limited altitude; and
- buffet- or manoeuvre-limited altitude.

Stall data above flight level (FL) 250 should generally be acceptable.

[…]

– ‘Full stall’ means the same as ‘post-stall’ as referred to in Commission Regulation that has been prepared and published based on EASA Opinion No 06/2017.

(b) Abbreviations

[…]

EVS = enhanced vision system

[…]

FMS = flight management system

[…]

GNSS = global navigation satellite system

[…]

HUGS = head-up guidance system

[…]

MMO = maximum operating limit speed (Mach)

[…]

PBN = performance-based navigation

[…]

VMO = maximum operating limit speed (airspeed)

2.2. AMC1 FSTD(A).300 is amended as follows:

SUBPART C — AEROPLANE FLIGHT SIMULATION TRAINING DEVICES

AMC1 FSTD(A).300 Qualification basis

(a) Introduction

(1) Purpose

[…]

(2) Background

(i) The availability of advanced technology has permitted greater use of FSTDs for training, testing and checking of flight crew members. The complexity, costs and operating environment of modern aeroplanes also encourage broader use of advanced simulation. FSTDs can provide more in-depth training than can be accomplished in aeroplane and provide a safe and suitable learning environment. Fidelity of modern FSTDs is sufficient to permit pilot assessment with the assurance that the observed behaviour will transfer to the aeroplane. Fuel conservation and reduction in adverse environmental effects are important by-products of FSTD use.

(ii) The methods, procedures, and testing criteria contained in this AMC are the result of the experience and expertise of competent authorities, operators, and aeroplane and FSTD manufacturers. From 1989 to 1992, a specially convened international working group under the sponsorship of the Royal Aeronautical Society (RAeS) held several meetings with the stated purpose of establishing common test criteria that would be recognised internationally. The final RAeS document, entitled 'International Standards for the Qualification of Airplane Flight Simulators', dated January 1992 (ISBN 0–903409–98–4), was the core document used to establish these criteria and also the ICAO Doc 9625 'Manual of Criteria for the Qualification of Flight Simulators' (1995 or as amended). An international review under the co-chair of the FAA and JAA during 2001 was the basis for a major modification of the ICAO Manual and for this CS.

[…]

Table of FSTD Validation Tests

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL										COMMENTS
			FFS				FTD		FNPT			BITD	
			A	B	C	D	Init	Rec	I	II	MCC		
													For FNPTs and BITDs, CT&M should be used for initial evaluations. The tolerances should be applied for recurrent evaluations (see AMC1 FSTD(A).300 (a)(5)(iv)). It is accepted that tests and associated tolerances only apply to a level 1 FTD if that system or flight condition is simulated.
1. PERFORMANCE													

[...]

2. HANDLING QUALITIES													
a. STATIC CONTROL CHECKS													NOTE: Pitch, roll and yaw controller position versus~~-~~ force or time should be measured at the control. An alternative method is to instrument the FSTD in an equivalent manner to the flight test aeroplane. The force and position data from this instrumentation should be directly recorded and matched to the aeroplane data. Such a permanent installation could be used without any time for installation of external devices. CCA: Testing of position versus force is not applicable if forces are generated solely by use of aeroplane hardware in the FSTD.
(1) Pitch controller position versus~~-~~ force and surface position calibration.	± 0·9 daN (2 lb~~s~~) breakout. ± 2·2 daN (5 lb~~s~~) or ± 10 % force. ± 2°~~º~~ elevator angle	Ground	✓	✓	✓	✓	C T & M	✓					Uninterrupted control sweep to stops~~. S~~ should be validated (where possible) with in-flight data from tests such as longitudinal static stability, stalls, etc. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures.

Column position versus~~.~~ force only.	± 2.2 daN (5 lb~~s~~) or ± 10 % force.	Cruise or approach							✓	✓	✓	✓	FNPTs level 1 and BITDs: control forces and travel should broadly correspond to that of the replicated class of aeroplane.

[…]

(10) Stick pusher system force calibration (if applicable)	± 10 % or ± 5 lb (2.2 daN) stick/column transient force	Ground or flight			✓	✓							This test is intended to validate the stick/column transient force resulting from a stick pusher system activation. This test may be conducted in an on-ground condition through stimulation of the stall protection system in a manner that generates a stick pusher response representative of an in-flight condition. Aeroplane manufacturer design data may be utilised as validation data, if acceptable to the competent authority. The test provisions may be met through column force validation testing in conjunction with the stall characteristics test (please refer to AMC1 FSTD(A).300(2)(c)(8)). This test is required only for FSTDs that are to be qualified to conduct full stall training tasks.

b. DYNAMIC CONTROL CHECKS													Tests 2.b(1), 2.b(2), and 2.b(3) are not applicable if dynamic response is generated solely by use of aeroplane hardware in the flight simulator. Power setting may be that required for level flight unless otherwise specified.
(1) Pitch control.	<u>For underdamped systems:</u> ± 10 % of time from 90 % of initial displacement (A_d) to first zero crossing and ± 10 (n+1) % of period thereafter. ± 10 % amplitude of first overshoot applied to all overshoots greater than 5 % of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched). <u>For overdamped systems:</u> ± 10 % of time from 90 % of initial displacement (A_d) to 10 % of initial displacement (0·1 A_d).	Take-off, cruise, and landing			✓	✓							Data should be for normal control displacements in both directions (approximately 25~~%~~ to 50 % full throw or approximately 25~~%~~ to 50 % of maximum allowable pitch controller deflection for flight conditions limited by the manoeuvring load envelope). Tolerances apply against the absolute values of each period (considered independently). n = The sequential period of a full oscillation. Please r~~R~~efer to AMC1 FSTD(A).300(b)(4)(i).

(2) Roll control.	<u>For underdamped systems:</u> ± 10 % of time from 90 % of initial displacement (A_d) to first zero crossing and ± 10 (n+1) % of period thereafter. ± 10 % amplitude of first overshoot applied to all overshoots greater than 5 % of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched). <u>For overdamped systems:</u> ± 10 % of time from 90 % of initial displacement (A_d) to 10 % of initial displacement (0·1 A_d).	Take-off, cruise, and landing			✓	✓							Data should be for normal control displacement (approximately 25~~%~~ to 50 % of full throw or approximately 25~~%~~ to 50 % of maximum allowable roll controller deflection for flight conditions limited by the manoeuvring load envelope). Please r~~R~~efer to AMC1 FSTD(A).300(b)(4)(i).

(3) Yaw control.	<u>For underdamped systems:</u> ± 10 % of time from 90 % of initial displacement (A_d) to first zero crossing and ± 10 (n+1) % of period thereafter. ± 10 % amplitude of first overshoot applied to all overshoots greater than 5 % of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched). <u>For overdamped systems:</u> ± 10 % of time from 90 % of initial displacement (A_d) to 10 % of initial displacement (0·1 A_d).	Take-off, cruise, and landing			✓	✓							Data should be for normal displacement (approximately 25~~%~~ to 50 % of full throw). Please r~~R~~efer to AMC1 FSTD(A).300(b)(4)(i).

[…]

c. LONGITUDINAL													Power setting may be that required for level flight unless otherwise specified.
(1) Power change dynamics.	± 3 kt~~s~~ airspeed ± 30 m (100 ft) altitude. ± 1.5°~~º~~ or ± 20 % pitch angle	Approach	✓	✓	✓	✓	C T & M	✓		✓	✓		Power change from thrust for approach or level flight to maximum continuous or go-around power. Time history of uncontrolled free response for a time increment equal to at least 5 s before initiation of the power change to completion of the power change + 15 s. CCA: Test in normal AND non-normal control state.
Power change force	± 2.2 daN (5 lb~~s~~) or ± 10 % ~~F~~force	Approach							✓	✓	✓	✓	For an FNPT level I and a BITD the power change force test only is acceptable.

[...]

(8a) Stall characteristics.	~~± 3 kts airspeed for initial buffet, stall warning, and stall speeds.~~ ~~For aeroplanes with reversible flight control systems (for FS only):~~ ~~± 10% or ± 2·2 daN (5 lb) column force (prior to g-break only.)~~ ± 3 kt airspeed for stall warning and stall speeds.	2nd segment climb, high-altitude cruise (near performance limited condition) and approach or landing	~~✓~~	~~✓~~	✓	✓	~~✓~~	~~✓~~	~~✓~~	~~✓~~	~~✓~~	~~✓~~	~~Wings-level 1 g stall entry with thrust at or near idle power. Time history data should be shown to include full stall and initiation of recovery. Stall warning signal should be recorded and should occur in the proper relation to stall. FSTDs for aeroplanes exhibiting a sudden pitch attitude change or 'g break' should demonstrate this characteristic.~~ ~~CCA: Test in normal AND~~

	± 2° angle of attack for the buffet threshold of perception and for the initial buffet based upon the Nz component. Control inputs must be plotted and demonstrate correct trend and magnitude. Approach to stall: ± 2.0° pitch angle; ± 2.0° angle of attack; and ± 2.0° bank angle. Stall warning up to stall: ± 2.0° pitch angle; ± 2.0° angle of attack; and correct trend and magnitude for roll rate and yaw rate. Stall break and recovery: see AMC10 FSTD(A).300. Additionally, for those simulators with reversible flight control systems or equipped with stick pusher systems: ± 10 % or ± 2·2 daN (5 lb) stick/column												~~non-normal control state.~~ ~~FNPT and BITD: Test should determine the actuation of the stall warning device only.~~ Please refer to AMC9 FSTD(A).300(b)(1). For CCA aeroplanes with stall envelope protection systems: test in normal and non-normal control states. In normal control state, it is expected that envelope protections will take effect, and it may not be possible to reach the aerodynamic stall condition for some aeroplanes. The test is only required for an angle of attack range necessary to demonstrate the correct operation of the system. These tests may be used to satisfy the required (angle of attack) flight manoeuvre and envelope protection tests (2.h.6.). In non-normal state, it is necessary to perform the test to the aerodynamic stall. It is understood that flight test data may not be available and, in this circumstance, engineering validation data may be used and the extent of the test should be adequate to allow training through to recovery, in accordance with the training

	force (prior to the stall angle of attack).												objectives. For safety of flight considerations, the flight test data may be limited to the stall angle of attack, and the modelling beyond the stall angle of attack is only required to ensure it is limited to continuity and completion of the recovery. Applicable only for those FSTDs that are to be qualified for full stall training tasks.
(8b) Approach-to-stall characteristics	± 3 kt airspeed for stall warning speeds. ± 2.0° angle of attack for initial buffet: ± 2.0° pitch angle; ± 2.0° angle of attack; and ± 2.0° bank angle. Additionally, for those aeroplanes with reversible flight control systems: ± 10 % or ± 5 lb (2.2 daN)) stick/column force.	Second-segment climb, high-altitude cruise (near performance limited condition) and approach or landing	✓	✓	✓ See (1)	✓ See (1)	✓	✓	✓	✓	✓	✓	Please refer to AMC9 FSTD(A).300(b)(2). CCA: Test in normal and non-normal control states. For FTDs, flight conditions required for second-segment climb and approach or landing only. AMC9 FSTD(A).300(b)(2) is not applicable. Note (1): For FSTDs not qualified to conduct full stall training tasks.
(9) Phugoid dynamics.	± 10 % period. ± 10 % time to ½ or double amplitude or ± 0·02 of damping ratio.	Cruise	✓	✓	✓	✓				✓	✓		Test should include three full cycles or that necessary to determine time to ½ or double amplitude, whichever is less. CCA: Test in non-normal control state.

	± 10 % ~~P~~period with representative damping.	Cruise							✓			✓	Test should include at least three full cycles. Time history recommended.
(10) Short-period dynamics.	± 1·5°º pitch angle or ± 2°º/s pitch rate. ± 0·1g normal acceleration.	Cruise	✓	✓	✓	✓				✓	✓		CCA: Test in normal AND non-normal control state.
d. LATERAL DIRECTIONAL													Power setting may be that required for level flight unless otherwise specified.
(1) Minimum control speed, air (V_{MCA} or V_{MCL}), per applicable airworthiness standard, ~~–~~or ~~–~~ ~~L~~low speed engine inoper-ative handling characteristics in the air.	± 3 kt~~s~~ airspeed	Take-off or landing (whichever is most critical in the aeroplane)	C T & M	✓	✓	✓	C T & M	✓	✓	✓	✓	✓	Minimum speed may be defined by a performance or control limit which prevents demonstration of V_{MC} or V_{MCL} in the conventional manner. Take-off thrust should be set on the operating engine(s). Time history or snapshot data may be used. CCA: Test in normal OR non-normal control state. FNPTs and BITDs: It is important that there exists a realistic speed relationship between V_{mca} and V_s for all configurations and in particular the most critical full-power engine-out take-off configurations.

[...]

(8) Steady state sideslip.	For a given rudder position: ± 2°º bank angle ± 1°º sideslip angle ± 10 % or ± 2°º aileron ± 10 % or ± 5°º spoiler or equivalent roll controller position or force. For FFSs representing ~~aircraft~~aeroplane with reversible flight control systems: ± 10 % or ± 1·3 daN (3 lb) wheel force ± 10 % or ± 2·2 daN (5 lb) rudder pedal force.	Approach or landing	✓	✓	✓	✓			✓	✓	✓	✓	May be a series of snapshot tests using at least two rudder positions (in each direction for propeller-driven aeroplanes), one of which should be near the maximum allowable rudder. For FNPTs and BITDs, a roll controller position tolerance of ± 10% or ± 5° applies instead of the aileron tolerance. For a BITD, the force tolerance should be CT&M.

[...]

f. GROUND EFFECT													
(1) A ~~T~~test to demonstrate ground effect.	± 1°~~º~~ elevator ± 0·5°~~º~~ stabili~~z~~ser angle. ± 5 % net thrust or equivalent. ± 1° AOA ± 1·5 m (5 ft) or ± 10 % height ± 3 kt~~s~~ airspeed ± 1° pitch angle	Landing		✓	✓	✓							Please r~~R~~efer to AMC1 FSTD(A).300(b)(4)(ii). A rationale should be provided with justification of results. CCA: Test in normal OR non-normal control state.

[…]

i. ENGINE AND AIRFRAME ICING EFFECTS													
(1) Engine and airframe icing effects Demonstration (high angle of attack)		Take-off or approach or landing (one flight condition, two tests: ice on and ice off)			✓	✓							Please refer to AMC9 FSTD(A).300(b)(3).
3. MOTION SYSTEM													
a. Frequency response	As specified by the applicant for FFS qualification.	n/a	✓	✓	✓	✓							Appropriate test to demonstrate the frequency response required. See also AMC1 FSTD(A).300 (b)(4)(iii)(B)

[…]

g. Characteristic motion vibrations	None	Ground and flight											The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. For atmospheric disturbance testing, general purpose disturbance models that approximate demonstrable flight test data are acceptable. Principally, the flight simulator results should exhibit the overall appearance and trends of the aeroplane plots, with at least some of the frequency ‘“spikes”’ being present within 1 or 2 Hz of the aeroplane data. See AMC1 FSTD(A).300 (b)(4)(iii)(E).
The following tests with recorded results and an SOC are required for characteristic motion vibrations, which can be sensed at the flight deck where applicable by aeroplane type:													
(1) Thrust effects with brakes set	n/a	Ground				✓							Test should be conducted at maximum possible thrust with brakes set.
(2) Landing gear	n/a	Flight				✓							Test condition should be for a normal operational speed and not at the gear limiting speed.

(3) Flaps extended buffet	n/a	Flight				✓							Test condition should be for a normal operational speed and not at the flap limiting speed.
(4) Speed brake deployed buffet	n/a	Flight				✓							
(5) Stall buffet	n/a	Cruise (high altitude), second-segment climb, and approach or landing			✓	✓							Test required only for FSTDs that are to be qualified for full stall training tasks or for those aeroplanes which exhibit stall buffet before the activation of the stall warning system. 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. Post-stall characteristics are not required. If stabilised flight data between buffet threshold of perception and stall angle of attack are not available, PSD analysis should be conducted for a time span between initial buffet and stall angle of attack. Please refer to the table of functions and subjective tests: AMC1 FSTD(A).300, Test 3.n.(6).
(~~5~~6) High speed or Mach buffet	n/a	Flight				✓							Test condition should be for high-speed manoeuvre buffet/wind-up-turn or alternatively Mach buffet.

(~~6~~7) In-flight vibrations	n/a	Flight (clean configuration)				✓							Test should be conducted to be representative of in-flight vibrations for propeller-driven aeroplanes.

[…]

Functions and subjective tests

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
	A	B	C	D	1	2	I	II	MCC	
a PREPARATION FOR FLIGHT										
(1) Preflight. Accomplish a functions check of all switches, indicators, systems, and equipment at all crew members' and instructors' stations and determine that: (a) the flight deck design and functions are identical to that of the aeroplane or class of aeroplane simulated; (b) design and functions represent those of the simulated class of aeroplane.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

[…]

f MANOEUVRES										
(1)(a) High angle of attack, approach-to-stalls, stall warning~~,~~ and stall buffet, (take-off, cruise, approach, and landing configuration), including reaction of the autoflight system and stall protection system.	✓	✓	~~✓~~	~~✓~~	✓	✓	✓	✓	✓	✓
(1)(b) High angle of attack, approach-to-stalls, stall warning, stall buffet and stall (and g-break, if applicable) (take-off, cruise, approach, and landing configuration), including reaction of the autoflight system and stall protection system.			✓ ✓	✓ ✓						
(1)(c) Upset prevention and recovery manoeuvre within the FSTD validation envelope.										
(2) Flight envelope protection (high angle of attack, bank limit, overspeed, etc.)	✓	✓	✓	✓	✓	✓				
(3) Turns with/without speed brake/spoilers deployed	✓	✓	✓	✓	✓	✓	✓	✓	✓	
(4) Normal and standard rate turns	✓	✓	✓	✓						✓
(5) Steep turns	✓	✓	✓	✓						✓
(6) Performance turn	✓	✓	✓	✓						
(7) In-flight engine shutdown and restart (assisted and windmill)	✓	✓	✓	✓	✓	✓			✓	
(8) Manoeuvring with one or more engines inoperative, as appropriate	✓	✓	✓	✓	✓	✓	✓(2)	✓	✓	✓(2)
(9) Specific flight characteristics (e.g. direct lift control)	✓	✓	✓	✓	✓	✓				
(10) Flight control system failures, reconfiguration modes, manual reversion and associated handling	✓	✓	✓	✓	✓	✓			✓	
(11) Other	✓	✓	✓	✓	✓	✓				

[…]

n MOTION EFFECTS										

[…]

(5) Buffet in the air due to flap and spoiler/speed brake extension ~~and approach to stall buffett~~ (a) First perform an approach and extend the flaps and slats, especially with airspeeds deliberately in excess of the normal approach speeds. In cruise configuration, verify the buffets associated with the spoiler/speed brake extension. The above effects could also be verified with different combinations of speed brake/flap/gear settings to assess the interaction effects.	*	✓	✓	✓						

(6) Approach-to-stall buffet and stall buffet (where applicable) (a) Conduct an approach-to-stall with engines at idle and a deceleration of 1 kt/s. Check that the motion cues of the buffet, including the level of buffet increase with decreasing speed, are reasonably representative of the actual aeroplane. Note: For FSTDs that are to be qualified for full stall training tasks (Level C or Level D), modelling that accounts for any increase in buffet amplitude from the initial buffet threshold of perception to the critical angle of attack or deterrent buffet as a function of the angle of attack; the stall buffet modelling should include effects of Nz, as well as Nx and Ny, if relevant.	✓	✓	✓	✓						

[…]

p SPECIAL EFFECTS										

[…]

(2) Effects of Airframe and Engine Icing (a) See Appendix 1 to CS FSTD(A).300, 1.t.1 Required only for those aeroplanes authorised for operations in known icing conditions. With the FSTD airborne, autopilot on and auto-throttles off, engine and aerofoil anti-ice/de-ice systems deactivated; activate icing conditions at a rate that allows monitoring of the FSTD and systems' response. Icing recognition typically includes airspeed decay, change in FSTD pitch attitude, change in engine performance indications (other than due to airspeed changes), and change in data from the pitot/static system. Activate heating, anti-ice, or de-ice systems independently. Recognition includes proper effects of these systems, eventually returning the simulated aeroplane to normal flight. Please refer to AMC13 FSTD(A).300.			✓	✓						

NOTE 1: For level ~~‘~~A~~’~~ FSTDs, an asterisk (*) denotes that the appropriate effect is required to be present.	
NOTE2: It is accepted that tests will only apply to FTDs level 1 if that system and flight condition is simulated. It is intended that the tests listed below should be conducted in automatic flight. Where automatic flight is not possible and pilot manual handling is required, the FTD level 1 should be at least controllable to permit the conduct of the flight.	

[…]

2.3. Appendix 8 to AMC1 FSTD(A).300 is amended as follows:

Appendix 8 to AMC1 FSTD(A).300 General technical requirements for FSTD qualification levels

This ~~a~~Appendix summarises the general technical requirements for full flight simulators level A, B, C and D, flight training devices level 1 and 2, flight navigation procedures trainers level I, II and II MCC, and basic instrument training devices.

Table 1: General technical requirements for level A, B, C and D full-flight simulators (FFSs)

Qualification Level	General technical requirements
A	The lowest level of FFS technical complexity. An enclosed full-scale replica of the aeroplane cockpit/flight deck including simulation of all systems, instruments, navigational equipment, communications, and caution and warning systems. An instructor's station with seat should be provided. Seats for the flight crew members and two seats for inspectors/observers should also be provided. Control forces and displacement characteristics should correspond to ~~that~~those of the replicated aeroplane and they should respond in the same manner as the aeroplane under the same flight conditions. The use of class-specific data tailored to the specific aeroplane type with fidelity sufficient to meet the objective tests, functions and subjective tests is allowed. Generic ground effect and ground handling models are permitted. Motion, visual and sound systems sufficient to support the training, testing and checking credits sought are required. The visual system should provide at least 45 degrees horizontal and 30 degrees vertical field of view per pilot. The response to control inputs should not be greater than 300 ms more than that experienced on the ~~aircraft~~aeroplane.
B	As for level A, plus: Validation flight test data should be used as the basis for flight and performance and systems' characteristics. Additionally, ground handling and aerodynamics programming to include ground effect reaction and handling characteristics should be derived from validation flight test data.

C	The second highest level of FFS fidelity. As for level B, plus: A daylight/twilight/night visual system is required with a continuous, cross-cockpit, minimum collimated visual field of view providing each pilot with 180 degrees horizontal and 40 degrees vertical field of view. A six-degrees-of-freedom motion system should be provided. The sound simulation should include the sounds of precipitation and other significant aeroplane noises perceptible to the pilot and should be able to reproduce the sounds of a crash landing. The response to control inputs should not be greater than 150 ms more than that experienced on the ~~airplane~~aeroplane. Wind shear simulation should be provided. An upset prevention and recovery training (UPRT) instructor operating station (IOS) feedback mechanism should be available.
D	The highest level of FFS fidelity. As for level C, plus: Extended set of sound and motion buffet tests.

[…]

2.4. New AMC9 FSTD(A).300 is added as follows:

AMC9 FSTD(A).300 Guidance on upset, stall (including in icing conditions), and qualification of FSTDs

(a) Flight Simulation Training Device Standards table of Appendix 1 to CS FSTD(A).300

(1) 1. General, h.3:

(i) a suitably qualified pilot should:

(A) hold a type rating qualification for the aeroplane being simulated; and

(B) be familiar with the upset scenarios and associated recovery methods as well as the cues necessary to accomplish the required training objectives;

(ii) the statement of compliance (SOC) should also confirm that for each upset scenario, the recovery manoeuvre can be performed such that the FSTD does not exceed the FSTD training envelope, or when the envelope is exceeded, that the FSTD is within the realms of confidence in the simulation accuracy;

(iii) the unrealistic degradation of the FSTD functionality (such as degrading flight control effectiveness) to drive an aeroplane upset is not acceptable unless used purely as a tool for repositioning the FSTD with the pilot out of the loop; and

(iv) consideration should be given to flight-envelope-protected aeroplanes as artificially positioning the aeroplane to a specified attitude may incorrectly initialise flight control laws.

(2) 1. General, s.1:

(i) the FSTD should be evaluated for specific upset recovery manoeuvres; a minimum set of manoeuvres:

(A) a nose-high wings level aeroplane upset;

(B) a nose-low aeroplane upset; and

(C) a high bank angle aeroplane upset;

(ii) other upset recovery scenarios, as developed by the FSTD operator, should be evaluated in the same manner; and

(iii) these evaluations should be made available to the instructor/evaluator.

(3) 1. General, s.2:

(i) for continuity purposes, the model should remain useable beyond the FSTD training envelope to the extent to allow completion of the recovery training; and

(ii) where known limitations exist in the aerodynamic model for particular stall event manoeuvres (such as aeroplane configuration, approach-to-stall entry methods, and limited range for continuity of the modelling), these limitations should be declared in the required SOC.

(4) 1. General, s.3:

(i) the aerodynamic stall modelling should include degradation of the static/dynamic lateral directional stability;

(ii) degradation in control response (pitch, roll, and yaw);

(iii) uncommanded roll response or roll-off requiring significant control deflection to counter;

(iv) apparent randomness or non-repeatability;

(v) changes in pitch stability;

(vi) Mach effects; and

(vii) stall buffet,

as appropriate to the aeroplane type;

(viii) as appropriate to the aeroplane type, the model should be capable of capturing the variations seen in the stall characteristics of the aeroplane (e.g. the presence or absence of a pitch break, deterrent buffet, or other indications of a stall where present on the aeroplane);

(ix) where known limitations exist in the aerodynamic model for particular stall manoeuvres (such as aeroplane configuration and stall-entry methods), these limitations must be declared in the required SOC;

(x) specific guidance should be available to the instructor which clearly communicates the flight configurations and stall manoeuvres that have been evaluated in the FSTD for use in training; and

(xi) FSTDs that are to be qualified for full stall training tasks must also meet the instructor operating station (lOS) provisions for upset prevention and recovery training (UPRT) tasks as described under ‘1. General, h.2’ of the FSTD Standards table.

(b) FSTD validation tests

(1) Stall characteristics test:

(i) Control inputs must be plotted and demonstrate correct trend and magnitude.

(ii) Each of the following stall entries must be demonstrated in at least one of the three flight conditions (please refer to Table of FSTD Validation Test, 8(a)):

(A) stall entry at wings level (1g);

(B) stall entry in turning flight of at least 25° bank angle (accelerated stall); and

(C) stall entry in a power-on condition (required only for propeller-driven aeroplanes).

(iii) The cruise flight condition must be conducted in a flaps-up (clean) configuration. The second-segment climb flight condition must use a different flap setting than for the approach or landing flight condition.

(iv) The stall warning signal and initial buffet, if applicable, must be recorded. Time-history data must be recorded for a full stall through recovery to normal flight. The stall warning signal must occur in the proper relation to buffet/stall. FSTDs of aeroplanes exhibiting a sudden pitch attitude change or ‘g break’ must demonstrate this characteristic. FSTDs of aeroplanes exhibiting a roll-off or loss-of-roll control authority must demonstrate this characteristic.

(v) Numerical tolerances are not applicable past the stall angle of attack, but must demonstrate correct trend through recovery. Please refer to AMC10 FSTD(A).300 for additional information concerning data sources and required angle of attack ranges.

(vi) For aeroplanes with stall envelope protection systems, the normal-mode testing is only required at an angle of attack range necessary to demonstrate the correct operation of the system. These tests may be used to satisfy the required (angle of attack) flight manoeuvre and envelope protection tests of AMC1 FSTD(A).300. Non-normal control states must be tested through stall identification and recovery.

(vii) In instances where flight test validation data is limited due to safety-of-flight considerations, engineering simulator validation data may be used in lieu of flight test validation data for angles of attack that exceed the activation of a stall protection system or stick pusher system.

(viii) Buffet threshold of perception should be based on 0.03 g peak to peak normal acceleration above the background noise at the pilot seat. Initial buffet to be based on normal acceleration at the pilot seat with a larger peak to peak value relative to buffet threshold of perception (some airframe manufacturers have used 0.1 g peak to peak). Demonstrate correct trend in growth of buffet amplitude from initial buffet to stall speed for normal and lateral acceleration.

(ix) The maximum buffet may be limited based on motion platform capability/limitations or other simulator system limitations. If the maximum buffet is limited, the limit should be sufficient to allow proper use in training (e.g. not less than 0.5 g peak to peak), and in any case the instructor should be informed of the limitations.

(x) Tests may be conducted at centres of gravity (CG) and weights typically required for aeroplane certification stall testing.

(xii) This test is only for FSTDs that are to be qualified to conduct full stall training tasks.

(xiii) Where approved engineering simulation validation is used, the reduced engineering tolerances (as defined in Appendix 1 to AMC1.300(b)) do not apply.

(2) Approach-to-stall characteristics test:

(i) Control displacements and flight control surfaces must be plotted and demonstrate correct trend and magnitude.

(ii) Each of the following stall entries must be demonstrated in at least one of the three flight conditions (please refer to Table of FSTD Validation Test, 8(b)):

(A) approach-to-stall entry at wings level (1g);

(B) approach-to-stall entry in turning flight of at least 25° bank angle (accelerated stall); and

(C) approach-to-stall entry in a power-on condition (required only for propeller-driven aeroplanes).

(iii) The cruise flight condition must be conducted in a flaps-up (clean) configuration. The second-segment climb flight condition must use a different flap setting than for the approach or landing flight condition.

(iv) For computer-controlled aeroplanes (CCAs) with stall envelope protection systems, the normal-mode testing is only required at an angle of attack range necessary to demonstrate the correct operation of the system. These tests may be used to satisfy the required (angle of attack) flight manoeuvre and envelope protection tests of AMC1 FSTD(A).300(2)(h).

(3) Engine and airframe icing effects demonstration (high angle of attack):

(i) Time history of a full stall and of the initiation of the recovery: tests are intended to demonstrate representative aerodynamic effects caused by in-flight ice accretion. Flight test validation data is not required.

(ii) Two tests are required, to demonstrate engine and airframe icing effects. One test demonstrates the FSTDs baseline performance without ice accretion, and the second test demonstrates the aerodynamic effects of ice accretion relative to the baseline test.

(iii) The test must utilise the icing model(s) as described in the SOC required in Appendix 1 to CS FSTD(A).300 1.t.1. The test must include a rationale that describes the icing effects being demonstrated. Icing effects may include, but are not limited to, the following effects, as applicable to the particular aeroplane type:

(A) decrease in the stall angle of attack;

(B) changes in the pitching moment;

(C) decrease in control effectiveness;

(D) changes in control forces;

(E) increase in drag;

(F) change in stall buffet characteristics and threshold of perception; and

(G) engine effects (power reduction/variation, vibration, etc. where expected to be present on the aeroplane in the ice accretion scenario being tested).

(iv) Tests are evaluated for representative effects on relevant aerodynamic and other parameters, such as angle of attack, control inputs, and thrust/power settings.

Recorded parameters (in the validation test result) should include the following:

(A) altitude;

(B) airspeed;

(C) normal acceleration;

(D) engine power;

(E) angle of attack;

(F) pitch attitude;

(G) bank angle;

(H) flight control inputs; and

(I) stall warning and stall buffet onset.

2.5. New AMC10 FSTD(A).300 is added as follows:

AMC10 FSTD(A).300 Guidance on high angle of attack/stall model evaluation

(a) This AMC applies to all FSTDs that are used to satisfy training provisions for stall manoeuvres conducted at angles of attack beyond the activation of the stall warning system. This AMC is not applicable to FSTDs that are only qualified for approach-to-stall manoeuvres where recovery is initiated at the first indication of the stall. This AMC supplements the following:

(1) Appendix 1 to CS FSTD(A).300 'Flight Simulation Training Device Standards';

(2) AMC1 FSTD(A).300(b)(3) 'Table of FSTD Validation Tests'; and

(3) AMC1 FSTD(A).300(c) 'Functions and subjective tests'.

(b) General provisions

The provisions for high angle of attack modelling should be applied to evaluate the recognition cues as well as performance and handling qualities of a developing stall through the stall identification angle of attack and stall recovery. Strict time-history-based evaluations against flight test data may not adequately validate the aerodynamic model in an unsteady and potentially unstable flight regime, such as stalled flight. As a result, the objective testing provisions of AMC1 FSTD(A).300 do not contain strict tolerances for any parameter at angles of attack beyond the stall identification angle of attack. In lieu of mandating such objective tolerances, an SOC should define the source data and methods used to develop the aerodynamic stall model.

(c) Fidelity provisions

The provisions for the evaluation of full stall training manoeuvres should provide the following levels of fidelity:

(1) aeroplane-type-specific recognition cues of the first indication of the stall (such as the stall warning system or aerodynamic stall buffet);

(2) aeroplane-type-specific recognition cues of an impending aerodynamic stall; and

(3) recognition cues and handling qualities from stall break through recovery which are sufficiently representative of the aeroplane being simulated to allow successful completion of the stall recovery training tasks.

For the purposes of stall manoeuvre evaluation, the term 'representative' is defined as a level of fidelity that is type-specific of the simulated aeroplane to the extent that the training objectives can be satisfactorily accomplished. Therefore, the term 'representative' in this AMC is specifically limited to the characteristics of the aerodynamic model in the post-stall region. The description of this term is given to explain the intent of the model rather than defining the meaning of the term 'representative modelling' which may be described in other simulator definitions.

(d) SOC (aerodynamic model)

At a minimum, the following must be addressed in the SOC:

(1) Source data and modelling methods

The SOC must identify the sources of data used to develop the aerodynamic model. These data sources may be from the aeroplane original equipment manufacturer (OEM), the original FSTD manufacturer/data provider, or other data providers acceptable to the competent authority. Of particular interest is a mapping of test points in the form of an alpha/beta envelope plot for a minimum of flaps-up and flaps-down aeroplane configurations. For the flight test data, a list of the types of manoeuvres used to define the aerodynamic model for angle of attack ranges greater than the first indication of stall must be provided per flap setting. Flight test reports, when available, describing stall characteristics of the aeroplane type being modelled, issued by the OEM or flight test pilot, can be referred to. In cases where it is impractical to develop and validate a stall model with flight-test data (e.g. due to safety concerns involving the collection of flight-test data past a certain angle of attack), the data provider is expected to make a reasonable attempt to develop a stall model through the required angle of attack range using analytical methods and empirical data (e.g. wind-tunnel data).

(2) Validity range

The FSTD operator should declare the range of angle of attack and sideslip where the aerodynamic model remains valid for training. Satisfactory aerodynamic model fidelity must be shown through stall recovery training tasks. For the purposes of determining this validity range, the stall identification angle of attack is defined as the angle of attack where the pilot is given a clear and distinctive indication to cease any further increase in the angle of attack where one or more of the following characteristics occur:

(i) no further increase in pitch occurs when the pitch control is held at the full aft stop for two seconds, leading to an inability to arrest the descent rate;

(ii) an uncommanded nose-down pitch that cannot be readily arrested, which may be accompanied by an uncommanded rolling motion;

(iii) buffeting of a magnitude and severity that is a strong and effective deterrent to a further increase in the angle of attack;

(iv) activation of a stick pusher.

For the validity range, the modelling continuity should allow for an angle of attack range that is adequate to allow for the completion of stall recovery; for pusher-equipped aeroplanes, this should be adequate to capture any inappropriate action during the recovery procedure.

For aeroplanes equipped with a stall envelope protection system, the model should allow training with the protection systems disabled or otherwise degraded (such as a degraded flight control mode as a result of a pitot/static system failure).

(3) Model characteristics

Within the declared model validity range, the SOC must address, and the aerodynamic model must incorporate, the following stall characteristics, where applicable by aeroplane type:

(i) degradation of the static/dynamic lateral-directional stability;

(ii) degradation in control response (pitch, roll, and yaw);

(iii) uncommanded roll acceleration or roll-off requiring significant control deflection to counter;

(iv) apparent randomness or non-repeatability;

(v) changes in pitch stability;

(vi) stall hysteresis;

(vii) Mach effects;

(viii) stall buffet; and

(ix) angle of attack rate effects.

An overview of the methodology used to address these features must be provided.

(e) SOC (subject-matter expert (SME) pilot's evaluation)

The operator must provide an SOC confirming that the simulation stall model has been subjectively evaluated by an SME pilot knowledgeable of the aeroplane's stall characteristics (please refer to (d)(1) above).

The operator is also required to provide a SOC to state that the simulation stall model, as defined above, has been implemented and verifies that the aerodynamic stall training tasks can be accomplished on the FSTD.

The purpose is to ensure that the stall model has been sufficiently evaluated using those general aeroplane configurations and stall-entry methods that will likely be conducted in training.

In order to qualify as an acceptable SME to evaluate the stall model characteristics, the SME must meet the following criteria:

(1) has held or currently holds a type rating/qualification in the aeroplane being simulated;

(2) has direct experience in conducting stall manoeuvres in an aeroplane that shares the same type rating as the make, model, and series of the simulated aeroplane; this stall experience must include hands-on manipulation of the controls at angles of attack sufficient to identify the stall (e.g. deterrent buffet, stick pusher activation, etc.) through recovery to stable flight;

(3) where the SME's stall experience is in an aeroplane of a different make, model, and series within the same type rating, differences in aeroplane-specific stall recognition cues and handling characteristics must be addressed using available documentation; this documentation may include aeroplane operating manuals (OMs), aeroplane manufacturer flight test reports, or other documentation that describes the stall characteristics of the aeroplane; and

(4) be familiar with the intended stall training manoeuvres to be conducted in the FSTD (e.g. general aeroplane configurations, stall-entry methods, etc.) and the cues necessary to accomplish the required training objectives.

This SOC will only be required at the time the FSTD is initially qualified for stall training tasks as long as the FSTD's stall model remains unmodified compared to what was originally evaluated and qualified. Where an FSTD shares common aerodynamic and flight control models with those of an engineering or development simulator, the competent authority will accept an SOC from the aeroplane manufacturer or data provider confirming that the stall characteristics have been subjectively assessed by an SME pilot on the engineering/development simulator (please refer to AMC1 FSTD(A).200 and AMC7 FSTD(A).300(b) for the description of an engineering/development simulator).

An FSTD operator may submit a request to the competent authority for approval of a deviation from the SME pilot's experience provisions under this paragraph. This request for deviation must include the following information:

(1) an assessment of pilot availability demonstrating that a subject-matter expert pilot, meeting the experience described in AMC10 FSTD(A).300(e), is not available; and

(2) alternative methods to subjectively evaluate the FSTD's capability to provide the stall recognition cues and handling characteristics needed to accomplish the training objectives.

(f) SOC (subjective tests)

Test provisions

The necessity of subjective tests arises from the need to confirm that the simulation model has been integrated correctly and performs as declared under (d) above. It is vital to examine, for example, that the simulation validity range allows modelling continuity that is adequate to allow for the completion of stall recovery.

Considerations on aeroplane certification flight test provisions

In aeroplane certification flight tests, there is no provision to go beyond the maximum coefficient of lift (CL max), and the aeroplane is not to be held indefinitely in a full stall condition, so this provision should be applied in the same way during the simulator's subjective evaluation.

The subjective tests of the simulation model should assess modelling continuity when slightly increasing the angle of attack beyond the validity range defined in paragraph (d)(2) of this section CL max.

The increase in angle of attack beyond the validity range CL max should be limited to a value not greater than the maximum angle achieved two seconds after stall recognition, which is sufficient to allow a proper recovery manoeuvre.

Stall recognition is defined as follows:

(1) no further increase in pitch occurs when the pitch control is held at the full aft stop for two seconds, leading to an inability to arrest the descent rate;

(2) an uncommanded nose-down pitch that cannot be readily arrested, which may be accompanied by an uncommanded rolling motion;

(3) buffeting of a magnitude and severity that is a strong and effective deterrent to a further increase in the angle of attack; and

(4) activation of a stick pusher.

Where known limitations exist in the aerodynamic model for particular stall event manoeuvres (such as aeroplane configuration, approach-to-stall entry methods, and limited range for continuity of the modelling), these limitations must be declared in the required SOC.

2.6. New AMC11 FSTD(A).300 is added as follows:

AMC11 FSTD(A).300 Guidance on high angle of attack/stall model evaluation, and approach to stall for previously qualified FSTDs

For FSTDs that are already qualified under CS-FSTD(A), it may not always be possible to provide the required validation data for the new or revised objective test cases to support FSTD qualification for stall and approach to stall. These validation tests have the following characteristics:

(a) Objective testing for stall characteristics (please refer to Table of FSTD Validation Tests, 2.c.(8a)) are only required for the (wings level) second-segment climb and approach or landing flight conditions.

(b) For the testing of the high-altitude cruise and turning-flight stall conditions, these manoeuvres may be subjectively evaluated by a qualified SME pilot (please refer to AMC10 FSTD(A).300(e)) and addressed in the required statement of compliance (SOC); these tests should utilise the footprint method to document the SME evaluation and this should be included in the approved master qualification test guide (MQTG). To allow for any randomisation during recurrent testing, one should apply engineering judgement to ensure that the key characteristics of the original SME assessment are maintained.

(c) Where existing flight test validation data in the FSTD's MQTG is missing required parameters, or is otherwise unsuitable to fully meet the objective testing provisions, the competent authority may accept alternative sources of validation, including subjective validation by an SME pilot with direct experience in the stall characteristics of the aeroplane (please refer to AMC10 FSTD(A).300(e)).

(d) Objective testing for characteristic motion vibrations (please refer to Table of FSTD Validation Tests, 3.g.(5)) is not required where the FSTD's stall buffets have been subjectively evaluated by an SME pilot. For previously qualified Level D FSTDs that currently have objective approach-to-stall buffet tests in their approved MQTG, the results of these existing tests must be provided to the competent authority with the updated stall and stall buffet models in place.

(e) As described in AMC10 FSTD(A).300, the competent authority may accept an SOC from the data provider, confirming that the stall characteristics have been subjectively evaluated by an SME pilot on an engineering simulator or development simulator that is acceptable to the competent authority. Where this evaluation takes place on an engineering or development simulator, additional objective 'proof-of-match' testing for all flight conditions, as described in Tests 2.c.(8a) and 3.g.(5), is required to verify the implementation of the stall model and stall buffets on the FSTD.

(f) Objective demonstration tests of engine and airframe icing effects (AMC1, FSTD Validation Tests, test 2.i) are not required for previously qualified FSTDs.

2.7. New AMC12 FSTD(A).300 is added as follows:

AMC12 FSTD(A).300 Guidance on upset prevention and recovery training (UPRT) for the FSTD Standards table

(a) Background

(1) This AMC provides guidance on Appendix 1 to CS FSTD(A).300, namely on the following:

(i) 1. General:

(A) h.2 (IOS tools);

(B) h.3 (upset scenarios); and

(C) s.1 (aerodynamics); and

(ii) 2. Motion system, a.1.

(2) This AMC applies to all FTSDs that are used to satisfy training provisions for UPRT manoeuvres. For the purposes of this AMC, an aeroplane upset (as defined in the ICAO Airplane Upset Prevention & Recovery Training Aid (AUPRTA) Rev 3, February 2017) is an undesired aeroplane state characterised by unintentional deviations from parameters experienced during normal operations. An aeroplane upset may involve pitch and/or bank angle deviations as well as inappropriate airspeeds for the given conditions.

(3) FSTDs that are used to conduct training manoeuvres where the FSTD is repositioned either into an aeroplane upset condition or an artificial stimulus (such as weather phenomena or system failures) that is intended to result in a flight crew entering an aeroplane upset condition, must be evaluated and qualified.

(b) FSTD Standards provisions

(1) The provisions of Appendix 1 to CS FSTD(A).300 define three basic elements that are required for qualifying an FSTD for UPRT manoeuvres:

(i) FSTD training envelope: see definition in AMC1 FSTD(A).200;

(ii) instructor feedback: provides the instructor/evaluator with a minimum set of feedback tools to properly evaluate the trainee's performance in accomplishing a UPRT task; and

(iii) upset scenarios: where dynamic upset scenarios or aeroplane system malfunctions are used to drive the FSTD into an aeroplane upset condition, specific guidance must be available to the instructor, e.g. on the IOS or manual, which describes how the upset scenario is driven along with any malfunction or degradation in FSTD functionality required to stimulate the upset.

(2) FSTD validation envelope

This envelope is defined by the following three subdivisions (see Appendix 3-D of the ICAO 'AUPRTA').

(i) Flight-test-validated region

This is the region of the flight envelope which has been validated with flight test data, typically by comparing the performance of the FSTD against these flight test data through tests incorporated in the QTG and other flight test data utilised to further extend the model beyond the minimum provisions. Within this region, there is high confidence that the FSTD responds similarly to the aeroplane. Please note that this region is not strictly limited to what has been tested in the QTG; as long as the aerodynamics mathematical model has been conformed to the flight test results, that portion of the mathematical model is considered to be within the flight-test-validated region.

(ii) Wind tunnel and/or analytical region

This is the region of the flight envelope for which there has been wind tunnel testing or the use of other reliable predictive methods (typically by the aeroplane manufacturer) to define the aerodynamic model. Any extensions to the aerodynamic model which have been evaluated in accordance with the definition of a representative stall model (as described in AMC10 FSTD(A).300) must be clearly indicated. Within this region, there is moderate confidence that the FSTD will respond in a similar way as the aeroplane.

(iii) Extrapolated region

This is the region extrapolated beyond the flight-test-validated and wind-tunnel/analytical regions. The extrapolation may be a linear one, a holding of the last value before the extrapolation began, or some other set of values. Whether this extrapolated data is provided by the aeroplane or FSTD manufacturer, it is a 'best estimation' only. Within this region, there is low confidence that the FSTD will respond in a similar way as the aeroplane.

(c) IOS feedback mechanism

(1) For the instructor/evaluator to provide feedback to the student during the upset prevention and recovery manoeuvre training, additional information must be accessible which indicates the fidelity of the simulation, the magnitude of the trainee's flight control inputs, as well as the aeroplane operational limits that could potentially affect the successful completion of the manoeuvre(s). At a minimum, the following must be available to the instructor/evaluator:

(i) FSTD validation envelope

The FSTD must employ a method to display the FSTD's expected fidelity with respect to the FSTD validation envelope. This may be displayed as an angle of attack versus sideslip (alpha/beta) envelope cross-plot on the IOS or other alternative method to clearly convey the FSTD's fidelity level during the manoeuvre. The cross-plot or other alternative method must display the relevant validity regions for flaps-up and flaps-down at a minimum. This validation envelope must be derived by the aerodynamic data provider, or using information and data sources provided by the aerodynamic data provider.

(ii) Flight control inputs

The FSTD must employ a method for the instructor/evaluator to assess the trainee's flight control inputs during the upset recovery manoeuvre. Additional parameters, such as cockpit control forces (forces applied by the pilot to the controls) and the flight control law mode for fly-by-wire aeroplanes, must be portrayed in this feedback mechanism as well. For passive side-sticks, whose displacement is the flight control input, the force applied by the pilot to the controls does not need to be displayed. This tool must include a time history or other equivalent method of recording flight control positions.

(iii) Aeroplane operational limits

The FSTD must employ a method to provide the instructor/evaluator with real-time information concerning the aeroplane operational limits. The simulated aeroplane's parameters must be displayed dynamically in real-time and provided in a time history or equivalent format. At a minimum, the following parameters must be available to the instructor/evaluator:

(A) airspeed and airspeed limits, including the stall speed and maximum operating limit airspeed (VMO)/maximum operating Mach (MMO);

(B) load factor and operational load factor limits; and

(C) angle of attack and stall identification angle of attack (please refer to AMC10 FSTD(A).300(d)(2) for additional information on the definition of the stall identification angle of attack); this parameter may be displayed in conjunction with the FSTD validation envelope.

(2) Optionally, a recorded feedback mechanism is available to the instructor/evaluator.

2.8. New GM12 FSTD(A).300 is added as follows:

GM12 FSTD(A).300 Additional guidance on upset prevention and recovery training (UPRT) for the FSTD Standards table

(a) Introduction

The FSTD should be provided with information pertaining to the aeroplane's parameters as described in AMC12 FSTD(A).300. This AMC details some of the performance provisions for these features.

The objective of the IOS feedback during UPRT exercises is to provide the instructor with the ability to assess the timely and proper control action, including sequence, to complete the recovery in a safe manner.

(b) Background

IOS feedback, which may also be via a separate mobile device, is used to monitor and debrief the crew regarding UPRT exercises in order to verify that proper control activity was executed. The instructor should have the necessary information to clearly establish whether the recovery was completed within the FSTD training envelope (please refer to AMC12 FSTD(A).300), and take any necessary action to complete the training.

The FSTD should include tools for the instructor to be able to immediately debrief the pilot(s) after the training event. All data recorded for the use in the UPRT debrief should be easily permanently deleted after the UPRT training event.

(c) IOS parameters

The tool should normally display:

(1) Pilot-induced control inputs, including:

(i) pitch,

(ii) roll,

(iii) rudder pedal,

(iv) throttles,

(v) flaps, and

(vi) speed brake/spoilers.

Time history of control inputs, including cockpit control forces and flight control law (fly-by-wire aeroplanes), as applicable.

In order to ascertain that the control inputs are applied in a correct, timely and smooth manner, the display should indicate these at a sampling frequency rate that is sufficiently high to prevent from missing possible abrupt pilot action. This may be limited to the debrief mode following the execution of the exercise or individual manoeuvre.

(2) Display of the primary flight parameters; if applicable, display a copy of the Primary Flight Display (PFD); if a PFD is displayed, then the parameters shall be the same as the ones displayed on the aeroplane PFD, including:

(i) pitch attitude,

(ii) roll attitude,

(iii) turn/sideslip,

(iv) indicated airspeed,

(v) stall warning speed/stall buffet speed,

(vi) VMO/MMO,

(vii) altitude,

(viii) rate of climb,

(ix) autopilot status, and

(x) auto-throttle status.

(3) Angle of attack.

(4) Angle of sideslip.

(5) G-loading.

The limitations of (3), (4), and (5) shall also be indicated, as follows:

One method is the simultaneous depiction of the angle of attack versus angle of sideslip and the corresponding FSTD validation envelope.

A presentation of the G-loading as function of the current airspeed and flight configuration.

The V-n diagram indicates the limitations of the aeroplane under given conditions. It displays the flight envelope as function of the airspeed versus G-loading. It shows the lower airspeed limits by means of a parabolic line. The intersection of this line with the 1.0g horizontal line corresponds to the stall speed at 1g. The regions above the 2.5g upper limit (maximum design limit) to the right of VNE and below the – 1.0g lower limit are the structural exceedance limits and should be avoided. The shape of the V-n diagram depends on the aeroplane itself, its configuration, as well as the environmental and flight conditions.

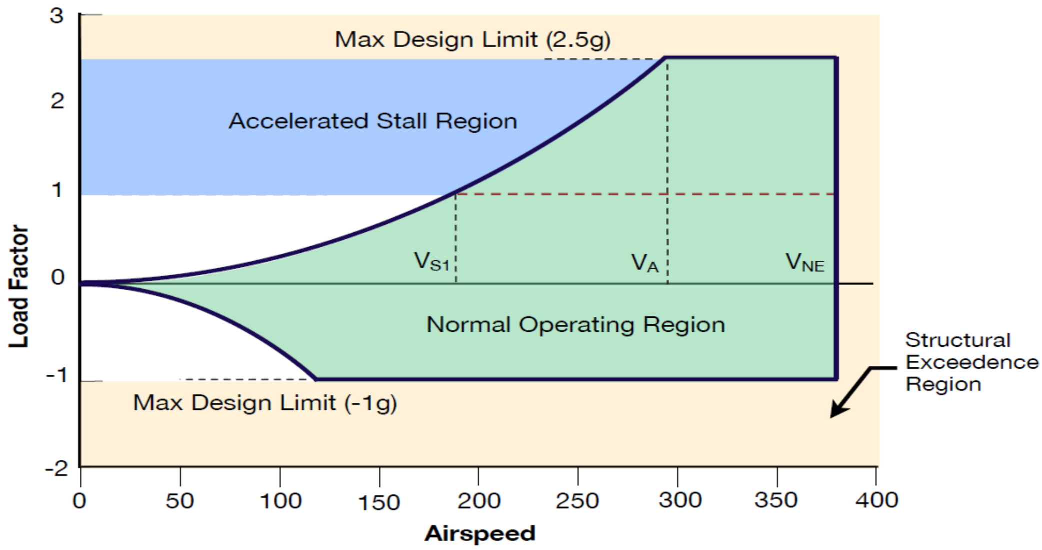

Figure 1 — V-n diagram (example)

Legend to Figure 1:

V_{S1} = clean stall speed at 1g

V_A = design manoeuvre speed

V_{NE} = never-exceed speed

2.9. New AMC13 FSTD(A).300 is added as follows:

AMC13 FSTD(A).300 Guidance material for engine and airframe icing evaluation provisions

(a) Applicability

This AMC applies to all FSTDs that are used to satisfy training provisions for engine and airframe icing. New general provisions as well as objective provisions for FSTD qualification have been developed in order to define aeroplane-specific icing models that support training objectives for the recognition of, and recovery from, an in-flight ice accretion event.

(b) General provisions

The following elements should be considered when developing the qualified ice accretion models for use in FSTD training:

(1) icing models must be able to train the specific skills required for the recognition of ice accumulation and for generating the required response;

(2) icing models must contain aeroplane-specific recognition cues as determined through data supplied by an aeroplane original equipment manufacturer (OEM) or through other suitable analytical methods; and

(3) at least one qualified icing model must be objectively tested to demonstrate that it has been implemented correctly and that it generates the correct cues as necessary for training.

(c) Statement of compliance (SOC)

The SOC described in Appendix 1 to CS FSTD(A).300 (1.t.1.) must contain the following information to support FSTD qualification of aeroplane-specific icing models:

(1) A description of expected aeroplane-specific recognition cues and degradation effects due to a typical in-flight icing encounter.

Typical cues may include loss of lift, decrease in stall angle of attack, changes in pitching moment, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag. This description must be based on relevant data sources, such as aeroplane OEM-supplied data, accident/incident data, or other acceptable data sources. Where a particular airframe has demonstrated vulnerabilities to a specific type of ice accretion (due to accident/incident history), which requires specific training (such as supercooled large-droplet icing or tailplane icing), ice accretion models must be developed that address those training provisions.

(2) A description of the data sources used to develop the qualified ice accretion models. Acceptable data sources may be but are not limited to flight test data, aeroplane certification data, aeroplane OEM engineering simulation data, or other analytical methods based on established engineering principles.

(d) Objective demonstration testing

The purpose of the objective demonstration test is to demonstrate that the ice accretion models, as described in the SOC, have been correctly implemented and demonstrate the proper cues and effects, as defined in the approved data sources. At least one ice accretion model must be selected for testing and included in the master qualification test guide (MQTG). Two tests are required to demonstrate engine and airframe icing effects. One test demonstrates the FSTD's baseline performance without icing, and the second test demonstrates the aerodynamic effects of ice accretion relative to the baseline test.

(1) Recorded parameters: in each of the two required MQTG cases, a time-history recording of the following parameters should be made:

(i) altitude;

(ii) airspeed;

(iii) normal acceleration;

(iv) engine power/settings;

(v) angle of attack/pitch attitude;

(vi) bank angle;

(vii) pilot-induced flight control inputs;

(viii) stall warning and stall buffet onset; and

(ix) other parameters necessary to demonstrate the effects of ice accretion.

(2) Demonstration manoeuvre: the FSTD operator must select an ice accretion model, as identified in the SOC for testing. The selected manoeuvre must demonstrate the effects of ice accretion at high angles of attack from a trimmed condition through approach-to-stall and full stall (full stall is applicable only for those FSTDs that are to be qualified for full stall training tasks), as compared to a baseline (no ice build-up) test. The ice accretion models must demonstrate the cues necessary to recognise the onset of ice accretion on the airframe, lifting surfaces, and engines, and provide a representative degradation in performance and handling qualities to the extent that a recovery can be executed. Typical recognition cues that may be present, depending on the simulated aeroplane, include:

(i) decrease in stall angle of attack;

(ii) increase in stall speed;

(iii) increase in stall buffet threshold of perception speed;

(iv) changes in pitching moment;

(v) changes in stall buffet characteristics;

(vi) changes in control effectiveness or control forces; and

(vii) engine effects (power variation, vibration, etc.).

The demonstration manoeuvre test may be conducted by initialising and maintaining a fixed amount of ice accretion throughout the manoeuvre in order to consistently evaluate the aerodynamic effects.